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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 - 2021

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, 2021, through December 31, 2021. 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 39 was implemented in 2021 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. The ODCM was not revising during this report period.

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. The ODCM was not revised during this report period.

No regulatory commitments are contained in this submittal.

Please refer any questions concerning this letter and its enclosures to Lee Grzeck, Fleet Licensing Manager (Acting), at (980) 373-1530.

Sincerely,

M. Christopher Nolan
Vice President, 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
Z. Stone, USNRC NRR Project Manager for CNS
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Enclosure 1
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ENCLOSURE 1: BNP Annual Radioactive Effluent Release Report

DUKE ENERGY

Brunswick Steam Electric Plant
Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2021 through December 31, 2021

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 1/1/2021 - 12/31/2021

Gaseous Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
1. Total Release	Ci	2.83E+02	3.51E+02	4.83E+02	3.66E+02	1.48E+03
2. Avg. Release Rate	μCi/sec	3.64E+01	4.46E+01	6.08E+01	4.60E+01	4.70E+01
B. Iodine-131						
1. Total Release	Ci	1.38E-02	1.21E-02	1.28E-02	1.21E-02	5.08E-02
2. Avg. Release Rate	μCi/sec	1.77E-03	1.54E-03	1.61E-03	1.53E-03	1.61E-03
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	2.57E-03	1.12E-03	1.24E-03	2.28E-03	7.21E-03
2. Avg. Release Rate	μCi/sec	3.31E-04	1.42E-04	1.56E-04	2.87E-04	2.29E-04
D. Tritium						
1. Total Release	Ci	2.83E+01	1.88E+01	2.25E+01	2.07E+01	9.03E+01
2. Avg. Release Rate	μCi/sec	3.63E+00	2.39E+00	2.84E+00	2.61E+00	2.87E+00
E. Carbon-14						
1. Total Release	Ci	4.89E+00	5.28E+00	6.00E+00	5.95E+00	2.21E+01
2. Avg. Release Rate	μCi/sec	6.29E-01	6.72E-01	7.55E-01	7.49E-01	7.01E-01
F. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Elevated Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	0.00E+00	8.77E-01	1.84E+00	1.23E-01	2.84E+00
Kr-85m	Ci	1.72E+01	4.87E+01	8.07E+01	5.17E+01	1.98E+02
Kr-85	Ci	0.00E+00	8.64E+00	0.00E+00	5.91E+00	1.46E+01
Kr-87	Ci	6.00E+00	8.67E+00	1.08E+01	6.04E+00	3.15E+01
Kr-88	Ci	1.11E+01	6.02E+01	9.84E+01	5.49E+01	2.25E+02
Xe-133	Ci	2.43E+01	4.35E+01	6.64E+01	4.77E+01	1.82E+02
Xe-135m	Ci	3.13E+01	2.38E+01	3.23E+01	2.33E+01	1.11E+02
Xe-135	Ci	1.37E+01	1.10E+01	1.34E+01	8.87E+00	4.70E+01
Xe-137	Ci	5.18E+01	3.37E+01	4.32E+01	5.24E+01	1.81E+02
Xe-138	Ci	8.29E+01	5.84E+01	6.81E+01	5.74E+01	2.67E+02
Total for Period	Ci	2.38E+02	2.98E+02	4.15E+02	3.08E+02	1.26E+03
B. Iodines						
I-131	Ci	7.15E-03	8.88E-03	8.70E-03	7.90E-03	3.26E-02
I-133	Ci	3.87E-02	4.65E-02	5.28E-02	4.73E-02	1.85E-01
I-135	Ci	4.47E-02	5.52E-02	6.79E-02	6.02E-02	2.28E-01
Total for Period	Ci	9.06E-02	1.11E-01	1.29E-01	1.15E-01	4.46E-01
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	0.00E+00	1.12E-05	0.00E+00	0.00E+00	1.12E-05
Mn-54	Ci	4.29E-06	2.02E-06	0.00E+00	0.00E+00	6.31E-06
Co-58	Ci	1.44E-05	2.07E-06	0.00E+00	0.00E+00	1.65E-05
Co-60	Ci	6.02E-05	1.19E-05	2.64E-06	2.55E-06	7.73E-05
Sr-89	Ci	2.12E-04	1.59E-04	1.09E-04	7.74E-05	5.57E-04
Sr-90	Ci	1.61E-07	0.00E+00	0.00E+00	0.00E+00	1.61E-07
Sb-125	Ci	0.00E+00	0.00E+00	4.86E-06	0.00E+00	4.86E-06
Ba-140	Ci	4.57E-04	1.87E-04	2.13E-04	1.58E-04	1.02E-03
La-140	CI	8.26E-04	3.15E-04	3.75E-04	2.77E-04	1.79E-03
Total	CI	1.57E-03	6.88E-04	7.04E-04	5.15E-04	3.48E-03
D. Tritium						
H-3	Ci	3.70E+00	3.89E+00	5.36E+00	3.17E+00	1.61E+01
E. Carbon-14						
C-14	Ci	1.96E+00	2.11E+00	2.40E+00	2.38E+00	8.85E+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 1/1/2021 - 12/31/2021

Gaseous Effluents - Elevated Releases - Batch Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Kr-85m	Ci	2.61E-02	0.00E+00	1.92E-03	0.00E+00	2.80E-02
Kr-87	Ci	9.91E-02	0.00E+00	2.02E-02	6.93E-01	8.12E-01
Xe-133	Ci	3.08E-06	3.41E-01	0.00E+00	0.00E+00	3.41E-01
Xe-135m	Ci	4.90E-02	5.07E-02	3.48E-02	2.59E-02	1.60E-01
Xe-135	Ci	1.61E+01	1.78E+01	1.33E+01	1.53E+01	6.25E+01
Xe-138	Ci	0.00E+00	0.00E+00	6.72E-02	4.04E-02	1.08E-01
Total for Period	Ci	1.63E+01	1.82E+01	1.34E+01	1.60E+01	6.39E+01
B. Iodines						
I-131	Ci	4.52E-03	2.56E-03	3.22E-03	3.11E-03	1.34E-02
I-133	Ci	2.51E-02	2.43E-02	3.04E-02	2.86E-02	1.08E-01
I-135	Ci	3.65E-02	3.82E-02	4.76E-02	4.53E-02	1.68E-01
Total for Period	Ci	6.61E-02	6.51E-02	8.12E-02	7.70E-02	2.89E-01
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	6.68E-07	0.00E+00	0.00E+00	0.00E+00	6.68E-07
Mn-54	Ci	7.45E-07	0.00E+00	1.71E-06	0.00E+00	2.46E-06
Co-58	Ci	1.72E-07	0.00E+00	0.00E+00	6.73E-07	8.45E-07
Co-60	Ci	1.66E-05	7.94E-06	1.86E-05	9.12E-07	4.41E-05
Sr-89	Ci	9.73E-05	1.10E-04	1.49E-04	1.02E-04	4.58E-04
Ru-103	Ci	2.05E-07	4.24E-08	0.00E+00	0.00E+00	2.47E-07
Ag-110m	Ci	1.51E-07	7.79E-06	0.00E+00	0.00E+00	7.94E-06
Ba-140	Ci	5.75E-05	9.20E-06	1.35E-05	7.72E-05	1.57E-04
La-140	Ci	1.18E-04	9.40E-05	8.55E-05	1.95E-04	4.93E-04
Total for Period	Ci	2.91E-04	2.29E-04	2.69E-04	3.76E-04	1.17E-03
D. Tritium						
H-3	Ci	1.66E+01	1.26E+01	1.49E+01	1.57E+01	5.98E+01
E. Carbon-14						
C-14	Ci	9.78E-01	1.06E+00	1.20E+00	1.19E+00	4.43E+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 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground Releases - Batch Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Mixed-Mode Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Kr-85	Ci	0.00E+00	0.00E+00	1.88E+01	0.00E+00	1.88E+01
Xe-133	Ci	0.00E+00	8.62E-01	0.00E+00	0.00E+00	8.62E-01
Xe-135m	CI	2.12E+01	2.64E+01	2.74E+01	3.28E+01	1.08E+02
Xe-135	CI	7.17E+00	7.75E+00	8.63E+00	8.83E+00	3.24E+01
Total for Period	Ci	2.84E+01	3.50E+01	5.48E+01	4.16E+01	1.60E+02
B. Iodines						
I-131	Ci	2.12E-03	6.56E-04	8.65E-04	1.13E-03	4.77E-03
I-133	Ci	1.71E-02	6.00E-03	9.15E-03	1.21E-02	4.44E-02
I-135	Ci	2.89E-02	1.02E-02	1.63E-02	2.24E-02	7.78E-02
Total for Period	Ci	4.81E-02	1.69E-02	2.64E-02	3.56E-02	1.27E-01
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	1.34E-04	2.55E-05	0.00E+00	0.00E+00	1.60E-04
Mn-54	Ci	1.17E-05	5.04E-06	1.89E-06	5.32E-05	7.18E-05
Fe-59	Ci	9.03E-06	2.68E-06	0.00E+00	5.22E-06	1.69E-05
Co-58	Ci	2.60E-05	1.28E-05	1.63E-05	8.06E-05	1.36E-04
Co-60	Ci	2.58E-04	7.05E-05	4.46E-05	1.32E-04	5.05E-04
Zn-65	Ci	0.00E+00	0.00E+00	0.00E+00	7.18E-05	7.18E-05
Sr-89	Ci	1.50E-06	0.00E+00	0.00E+00	0.00E+00	1.50E-06
Ag-110m	Ci	8.06E-07	0.00E+00	0.00E+00	1.65E-05	1.73E-05
Cs-137	Ci	2.14E-06	1.40E-06	0.00E+00	0.00E+00	3.54E-06
Ba-140	Ci	7.92E-05	2.55E-05	6.26E-05	3.62E-04	5.29E-04
La-140	Ci	1.89E-04	5.85E-05	1.44E-04	6.68E-04	1.06E-03
Total for Period	Ci	7.11E-04	2.02E-04	2.69E-04	1.39E-03	2.57E-03
Tritium						
D. H-3	Ci	7.92E+00	2.30E+00	2.23E+00	1.81E+00	1.43E+01
Carbon-14						
E. C-14	Ci	1.96E+00	2.11E+00	2.40E+00	2.38E+00	8.85E+00
Gross Alpha						
F. Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Mixed-Mode Releases - Batch Mode *

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	2.14E-02	2.87E-03	6.15E-03	2.97E-03	3.34E-02
2. Avg. Diluted Conc.	µCi/ml	5.80E-11	5.98E-12	1.17E-11	6.32E-12	2.05E-11
B. Tritium						
1. Total Release	Ci	1.81E+01	1.78E+01	1.72E+01	1.98E+01	7.29E+01
2. Avg. Diluted Conc.	µCi/ml	4.92E-08	3.70E-08	3.28E-08	4.22E-08	4.03E-08
C. Dissolved & Entrained Gases						
1. Total Release	Ci	2.10E-02	4.32E-02	5.09E-02	7.64E-02	1.92E-01
2. Avg. Diluted Conc.	µCi/ml	5.69E-11	9.00E-11	9.69E-11	1.63E-10	1.02E-10
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	3.08E+06	4.33E+06	5.98E+06	5.21E+06	1.86E+07
2. Continuous Releases	Liters	1.65E+08	8.50E+07	2.01E+08	1.13E+08	5.64E+08
F. Volume of Dilution Water						
1. All Releases	Liters	3.68E+11	4.80E+11	5.25E+11	4.70E+11	1.84E+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 1/1/2021 - 12/31/2021

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	2.68E-02	3.49E-03	6.00E-03	8.96E-03	4.53E-02
2. Avg. Diluted Conc.	µCi/ml	5.35E-07	6.89E-08	1.17E-07	1.75E-07	2.24E-07
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 1/1/2021 - 12/31/2021

Liquid Effluents - Continuous Mode - Discharge Canal

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	2.68E-02	3.49E-03	6.00E-03	8.96E-03	4.53E-02
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Liquid Effluents - Batch Mode - Discharge Canal

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Mn-54	Ci	7.85E-04	1.47E-05	0.00E+00	2.92E-06	8.03E-04
Fe-55	Ci	9.10E-04	6.34E-06	5.54E-04	0.00E+00	1.47E-03
Co-58	Ci	8.67E-05	0.00E+00	0.00E+00	0.00E+00	8.67E-05
Co-60	Ci	1.32E-02	4.38E-04	2.44E-04	1.50E-04	1.40E-02
Ni-63	Ci	4.04E-03	1.05E-04	1.18E-04	0.00E+00	4.26E-03
Zn-65	Ci	3.95E-04	0.00E+00	0.00E+00	0.00E+00	3.95E-04
Br-82	Ci	0.00E+00	2.58E-06	0.00E+00	2.97E-06	5.55E-06
Sr-89	Ci	3.30E-04	2.30E-06	0.00E+00	0.00E+00	3.32E-04
Zr-97	Ci	0.00E+00	0.00E+00	2.45E-05	0.00E+00	2.45E-05
Tc-104	Ci	0.00E+00	7.75E-06	7.23E-06	9.91E-06	2.49E-05
Ru-105	Ci	0.00E+00	0.00E+00	8.82E-06	0.00E+00	8.82E-06
I-131	Ci	5.11E-04	9.37E-04	1.62E-03	1.27E-03	4.34E-03
I-132	Ci	0.00E+00	0.00E+00	1.01E-06	0.00E+00	1.01E-06
I-133	Ci	2.22E-04	1.11E-03	2.92E-03	1.28E-03	5.53E-03
I-135	Ci	0.00E+00	1.93E-04	6.49E-04	2.29E-04	1.07E-03
Cs-134	Ci	1.03E-04	3.37E-06	0.00E+00	0.00E+00	1.06E-04
Cs-137	Ci	6.75E-04	5.05E-05	6.48E-06	1.14E-05	7.43E-04
Cs-138	Ci	0.00E+00	0.00E+00	0.00E+00	6.69E-06	6.69E-06
La-140	Ci	4.41E-06	2.80E-06	0.00E+00	0.00E+00	7.21E-06
Ce-144	Ci	4.16E-05	0.00E+00	0.00E+00	0.00E+00	4.16E-05
Hf-181	Ci	1.08E-05	0.00E+00	0.00E+00	0.00E+00	1.08E-05
W-187	Ci	4.76E-05	0.00E+00	0.00E+00	0.00E+00	4.76E-05
Total for Period	Ci	2.14E-02	2.87E-03	6.15E-03	2.97E-03	3.34E-02
B. Tritium						
H-3	Ci	1.81E+01	1.78E+01	1.72E+01	1.98E+01	7.29E+01
C. Dissolved & Entrained Gases						
Xe-133m	Ci	7.93E-05	3.08E-05	5.44E-05	1.00E-04	2.65E-04
Xe-133	Ci	4.76E-03	7.87E-03	9.72E-03	1.48E-02	3.72E-02
Xe-135m	Ci	3.40E-06	2.05E-05	1.08E-04	9.49E-05	2.27E-04
Xe-135	Ci	1.61E-02	3.53E-02	4.10E-02	6.13E-02	1.54E-01
Total for Period	Ci	2.10E-02	4.32E-02	5.09E-02	7.64E-02	1.92E-01
Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D.						

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Liquid Effluents - Batch Mode - Marsh Area

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

ATTACHMENT 2

Supplemental Information

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

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	172
2. Total Time (min) for Batch Releases	=	2.30E+05	2.93E+05
3. Maximum Time (min) for a Batch Release	=	7.37E+04	7.08E+04
4. Average Time (min) for Batch Releases	=	2.02E+03	1.70E+03
5. Minimum Time (min) for a Batch Release	=	1.30E+01	1.50E+01
6. Average Dilution Water Flow During Release (gpm)	=	7.80E+05	8.29E+05

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

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

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 2021 ARERR contains estimates of C-14 radioactivity released in 2021 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 2.21E+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 2021 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Based on the 2021 Land Use Census, the critical receptor is located in the south sector at 2.2 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 2021 was 1.75E+00 mrem and the total body dose was 3.51E-01 mrem.

	Units	Year
1. C-14 Activity Released	Ci	2.21E+01
2. C-14 Total Body Dose	mREM	3.51E-01
3. C-14 Organ Dose	mREM	1.75E+00

Receptor Location ***2.2*** miles ***S***
Critical Age ***CHILD***
Critical Organ ***BONE***

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

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 34 occasions in 2021 due to heavy rains. Approximately 7.085E+06 gallons containing 1.70E-02 curies of tritium were released. There was no detectable gamma radioactivity.

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

The SDSF collects rainwater, water from miscellaneous low volume drains on plant site, water from the Groundwater Extraction System, and water from the Unit 1 CST Remediation Facility. Treatment consists of filtration and evaporation. When sufficient water has accumulated in the pond it is released into the intake canal where it is drawn into the plant circulating and service water system and eventually released into the discharge canal. There were 9 SDSF releases in 2021. Approximately 1.42 E+08 gallons containing 9.25E-01 curies of tritium were released from the SDSF. There was no detectable gamma radioactivity.

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

It was calculated that up to 7.88E+06 cubic feet of water vapor were released via evaporation from the SDSP in 2021. This yields 2.94E-01 curies of tritium released to the atmosphere as a ground release. The nearest resident to the pond is in the northwest sector at approximately 0.3 miles. The maximum exposed individuals at that location received a calculated dose of 8.99E-05 mrem via the inhalation pathway in 2021. 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.

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

It was calculated that 6.19E+05 cubic feet of water vapor were released via evaporation from the SDSF in 2021. This yields 9.51E-02 curies of tritium released to the atmosphere as a ground release. The nearest resident to the pond is in the north-northwest sector at approximately 0.5 miles. The maximum exposed individuals at that location received a calculated dose of 6.13E-05 mrem via the inhalation pathway in 2021. 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.

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 2021 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 2021, it was calculated that 5.38E+07 gallons were released to Nancy's Creek containing 4.53E-02 curies of tritium. This yielded a Total Body dose of 5.50E-04 mrem to an adult from eating fish and invertebrate (shrimp, crabs, etc.).

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

The SDSP collects rainwater as its only input source. Treatment from this location consists of sedimentation, evaporation, and transpiration. When sufficient water has accumulated in the pond, it is released into the intake canal where it is drawn into the circulating and service water system and eventually released into the discharge canal. There was 0 SDSP release in 2021. Approximately 0.00E+00 gallons were released in 2021 containing 0.00E+00 curies of tritium. There was no detectable gamma radioactivity.

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

The risk will be managed once initial pond retirement actions are completed for vegetation removal and stabilization of the perimeter berm. The risk will be eliminated with subsequent pond retirement actions including back grading the pond and culverting runoff toward an engineered breach at site-side waters, removing pond static head at the perimeter. A new Drainage Holding Facility (DHF) will be constructed within the SDSP utilizing the existing permitted outfall discharging to the Intake Canal. The DHF will control aquatic vegetation by use of an aeration system and weighted high-density polyethylene (HDPE) balls. Similarly, the SDSF reliability will be enhanced by installing a new aeration system with weighted HDPE balls. This project reduces the risk to the site of a failure of the pond that could potentially release radionuclide contents to the adjacent creek over time. Also, the DHF will be double lined to reduce the potential for any tritium leakage to groundwater. Due to the decision to double line the new DHF pond and delays the newest expected completion date is December 2022.

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

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%.

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2021 Land Use Census was performed June 7-9, 2021. The results were certified and made available for use on July 21, 2021. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

- There were no nearest residence changes in the 2021 LUC

Gardens

- In 2020, a garden was found in the ESE sector at 1.37 miles, but in 2021 a garden was not found within 5 miles of BSEP in the ESE sector.
- The garden in the WSW sector at 3.31 miles was replaced by a new garden at 1.36 miles.
- The garden in the W sector at 2.59 miles was replaced by a new garden at 1.34 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

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Solidification Agent	Burial Volume (m^3)	Total Activity (Curies)
1. <u>Waste from Liquid Systems</u>							
a. Spent Resins, Filters, Sludges (dewatered)	28	28	A	Type A GDP	N/A	1.11E+2	2.52E+2
b. Spent Resins, Filters, Sludges (dewatered)	1	1	B	Type B	N/A	2.41E+0	2.90E+1
c. Solidified (cement) Acids, Oily Water	0	-	-	-	-	-	-
2. <u>Dry Solid Waste</u>							
a. Dry Active Waste (compacted & non-compacted)	36	45	A	Type A GDP	N/A	7.93E+2	1.24E+1
b. Irradiated Components	2	2	C	Type B	N/A	3.86E-1	1.49E+4
c. Other Waste (oil/sludge)	0	-	-		-	-	-
3. <u>Total Solid Waste</u>	**67**	**76**	**-**	**-**	**-**	**9.07E+2**	**1.52E+4**

<u>NOTE:</u> *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 1/1/2021 - 12/31/2021

	Type of Waste Shipped	Radionuclide	% Abundance
1.	**Waste from Liquid Systems**		
	a. Spent Resins, Filters, Sludges (dewatered)	Fe-55	24.43
		Mn-54	2.27
		Co-60	50.08
		Ni-63	13.3
		Zn-65	1.59
		Cs-137	5.78
	b. Solidified (cement) Acids, Oily Water	N/A	N/A
2.	**Dry Solid Waste**		
	a. Dry Active Waste (compacted & non-compacted)	Fe-55	49.38
		Mn-54	3.14
		Co-60	43.99
		Ni-63	2.11
	b. Irradiated Components	Fe-55	63.74
		Co-60	21.17
		Ni-63	4.21
		Mn-54	3.15
		Ta-182	6.69
	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).

Attachment 4
Meteorological Data

Brunswick Nuclear Plant
Period 1/1/2021 - 12/31/2021

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	5	3	0	0	0	0	0	0	0	1	0	0	3	1	1	3
	7.51-12.50	6	4	3	6	4	1	2	0	3	20	80	2	1	0	2	9
	12.51-18.50	0	0	3	5	1	0	0	0	0	10	37	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	1	0	0	1
	3.51-7.50	8	6	1	4	2	5	7	3	4	1	9	0	2	6	7	15
	7.51-12.50	9	5	9	16	14	12	9	7	14	45	104	12	0	2	9	12
	12.51-18.50	0	0	3	4	2	0	0	0	7	11	20	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	1	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	0	1	0	0	0	0	0	0	0	0	2	1	0	5	1
	3.51-7.50	24	13	6	2	7	11	20	11	9	10	28	17	18	15	23	26
	7.51-12.50	27	15	31	38	26	9	16	6	35	54	117	9	2	6	8	11
	12.51-18.50	2	2	3	9	2	0	0	0	2	6	22	0	1	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	1	1	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	47	16	6	5	3	15	21	14	4	5	17	10	26	13	38	55
	3.51-7.50	247	175	98	96	88	65	101	64	108	124	380	122	63	67	78	139
	7.51-12.50	92	147	128	139	55	10	24	31	64	145	382	68	7	8	29	52
	12.51-18.50	20	10	12	11	0	0	0	3	12	25	35	0	2	0	0	2
	18.51-25.00	0	0	0	0	0	0	0	0	4	2	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 1/1/2021 - 12/31/2021

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	42	39	25	16	23	27	30	23	36	66	89	99	69	73	66
	3.51-7.50	89	51	25	26	44	26	37	24	33	35	256	122	38	27	31	44
	7.51-12.50	2	7	1	2	7	2	6	2	12	19	78	21	1	0	0	2
	12.51-18.50	3	0	0	0	0	0	0	0	1	1	5	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	5	3	0	0	0	1	2	0
F	0.75-3.50	106	35	13	10	13	7	8	12	17	22	48	55	57	49	65	82
	3.51-7.50	11	2	1	1	1	2	2	5	4	7	23	10	4	6	5	5
	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	63	13	5	3	0	1	1	1	1	9	11	29	40	99	131	125
	3.51-7.50	4	0	0	0	0	0	0	0	0	0	1	3	1	3	2	0
	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	1	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 1/1/2021 - 12/31/2021

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	1	0	0	0	0	0	1
	7.51-12.50	4	3	0	4	1	1	1	0	0	3	10	0	3	1	0	4
	12.51-18.50	6	2	3	3	4	0	1	1	2	19	64	3	0	1	3	9
	18.51-25.00	0	0	3	4	0	0	0	0	0	11	35	2	0	0	0	1
	25+	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
B	0.75-3.50	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	3.51-7.50	0	0	0	1	0	2	2	3	0	1	0	0	0	0	2	3
	7.51-12.50	4	7	3	10	12	10	14	6	10	23	22	2	3	6	4	13
	12.51-18.50	8	4	5	9	6	3	1	1	10	31	63	19	0	4	10	11
	18.51-25.00	2	0	4	5	0	0	0	0	2	10	28	3	0	0	2	0
	25+	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0
C	0.75-3.50	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	3.51-7.50	12	4	1	1	4	4	6	2	3	4	5	4	9	4	10	5
	7.51-12.50	15	6	12	13	16	13	24	14	27	33	42	14	10	13	16	14
	12.51-18.50	17	14	17	31	15	4	4	0	9	31	48	30	2	6	10	10
	18.51-25.00	6	4	7	6	3	0	1	0	1	7	34	2	2	3	3	6
	25+	1	0	0	0	0	0	0	0	0	5	8	1	1	0	0	1
D	0.75-3.50	1	4	0	2	1	2	4	4	0	1	3	1	4	6	4	9
	3.51-7.50	31	18	20	22	28	21	43	24	26	27	23	22	10	14	25	26
	7.51-12.50	107	104	61	69	65	49	60	49	77	139	130	63	44	37	31	68
	12.51-18.50	133	150	118	117	58	11	23	23	47	128	317	113	44	31	46	74
	18.51-25.00	49	96	52	54	14	4	6	10	12	60	162	76	17	6	21	41
	25+	16	16	11	0	0	0	0	6	12	18	38	9	3	0	0	8

Attachment 4
Meteorological Data

Brunswick Nuclear Plant
Period 1/1/2021 - 12/31/2021

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	1	2	1	2	4	1	5	4	0	1	3	3	4	2	3	4
	3.51-7.50	4	2	9	8	13	9	25	26	18	15	9	11	8	5	4	5
	7.51-12.50	36	23	24	29	36	21	27	21	30	53	55	54	31	23	22	25
	12.51-18.50	61	63	44	20	41	11	12	23	14	56	118	104	76	38	27	34
	18.51-25.00	18	16	4	1	4	3	6	5	11	20	114	123	34	16	10	18
	25+	2	2	0	0	0	0	0	0	2	9	13	10	0	0	0	0
F	0.75-3.50	2	0	0	1	4	0	0	2	2	2	1	4	1	3	2	1
	3.51-7.50	2	2	6	8	10	6	15	19	12	12	12	6	11	2	6	9
	7.51-12.50	9	5	11	28	4	16	16	17	31	28	29	16	15	18	7	9
	12.51-18.50	14	25	24	12	5	4	1	4	18	18	34	31	28	18	15	14
	18.51-25.00	13	14	3	0	0	0	2	4	2	9	21	20	19	17	8	9
	25+	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
G	0.75-3.50	6	3	3	4	0	6	4	1	3	5	3	1	6	3	5	5
	3.51-7.50	10	13	9	11	9	10	15	14	11	4	11	4	8	8	5	3
	7.51-12.50	17	19	41	43	9	11	13	5	16	29	22	19	7	9	9	10
	12.51-18.50	15	20	28	13	1	1	0	4	9	19	19	32	15	20	12	13
	18.51-25.00	13	5	6	0	0	0	0	0	1	0	2	2	16	11	10	12
	25+	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0

ATTACHMENT 5

Unplanned Offsite Releases

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

Attachment 5
Unplanned Offsite Releases

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Brunswick Steam Electric Plant did not experience any unplanned offsite gaseous or liquid effluent releases in 2021.

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 1/1/2021 - 12/31/2021

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Beta Air	mRAD	1.10E-02	1.20E-02	1.26E-02	1.27E-02	4.83E-02
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		5.52E-02	5.98E-02	6.31E-02	6.35E-02	1.21E-01
2. Maximum Gamma Air	mRAD	1.60E-02	2.00E-02	2.20E-02	2.09E-02	7.88E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.60E-01	2.00E-01	2.20E-01	2.09E-01	3.94E-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	3.93E-01	4.20E-01	4.72E-01	4.68E-01	1.75E+00
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		2.62E+00	2.80E+00	3.15E+00	3.12E+00	5.85E+00

Receptor Location ***2.2*** miles ***S***
Critical Age ***Child***
Critical Organ ***Bone***

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	3.63E-03	1.82E-04	2.06E-04	1.66E-04	4.18E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		3.63E-02	1.82E-03	2.06E-03	1.66E-03	2.09E-02
2. Maximum Total Body Dose	mREM	1.28E-03	1.17E-04	1.29E-04	1.43E-04	1.67E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		4.27E-02	3.90E-03	4.30E-03	4.78E-03	2.78E-02

Critical Age ***ADULT***
Critical Organ ***GI-LLi***

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 mi. NE	1. Location	0.30 mi. NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	5.36E-01	4. Organ Dose (mREM)	8.99E-05
5. Total Body Dose (mREM)	3.19E-03	5. Total Body Dose (mREM)	8.99E-05
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	GI-LLi	3. Critical Organ	N/A
4. Organ Dose (mREM)	3.63E-03	4. Organ Dose (mREM)	6.13E-05
5. Total Body Dose (mREM)	1.12E-03	5. Total Body Dose (mREM)	6.13E-05
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	2.20 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)	1.75E+00	4. Organ Dose (mREM)	5.50E-04
5. Total Body Dose (mREM)	3.51E-01	5. Total Body Dose (mREM)	5.50E-04

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

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 1.75E+00 mrem/yr based on 2.21E+01 Curies released in 2021 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of the Storm Drain Stabilization Pond (SDSP) have been determined from ODCM 3.3.2, I-131, I-133, Particulates, and Tritium, equation 3.2-19. The maximum dose rate to the nearest real individual from evaporation of tritium in the SDSP is conservatively calculated to be 8.99E-05 mrem/yr based on 2.94E-01 Curies released in 2021 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of the Storm Drain Stabilization Facility (SDSF) have been determined from ODCM 3.3.2, I-131, I-133, Particulates, and Tritium, equation 3.2-19. The maximum dose rate to the nearest real individual from evaporation of tritium in the SDSF is conservatively calculated to be less than 6.13E-05 mrem/yr based on 9.51E-02 Curies released in 2021 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from marsh releases to Nancy's Creek from ODCM 2.1.5, Marsh Releases. The maximum dose rate to the nearest real individual from marsh releases to Nancy's Creek is conservatively calculated to be less than 5.50E-04 mrem/yr based on 4.53E-02 Curies released in 2021 (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 20 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 1/1/2021 - 12/31/2021

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

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

Monitoring wells are typically sampled quarterly or semi-annually. Ground water samples are regularly analyzed for tritium. There were no notifications per NEI 07-07, Industry Ground Water Protection Initiative in 2021.

Results from sampling during 2021 are shown in the table below.

Key to below table

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

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 Shallow Wells for Plant Site						
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)**
ESS-2C	4	4	7.54E+02	4.85E+02	9.37E+02	27
ESS-3C	2	2	3.79E+02	3.17E+02	4.41E+02	14
ESS-12C	1	0	<LLD	<LLD	<LLD	15
ESS-13C	5	2	2.32E+02	1.92E+02	2.71E+02	25
ESS-16	1	1	6.39E+02	6.39E+02	6.39E+02	27
ESS-17C	4	4	6.18E+03	5.89E+03	6.73E+03	26
ESS-18C	3	3	1.47E+03	1.16E+03	1.94E+03	20
ESS-19C	2	2	6.09E+04	5.21E+04	6.96E+04	20
ESS-20C	4	4	3.47E+03	2.99E+03	3.87E+03	20
ESS-23C	1	1	2.99E+04	2.99E+04	2.99E+04	23
ESS-24C	4	4	5.14E+03	4.26E+03	5.68E+03	18
ESS-25C	1	0	<LLD	<LLD	<LLD	22
ESS-26C	2	2	1.07E+03	1.00E+03	1.13E+03	15
ESS-27C	1	1	6.58E+04	6.58E+04	6.58E+04	16
ESS-28C	2	1	2.11E+02	2.11E+02	2.11E+02	23
ESS-29C	2	0	<LLD	<LLD	<LLD	28
ESS-30C	2	0	<LLD	<LLD	<LLD	15
ESS-31C	2	0	<LLD	<LLD	<LLD	15
ESS-38C	1	0	<LLD	<LLD	<LLD	15
ESS-39C	1	1	2.00E+02	2.00E+02	2.00E+02	20
ESS-40C	1	0	<LLD	<LLD	<LLD	30
ESS-41C	1	0	<LLD	<LLD	<LLD	27
ESS-42C	1	0	<LLD	<LLD	<LLD	30
ESS-44C	1	0	<LLD	<LLD	<LLD	15
ESS-45C	1	0	<LLD	<LLD	<LLD	21
ESS-46C	1	0	<LLD	<LLD	<LLD	18
ESS-48C	1	0	<LLD	<LLD	<LLD	18
ESS-49C	1	0	<LLD	<LLD	<LLD	19
ESS-50C	1	0	<LLD	<LLD	<LLD	22
ESS-51C	1	0	<LLD	<LLD	<LLD	22
ESS-54C	1	0	<LLD	<LLD	<LLD	24
ESS-55C	1	0	<LLD	<LLD	<LLD	38
ESS-56C	1	0	<LLD	<LLD	<LLD	32
ESS-58C	1	0	<LLD	<LLD	<LLD	18
ESS-59C	1	0	<LLD	<LLD	<LLD	18
ESS-60C	1	0	<LLD	<LLD	<LLD	19

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Brunswick Shallow Wells for Plant Site						
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)**
ESS-67C	2	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	2	0	<LLD	<LLD	<LLD	18
ESS-73C	1	0	<LLD	<LLD	<LLD	15
ESS-74C	1	0	<LLD	<LLD	<LLD	25
ESS-201C	4	4	9.01E+02	2.77E+02	1.28E+03	19
ESS-202C	4	4	2.22E+04	1.87E+04	2.51E+04	19
ESS-203C	4	4	8.03E+02	5.85E+02	1.01E+03	19
ESS-STAB	2	1	4.16E+02	4.16E+02	4.16E+02	31
ESS-NC-4A	13	13	1.83E+04	1.55E+04	2.15E+04	17
MW-3	2	2	2.59E+02	2.28E+02	2.89E+02	26
MWPA-100C	2	0	<LLD	<LLD	<LLD	30
MWPA-101C	2	2	2.60E+02	2.60E+02	2.60E+02	29
MWPA-102C	2	2	3.73E+02	3.15E+02	4.31E+02	30
MWPA-103C	2	2	2.55E+02	2.30E+02	2.80E+02	30
MWPA-104C	2	2	8.79E+02	8.12E+02	9.46E+02	29
MWPA-105C	2	2	4.76E+02	4.21E+02	5.31E+02	30
MWPA-106C	1	1	4.66E+02	4.66E+02	4.66E+02	29
MWPA-107C	4	4	4.02E+03	3.19E+03	5.08E+03	29
MWPA-108C	2	1	3.90E+02	3.90E+02	3.90E+02	29
MWPA-109C	4	4	9.32E+02	7.39E+02	1.14E+03	29
MWPA-110C	4	3	4.27E+02	3.70E+02	5.30E+02	29
MWPA-113C	2	2	1.73E+03	1.39E+03	2.06E+03	25
MWPA-114C	4	4	1.28E+03	6.81E+02	1.51E+03	30
MWPA-115C	4	4	2.97E+03	2.28E+03	3.95E+03	34
MWPA-117C	2	2	6.84E+02	6.54E+02	7.14E+02	30
MWPA-118C	1	1	4.34E+02	4.34E+02	4.34E+02	30

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 Intermediate Wells for Plant Site						
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)**
ESS-3B	1	0	<LLD	<LLD	<LLD	52
ESS-18B	4	4	1.41E+03	1.33E+03	1.46E+03	63
ESS-19B	4	4	7.61E+03	5.37E+03	1.11E+04	42
ESS-20B	4	0	<LLD	<LLD	<LLD	43
ESS-22B	4	4	3.80E+03	3.15E+03	4.38E+03	76
ESS-38B	1	0	<LLD	<LLD	<LLD	55
ESS-39B	1	0	<LLD	<LLD	<LLD	55
ESS-51B	1	0	<LLD	<LLD	<LLD	45
ESS-52B	1	0	<LLD	<LLD	<LLD	51
ESS-53B	1	0	<LLD	<LLD	<LLD	76
MWPA-104B	2	2	2.69E+03	2.59E+03	2.78E+03	59
MWPA-107B	4	4	3.41E+03	2.94E+03	3.82E+03	60

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

ATTACHMENT 8

Inoperable Equipment

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

Attachment 8
Inoperable Equipment

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Brunswick Steam Electric Plant experienced one (1) instance of inoperable equipment relevant to effluent monitoring in excess of ODCM Specification 7.3.0 limits during 2021.

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

Description:

The 2-OG-AIT-4284 (SJAE Room 2A/2B H2/O2 Analyzer H3B) was out of service greater than 30-days due to erroneous stream 2 hydrogen readings. Investigation found that the detector needed a new flow indicator for the vacuum return flow. Delays in procurement of flowmeter and other needed parts is the cause of the 30-day exceedance. Once the part was received it was replaced. The monitor was out of service from 4-5-21 to 6-2-21.

Brunswick Steam Electric Plant experienced no Liquid Hold-Up Tank exceeding the 10 Curie limit of ODCMS 7.3.6 during 2021.

<u>ATTACHMENT 9</u>

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 1/1/2021 - 12/31/2021

ODCM Revision 39

The Brunswick Steam Electric Plant ODCM was revised in 2021 and is included in this attachment.

Below is a summary of the changes.

- Section 7.3.2 Condition (J) which contains the required compensatory measures for Main Condenser Air Ejector Noble Gas Radioactivity Monitor condition (I) not being met, has been updated. This was changed from "Be in mode 2 in 12 hours" to "Suspend effluent releases via the associated pathway immediately." The requirement to report a greater than 30-day inoperable condition on the Radioactive Effluent Release Report has remained the same.
- Table 7.3.3-1 Radioactive Liquid Waste Sampling and Analysis Program has changes to "Stabilization Pond (SDSP)," "Stabilization Facility (SDSF)," "Storm Drain Collation Basin (SDCB)," and "Sample Tanks, Detergent Drain Tank, and Salt-Water Release Tanks (Batch Release)" sections. These changes included adding Ni-63 sampling requirements for hard to detects and an associated LLD.
- SDSP, SDSF, and the SDCB were updated to align with batch releases. This includes changes to Liquid Alpha to analyze a composite from the release pathway every 31 days, and for hard to detects to an analyze a composite at a frequency of every 92 days.
- Statement (i) on page 7.3.3-5 was updated to include Ni-63.
- "Service Water (Continuous Release)," in Table 7.3.3-2 was changed to include the hard to detect Ni-63 with an associated LLD.

Brunswick Steam Electric Plant

Off Site Dose Calculation Manual (ODCM)

REVISION 39

Docket NOs. 50-324
50-325

Effective Date: 11/01/2021

Prepared By (Print): Brad Bagwell	Brady R. Bagwell	11/1/21
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BNP ORC Chairman	Signature	Date
Approved By (Print): JAY RATLIFF	[signature]	11/1/2021
BNP Plant Manager	Signature	Date

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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:

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

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:

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

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 is considered a continuous release. 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 Stabilization Pond and Stabilization Facility Releases

Prerelease and post-release compliance checks similar to those of Section 2.1.1 are to be performed for releases from the Stabilization Pond and Stabilization Facility. Prerelease calculations will be based on a gamma isotopic and a tritium analysis prior to release. Post-release calculations will be based on a composite sample that is collected in proportion to flow during the release period. Analyses will be performed on the composite sample after the release is complete in accordance with Table 7.3.3-1. Dilution flow will be estimated from the minimum number of circulating water and service water pumps that were in use during the release period. Typical release times are on the order of days. (Note: Calculated doses as in Section 2.2 will be compiled along with those resulting from normal radwaste discharges.)

2.1.4 Groundwater Extraction System Releases

Prerelease and post release compliance checks similar to those of Section 2.1.1 are to be performed for releases from the Groundwater Extraction System. Prerelease calculations will be based on gamma isotopic and a tritium analysis prior to release. Post-release calculations will be based on a composite sample that is collected in proportion to flow during the release period. Analyses will be performed on the composite sample in accordance with Table 7.3.3-1. Dilution flow will be estimated from the minimum number of circulating water and service water pumps that were in use during the release period. (Note: Calculated doses as in Section 2.2 will be compiled along with those resulting from normal radwaste discharges.)

2.1.5 Marsh Releases

Marsh releases from the area around the outside area of the Stabilization Pond 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 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.)

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

$A_{i\tau}$ = 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

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

Where:

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

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
SB-124	2.76E+02	5.22E+00	1.09E+02	6.70E-01	0.00E+00	2.15E+02	7.84E+03

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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.

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

$\overline{(\chi/Q)}_{tb}$ = 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.

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

$L_i + 1.1M_i$ = 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

= 15,500 cfm (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 Setpoint Based on Conservative Radionuclide Mix (Long-Term Elevated Release

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.

$$S_i = \frac{A_i}{\Sigma_i A_i} \quad (3.1\text{-}7)$$

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.

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

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.

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

$L_i \overline{(\chi / Q)_s} + 1.1 B_i$ = 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).

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

> **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

= 86,000 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).

$$CR = \frac{C_t}{E_m} \tag{3.1-11}$$

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).

$$HHSP = T_m CR + Bkg \tag{3.1-12}$$

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 = $(12.782\ \text{E6 lbs/hr})\left(\frac{0.1260\ \text{gm/sec}}{\text{lbs/hr}}\right) = 1.61\text{E}+6\ \text{gm/sec}$

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 (3.1-13)

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	=	$Q_s \div f$	(3.1-16)
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.

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

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

where:

K_i = The total body dose factor due to gamma emissions for noble gas radionuclide i, mrem/year per 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

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:

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

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:

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

For the skin:

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

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

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.

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

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

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

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

$$= 2.1 \times 10^4 \text{ mrad } (\text{m}^3) \text{ (transformation) / year (Mev) } (\mu\text{Ci})$$

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_i, 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.

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

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	-	-	-	0.8	0.9
NE	0.7	4.75*	-	-	-	-
ENE	0.7	-	-	-	-	-
E	0.7	-	-	-	-	-
ESE	0.7	-	-	-	1.4	-
SE	0.7	-	-	-	-	-
SSE	0.7	-	-	-	2.1	-
S	0.8	-	-	-	1.1	2.2
SSW	0.8	-	-	-	1.2	1.6
SW	0.7	-	-	-	1.1	1.4
WSW	0.7	-	-	-	1.2	1.2
W	0.7	-	-	-	0.9	0.9
WNW	0.6	-	-	-	0.9	1.0
NW	0.6	-	-	-	0.9	1.0
NNW	0.6	-	-	-	0.8	0.9
N	0.7	-	-	-	0.7	1.0

* 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 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

$\overline{(\chi/Q)_v}$ = 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:

$$D\gamma \leq 10\text{mrad} \tag{3.3-9}$$

$$D\beta \leq 20\text{mrad} \tag{3.3-10}$$

For the calendar year:

$$D\gamma \leq 20\text{mrad} \tag{3.3-11}$$

$$D\beta \leq 40\text{mrad} \tag{3.3-12}$$

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:

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

≤ 7.5 mrem per quarter or 15 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:

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

$$\leq 15.0 \text{ mrem per quarter or } 30 \text{ mrem per year}$$

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:

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

(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:

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

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 $\mu Ci/m^3$

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

R_{T_B} = Dose factor for an organ for tritium for the beef pathway, mrem/yr per $\mu Ci/m^3$

R_{T_I} = Dose factor for an organ for tritium for the inhalation pathway, mrem/yr per $\mu Ci/m^3$

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 Stabilization Pond and Stabilization Facility

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

(3.2-19)

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

Where:

D_T = Dose rate from the SDSP 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 SDSP or SDSF to the nearest resident.

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

Note: The nearest resident from the center of the SDSP is typically to the NW 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:

$$D\tau \leq 15 \text{ mrem} \quad (3.3\text{-}19)$$

For the calendar year:

$$D\tau \leq 30 \text{ mrem} \quad (3.3\text{-}20)$$

Where:

$D\tau$ = 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 3.3-19 or 3.3-20 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 μCi/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 μCi/m^3 for inhalation and tritium, and in units of m^2-mrem/yr per μCi/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 μCi/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:

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

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

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

   $\left(\frac{x}{Q}\right)$ 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:

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

   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:

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

Where:

$D_{j\,a}^{D}$ 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 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	1	1.1 miles E	Q	Q	Gamma Dose
	2	0.9 miles ESE	Q	Q	Gamma Dose
	3	0.9 miles SE	Q	Q	Gamma Dose
	4	1.1 miles SSE	Q	Q	Gamma Dose
	5	1.1 miles S	Q	Q	Gamma Dose
	6	1.6 miles SSW	Q	Q	Gamma Dose
	7	1.1 miles SW	Q	Q	Gamma Dose
	8	1.2 miles W	Q	Q	Gamma Dose
	9	1.0 miles WNW	Q	Q	Gamma Dose
	10	0.8 miles NW	Q	Q	Gamma Dose
	11	0.9 miles NNW	Q	Q	Gamma Dose
	12	1.1 miles N	Q	Q	Gamma Dose
	13	1.2 miles NNE	Q	Q	Gamma Dose
	14	0.5 miles NE	Q	Q	Gamma Dose
	15	0.9 miles ENE	Q	Q	Gamma Dose
	16	1.0 miles WSW	Q	Q	Gamma Dose
	17	1.4 miles ESE	Q	Q	Gamma Dose

*Refer to Figure 4.0-1 and Figure F-2.

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)	18	1.7 miles	Q	Q	Gamma Dose
	77	5.4 miles S	Q	Q	Gamma Dose
	75	4.7 miles S	Q	Q	Gamma Dose
	76	4.8 miles SSW	Q	Q	Gamma Dose
	22	5.3 miles SW	Q	Q	Gamma Dose
	23	4.6 miles WSW	Q	Q	Gamma Dose
	24	3.0 miles W	Q	Q	Gamma Dose
	25	8.6 miles WNW	Q	Q	Gamma Dose
	26	5.9 miles NW	Q	Q	Gamma Dose
	27	5.1 miles NNW	Q	Q	Gamma Dose
	79	9.5 miles N	Q	Q	Gamma Dose
	78	9.9 miles NNE	Q	Q	Gamma Dose
	30	2.0 miles NE	Q	Q	Gamma Dose
	31	2.5 miles ENE	Q	Q	Gamma Dose
	32	5.8 miles ENE	Q	Q	Gamma Dose
	33	4.1 miles E	Q	Q	Gamma Dose
	34	5.4 miles E	Q	Q	Gamma Dose
	81	9.9 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	8.9 miles NE	Q	Q	Gamma Dose
	37	5.5 miles NW	Q	Q	Gamma Dose
	38	11.0 miles W	Q	Q	Gamma Dose
	39	5.3 miles SW	Q	Q	Gamma Dose
	40	6.9 miles WSW	Q	Q	Gamma Dose
	20	2.1 miles S	Q	Q	Gamma Dose
	21	2.9 miles SSW	Q	Q	Gamma Dose
	28	4.2 miles NW	Q	Q	Gamma Dose
	29	2.6 miles SSW	Q	Q	Gamma Dose
	35	7.3 miles SSE	Q	Q	Gamma Dose
	82	0.17 miles NNE	Q	Q	Gamma Dose
	83	0.27 miles NE	Q	Q	Gamma Dose
	84	0.27 miles NE	Q	Q	Gamma Dose
	85	0.09 miles ENE	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	1.0 miles WSW - Visitors 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	0.5 miles NE – Bio. Lab Road – Projected Maximum Annual Concentration (PMAC)			Gross beta radioactivity analysis following filter change [b]
	202	1.0 miles S – Substation, Construction Rd.		Q	Gamma isotopic analysis of composite by location
	203	2.0 miles SSW - Southport Substation			
	204	22.4 miles NNE - Sutton Plant – (Historical Control)			
	205	0.6 miles SSE - Spoil Pond			
	206	11.3 miles NW – Brunswick County Complex – Control[c]			

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 a. Surface	400	0.6 miles NE - Intake Canal - Control (c)	Composite sample (d) Collection-M	Monthly	Gamma Isotopic
	401	4.9 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 (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 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)
b. Sediment	500	5.0 miles SSW – Discharge – Beach near OD Pumps	Semiannual	Semiannual	Gamma Isotopic (f)
	501	Nancy's Creek, Adjacent to WP-55, Near Storm Drain Stabilization Pond	Annual	Annual	Gamma Isotopic h
c. Groundwater	404	Monitoring Well ESS-1B, 0.16 miles SW	Grab Sample, Quarterly, Semiannual	Q Semiannual	Tritium Gamma Isotopic f
	407	Monitoring Well ESS-13B, 0.06 miles ENE			
	409	Monitoring Well ESS-17A, 0.65 miles NE			
	410	Monitoring Well ESS-17B, 0.65 miles NE			
	418	Monitoring Well ESS-21B, Near Storm Drain Stabilization Pond			
	423	Monitoring Well ESS-24A, Near Storm Drain Stabilization Pond			
	424	Monitoring Well ESS-24B, 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			
	612	Monitoring Well ESS MWPA-118B, Near Intake Canal and Plant Stack			

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)
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				
	602			Monthly	Gamma isotopic and I-131 analysis (other times)
	603				
b. Fish and Invertebrates (shrimp)	700-702	5.5 mile SSW - Atlantic Ocean [e] at Discharge	When in Season – Semiannual	Semiannual	Gamma isotopic on edible portions
	703-705	Not Specified - Atlantic Ocean [c][e]			
	706-708	Nancy's Creek [e]	Annual	Annual	Gamma isotopic on edible portions

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)]
c. Broadleaf Vegetation	800	0.7 miles NE - Intake Canal	When available - Monthly	Monthly	Gamma Isotopic
	801	0.8 miles SW - Discharge Canal		Monthly	I-131
	802	10.1 miles - Control - Location not Specified [(c)]			
	803	0.6 miles SSE - Spoil Pond			
	804	0.7 miles S – Leonard Street plant exit adjacent to RR tracks			

(a) The LLD for each analysis is specified in Table 7.3.15-3, with the exception of 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 (shrimp) will be collected if available. A control sample of each species collected will be obtained if available.

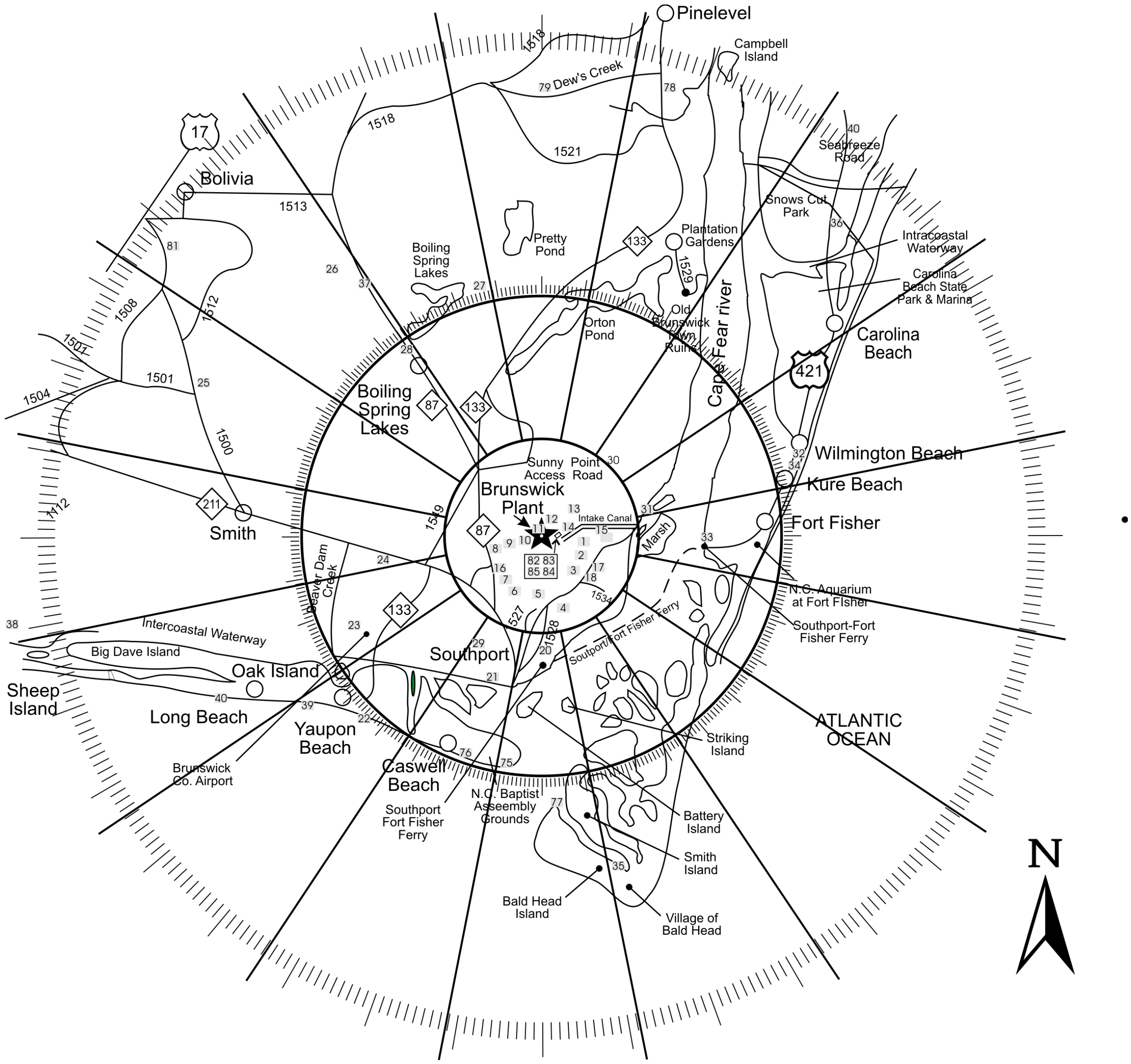
(f) Gamma isotopic scan means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

(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



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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 Environmental Sample Analyses Comparison Program

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 Effluent Release Analyses Program

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 Abnormal Results

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.

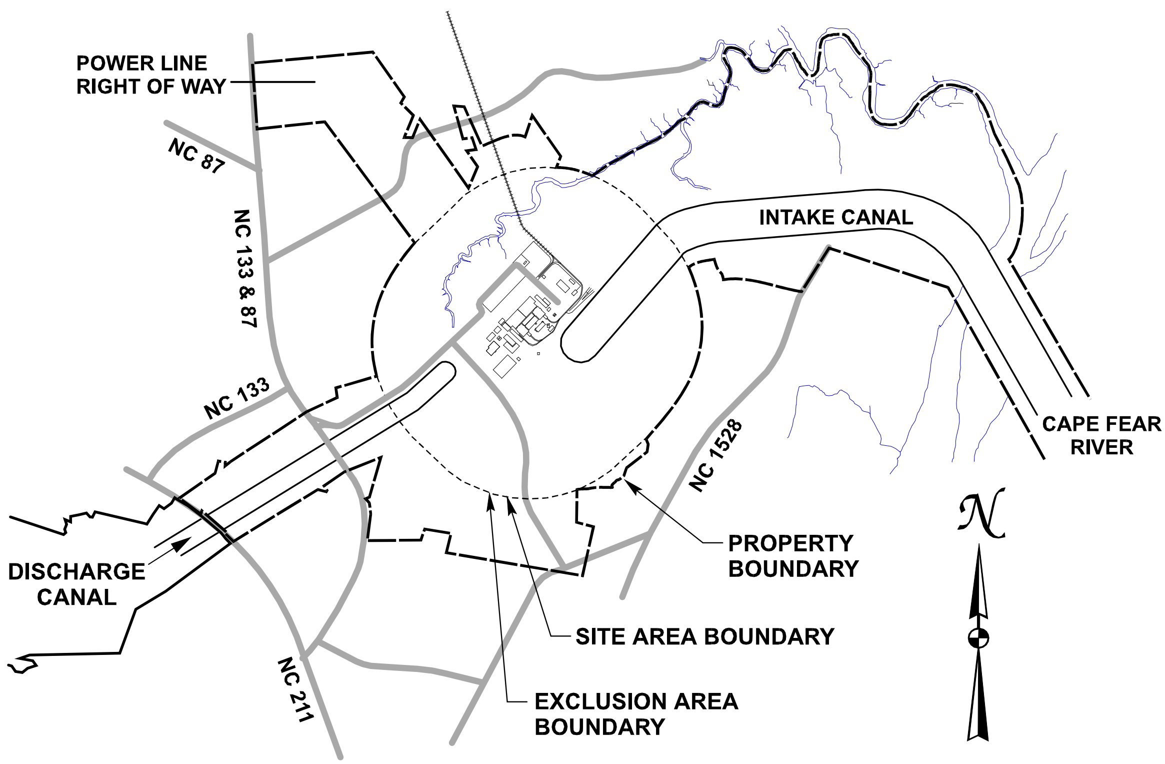

Figure 7.1.1-1 (page 1 of 1)
SITE BOUNDARY

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 <u>AND</u> and <u>OR</u>. 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)

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. AND 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 AND in MODE 4 within 36 hours. A total of 12 hours is allowed for reaching MODE 3 and a total of 36 hours (**not 48 hours**) 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. AND 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. OR C.2 Restore Function Y subsystem to OPERABLE status.	72 hours 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)

ODCMS 7.1.3 Completion Times (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)

ODCMS 7.1.4 Frequency (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)

ODCMS 7.1.4 Frequency (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
	AND		
	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 $\leq$ 1.0 E-7 μCi/gm.	Once per 12 hours
	AND		
	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
	AND		
	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 flow rate through the associated pathway using the V-notch weir or another acceptable method.	Once per 24 hours
	AND		
	F.2	Restore the channel to OPERABLE status.	30 days
G. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.1-1.	G.1	Estimate the tank liquid level.	Once per 8 hours during all liquid additions and deletions to and from the tank
	AND		
	G.2	Restore the channel to OPERABLE status.	30 days
H. Required Compensatory Measure B.1, B.2, C.1, D.1, E.1, F.1, or G.1 and associated Completion Time not met.	H.1	Suspend effluent releases via the associated pathway.	Immediately
	AND		
	H.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
I. Required Compensatory Measure B.3, C.2, D.2, E.2, F.2, G.2, or J.2 and associated Completion Time not met.	I.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
J. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.1-1.	J.1	Estimate the flow rate through the associated pathway using the Parshall flume or another acceptable method.	Once per 24 hours
	<u>AND</u>		
	J.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. Stabilization Pond Effluent Composite Sampler	(d)	1	E	TR 7.3.1.1 TR 7.3.1.5 TR 7.3.1.7	NA [e]
5. Stabilization Pond Effluent Flow Measurement Device	(d)	1	F	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	G	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	J	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	J	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 2-DST-FQIS-5026 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.

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
	AND	
	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
	AND	
	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. <u>AND</u> F.2 Analyze the grab sample required by Required Compensatory Measure F.1. <u>AND</u> F.3 Verify proper functioning of the operating recombiner train by monitoring recombiner temperature. <u>AND</u> F.4 Restore the channel(s) to OPERABLE status.	 Once per 24 hours 4 hours after completion of Required Compensatory Measure F.1 In accordance with approved procedures 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. Required Compensatory Measure and associated completion Time of I.4	J.1 Suspend effluent releases via the associated pathway. J.2 Prepare and submit in the Radioactive Effluent Release Report, the reason the channel was not restored to OPERABLE status within 30 days.	Immediately Upon submittal of current calendar year Radioactive Effluent Release Report
K. As required by Required Compensatory Measure A.1 and referenced in Table 7.3.2-1.	K.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	K	TR 7.3.2.2	NA
b. Particulate Sampler Filter	(j)	1	K	TR 7.3.2.2	NA
c. Sampler Flow Rate Measurement Device	(j)		K	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	K	TR 7.3.2.1	NA
b. Particulate Sampler Filter	(g)	1	K	TR 7.3.2.1	NA [(i)]
c. Sampler Flow Rate Measurement Device	(g)	1	K	TR 7.3.2.1	NA
9. Low Level Warehouse					
a. Particulate Sampler Filter	(h)	1	K	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} μCi/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 x 10^{-6} μCi/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	5×10^{-7} [(b)] µCi/ml 1×10^{-6} µCi/ml
	Prior to release of one batch once per 31 days	31 days	Dissolved and entrained gases (Gamma Emitters)	1×10^{-5} µCi/ml
	Prior to release of each batch	31 days Composite[(c)]	Gross Alpha H-3	1×10^{-7} µCi/ml 1×10^{-5} µCi/ml
	Prior to release of each batch	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} µCi/ml
2. Stabilization Pond	Prior to each release AND 24 hours during periods of release [(f)]	Prior to each release AND 24 hours during periods of release [(f)]	Principal Gamma Emitters [(g)] H-3	5×10^{-7} [(b)] µCi/ml 1×10^{-5} µCi/ml
	After completion of each release [(i)]	After completion of each release [(i)]	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
3. Service Water [(d)] (Potential Continuous Release)	7 days during system operation	7 days during system operation	Principal Gamma Emitters [(g)]	5×10^{-7} µCi/ml[(b)]
4. Groundwater Extraction System (Continuous Release)	Prior to each release[(j)] AND 7 days during system operation[(c)(j)]	Grab Sample 7 day Composite[(c)]	Principal Gamma Emitters[(g)] I-131 H-3	5×10^{-7} µCi/ml 1×10^{-6} µCi/ml 1×10^{-5} µCi/ml
		31 day Composite[(c)]	Gross Alpha	1×10^{-7} µCi/ml
		92 day Composite[(c)]	Sr-89, Sr-90 Fe-55	5×10^{-8} µCi/ml 1×10^{-6} µCi/ml

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)]
5. Stabilization Facility	Prior to each release	Prior to each release	Principal Gamma Emitters [(g)] H-3	5×10^{-7} [(b)] μCi/ml 1×10^{-5} μCi/ml
	AND	AND		
	24 hours during periods of release[(f)]	24 hours during periods of release[(f)]		
	After completion of each release[(i)]	After completion of each release[(i)]	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
6. 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 “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)

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) The stabilization pond and stabilization facility are typically released over a several-day period. The pond and facility are to be sampled and analyzed prior to commencing a release. When composite sampling instrumentation is OPERABLE, daily grab sampling of the stabilization pond or stabilization facility effluent will not be required during release and the composite sample will be analyzed at the end of the release.

(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 Stabilization Pond 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
TR 7.3.5.2	NOTE Only required to be performed when the Liquid Radwaste Treatment System is not in use when performing Liquid Radwaste Releases. Determine the projected doses due to liquid releases from the site to UNRESTRICTED AREAS in accordance with the methodology and parameters in the ODCM.	31 days

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
	<u>AND</u>	
	A.2 Restore quantity of radioactive material in the tank to within limit.	48 hours
	<u>AND</u>	
	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:

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

Where:

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

σ_b	=	$(N/t_b)^{½}$
	=	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 AND Gross beta radioactivity analysis of particulate sampler: following filter change[(d)] AND 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.	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.

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				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

(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

$$\frac{\text{concentration(1)}}{\text{limit (1)}} + \frac{\text{concentration(2)}}{\text{limit (2)}} + \ldots < 1.0.$$

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					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1[(c)]	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 drinking water samples. If no drinking water pathway exists, a value of 15 pCi/L may 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. OR 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
	AND		
	C.2	Delete the sampling location having the lowest calculated dose or dose commitment, via the same exposure pathway, from the Radiological Monitoring program.	After October 31 of the year in which land use census was conducted
	AND		
	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.

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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.

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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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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.

(continued)

BASES

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.

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APPENDIX B (continued)

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 $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	9.02E-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

<table>
<tr><th colspan="10">MAXIMUM WIND SPEED (m/sec)</th></tr>
<tr><th>Stability</th><th>Total</th><th>0.36</th><th>1.56</th><th>3.35</th><th>5.59</th><th>8.27</th><th>10.95</th><th colspan="2">15.65</th></tr>
<tr><td>1</td><td>0.17</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.06</td><td>0.09</td><td>0.01</td><td colspan="2">0.00</td></tr>
<tr><td>2</td><td>0.33</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.13</td><td>0.16</td><td>0.03</td><td colspan="2">0.00</td></tr>
<tr><td>3</td><td>0.62</td><td>0.00</td><td>0.00</td><td>0.02</td><td>0.27</td><td>0.23</td><td>0.08</td><td colspan="2">0.01</td></tr>
<tr><td>4</td><td>2.93</td><td>0.00</td><td>0.04</td><td>0.25</td><td>0.86</td><td>1.04</td><td>0.58</td><td colspan="2">0.15</td></tr>
<tr><td>5</td><td>1.86</td><td>0.00</td><td>0.02</td><td>0.18</td><td>0.48</td><td>0.52</td><td>0.41</td><td colspan="2">0.24</td></tr>
<tr><td>6</td><td>0.62</td><td>0.00</td><td>0.02</td><td>0.11</td><td>0.22</td><td>0.20</td><td>0.06</td><td colspan="2">0.00</td></tr>
<tr><td>7</td><td>0.57</td><td>0.00</td><td>0.04</td><td>0.16</td><td>0.22</td><td>0.13</td><td>0.02</td><td colspan="2">0.00</td></tr>
<tr><td>Total</td><td>7.11</td><td>0.01</td><td>0.13</td><td>0.74</td><td>2.24</td><td>2.38</td><td>1.19</td><td colspan="2">0.41</td></tr>
<tr><td colspan="2">Entrapment</td><td rowspan="3"></td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Ground Velocity</td><td>0.06</td><td>0.30</td><td>0.76</td><td>1.39</td><td>2.15</td><td>2.98</td><td>4.12</td></tr>
<tr><td colspan="2">Elevated Velocity</td><td>0.18</td><td>0.95</td><td>2.42</td><td>4.40</td><td>6.83</td><td>9.47</td><td>13.10</td></tr>
</table>

<table>
<tr><th colspan="4">AVERAGE WIND SPEED (m/sec)</th></tr>
<tr><th>Mean</th><th>Ground</th><th>Elevated</th><th>Combined</th></tr>
<tr><td>Arithmetic</td><td>0.00</td><td>6.29</td><td>6.29</td></tr>
<tr><td>Harmonic</td><td>0.00</td><td>4.62</td><td>4.62</td></tr>
</table>

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 1-1-77 THROUGH 12-31-77
BRUNSWICK STEAM ELECTRIC PLANT

MAXIMUM WIND SPEED (m/sec)							
Stability	Total	1.50	3.00	5.00	7.50	10.00	12.50
1	0.02	0.00	0.00	0.00	0.01	0.00	0.01
2	0.21	0.00	0.00	0.00	0.05	0.10	0.06
3	1.13	0.00	0.00	0.03	0.28	0.50	0.32
4	7.30	0.01	0.15	0.63	2.50	2.51	1.50
5	5.15	0.03	0.09	0.30	1.21	1.99	1.53
6	1.04	0.01	0.06	0.32	0.33	0.24	0.08
7	0.41	0.01	0.12	0.10	0.13	0.03	0.02
Total	15.26	0.06	0.42	1.38	4.51	5.37	3.52
Entrapment		0.00	0.00	0.00	0.00	0.00	0.00
Ground Velocity		0.23	0.70	1.24	1.93	2.71	3.48
Elevated Velocity		0.74	2.21	3.93	6.14	8.59	11.05

AVERAGE WIND SPEED (m/sec)			
Mean	Ground	Elevated	Combined
Arithmetic	0.00	7.81	7.81
Harmonic	0.00	6.63	6.63

TABLE B-9

DOSE PARAMETERS FOR FINITE ELEVATED PLUMES
E 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	1.05E-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 $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	1.45E-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 $\left(\frac{\text{mrem/yr}}{\mu\text{Ci/ sec}}\right)$	B_i Gamma Air $\left(\frac{\text{mrad/yr}}{\mu\text{Ci/ sec}}\right)$
Kr-83m	1.45E-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 $\left(\frac{mrem/yr}{\mu Ci/sec}\right)$	B_i Gamma Air $\left(\frac{mrad/yr}{\mu Ci/sec}\right)$
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

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

where:

P_{i_I} = dose parameter for radionuclide i for the inhalation pathway, mrem/yr per μCi/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 μCi/m^3

K' = A constant of unit conversion

= 10^6 pCi/μCi

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

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

The breathing rates $(BR)_a$ for the various age groups are tabulated below, as given in Table E-5 of 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

$$R_{i_G} = I_i K'K''(SF)\, DFG_i\, (1 - e^{-\lambda_i t}) / \lambda_i \tag{C.2-2}$$

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 Grass-Cow or Goat Milk Pathway

$$R_{i_M} = I_i K' Q_F U_{ap} F_m (DFL_i)_a e^{-\lambda_i t_f}$$

$$\left\{ f_p f_s \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] + (1-f_p f_s) \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] e^{-\lambda_i t_h} \right\}$$

(C.2-3)

where:

R_{i_M}	=	Dose factor for the cow milk or goat milk pathway, for each identified radionuclide i for the organ of interest, mrem/yr per μCi/sec per m^{-2}
K′	=	A constant of unit conversion
	=	10^6 pCi/μCi
Q_F	=	The cow's or goat's feed consumption rate. kg/day (wet weight)
U_{ap}	=	The receptor's milk consumption rate for age group a, liters/yr
Y_p	=	The agricultural productivity by unit area of pasture feed grass, kg/m^2
Y_s	=	The agricultural productivity by unit area of stored feed, kg/m^2
F_m	=	The stable element transfer coefficients, pCi/liter per pCi/day

r	=	Fraction of deposited activity retained on cow's feed grass
$(DFL_i)_a$	=	The organ ingestion dose 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}
	=	$5.73x10^{-7}$ 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:

$$R_{T_M} = K'K'''F_m Q_F U_{ap} (DFL_i)_a \left[0.75 \left(\frac{0.5}{H} \right) \right] \tag{C.2-4}$$

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 Grass-Cow-Meat Pathway

The integrated concentration in meat follows in a similar manner to the development for the milk pathway, therefore:

$$R_{i_B} = I_i K' Q_F U_{ap} F_f (DFL_i)_a e^{-\lambda_i t_s}$$

$$\left\{ f_p f_s \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] + (1-f_p f_s) \left[\frac{r(1-e^{-\lambda_{E_i} t_e})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{P\lambda_i} \right] e^{-\lambda_i t_h} \right\} \tag{C.2-5}$$

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:

$$R_{T_V} = K'K''' \left[U_a^L f_L + U_a^S f_g\right](DFL_i)_a \left[0.075\left(\frac{0.5}{H}\right)\right] \quad \text{(C.2-8)}$$

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)	1.73×10^5 (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)	4.73×10^8 (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)	7.78×10^6 (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)	2.59×10^6 (pasture) 5.18×10^6 (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)	Table E-1
		0.2 (particulates)	Table E-1
$(DFL_i)_a$ (mrem/Ci)		Each radionuclide	Tables E-11 to E-14*
U_a^L (kg/yr)	-Infant	0	Table E-5
	-Child	26	Table E-5
	-Teen	42	Table E-5
	-Adult	64	Table E-5
U_a^S (kg/yr)	-Infant	0	Table E-5
	-Child	520	Table E-5
	-Teen	630	Table E-5
	-Adult	520	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):

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

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.	Stabilization Pond Effluent Composite Sampler	2-DST-XE-5027
E.	Stabilization Pond Effluent Flow Measurement Device	2-DST-FIT-5026
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

II. 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

APPENDIX E (Cont'd)

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

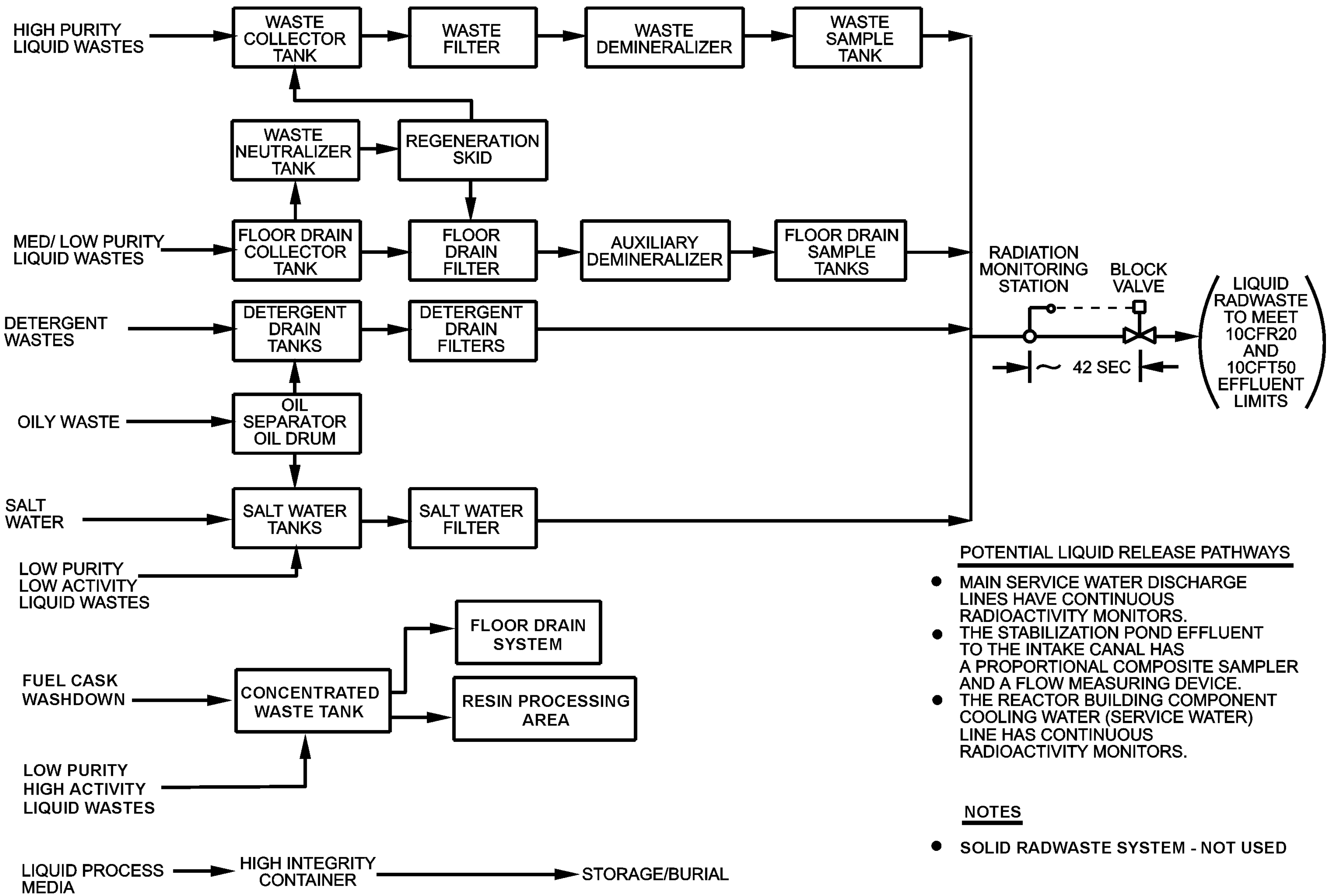
   c. Sampler Flow Rate Measurement Device

APPENDIX F

LIQUID AND GASEOUS EFFLUENT SYSTEM DIAGRAMS

FIGURE F-1

Liquid Radwaste Effluent System



POTENTIAL LIQUID RELEASE PATHWAYS

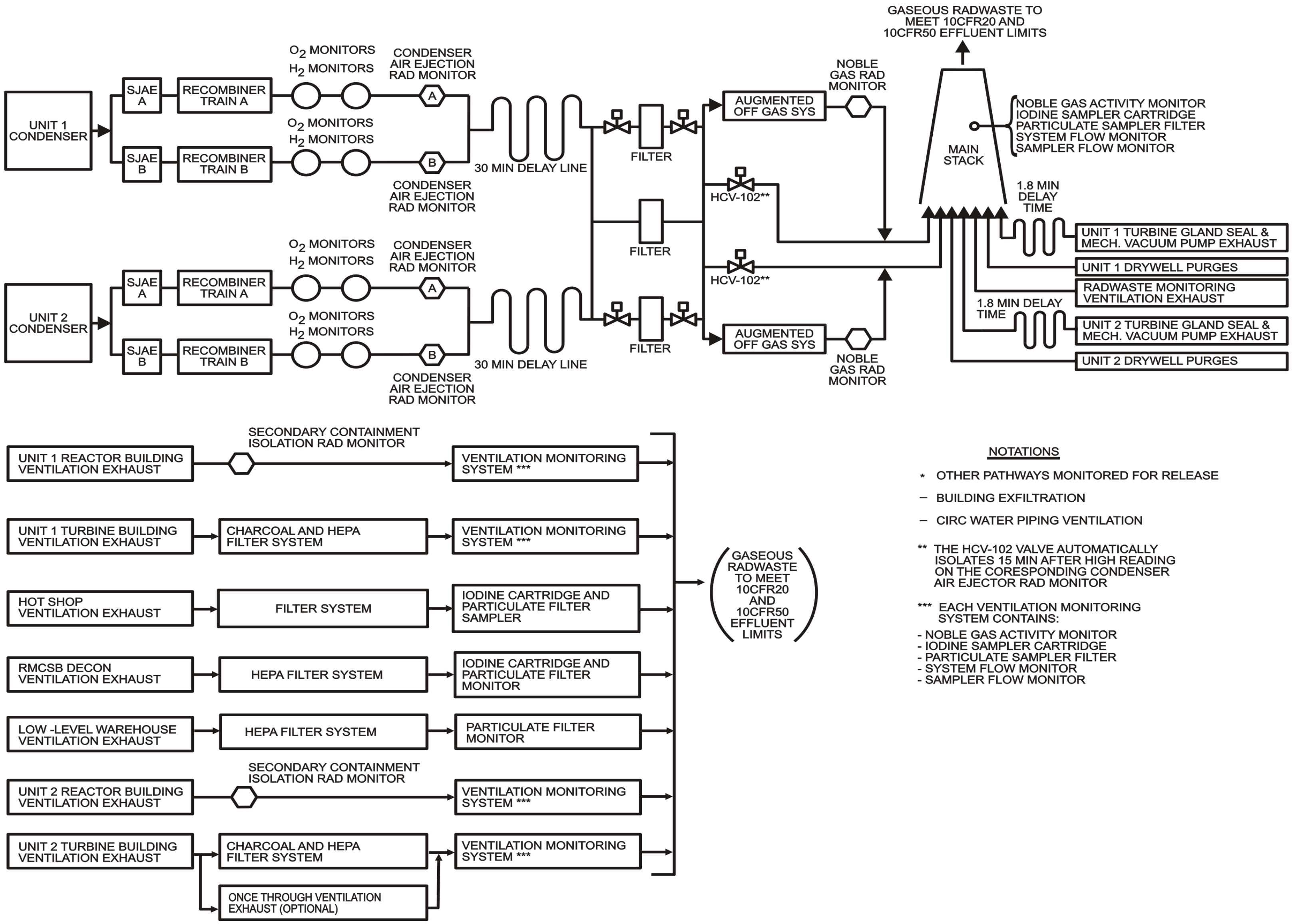
- MAIN SERVICE WATER DISCHARGE LINES HAVE CONTINUOUS RADIOACTIVITY MONITORS.
- THE STABILIZATION POND EFFLUENT TO THE INTAKE CANAL HAS A PROPORTIONAL COMPOSITE SAMPLER AND A FLOW MEASURING DEVICE.
- THE REACTOR BUILDING COMPONENT COOLING WATER (SERVICE WATER) LINE HAS CONTINUOUS RADIOACTIVITY MONITORS.

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:

$$Dt = (Dh \times Ct)/Ch$$

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

ATTACHMENT 10

Summary of Changes to the Process Control Program

This attachment includes a summary of changes to the PCP.

Attachment 10
Summary of Changes to the Process Control Program

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

No changes were made to the BSEP Process Control Program (PCP) in 2021. The most recent revision is 5.

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

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

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

Summary:

An engineering change installed a contingency radwaste processing system that can be used in parallel with the current operating system to augment radwaste during periods of high organic, conductivity, oil, various chemical, or other intrusions.

Before this modification, the Brunswick Nuclear Plant (BNP) Rad Waste Floor Processing System did not provide a ready means to separate oils or solids other than use of natural settling and did not provide means to process off-spec in-leakage. As such, the system was not capable of readily processing intrusions from salt water or other high conductivity sources, oils, organics or various chemicals. Separable solids and iron oxides were also not able to be handled in a reliable manner. This type of "off-spec" inventory is routinely introduced to the floor drain system requiring Rad Waste operations to respond in an "emergent" manner depending on the specific challenge.

The contingency radwaste processing system resolves the issues with off-spec in-leakage. The system is expected to improve chemical parameters of liquid radwaste influents. There is no expected change in the total activity releases annually from the liquid radwaste system overall as a result of implementing the engineering change.

ATTACHMENT 12

Errata to a Previous Year's ARERR

The following contains amended pages to the BNP 2013-2020 ARERR. Amended pages are identified with 'Amendment #' on page. Specific changes are identified with change bars in right margin. A copy of the original submittal will appear before the amendment page.

Reasoning:

Duke Energy was notified by Mirion (OpenEMS effluent permit vendor) that OpenEMS was not calculating liquid doses for the ARERR in accordance with the Offsite Dose Calculation Manual (ODCM). The ODCM liquid dose equation specifies that the dilution volume used in the near field average dilution factor should be the dilution water volume during the period of release. Previously, OpenEMS was using the dilution volume for a larger time frame when calculating liquid dose for the ARERR. The OpenEMS software ARERR liquid dose calculation was corrected to only include dilution during the liquid effluent release in the near field average dilution factor. Liquid doses on release permits were not impacted by this issue.

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Following is an Amended page from the 2013 ARERR:

Attachment 7

Annual Dose Assessment

Liquid Effluents

Critical Age: Adult
Controlling Location for Routine ODCM Liquid Releases: SW sector at 0.1 miles

Supplemental Dose*	Marsh[1]
mrem	1.46E-03

*Reference pages 6-7 of Supplemental Information for a discussion of the Marsh release.

	Routine ODCM Dose (mrem)	Marsh Dose (mrem)	Total Dose (mrem)	Limit (mrem)
GI-LLI	1.30E-04	1.46E-03	1.59E-03	2.00E+01
Bone	8.52E-06	0.00E+00	8.52E-06	2.00E+01
Liver	1.34E-04	1.46E-03	1.59E-03	2.00E+01
Lung	1.08E-04	1.46E-03	1.57E-03	2.00E+01
Total Body	1.20E-04	1.46E-03	1.58E-03	6.00E+00
Thyroid	1.36E-04	1.46E-03	1.60E-03	2.00E+01
Kidney	1.25E-04	1.46E-03	1.59E-03	2.00E+01

[1] Dose from the Marsh was calculated based on guidance from Regulatory Guide 1.109 assuming a fish and invertebrate ingestion pathway for an adult.

Attachment 7

Annual Dose Assessment

Liquid Effluents

Critical Age: Adult

Controlling Location for Routine ODCM Liquid Releases: SW sector at 0.1 miles

Supplemental Dose*	Marsh[1]
mrem	1.46E-03

*Reference pages 6-7 of Supplemental Information for a discussion of the Marsh release.

	Routine ODCM Dose (mrem)	Marsh Dose (mrem)	Total Dose (mrem)	Limit (mrem)
GI-LLI	1.48E-03	1.46E-03	2.94E-03	2.00E+01
Bone	7.96E-05	0.00E+00	7.96E-05	2.00E+01
Liver	1.51E-03	1.46E-03	2.97E-03	2.00E+01
Lung	1.26E-03	1.46E-03	2.72E-03	2.00E+01
Total Body	1.38E-03	1.46E-03	2.84E-03	6.00E+00
Thyroid	1.60E-03	1.46E-03	3.06E-03	2.00E+01
Kidney	1.42E-03	1.46E-03	2.88E-03	2.00E+01

(1) Dose from the Marsh was calculated based on guidance from Regulatory Guide 1.109 assuming a fish and invertebrate ingestion pathway for an adult.

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Following is an Amended page from the 2014 ARERR:

Attachment 7

Annual Dose Assessment

Liquid Effluents

Critical Age: Adult

Controlling Location for Routine ODCM Liquid Releases: SW sector at 0.1 miles

Supplemental Dose*	Marsh[1]
mrem	1.57E-03

*Reference page 6 of Supplemental Information for a discussion of the Marsh release.

	Routine ODCM Dose (mrem)	Marsh Dose (mrem)	Total Dose (mrem)	Limit (mrem)
GI-LLI	1.29E-04	1.57E-03	1.70E-03	2.00E+01
Bone	3.02E-05	0.00E+00	3.02E-05	2.00E+01
Liver	7.40E-05	1.57E-03	1.64E-03	2.00E+01
Lung	6.67E-05	1.57E-03	1.64E-03	2.00E+01
Total Body	7.58E-05	1.57E-03	1.65E-03	6.00E+00
Thyroid	8.89E-05	1.57E-03	1.66E-03	2.00E+01
Kidney	6.79E-05	1.57E-03	1.64E-03	2.00E+01

[1] Dose from the Marsh was calculated based on guidance from Regulatory Guide 1.109 assuming a fish and invertebrate ingestion pathway for an adult.

Attachment 7

Annual Dose Assessment

Liquid Effluents

Critical Age: Adult

Controlling Location for Routine ODCM Liquid Releases: SW sector at 0.1 miles

Supplemental Dose*	Marsh[1]
mrem	1.57E-03

*Reference page 6 of Supplemental Information for a discussion of the Marsh release.

	Routine ODCM Dose (mrem)	Marsh Dose (mrem)	Total Dose (mrem)	Limit (mrem)
GI-LLI	1.89E-03	1.57E-03	3.46E-03	2.00E+01
Bone	4.87E-04	0.00E+00	4.87E-04	2.00E+01
Liver	1.01E-03	1.57E-03	2.58E-03	2.00E+01
Lung	8.89E-04	1.57E-03	2.46E-03	2.00E+01
Total Body	1.04E-03	1.57E-03	2.61E-03	6.00E+00
Thyroid	1.12E-03	1.57E-03	2.69E-03	2.00E+01
Kidney	9.07E-04	1.57E-03	2.48E-03	2.00E+01

[1] Dose from the Marsh was calculated based on guidance from Regulatory Guide 1.109 assuming a fish and invertebrate ingestion pathway for an adult.

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Following is an Amended page from the 2015 ARERR:

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2015 - 12/31/2015

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	7.77E-04	4.49E-04	1.65E-04	4.94E-04	1.88E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		7.77E-03	4.49E-03	1.65E-03	4.94E-03	9.41E-03
2. Maximum Total Body Dose	mREM	7.61E-04	4.46E-04	1.65E-04	4.61E-04	1.83E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		2.54E-02	1.49E-02	5.50E-03	1.54E-02	3.05E-02

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2015 - 12/31/2015

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	1.17E-03	6.27E-04	3.19E-04	1.05E-03	3.15E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.17E-02	6.27E-03	3.19E-03	1.05E-02	1.58E-02
2. Maximum Total Body Dose	mREM	9.99E-04	5.92E-04	3.19E-04	7.97E-04	2.70E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		3.33E-02	1.97E-02	1.06E-02	2.66E-02	4.51E-02

Critical Age ***ADULT***
Critical Organ ***GI-LLI***

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2015 - 12/31/2015

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 miles NE	1. Location	0.30 miles NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-02	4. Organ Dose (mREM)	1.28E-04
5. Total Body Dose (mREM)	1.13E-02	5. Total Body Dose (mREM)	1.28E-04
B. Liquid Effluent Dose		E. SDSF Evaporation H-3 Dose	
1. Location	0.10 miles SW	1. Location	0.50 miles NNW
2. Critical Age	ADULT	2. Critical Age	TEEN
3. Critical Organ	GI-LLI	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.62E-04	4. Organ Dose (mREM)	2.51E-04
5. Total Body Dose (mREM)	1.10E-04	5. Total Body Dose (mREM)	2.51E-04
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.80 miles 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)	2.02E+00	4. Organ Dose (mREM)	1.72E-03
5. Total Body Dose (mREM)	4.05E-01	5. Total Body Dose (mREM)	1.72E-03

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2015 - 12/31/2015

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for ***Brunswick Steam Electric Plant*** includes liquid and gaseous effluent dose contributions from ***Brunswick Steam Electric Plant*** and direct and air-scatter dose from the onsite ***ISFSI and Turbine Buildings***. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 miles NE	1. Location	0.30 miles NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.46E-02	4. Organ Dose (mREM)	1.28E-04
5. Total Body Dose (mREM)	1.13E-02	5. Total Body Dose (mREM)	1.28E-04
B. Liquid Effluent Dose		E. SDSF Evaporation H-3 Dose	
1. Location	0.10 miles SW	1. Location	0.50 miles NNW
2. Critical Age	ADULT	2. Critical Age	TEEN
3. Critical Organ	GI-LLI	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.43E-03	4. Organ Dose (mREM)	2.51E-04
5. Total Body Dose (mREM)	9.83E-04	5. Total Body Dose (mREM)	2.51E-04
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.80 miles 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)	2.02E+00	4. Organ Dose (mREM)	1.72E-03
5. Total Body Dose (mREM)	4.05E-01	5. Total Body Dose (mREM)	1.72E-03

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Following is an Amended page from the 2016 ARERR:

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	4.77E-05	4.38E-05	8.51E-05	7.53E-05	2.52E-04
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.77E-04	4.38E-04	8.51E-04	7.53E-04	1.26E-03
2. Maximum Total Body Dose	mREM	3.13E-05	1.93E-05	3.72E-05	2.63E-05	1.14E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.04E-03	6.43E-04	1.24E-03	8.78E-04	1.90E-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 1/1/2016 - 12/31/2016

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	1.10E-03	8.09E-04	8.78E-04	1.64E-03	4.42E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.10E-02	8.09E-03	8.78E-03	1.64E-02	2.21E-02
2. Maximum Total Body Dose	mREM	9.50E-04	5.43E-04	5.52E-04	1.16E-03	3.20E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		3.17E-02	1.81E-02	1.84E-02	3.85E-02	5.33E-02

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 1/1/2016 - 12/31/2016

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 miles NE	1. Location	0.30 miles NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	3.88E-02	4. Organ Dose (mREM)	6.70E-05
5. Total Body Dose (mREM)	8.84E-03	5. Total Body Dose (mREM)	6.70E-05
B. Liquid Effluent Dose		E. SDSF Evaporation H-3 Dose	
1. Location	0.10 miles SW	1. Location	0.50 miles NNW
2. Critical Age	ADULT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	2.52E-04	4. Organ Dose (mREM)	2.37E-04
5. Total Body Dose (mREM)	1.14E-04	5. Total Body Dose (mREM)	2.37E-04
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.70 miles 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)	2.04E+00	4. Organ Dose (mREM)	2.20E-03
5. Total Body Dose (mREM)	4.09E-01	5. Total Body Dose (mREM)	2.20E-03

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for ***Brunswick Steam Electric Plant*** includes liquid and gaseous effluent dose contributions from ***Brunswick Steam Electric Plant*** and direct and air-scatter dose from the onsite ***ISFSI and Turbine Buildings***. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 miles NE	1. Location	0.30 miles NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	3.88E-02	4. Organ Dose (mREM)	6.70E-05
5. Total Body Dose (mREM)	8.84e-03	5. Total Body Dose (mREM)	6.70E-05
B. Liquid Effluent Dose		E. SDSF Evaporation H-3 Dose	
1. Location	0.10 miles SW	1. Location	0.50 miles NNW
2. Critical Age	ADULT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	2.22E-03	4. Organ Dose (mREM)	2.37E-04
5. Total Body Dose (mREM)	1.00E-03	5. Total Body Dose (mREM)	2.37E-04
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.80 miles 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)	2.04E+00	4. Organ Dose (mREM)	2.20E-03
5. Total Body Dose (mREM)	4.09E-01	5. Total Body Dose (mREM)	2.20E-03

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Following is an Amended page from the 2017 ARERR:

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2017 - 12/31/2017

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	4.71E-05	2.20E-05	2.23E-05	2.88E-05	1.20E-04
(a) Limit	mREM	10.00	10.00	10.00	10.00	20.00
(b) % of Limit		4.71E-04	2.20E-04	2.23E-04	2.88E-04	6.02E-04
2. Maximum Total Body Dose	mREM	2.56E-05	1.77E-05	1.40E-05	1.03E-05	6.76E-05
(a) Limit	mREM	3.00	3.00	3.00	3.00	6.00
(b) % of Limit		8.55E-04	5.89E-04	4.65E-04	3.44E-04	1.13E-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 1/1/2017 - 12/31/2017

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	1.32E-03	5.04E-04	2.71E-04	4.88E-04	2.59E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.32E-02	5.04E-03	2.71E-03	4.88E-03	1.30E-02
2. Maximum Total Body Dose	mREM	1.10E-03	4.66E-04	1.97E-04	2.13E-04	1.98E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		3.67E-02	1.55E-02	6.56E-03	7.11E-03	3.30E-02

Critical Age ***ADULT***
Critical Organ ***THYROID***

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2017 - 12/31/2017

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 miles NE	1. Location	0.30 miles NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.14E-02	4. Organ Dose (mREM)	7.64E-05
5. Total Body Dose (mREM)	7.45E-03	5. Total Body Dose (mREM)	7.64E-05
B. Liquid Effluent Dose		E. SDSF Evaporation H-3 Dose	
1. Location	0.10 miles SW	1. Location	0.50 miles NNW
2. Critical Age	ADULT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.20E-04	4. Organ Dose (mREM)	1.94E-04
5. Total Body Dose (mREM)	6.76E-05	5. Total Body Dose (mREM)	1.94E-04
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.00 miles S	1. Location	Nancy's Creek
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.28E+00	4. Organ Dose (mREM)	1.29E-03
5. Total Body Dose (mREM)	8.55E-01	5. Total Body Dose (mREM)	1.29E-03

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2017 - 12/31/2017

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for ***Brunswick Steam Electric Plant*** includes liquid and gaseous effluent dose contributions from ***Brunswick Steam Electric Plant*** and direct and air-scatter dose from the onsite ***ISFSI and Turbine Buildings***. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 miles NE	1. Location	0.30 miles NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.14E-02	4. Organ Dose (mREM)	7.64E-05
5. Total Body Dose (mREM)	7.45e-03	5. Total Body Dose (mREM)	7.64E-05
B. Liquid Effluent Dose		E. SDSF Evaporation H-3 Dose	
1. Location	0.10 miles SW	1. Location	0.50 miles NNW
2. Critical Age	ADULT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.30E-03	4. Organ Dose (mREM)	1.94E-04
5. Total Body Dose (mREM)	6.90E-04	5. Total Body Dose (mREM)	1.94E-04
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.00 miles S	1. Location	Nancy's Creek
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.28E+00	4. Organ Dose (mREM)	1.29E-03
5. Total Body Dose (mREM)	8.55E-01	5. Total Body Dose (mREM)	1.29E-03

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Following is an Amended page from the 2018 ARERR:

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2018 - 12/31/2018

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	4.90E-05	6.22E-05	6.44E-05	3.56E-04	5.32E-04
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.90E-04	6.22E-04	6.44E-04	3.56E-03	2.66E-03
2. Maximum Total Body Dose	mREM	1.38E-05	2.37E-05	1.58E-05	6.70E-05	1.20E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		4.59E-04	7.91E-04	5.26E-04	2.23E-03	2.00E-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 1/1/2018 - 12/31/2018

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	9.66E-04	5.27E-04	4.35E-04	9.47E-04	2.87E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		9.66E-03	5.27E-03	4.35E-03	9.47E-03	1.44E-02
2. Maximum Total Body Dose	mREM	5.27E-04	2.86E-04	1.06E-04	3.86E-04	1.31E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.76E-02	9.53E-03	3.53E-03	1.29E-02	2.18E-02

Critical Age ***ADULT***
Critical Organ ***THYROID***

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2018 - 12/31/2018

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 mi. NE	1. Location	0.30 mi. NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.01E-01	4. Organ Dose (mREM)	2.24E-04
5. Total Body Dose (mREM)	2.99E-03	5. Total Body Dose (mREM)	2.24E-04
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)	5.32E-04	4. Organ Dose (mREM)	1.04E-04
5. Total Body Dose (mREM)	1.20E-04	5. Total Body Dose (mREM)	1.04E-04
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.00 mi. S	1. Location	Nancy's Creek
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.07E+00	4. Organ Dose (mREM)	7.50E-04
5. Total Body Dose (mREM)	8.14E-01	5. Total Body Dose (mREM)	7.50E-04

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2018 - 12/31/2018

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Gaseous Effluent Dose	
1. Location	4.75 mi. NE
2. Critical Age	INFANT
3. Critical Organ	THYROID
4. Organ Dose (mREM)	1.01E-01
5. Total Body Dose (mREM)	2.99E-03
B. Liquid Effluent Dose	
1. Location	0.10 mi. SW
2. Critical Age	ADULT
3. Critical Organ	THYROID
4. Organ Dose (mREM)	2.12E-03
5. Total Body Dose (mREM)	5.56E-04
C. Carbon-14 Dose	
1. Location	1.00 mi. S
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	4.07E+00
5. Total Body Dose (mREM)	8.14E-01
D. SDSP Evaporation H-3 Dose	
1. Location	0.30 mi. NW
2. Critical Age	TEEN
3. Critical Organ	N/A
4. Organ Dose (mREM)	2.24E-04
5. Total Body Dose (mREM)	2.24E-04
E. SDSF Evaporation H-3 Dose	
1. Location	0.50 mi. NNW
2. Critical Age	TEEN
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.04E-04
5. Total Body Dose (mREM)	1.04E-04
F. Nancy's Creek Marsh H-3 Dose	
1. Location	Nancy's Creek
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	7.50E-04
5. Total Body Dose (mREM)	7.50E-04

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Following is an Amended page from the 2019 ARERR:

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2019 - 12/31/2019

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	1.83E-05	1.64E-05	3.09E-05	1.40E-05	7.96E-05
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.83E-04	1.64E-04	3.09E-04	1.40E-04	3.98E-04
2. Maximum Total Body Dose	mREM	7.11E-06	7.49E-06	1.00E-05	3.93E-06	2.86E-05
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		2.37E-04	2.50E-04	3.35E-04	1.31E-04	4.76E-04

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 1/1/2019 - 12/31/2019

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	3.17E-04	2.51E-04	2.98E-04	2.27E-04	1.09E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		3.17E-03	2.51E-03	2.98E-03	2.27E-03	5.47E-03
2. Maximum Total Body Dose	mREM	1.76E-04	1.51E-04	9.68E-05	6.34E-05	4.87E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		5.86E-03	5.02E-03	3.23E-03	2.11E-03	8.12E-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 1/1/2019 - 12/31/2019

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 mi. NE	1. Location	0.30 mi. NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.39E-01	4. Organ Dose (mREM)	2.43E-04
5. Total Body Dose (mREM)	3.73E-03	5. Total Body Dose (mREM)	2.43E-04
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)	7.96E-05	4. Organ Dose (mREM)	9.16E-05
5. Total Body Dose (mREM)	2.86E-05	5. Total Body Dose (mREM)	9.16E-05
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.00 mi. S	1. Location	Nancy's Creek
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.08E+00	4. Organ Dose (mREM)	1.51E-04
5. Total Body Dose (mREM)	8.15E-01	5. Total Body Dose (mREM)	1.51E-04

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2019 - 12/31/2019

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 mi. NE	1. Location	0.30 mi. NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.39E-01	4. Organ Dose (mREM)	2.43E-04
5. Total Body Dose (mREM)	3.73E-03	5. Total Body Dose (mREM)	2.43E-04
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)	9.43E-04	4. Organ Dose (mREM)	9.16E-05
5. Total Body Dose (mREM)	3.36E-04	5. Total Body Dose (mREM)	9.16E-05
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	1.00 mi. S	1. Location	Nancy's Creek
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.08E+00	4. Organ Dose (mREM)	1.51E-04
5. Total Body Dose (mREM)	8.15E-01	5. Total Body Dose (mREM)	1.51E-04

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Following is an Amended page from the 2020 ARERR:

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2020 - 12/31/2020

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	2.74E-04	2.93E-04	5.48E-05	4.09E-04	1.03E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		2.74E-03	2.93E-03	5.48E-04	4.09E-03	5.15E-03
2. Maximum Total Body Dose	mREM	2.74E-04	2.93E-04	5.48E-05	4.09E-04	1.03E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		9.13E-03	9.78E-03	1.83E-03	1.36E-02	1.72E-02

Critical Age ***ADULT***
Critical Organ ***LIVER***

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2020 - 12/31/2020

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	6.20E-04	1.12E-03	8.96E-04	8.15E-04	3.44E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		6.20E-03	1.12E-02	8.96E-03	8.15E-03	1.72E-02
2. Maximum Total Body Dose	mREM	3.74E-04	3.55E-04	1.02E-04	4.57E-04	1.29E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.25E-02	1.18E-02	3.40E-03	1.52E-02	2.14E-02

Critical Age ***ADULT***
Critical Organ ***THYROID***

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2020 - 12/31/2020

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 mi. NE	1. Location	0.30 mi. NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	5.18E-01	4. Organ Dose (mREM)	0.00E+00
5. Total Body Dose (mREM)	3.99E-03	5. Total Body Dose (mREM)	0.00E+00
B. Liquid Effluent Dose		E. SDSF Evaporation H-3 Dose	
1. Location	0.10 mi. SW	1. Location	0.50 mi. NNW
2. Critical Age	ADULT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	1.97E-04	4. Organ Dose (mREM)	6.92E-05
5. Total Body Dose (mREM)	2.00E-05	5. Total Body Dose (mREM)	6.92E-05
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	2.20 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)	1.71E+00	4. Organ Dose (mREM)	1.03E-03
5. Total Body Dose (mREM)	3.41E-01	5. Total Body Dose (mREM)	1.03E-03

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

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2020 - 12/31/2020

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Gaseous Effluent Dose		D. SDSP Evaporation H-3 Dose	
1. Location	4.75 mi. NE	1. Location	0.30 mi. NW
2. Critical Age	INFANT	2. Critical Age	TEEN
3. Critical Organ	THYROID	3. Critical Organ	N/A
4. Organ Dose (mREM)	5.18E-01	4. Organ Dose (mREM)	0.00E+00
5. Total Body Dose (mREM)	3.99E-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)	2.41E-03	4. Organ Dose (mREM)	6.92E-05
5. Total Body Dose (mREM)	2.56E-04	5. Total Body Dose (mREM)	6.92E-05
C. Carbon-14 Dose		F. Nancy's Creek Marsh H-3 Dose	
1. Location	2.20 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)	1.71E+00	4. Organ Dose (mREM)	1.03E-03
5. Total Body Dose (mREM)	3.41E-01	5. Total Body Dose (mREM)	1.03E-03

ENCLOSURE 2: CNS Annual Radioactive Effluent Release Report

Catawba Nuclear Station
Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2021 through December 31, 2021

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. 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	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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
1. Total Release	Ci	1.96E+00	1.12E+00	1.31E+00	5.84E-01	4.97E+00
2. Avg. Release Rate	µCi/sec	2.52E-01	1.42E-01	1.64E-01	7.35E-02	1.57E-01
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	5.48E+01	6.93E+01	6.40E+01	6.56E+01	2.54E+02
2. Avg. Release Rate	µCi/sec	7.04E+00	8.82E+00	8.05E+00	8.25E+00	8.04E+00
E. Carbon-14						
1. Total Release	Ci	5.26E+00	4.45E+00	5.32E+00	4.92E+00	1.99E+01
2. Avg. Release Rate	µCi/sec	6.76E-01	5.65E-01	6.70E-01	6.19E-01	6.33E-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 1/1/2021 - 12/31/2021

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 1/1/2021 - 12/31/2021

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 1/1/2021 - 12/31/2021

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	5.47E+01	6.92E+01	6.39E+01	6.55E+01	2.53E+02
E. Carbon-14 *						
C-14	Ci	1.58E+00	1.33E+00	1.60E+00	1.48E+00	5.98E+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 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
AR-41	Ci	1.41E+00	8.94E-01	1.06E+00	5.08E-01	3.87E+00
KR-85	Ci	0.00E+00	0.00E+00	3.55E-03	1.01E-03	4.57E-03
XE-133	Ci	5.35E-01	2.03E-01	2.16E-01	6.73E-02	1.02E+00
XE-135	Ci	1.58E-02	2.11E-02	2.49E-02	8.03E-03	6.98E-02
Total for Period	Ci	1.96E+00	1.12E+00	1.31E+00	5.84E-01	4.97E+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	1.11E-01	1.38E-01	1.41E-01	5.18E-02	4.42E-01
E. Carbon-14 *						
C-14	Ci	3.68E+00	3.11E+00	3.73E+00	3.45E+00	1.40E+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 1/1/2021 - 12/31/2021

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 1/1/2021 - 12/31/2021

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 1/1/2021 - 12/31/2021

Liquid Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
1. Total Release	Ci	1.21E-02	1.04E-02	8.54E-03	7.12E-03	3.82E-02
2. Avg. Diluted Conc.	µCi/ml	4.16E-10	3.06E-10	2.17E-10	2.39E-10	2.89E-10
3. Batch Releases	µCi/ml	4.16E-10	3.06E-10	2.17E-10	2.39E-10	2.89E-10
B. Tritium						
1. Total Release	Ci	1.70E+02	1.56E+02	5.93E+02	2.37E+02	1.16E+03
2. Avg. Diluted Conc.	µCi/ml	6.67E-06	4.56E-06	1.51E-05	7.98E-06	8.92E-06
3. Batch Releases	µCi/ml	5.77E-06	4.56E-06	1.51E-05	7.98E-06	8.72E-06
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Batch Releases	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Continuous Releases	liters	9.61E+07	0.00E+00	0.00E+00	0.00E+00	9.61E+07
2. Batch Releases	liters	1.08E+06	2.30E+06	1.60E+06	1.18E+06	6.16E+06
F. Volume of Dilution Water						
1. Continuous Releases	liters	2.90E+09	3.41E+09	3.93E+09	2.98E+09	1.32E+10
2. Batch Releases	liters	2.90E+10	3.41E+10	3.93E+10	2.98E+10	1.32E+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 1/1/2021 - 12/31/2021

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	2.61E+00	0.00E+00	0.00E+00	0.00E+00	2.61E+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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	0.00E+00	0.00E+00	5.46E-06	5.46E-06
Be-7	Ci	2.00E-05	0.00E+00	8.14E-05	0.00E+00	1.01E-04
Bi-214	Ci	3.09E-06	1.37E-05	1.26E-06	1.82E-06	1.99E-05
Co-57	Ci	1.44E-05	0.00E+00	0.00E+00	0.00E+00	1.44E-05
Co-58	Ci	7.33E-04	1.54E-03	4.80E-04	1.92E-04	2.94E-03
Co-60	Ci	8.50E-03	2.33E-03	5.77E-03	3.67E-03	2.03E-02
Cr-51	Ci	0.00E+00	1.01E-03	1.59E-05	1.11E-03	2.14E-03
Cs-137	Ci	3.75E-06	2.63E-06	0.00E+00	3.05E-05	3.69E-05
F-18	Ci	5.29E-05	0.00E+00	1.71E-05	0.00E+00	7.00E-05
Fe-55	Ci	8.68E-04	2.62E-03	7.39E-04	1.04E-03	5.27E-03
Fe-59	Ci	0.00E+00	3.71E-04	1.02E-06	3.10E-05	4.03E-04
I-134	Ci	0.00E+00	0.00E+00	1.85E-06	0.00E+00	1.85E-06
Mn-54	Ci	5.32E-04	4.15E-05	4.51E-04	2.00E-04	1.22E-03
Na-24	Ci	4.87E-06	0.00E+00	0.00E+00	0.00E+00	4.87E-06
Nb-95	Ci	3.67E-05	5.60E-05	9.92E-05	4.10E-05	2.33E-04
Nb-97	Ci	0.00E+00	0.00E+00	0.00E+00	6.67E-06	6.67E-06
Ni-63	Ci	1.04E-03	2.35E-03	5.69E-04	7.24E-04	4.68E-03
Pb-214	Ci	2.39E-06	3.68E-05	2.84E-05	2.54E-05	9.29E-05
Sb-125	Ci	2.05E-04	3.88E-05	2.05E-04	1.99E-05	4.68E-04
Zn-65	Ci	3.36E-05	0.00E+00	4.59E-05	7.86E-06	8.74E-05
Zn-69m	Ci	0.00E+00	0.00E+00	4.34E-06	0.00E+00	4.34E-06
Zr-95	Ci	1.84E-05	3.00E-05	2.96E-05	2.38E-05	1.02E-04
Total for Period	Ci	1.21E-02	1.04E-02	8.54E-03	7.12E-03	3.82E-02
B. Tritium						
H-3	Ci	1.67E+02	1.56E+02	5.93E+02	2.37E+02	1.15E+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	0.0E+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 1/1/2021 - 12/31/2021

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	=	122
2. Total Time (min) for Batch Releases	=	1.64E+04
3. Maximum Time (min) for a Batch Release	=	1.52E+03
4. Average Time (min) for Batch Releases	=	1.34E+02
5. Minimum Time (min) for a Batch Release	=	1.80E+01
6. Average Dilution Water Flow During Release (gpm)	=	6.65E+04

B. Gaseous Effluents

1. Total Number of Batch Releases	=	62
2. Total Time (min) for Batch Releases	=	1.02E+06
3. Maximum Time (min) for a Batch Release	=	4.45E+04
4. Average Time (min) for Batch Releases	=	1.65E+04
5. Minimum Time (min) for a Batch Release	=	1.38E+02

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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 2021 ARERR contains estimates of C-14 radioactivity released in 2021 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 2021 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 2021 results in a site total C-14 gaseous release estimate to the environment of 1.99E+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 2021 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 2021 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 1/1/2021 - 12/31/2021

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 2021 Land Use Census was performed June 23-24,2021, and the results were certified and made available for use on August 2, 2021. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

No changes to nearest residences in each sector.

Gardens

The garden in the NNE sector (2.51 miles) was replaced with a garden at 2.75 miles.
The garden in the E sector (2.26 miles) was replaced with a garden at 2.21 miles.
The garden in the S sector (1.26 miles) was replaced with a garden at 1.87 miles.
The garden in the SSW sector (1.33 miles) was replaced with a garden at 1.03 miles.
The garden in the SW sector (2.88 miles) was replaced with a garden at 1.99 miles.
The garden in the WSW sector (0.91 miles) was replaced with a garden at 2.60 miles.
The garden in the WNW sector (1.35 miles) was replaced with a garden at 1.31 miles.
The garden in the NW sector (1.76 miles) was replaced with a garden at 1.75 miles.
The garden in the NNW sector (1.17 miles) was replaced with a garden at 1.04 miles.

Milk Animals

No changes to nearest milk animal in each sector.

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 1/1/2021 - 12/31/2021

	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	4	23	A	B-25	NA	77.57	2.96E-02
	b. Dewatered Primary Resins	5	5	A / B	HIC	NA	24.31	484
	c. Evaporator Concentrates	0	-	-	-	-	-	-
	d. Dewatered Mechanical Filters	1	1	C	HIC	NA	3.41	39.6
	e. Dewatered Demineralizers	0	-	-	-	-	-	-
	f. Solidified (cement) Acids, Oils, Sludge	2	6	A	GDP	NA	51.73	6.96E-03
	g. ***Other (add as necessary)***	0	-	-	-	-	-	-
2.	**Dry Solid Waste**							
	a. Dry Active Waste (compacted)	0	-	-	-	-	-	-
	b. Dry Active Waste (non-compacted)	0	-	-	-	-	-	-
	c. Dry Active Waste (brokered)	15	47	A	GDP	NA	110.7	1.83
	d. Irradiated Components	0	-	-	-	-	-	-
	e. ***Other (add as necessary)***	0	-	-	-	-	-	-
3.	**Total Solid Waste**	**27**	**82**				**267.72**	**525.5**

Attachment 3
Solid Radioactive Waste Disposal

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Dewatered Secondary Resins	Mn-54	11.1%
	Co-60	11.2%
	Cs-137	32.6%
	Ce-144	45.0%
b. Dewatered Primary Resins	H-3	0.07%
	Be-7	0.11%
	Mn-54	4.15%
	Co-57	0.16%
	Co-58	1.71%
	Fe-59	0.00%
	Co-60	13.83%
	Zn-65	0.76%
	Nb-95	0.00%
	Zr-95	0.00%
	Sb-124	0.00%
	Sb-125	0.12%
	Cs-134	0.05%
	Cs-137	0.21%
	Ce-144	0.04%
	Pu-239	0.00%
	C-14	0.05%
	Fe-55	25.50%
	Ni-59	0.35%
	Ni-63	52.80%
	Sr-90	0.01%
	Tc-99	0.10%
	Am-241	0.00%
c. Evaporator Concentrates	N/A	N/A
d. Dewatered Mechanical Filters	H-3	0.00%
	Cr-51	0.38%
	Mn-54	3.96%
	Co-57	0.19%
	Co-58	3.89%
	Fe-59	0.06%
	Co-60	33.32%
	Zn-65	1.78%
	Nb-94	0.00%
	Nb-95	3.18%
	Zr-95	1.47%
	Sn-113	0.13%
	Sb-124	0.04%
	Sb-125	1.09%
	Cs-137	0.49%
	Hf-181	0.00%
	Ce-144	0.71%
	Pu-238	0.00%
	C-14	0.92%
	Fe-55	31.80%
	Ni-63	15.09%
	Sr-90	0.00%
	Tc-99	1.51%
	Sn-117m	0.00%
	Am-241	0.00%
	Pu-241	0.00%
	Cm-242	0.00%
	Cm-243	0.00%
	Cm-244	0.00%
e. Dewatered Demineralizers	N/A	N/A

Attachment 3
Solid Radioactive Waste Disposal

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

f.	Solidified (cement) Acids, Oils, Sludge	Cr-51	24.38%
		Mn-54	0.75%
		Co-57	0.07%
		Co-58	2.24%
		Fe-59	0.81%
		Co-60	16.63%
		Zn-65	0.54%
		Nb-95	15.95%
		Zr-95	8.89%
		Sn-113	0.47%
		Sb-124	0.06%
		Sb-125	0.38%
		Cs-137	0.08%
		Ce-144	0.29%
		Fe-55	22.73%
		Ni-63	5.74%
g.	***Other (add as necessary)***	N/A	N/A
2.	**<u>Dry Solid Waste</u>**		
a.	Dry Active Waste (compacted)	N/A	N/A
b.	Dry Active Waste (non-compacted)	N/A	N/A
c.	Dry Active Waste (brokered)	H-3	0.15%
		Be-7	0.00%
		Cr-51	23.68%
		Mn-54	1.12%
		Co-57	0.07%
		Co-58	3.30%
		Fe-59	0.85%
		Co-60	17.61%
		Zn-65	0.51%
		Nb-95	17.22%
		Zr-95	9.49%
		Sn-113	0.48%
		Sb-124	0.06%
		Sb-125	0.39%
		Cs-134	0.00%
		Cs-137	0.29%
		Hf-181	0.00%
		Ce-144	0.41%
		C-14	0.02%
		Fe-55	19.56%
		Ni-63	4.79%
		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).

Attachment 4
Meteorological Data

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	1	0	2	0	0	0	0	0
	1.51-2.00	2	2	0	0	1	0	2	7	6	23	16	7	6	2	4	1
	2.01-3.00	8	1	3	4	3	2	5	61	44	103	157	51	46	12	6	4
	3.01-4.00	21	29	9	1	1	0	4	9	16	64	59	16	7	12	6	10
	4.01-5.00	21	28	7	0	0	0	0	3	0	6	11	1	2	5	6	10
	5.01-6.00	13	24	3	0	1	0	0	0	1	0	0	1	0	0	3	7
	6.01-8.00	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	7
	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	1	0	1	0	0	0	0
	1.26-1.50	1	0	0	0	0	2	0	0	5	2	1	4	1	1	1	0
	1.51-2.00	3	0	1	3	0	3	4	11	15	16	13	5	4	5	1	2
	2.01-3.00	12	10	2	1	1	3	7	25	27	53	22	14	11	6	3	1
	3.01-4.00	25	28	7	2	1	0	1	1	1	5	3	0	0	4	7	10
	4.01-5.00	17	22	2	3	0	0	0	0	0	0	4	1	0	0	2	7
	5.01-6.00	3	6	6	0	0	0	0	0	0	0	0	0	0	0	1	2
	6.01-8.00	3	5	1	0	0	0	0	0	0	0	0	0	0	0	0	2
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	2	0	0	0	0	0	0	0
	1.01-1.25	1	0	0	0	0	0	1	0	0	0	2	1	0	0	0	1
	1.26-1.50	0	0	0	0	0	0	0	2	3	5	5	6	1	2	0	2
	1.51-2.00	7	4	1	1	3	7	12	14	19	24	20	7	4	3	3	3
	2.01-3.00	28	16	7	2	4	1	5	16	26	23	21	11	7	3	7	5
	3.01-4.00	45	26	11	6	1	0	8	5	3	6	10	2	1	0	6	5
	4.01-5.00	6	24	12	0	1	0	0	0	0	2	1	0	0	0	0	4
	5.01-6.00	6	14	7	1	0	0	0	0	0	0	0	0	0	0	2	3
	6.01-8.00	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.46-0.75	0	0	0	0	0	0	0	0	0	4	0	0	0	2	0	0
	0.76-1.00	2	1	0	0	1	0	3	5	5	6	7	7	7	6	4	0
	1.01-1.25	2	1	4	2	1	0	3	10	17	17	31	16	13	8	5	5
	1.26-1.50	12	8	4	4	3	6	11	15	51	61	38	22	19	14	15	13
	1.51-2.00	26	10	12	9	7	7	19	41	95	126	69	30	23	17	20	35
	2.01-3.00	164	57	40	15	12	14	24	58	109	114	64	27	12	19	15	58
	3.01-4.00	175	142	54	19	3	3	24	10	19	25	25	4	2	11	13	27
	4.01-5.00	82	99	59	9	0	0	7	2	1	8	4	0	3	0	4	20
	5.01-6.00	15	27	16	6	0	0	0	0	1	0	0	0	0	0	1	6
	6.01-8.00	7	7	1	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	1	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 1/1/2021 - 12/31/2021

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	2	6	12	4	1	3	1	0
	0.76-1.00	1	0	0	1	0	0	2	5	19	56	44	31	18	11	11	0
	1.01-1.25	2	1	0	0	1	3	2	4	43	84	35	21	25	19	8	7
	1.26-1.50	5	0	0	0	0	3	5	13	93	98	34	21	17	18	22	17
	1.51-2.00	14	0	1	1	0	5	9	34	113	73	42	16	17	26	38	58
	2.01-3.00	110	14	2	6	6	4	27	25	65	30	28	12	7	22	48	140
	3.01-4.00	51	14	5	0	0	3	12	16	6	12	4	0	0	8	21	34
	4.01-5.00	16	2	7	3	0	1	3	1	0	0	0	0	0	0	8	6
	5.01-6.00	3	0	3	1	0	0	0	0	0	0	0	0	0	1	1	0
	6.01-8.00	1	0	4	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
F	0.46-0.75	0	0	1	0	0	0	0	1	6	12	10	3	6	1	1	0
	0.76-1.00	1	0	0	0	0	0	0	2	23	55	42	23	15	15	7	1
	1.01-1.25	0	0	0	0	0	1	0	5	48	59	34	23	11	9	26	5
	1.26-1.50	1	1	1	0	0	0	0	4	38	33	18	23	16	10	21	20
	1.51-2.00	13	0	0	0	0	0	0	4	22	14	5	7	18	20	28	44
	2.01-3.00	27	0	0	0	0	0	1	8	0	2	0	2	8	7	12	52
	3.01-4.00	2	2	0	0	0	0	2	2	0	0	0	0	0	0	0	1
	4.01-5.00	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	9	22	17	12	13	13	3	0
	0.76-1.00	0	0	0	0	0	0	0	0	37	54	42	39	31	25	23	1
	1.01-1.25	0	0	0	0	0	0	0	1	44	41	28	14	24	20	26	11
	1.26-1.50	1	0	0	0	0	0	0	1	21	31	19	11	9	9	11	33
	1.51-2.00	9	0	0	0	0	0	0	0	5	5	4	1	9	7	7	26
	2.01-3.00	2	0	0	0	0	0	0	0	0	0	0	2	4	2	1	8
	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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Catawba Nuclear Station had no unplanned liquid releases in 2021.

Catawba Nuclear Station had two unplanned gaseous releases in 2021:

- As documented in Nuclear Condition Report (NCR) 02372324, an unplanned release occurred from Waste Gas Decay Tank (WGDT) D via a body to bonnet leak from 1WG-239 in room 206B of the Auxiliary Building. Review of WGDT D pressure trends identified the leak started 02/25/2021 2300 and continued until 03/02/2021 1745 with an initial pressure of 47.4 psig and final pressure of 36.6 psig. Gaseous radioactivity monitor trends for the Auxiliary Building and Unit 1 and Unit 2 ventilation stacks indicated no discernable rising or lowering trends in count rate during the period of the release, so bounding Xe-133 equivalent concentration was used to evaluate this release based on the minimum sensitivity of these monitors (1.20E-06 µCi/mL). The release pathway for this release was from room 206B to the Unit 2 ventilation stack via the Unit 2 Auxiliary Building ventilation system.
- As documented in NCR 02391401, an unplanned release from WGDT D occurred between 07/26/2021 2210 and 07/27/2021 1010. Lowering pressure on WGDT D corresponded to a change in flow output from "A" Combined Hydrogen Recombiner (CHR). Operations responded by shifting configuration of the operating CHRs - initially A CHR operating and B CHR in split flow, swapped to A CHR in split flow and B CHR operating. The WGDT D pressure stabilized following closure of 1WG-286 and remained stable following the train swap. Gaseous radioactivity monitor trends for the Auxiliary Building and Unit 1 and Unit 2 ventilation stacks indicated no discernable rising or lowering trends in count rate during the period of the release, so bounding Xe-133 equivalent concentration was used to evaluate this release based on the minimum sensitivity of these monitors (1.20E-06 µCi/mL). The release pathway for this release was from room 205 to the Unit 2 ventilation stack via the Unit 2 Auxiliary Building ventilation system.

Catawba Selected Licensee Commitment (SLC) 16.11-6 limits SITE BOUNDARY dose rates for gaseous effluent releases of noble gases ≤ 500 mrem/yr to the whole body and ≤ 3000 mrem/yr to the skin. Table 5.1 provides the total activity released, whole body dose rate, skin dose rate, gamma air dose, and beta air dose for each of these releases. Maximum organ dose is 0.000 mrem as there is no inhalation pathway for noble gas. Gaseous Waste Release (GWR) permits were generated for each of these releases, and they are included in the gaseous effluents data in Attachment 1 and the effluent dose data in Attachment 6.

Table 5.1. Total activity released, gamma air dose, and beta air dose for each unplanned release for 2021:

Release Source	Release Dates/Times	Whole Body Dose Rate (mrem/yr)	Skin Dose Rate (mrem/yr)	Activity Released (Ci, Xe-133)	Gamma Air Dose (mrad)	Beta Air Dose (mrad)
WGDT D	02/25/2021 2300 to 03/02/2021 1745	7.60E-03	1.79E-02	3.04E-01	1.19E-04	3.55E-04
WGDT D	07/26/2021 2210 to 07/27/2021 1010	2.34E-03	5.52E-03	9.79E-03	3.85E-06	1.14E-05
Total for all 2021 unplanned releases:				3.14E-01	1.23E-04	3.67E-04

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 1/1/2021 - 12/31/2021

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	1.48E-02	9.38E-03	1.11E-02	5.30E-03	4.06E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		1.48E-01	9.38E-02	1.11E-01	5.30E-02	2.03E-01
Receptor Location	***0.5*** miles	***NNE***	***NNE***	***NNE***	***NNE***	***NNE***
2. Maximum Beta Air	mRAD	5.81E-03	3.56E-03	4.20E-03	1.96E-03	1.55E-02
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		2.90E-02	1.78E-02	2.10E-02	9.78E-03	3.88E-02
Receptor Location	***0.5*** miles	***NNE***	***NNE***	***NNE***	***NNE***	***NNE***
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	1.23E+00	1.04E+00	1.25E+00	1.16E+00	4.68E+00
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		8.23E+00	6.96E+00	8.33E+00	7.70E+00	1.56E+01
Receptor Location	***0.5*** miles	***NE***	***NE***	***NE***	***NE***	***NE***
Critical Age		***CHILD***	***CHILD***	***CHILD***	***CHILD***	***CHILD***
Critical Organ		***BONE***	***BONE***	***BONE***	***BONE***	***BONE***
Critical Pathway		***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 1/1/2021 - 12/31/2021

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	2.26E-02	1.78E-02	4.75E-02	2.60E-02	1.18E-01
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		2.26E-01	1.78E-01	4.75E-01	2.60E-01	5.89E-01
Critical Age		***ADULT***	***ADULT***	***ADULT***	***ADULT***	***ADULT***
Critical Organ		***GI-LLI***	***GI-LLI***	***GI-LLI***	***GI-LLI***	***GI-LLI***
Critical Pathway		***POTABLE WATER***	***FRESH WATER FISH***	***POTABLE WATER***	***POTABLE WATER***	***POTABLE WATER***
2. Maximum Total Body Dose	mREM	1.81E-02	1.38E-02	4.49E-02	2.42E-02	1.05E-01
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		6.03E-01	4.61E-01	1.50E+00	8.06E-01	1.75E+00
Critical Age		***CHILD***	***CHILD***	***CHILD***	***CHILD***	***CHILD***
Critical Pathway		***POTABLE WATER***	***POTABLE WATER***	***POTABLE WATER***	***POTABLE WATER***	***POTABLE WATER***
B. Continuous Mode						
1. Maximum Organ Dose	mREM	2.49E-03	0.00E+00	0.00E+00	0.00E+00	2.27E-03
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		2.49E-02	0.00E+00	0.00E+00	0.00E+00	1.14E-02
Critical Age		***CHILD***	***N/A***	***N/A***	***N/A***	***CHILD***
Critical Organ		***LIVER***	***N/A***	***N/A***	***N/A***	***LIVER***
Critical Pathway		***POTABLE WATER***	***N/A***	***N/A***	***N/A***	***POTABLE WATER***
2. Maximum Total Body Dose	mREM	2.49E-03	0.00E+00	0.00E+00	0.00E+00	2.27E-03
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		8.30E-02	0.00E+00	0.00E+00	0.00E+00	3.79E-02
Critical Age		***CHILD***	***N/A***	***N/A***	***N/A***	***CHILD***
Critical Pathway		***POTABLE WATER***	***N/A***	***N/A***	***N/A***	***POTABLE WATER***

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Catawba Nuclear Station includes liquid and gaseous effluent dose contributions from Catawba Nuclear Station and direct and air-scatter dose from the onsite ISFSI. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose calculations is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose from the ISFSI is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Maximum Organ Dose (other than TB)	4.700E+00 mrem
1. Location	0.5 miles NE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Gas Contribution %	99.624%
5. Liquid Contribution %	0.376%
B. Maximum Total Body Dose	2.273E+00 mrem
1. Location	0.5 miles NE
2. Critical Age	CHILD
3. Gas non-NG Contribution %	93.967%
4. Gas NG Contribution %	1.414%
5. Liquid Contribution %	4.619%

Direct and air-scatter radiation dose contributions from the onsite ISFSI have been determined from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 3.

The attached excerpt from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 3 is provided to document the method used to calculate the dose from ISFSI as less than 24.2 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 12 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 3

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).

Calculation CNC-1229.00-00-0061, "UMS Cask Array Dose Analysis for Duke Catawba (NAC International Calculation 12418-5004, Revision 1)" determined the annual total dose (gamma plus neutron) at a distance of 495 meters from a 2x12 array of NAC-UMS® casks to be approximately 6.7 mrem. The evaluation was conservatively based on full cask loads of 24 bounding fuel assemblies (52,000 MWD/MTU, 3.45 wt% U-235, and 8 years cooling) as well as bounding activated components. The cask decay heat load was conservatively assumed to be 20 kW. The distance at which this dose was calculated (495 meters) is conservative compared to the distance to the closest real individual.

Calculation CNC-1229.00-00-0067, "MAGNASTOR Cask Array Dose Analysis for Duke Catawba" determined the annual total dose (gamma plus neutron) at a distance of 535 meters from a (future) 2x12 array of MAGNASTOR® casks to be approximately 7.97 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.

NAC MAGNASTOR FSAR Section 5.8.3.5 documents the annual total dose (gamma plus neutron) for a single bounding cask in Figure 5.8.3-14. It is determined to be less than 4.5 mrem at a distance of 550 meters. The evaluation was conservatively based on the allowable payload combination that produced the maximum dose rates. The cask decay heat load was conservatively assumed to be 40 kW. The distance at which this dose is calculated (550 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.

The 2021 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 495 m, 2 x 12 array of MAGNASTOR casks at 535 m, and single MAGNASTOR cask 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 6.509 mrem direct radiation dose at the nearest resident distance of 901 m. Combined with the dose from effluents, maximum organ dose from Catawba is 11.209 mrem and maximum total body dose is 8.782 mrem, which are below the dose limits of 40 CFR 190.

ATTACHMENT 7

Information to Support the NEI Ground Water Protection Initiative

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

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Duke Energy implemented a Ground Water Protection program in 2007. This initiative was developed to ensure timely and effective management of situations involving inadvertent releases of licensed material to ground water. As part of this program, Catawba Nuclear Station monitored 49 wells and 1 outfall from the Conventional Wastewater Treatment Ponds in 2021.

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 2021 confirmed existing knowledge of tritium concentrations in site ground water.

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

Tritium results from sampling during 2021 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 2021.

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 1/1/2021 - 12/31/2021

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	3.34E+02	2.47E+02	3.08E+02	2.03E+02	4
C-101DR	CNS GWPI / C-101DR / U-1 SFP	3.57E+02	2.71E+02	2.87E+02	<MDA	4
C-101R	CNS GWPI / C-101R / U-1 SFP	6.70E+02	4.33E+02	6.38E+02	3.87E+02	4
C-102	CNS GWPI / C-102 / E of U1 SFP O/S protected area	2.77E+02	NS	2.25E+02	NS	2
C-103	CNS GWPI / C-103 / E of U1 SFP @ Cooling Towers	2.75E+02	NS	2.72E+02	NS	2
C-104	CNS GWPI / C-104 / U-1 RMWST	6.49E+02	3.58E+02	4.14E+02	3.10E+02	4
C-105	CNS GWPI / C-105 / Engr. Bldg.	6.69E+02	<MDA	3.06E+02	NS	3
C-105R	CNS GWPI / C-105R / Engr. Bldg.	7.16E+02	4.67E+02	3.98E+02	2.46E+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	5.83E+02	6.65E+02	5.47E+02	5.71E+02	4
C-108	CNS GWPI / C-108 /	4.14E+03	8.58E+02 1.42E+03	4.27E+02	NS	4
C-109	CNS GWPI / C-109 /	6.05E+02	NS	7.38E+02	NS	2
C-110	CNS GWPI / C-110 /	1.29E+03	1.13E+03	1.15E+03	1.02E+03	4
C-200DR	CNS GWPI / C-200DR / U-2 SFP	5.11E+02	3.44E+02	4.96E+02	3.74E+02	4
C-200R	CNS GWPI / C-200R / U-2 SFP	6.41E+02	6.00E+02	6.75E+02	4.99E+02	4
C-201DR	CNS GWPI / C-201DR / U-2 SFP	4.41E+02	3.77E+02	5.37E+02	3.11E+02	4
C-201R	CNS GWPI / C-201R / U-2 SFP	1.09E+03	8.89E+02	1.37E+03	1.25E+03	4
C-202	CNS GWPI / C-202 / S of RMC Tent	7.44E+02	NS	7.44E+02	NS	2
C-203	CNS GWPI / C-203 / E of RMC Tent @ Cooling Towers	3.60E+02	NS	4.07E+02	NS	2
C-204	CNS GWPI / C-204 / S of RMC Tent	7.25E+02	NS	5.95E+02	NS	2
C-205	CNS GWPI / C-205 / Adm. Parking	<MDA	<MDA	<MDA	<MDA	4
C-205R	CNS GWPI / C-205R / Adm. Parking	<MDA	<MDA	<MDA	<MDA	4
C-206	CNS GWPI / C-206 / W Parking Lot	<MDA	NS	<MDA	NS	2
C-207	CNS GWPI / C-207 / Mon. Tank B	2.84E+02	<MDA	2.21E+02	1.97E+02	4
C-207R	CNS GWPI / C-207R / Mon. Tank B	2.60E+02	<MDA	<MDA	<MDA	4
C-208	CNS GWPI / C-208 / N of MTB	<MDA	NS	2.26E+02	NS	2
C-209	CNS GWPI / C-209 / MTUville S of light pole 23A	2.27E+02	<MDA	2.28E+02	<MDA	4
C-210	CNS GWPI / C-210 / N of U2 Mech Equip Bldg	1.94E+02	NS	<MDA	NS	2
C-211	CNS GWPI / C-211 / W of RL Intake O/S Protected Area	3.58E+02	NS	1.20E+03	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	5.45E+03	4.98E+03	3.95E+03	2.42E+03	4

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
C-213R	CNS GWPI / C-213R / Mon. Tank B	<MDA	<MDA	<MDA	<MDA	4
C-214	CNS GWPI / C-214 / N of U2 TB	6.18E+02	6.07E+02	5.64E+02	4.52E+02	4
C-215	CNS GWPI / C-215 / N of U2 TB	5.94E+02	3.99E+02	3.98E+02	4.03E+02	4
C-217	CNS GWPI / C-217 / N of U2 TB	5.64E+02	NS	4.61E+02	NS	2
C-218	CNS GWPI / C-218 / N of U2 TB	3.75E+02	1.99E+02	2.40E+02	5.52E+02	4
C-220	CNS GWPI / C-220 / N of U2 TB	1.19E+03	8.38E+02	8.80E+02	8.94E+02	4
C-221	CNS GWPI / C-221 / N of U2 TB	4.03E+02	4.28E+02	3.35E+02	3.29E+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	<MDA	NS	<MDA	2
LMW-5D	CNS Landfill / LMW-5D / Landfill	NS	<MDA	NS	<MDA	2
LMW-5S	CNS Landfill / LMW-5S / Landfill	NS	<MDA	NS	<MDA	2
OUTFALL 017	CNS WC Ponds / OUTFALL-017 / WC Ponds	7.40E+02	7.85E+02	1.29E+03	2.74E+03	4
WCMW-2	CNS WC Ponds / WCMW-2 / WC Ponds	1.33E+03	1.52E+03	1.66E+03	1.93E+03	4
WCMW-3	CNS WC Ponds / WCMW-3 / WC Ponds	1.32E+03	1.20E+03	1.03E+03	9.83E+02	4
WCMW-4	CNS WC Ponds / WCMW-4 / WC Ponds	3.33E+02	3.97E+02	3.73E+02	4.77E+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 1/1/2021 - 12/31/2021

Catawba Nuclear Station had one instance of any inoperable equipment relevant to effluent monitoring in excess of SLC 16.11 limits during 2021. Details are discussed below.

Catawba Nuclear Station did not experience any temporary unprotected outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2021.

SLC # from Table 16.11-7-1	Title	Completion Time	Determination and Data Reviewed
1.a	0EMF-50L	14 days	For 0EMF-50L, out of service time for 2021 was 35.32 days (09/02/2021 07:43:00 to 10/07/2021 15:30:00) LCOTR A-0-21-01502.

The Noble Gas Radiation Monitor for the Waste Gas Holdup System, 0EMF-50L, was removed from service on 02 September 2021 for routine calibration under Work Order 20431276. The detector was found out of calibration and required replacement. Replacement detector was installed on 13 September 2021 and allowed to burn in overnight. NCR 02397142 (WG System Leakage Contaminated 0EMF50 - Unable to Decon) was generated to identify contamination levels within the monitor chamber were at high levels and the crew was unable to decontaminate the chamber and detector to levels acceptable per the procedural guidance. On 04 October 2021, the priority was increased on the open work order. After 35 days elapsed, calibration was completed successfully on 07 October 2021.

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

The Catawba ODCM was not revised in 2021. The most recent revision is 64 and was provided with the 2020 ARERR.

Radiological Effluent Controls (SLC 16.11)

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

There was one revisions to the Catawba Nuclear Station Updated Final Safety Analysis Report, Section 16.11, Radiological Controls, in 2021. SLC 16.11-2, Radioactive Liquid Effluent Monitoring Instrumentation, Rev. 6, was implemented on 05/13/2021. This revision changes the Frequency for Test TR 16.11-2-5 from 92 days to 182 days.

As per TS 5.5.5.b, "Licensee initiated changes to the Radiological Effluent Controls of the UFSAR," Catawba is attaching the entire Section 16.11 here.

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
TABLE OF CONTENTS	15	05/10/16
16.1	1	08/27/08
16.2	2	08/21/09
16.3	1	08/21/09
16.5-1	7	03/30/21
16.5-2	Deleted	
16.5-3	2	09/19/19
16.5-4	0	10/09/02
16.5-5	1	01/28/10
16.5-6	1	08/21/09
16.5-7	2	02/06/15
16.5-8	Deleted	
16.5-9	Deleted	03/02/21
16.5-10	Deleted	
16.6-1	0	10/09/02
16.6-2	Deleted	
16.6-3	1	08/21/09
16.6-4	2	11/21/19
16.6-5	3	07/07/20
16.7-1	1	08/21/09
16.7-2	4	02/03/11
16.7-3	5	11/21/19
16.7-4	2	08/21/09
16.7-5	5	04/20/21

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.7-6	3	06/10/16
16.7-7	1	08/21/09
16.7-8	2	08/21/09
16.7-9	13	09/14/21
16.7-10	9	04/23/20
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	1	08/21/09
16.7-16	0	06/08/09
16.7-17	0	02/10/15
16.7-18	0	05/10/16
16.8-1	7	06/01/20
16.8-2	3	12/18/19
16.8-3	1	10/24/06
16.8-4	2	11/05/07
16.8-5	3	08/21/09
16.9-1	10	01/29/19
16.9-2	6	08/03/17
16.9-3	5	07/03/18
16.9-4	5	09/11/17
16.9-5	11	10/08/19
16.9-6	12	07/03/18

LIST OF EFFECTIVE SECTIONS

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

LIST OF EFFECTIVE SECTIONS

SECTION	REVISION NUMBER	REVISION DATE
16.10-5	1	03/16/21
16.11-1	1	07/27/13
16.11-2	6	05/13/21
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	12	08/06/20
16.11-8	0	10/09/02
16.11-9	0	10/09/02
16.11-10	1	08/21/09
16.11-11	1	03/20/03
16.11-12	0	10/09/02
16.11-13	1	07/27/13
16.11-14	0	10/09/02
16.11-15	0	10/09/02
16.11-16	1	10/24/11
16.11-17	0	10/09/02
16.11-18	1	08/21/09
16.11-19	0	10/09/02
16.11-20	3	11/21/19
16.11-21	0	10/09/02
16.12-1	0	10/09/02
16.13-1	1	08/03/17
16.13-2	Deleted	

LIST OF EFFECTIVE SECTIONS

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-1 Liquid Effluents

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

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

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

Table 16.11-1-1

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

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

Table 16.11-1-1

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

NOTES:

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

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

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

Where:

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

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

E = the counting efficiency (counts per disintegration),

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

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

Y = the fractional radiochemical yield, when applicable,

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

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

T = the sample counting time (min).

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

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

(2) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed to assure representative sampling.

Table 16.11-1-1

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

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

Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. The LLD for Ce-144 is $5x10^{-6}$ μCi/ml. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

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

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

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

BASES

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

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

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

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

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

BASES (continued)

20, Appendix B, Table 2, Column 2, are based. Compliance with the limits of the new 10 CFR 20.1301 will be demonstrated by operating within the limits of 10 CFR 50, Appendix I and 40 CFR 190. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

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

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L. A., “Limits for Qualitative Detection and Quantitative Determination – Application to Radiochemistry,” Annal. Chem. 40, 586-93 (1968), and Hartwell, J. K., “Detection Limits for Radioanalytical Counting Techniques,” Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-2 Radioactive Liquid Effluent Monitoring Instrumentation

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

AND

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

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

REMEDIAL ACTIONS

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

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

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

(continued)

REMEDIAL ACTIONS (continued)

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

(continued)

REMEDIAL ACTIONS (continued)

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

(continued)

REMEDIAL ACTIONS (continued)

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

TESTING REQUIREMENTS

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

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

(continued)

TESTING REQUIREMENTS (continued)

	TEST	FREQUENCY
TR 16.11-2-7	----------NOTE---------- For Instrument 1, the initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used. ---------------------------- Perform CHANNEL CALIBRATION.	18 months

Table 16.11-2-1

Radioactive Liquid Effluent Monitoring Instrumentation

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

BASES

The Radioactive Liquid Effluent Monitoring Instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the Alarm/Trip will occur prior to exceeding the limits of 10 CFR Part 20. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-3 Dose

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

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

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

BASES

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

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-4 Liquid Radwaste Treatment System

COMMITMENT The Liquid Radwaste Treatment System shall be FUNCTIONAL and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS (see Figure 16.11-16-1 in SLC 16.11-16) would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31-day period.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

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

BASES

The FUNCTIONALITY of the Liquid Radwaste Treatment System ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept “as low as is reasonably achievable”. This COMMITMENT implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

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

REFERENCES

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

REFERENCES (continued)

3. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-5 Chemical Treatment Ponds

COMMITMENT

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

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

excluding tritium and dissolved or entrained noble gases,

where:

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

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

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

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

BASES

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

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

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

where:

BASES (continued)

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

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

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

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

where:

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

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

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

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-6 Gaseous Effluents

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

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

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

Table 16.11-6-1

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

GASEOUS RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD)(1) (µCi/ml)
1. Waste Gas Storage Tank	Prior to each release Each Tank Grab Sample	Prior to each release Each Tank	Principal Gamma Emitters(2)	$1x10^{-4}$
2. Containment Purge	Prior to each release Each PURGE(3) Grab Sample	Prior to each release Each PURGE(3)	Principal Gamma Emitters(2)	$1x10^{-4}$
		31 days	H-3 (oxide)	$1x10^{-6}$
3. Unit Vent	7 days(3)(4) Grab Sample	7 days(3)	Principal Gamma Emitters(2)	$1x10^{-4}$
			H-3 (oxide)	$1x10^{-6}$
4. Containment Air Release and Addition System	24 hours(3)(5) Grab Sample	24 hours(3)(5)	Principal Gamma Emitters(2)	$1x10^{-4}$
		31 days	H-3 (oxide)	$1x10^{-6}$
5. All Release Types as Listed in 3. Above	Continuous(6)	7 days(7) Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous(6)	7 days(7) Particulate Sample	Principal Gamma Emitters(2)	$1x10^{-11}$
	Continuous(6)	31 days Composite Particulate Sample	Gross Alpha(8)	$1x10^{-11}$
	Continuous(6)	92 days Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$

(continued)

Table 16.11-6-1

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

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

Table 16.11-6-1

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

NOTES:

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

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

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

Where:

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

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

E = the counting efficiency (counts per disintegration);

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

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

Y = the fractional radiochemical yield, when applicable;

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

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

T = the sample counting time (min).

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

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

Table 16.11-6-1

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

(2) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases based on grab samples and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, and Ce-141 in Iodine and particulate releases based on continuous samples. The LLD for Ce-144 is 5×10^{-9} μCi/ml and is based on continuous samples. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report, pursuant to Technical Specification 5.6.3 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(3) Sampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER stabilization (power level constant at desired power level) after a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period, for at least one of the three gaseous release types with this notation.

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

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

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

(7) Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or after removal from sampler. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup, or THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if: (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the reactor coolant has not increased more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

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

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

BASES

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

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

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

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

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

BASES (continued)

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

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

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

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

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

REFERENCES 1. Catawba Offsite Dose Calculation Manual.

REFERENCES (continued)

2. 10 CFR Part 20, Appendix B.
3. 10 CFR Part 20.
4. 10 CFR Part 50.
5. 40 CFR Part 190.
6. NUREG-1301.
7. Regulatory Guide 1.21.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-7 Radioactive Gaseous Effluent Monitoring Instrumentation

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

<u>AND</u>

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

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

REMEDIAL ACTIONS

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

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

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

REMEDIAL ACTIONS (continued)

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

(continued)

REMEDIAL ACTIONS (continued)

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

(continued)

REMEDIAL ACTIONS (continued)

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

(continued)

REMEDIAL ACTIONS (continued)

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

REMEDIAL ACTIONS

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

REMEDIAL ACTIONS

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

(continued)

REMEDIAL ACTIONS (continued)

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

TESTING REQUIREMENTS

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

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

(continued)

TESTING REQUIREMENTS (continued)

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

(continued)

TESTING REQUIREMENTS (continued)

	TEST	FREQUENCY
TR 16.11-7-9	---------------------------------NOTE--------------------------------- For Instruments 1a, 2, 3a, 3c, 4, 5, and 6a, the initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NBS. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used. --- Perform CHANNEL CALIBRATION.	18 months

Table 16.11-7-1

Radioactive Gaseous Effluent Monitoring Instrumentation (page 1 of 2)

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

(continued)

Table 16.11-7-1

Radioactive Gaseous Effluent Monitoring Instrumentation (page 2 of 2)

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

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

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

BASES

The Radioactive Gaseous Effluent Monitoring Instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The Alarm/Trip Setpoints for these instruments shall be calculated in accordance with the methodology and parameters in the ODCM to ensure that the Alarm/Trip will occur prior to exceeding the limits of 10 CFR Part 20. Conservative Alarm/Trip Setpoints may be used during a release provided they are less than or equal to the setpoints determined by the methodology and parameters of the ODCM. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. The sensitivity of any noble gas activity monitor used to show compliance with the gaseous effluent release requirements of SLC 16.11-8 shall be such that concentrations as low as 1×10^{-6} μCi/cc are measurable.

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

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

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

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

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

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

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

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

BASES (continued)

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

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

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

0EMF-58
This monitor provides no control function.

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

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

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

1/2EMF-39 - Containment Noble Gas Monitor

BASES (continued)

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

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-8 Dose - Noble Gases

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

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

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

BASES

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

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

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

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

a. During any calendar quarter: ≤ 7.5 mrem to any organ, and

b. During any calendar year: ≤ 15 mrem to any organ.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

BASES

This SLC is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50, and are the guides set forth in Section II.C of Appendix I. The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable". The ODCM calculational methods specified in the TESTING REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate COMMITMENTS for Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of the calculations were: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat-producing animals graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure of man.

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-10 Gaseous Radwaste Treatment System

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

a. 0.2 mrad to air from gamma radiation, or

b. 0.4 mrad to air from beta radiation, or

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

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

BASES

The FUNCTIONALITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept “as low as is reasonably achievable”. This COMMITMENT implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-11 Solid Radioactive Wastes

COMMITMENT

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

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

(continued)

REMEDIAL ACTIONS (continued)

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

(continued)

REMEDIAL ACTIONS (continued)

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

TESTING REQUIREMENTS

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

BASES

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

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

REFERENCES

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

2. 10 CFR Part 50, Appendix A.

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

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

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

6. PROCESS CONTROL PROGRAM Manual.

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

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-12 Total Dose

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

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

BASES

This SLC is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The SLC requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mrem to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the units and from outside storage tanks are kept small.

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

BASES (continued)

If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 and a variance is granted until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in SLC 16.11-1 and SLC 16.11-6.

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-13 Monitoring Program

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

(continued)

REMEDIAL ACTIONS (continued)

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

TESTING REQUIREMENTS

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

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 1 of 7)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation(2)	Forty routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the SITE BOUNDARY; An outer ring of stations, one in each meteorological sector in the 6- to 8-km range from the site; and The balance of the stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly	Gamma dose quarterly

(continued)

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 2 of 7)

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

(continued)

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 3 of 7)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS(1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
3. Waterborne			
a. Surface(5)	One sample upstream. One sample downstream.	Composite sample over 1-month period (6).	Gamma isotopic analysis (4) monthly. Composite for tritium analysis quarterly.
b. Ground	Samples from one or two sources only if likely to be affected(7).	Quarterly	Gamma isotopic (4) and tritium analysis quarterly.
c. Drinking	One sample of each of one to three of the nearest water supplies that could be affected by its discharge. One sample from a control location.	Composite sample over 2-week period (6) when I-131 analysis is performed; monthly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year (8). Composite for gross beta and gamma isotopic analyses (4) monthly. Composite for tritium analysis quarterly.
d. Sediment from Shoreline	One sample from downstream area with existing or potential recreational value.	Semiannually	Gamma isotopic analysis (4) semiannually.

(continued)

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 4 of 7)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. Ingestion			
a. Milk	Samples from milking animals in three locations within 5-km distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 5 to 8 km distant where doses are calculated to be greater than 1 mrem per year [8]. One sample from milking animals at a control location 15 to 30 km distant and in the least prevalent wind direction.	Semimonthly when animals are on pasture; monthly at other times.	Gamma isotopic [4] and I-131 analysis semi-monthly when animals are on pasture; monthly at other times.
b. Fish and Invertebrates	One sample each of a predatory species, a bottom feeder and a forage species in vicinity of plant discharge area. One sample each of a predatory species, a bottom feeder and a forage species in areas not influenced by plant discharge.	Sample in season, or semiannually if they are not seasonal.	Gamma isotopic analysis [4] on edible portions.

(continued)

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 5 of 7)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
4. Ingestion (Continued)			
c. Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest [9].	Gamma isotopic analyses [4] on edible portion.
	Samples of three different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed.	Monthly, when available.	Gamma isotopic [4] and I-131 analysis.
	One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly, when available.	Gamma isotopic [4] and I-131 analysis.

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 6 of 7)

NOTES:

(1) Specific parameters of distance and direction sector from the centerline of the station, and additional description where pertinent, shall be provided for each and every sample location in Table 16.11-13-1 in a table and figure(s) in the ODCM. Refer to NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," October 1978, and to Radiological Assessment Branch Technical Position, Revision 1, November 1979. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances such as hazardous conditions, seasonal unavailability, and malfunction of automatic sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the Radiological Environmental Monitoring Program. In lieu of any Licensee Event Report required by 10 CFR 50.73 and pursuant to Technical Specification 5.6.3, identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

(2) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. (The 40 stations is not an absolute number. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information within minimal fading.)

(3) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than 10 times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

Table 16.11-13-1

Radiological Environmental Monitoring Program (page 7 of 7)

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

(5) The “upstream sample” shall be taken at a distance beyond significant influence of the discharge. The “downstream” sample shall be taken in an area beyond but near the mixing zone. “Upstream” samples in an estuary must be taken far enough upstream to be beyond the plant influence. Salt water shall be sampled only when the receiving water is utilized for recreational activities.

(6) A composite sample is one in which the rate at which the liquid sampled is uniform and in which the method of sampling employed results in a specimen that is representative of the time-averaged concentration at the location being sampled. In this program composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

(7) Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

(8) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

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

Table 16.11-13-2

Reporting Levels for Radioactivity Concentrations in Environmental Samples

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)
H-3	20,000[(1)]				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200			300	

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

Table 16.11-13-3

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

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	FOOD PRODUCTS (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2000[5]					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1[4]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		

Table 16.11-13-3

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

NOTES:

(1) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2.

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

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

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

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

Where:

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

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

E = the counting efficiency (counts per disintegration);

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

2.22 = the number of disintegrations per minute per picoCurie;

Y = the fractional radiochemical yield, when applicable;

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

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

T = the sample counting time (min).

Table 16.11-13-3

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

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

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2.

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

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

BASES

The Radiological Environmental Monitoring Program required by this SLC provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the plant operation. This Monitoring Program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the Radiological Effluent Monitoring Program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this Monitoring Program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified Monitoring Program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

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

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

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

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

BASES (continued)

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

REFERENCES

1. Catawba Offsite Dose Calculation Manual.

2. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-14 Land Use Census

COMMITMENT

--NOTE--
Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Requirements for broad leaf vegetation sampling in Table 16.11-13-1 (Item 4c) shall be followed, including analysis of control samples.

A Land Use Census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence, and the nearest garden of > 50 m^2 (500 ft^2) producing broad leaf vegetation.

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

(continued)

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

BASES This SLC is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the Radiological Environmental Monitoring Program given in the ODCM are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey, or from consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 m^2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantify (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and (2) a vegetation yield of 2 kg/m^2.

BASES (continued)

With a Land Use Census identifying a location(s) which yield a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with SLC 16.11-13, add the new location(s) within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment, via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this Land Use Census was conducted.

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-15 Interlaboratory Comparison Program

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

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

BASES (continued)

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

REFERENCES 1. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

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

COMMITMENT Annual Radiological Environmental Operating Report

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

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, with operational controls as appropriate, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of the Land Use Census.

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

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

A single submittal may be made for the station.

(continued)

COMMITMENT (continued)

Radioactive Effluent Release Report

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

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

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

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

(continued)

COMMITMENT (continued)

a. Total container volume, in cubic meters,

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

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

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

e. Number of shipments, and

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

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

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

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS None

TESTING REQUIREMENTS None

BASES None

REFERENCES None

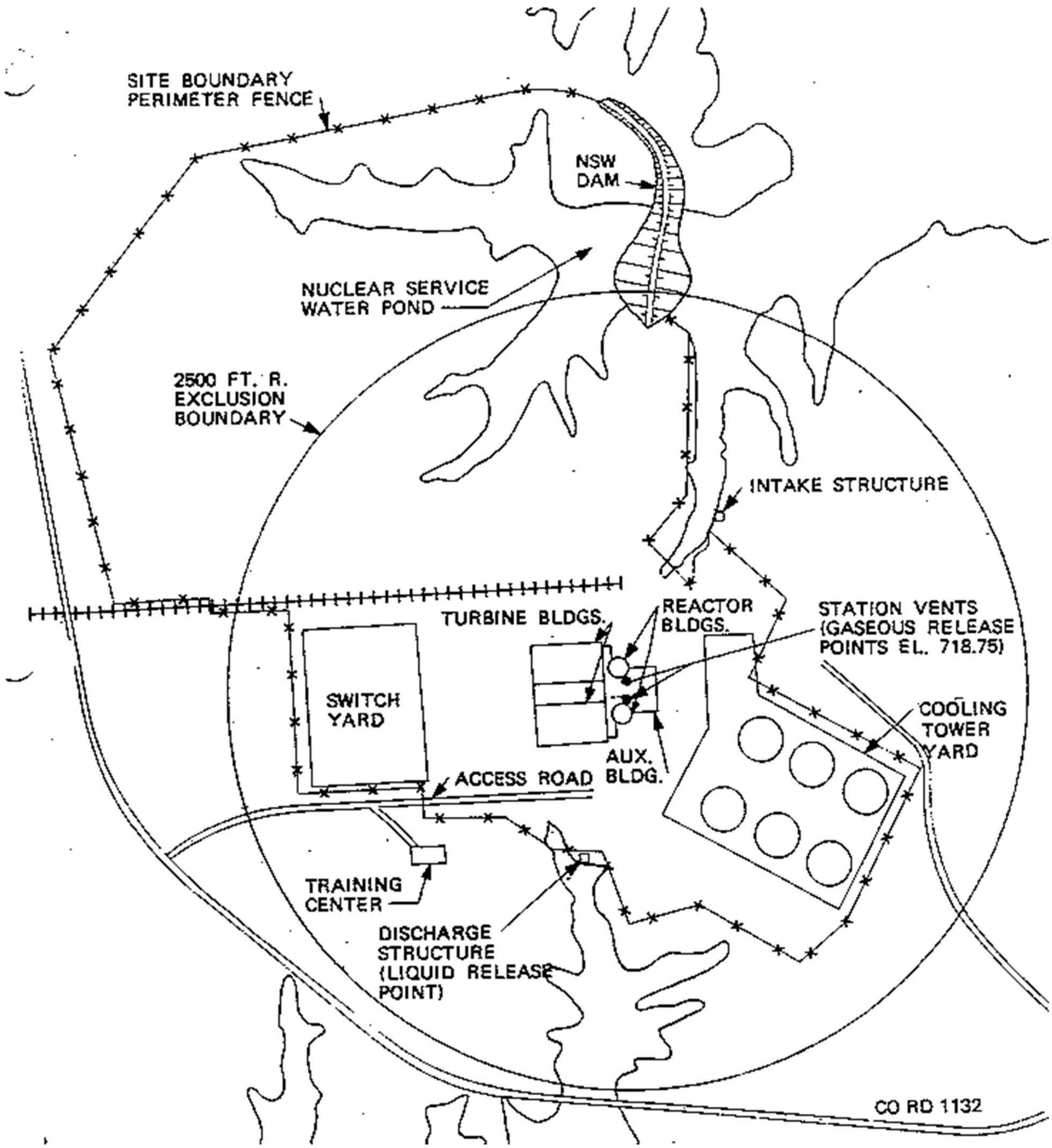


Figure 16.11-16-1

UNRESTRICTED AREA and SITE BOUNDARY for Radioactive Effluents

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-17 Liquid Holdup Tanks

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

BASES

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

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

REFERENCES

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

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-18 Explosive Gas Mixture

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

BASES

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

REFERENCES

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

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-19 Gas Storage Tanks

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

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

BASES

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

REFERENCES

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

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

16.11-20 Explosive Gas Monitoring Instrumentation

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

APPLICABILITY: During WASTE GAS HOLDUP SYSTEM operation.

REMEDIAL ACTIONS

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

(continued)

REMEDIAL ACTIONS (continued)

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

TESTING REQUIREMENTS

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

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

(continued)

TESTING REQUIREMENTS (continued)

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

Table 16.11-20-1

Explosive Gas Monitoring Instrumentation

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

BASES

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

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

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

REFERENCES

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

16.11 RADIOLOGICAL EFFLUENTS CONTROLS

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

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

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

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

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

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

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

    e. An evaluation of the change, which shows the expected maximum exposures to a MEMBER OF THE PUBLIC in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto;

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

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

(continued)

COMMITMENT (continued)

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

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

APPLICABILITY: At all times.

REMEDIAL ACTIONS None

TESTING REQUIREMENTS None

BASES None

REFERENCES

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

ATTACHMENT 10

Summary of Changes to the Process Control Program

This attachment includes a summary of changes to the PCP.

Attachment 10
Summary of Changes to the Process Control Program

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

No revision of the Catawba Nuclear Station PCP was published in 2021.

<u>ATTACHMENT 11</u>

Summary of Major Modifications to the Radioactive Waste Treatment Systems

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

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

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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 2021.

<u>ATTACHMENT 12</u>

Errata to a Previous Year's ARERR

This attachment includes any amended pages from a previous year's ARERR.

Attachment 12
Errata to a Previous Year's ARERR

Catawba Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

There is are no amendments to a previous year's ARERR.

ENCLOSURE 3: HNP Annual Radioactive Effluent Release Report

Shearon Harris Nuclear Power Plant
Unit 1

Annual Radioactive Effluent Release Report

January 1, 2021 through December 31, 2021

Docket 50-400

Introduction

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

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

ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
1. Total Release	Ci	1.67E-01	0.00E+00	3.86E+00	1.16E-01	4.41E+00
2. Avg. Release Rate	μCi/sec	2.15E-02	0.00E+00	4.86E-01	1.46E-02	1.74E-01
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	2.98E+01	2.81E+01	2.15E+01	1.73E+01	9.67E+01
2. Avg. Release Rate	μCi/sec	3.83E+00	3.57E+00	2.70E+00	2.17E+00	3.06E+00
E. Gross Alpha						
1. Total Release	Ci	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00
2. Avg. Release Rate	μCi/sec	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Gross Alpha						
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* 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 1/1/2021 - 12/31/2021

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	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Gross Alpha						
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* 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 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	1.67E-01	-	3.86E+00	1.16E-01	4.14E+00
Total for Period	Ci	1.67E-01	-	3.86E+00	1.16E-01	4.14E+00
B. Iodines						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00+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	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
H-3	Ci	2.98E+01	2.80E+01	2.15E+01	3.73E+01	1.73E+01
E. Gross Alpha						
Total for Period	Ci	0.00+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 1/1/2021 - 12/31/2021

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	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00+00	0.00+00	0.00+00
C. Particulates Half-Life ≥ 8 days						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00+00	0.00+00	0.00E+00
D. Tritium						
H-3	Ci	1.11E-04	5.18E-02	0.00E+00	0.00+00	5.19E-02
E. Gross Alpha						
Total for Period	Ci	0.00+00	0.00+00	0.00+00	0.00+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Gross Alpha						
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* 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 1/1/2021 - 12/31/2021

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	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Gross Alpha						
Total for Period	Ci	0.00+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* 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 1/1/2021 - 12/31/2021

Liquid Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
1. Total Release	Ci	1.16E-04	4.40E-03	1.73E-03	1.04E-03	7.28E-03
2. Avg. Diluted Conc.	µCi/ml	2.41E-11	9.12E-10	3.65E-10	2.03E-10	3.76E-10
B. Tritium						
1. Total Release	Ci	2.11E+02	1.20E+02	4.33E+01	4.33E+01	4.17E+02
2. Avg. Diluted Conc.	µCi/ml	4.40E-05	2.49E-05	9.11E-06	8.48E-06	2.16E-05
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	2.41E-04	0.00E+00	0.00E+00	2.41E-04
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	4.99E-11	0.00E+00	0.00E+00	4.99E-11
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Batch Releases	liters	7.84E+05	1.13E+06	1.17E+06	6.05E+05	3.68E+06
2. Continuous Releases	liters	1.26E+07	1.30E+07	1.46E+07	1.15E+07	5.16E+07
F. Volume of Dilution Water						
1. Batch Releases	liters	4.79E+09	4.83E+09	4.75E+09	5.11E+09	1.94E+10
2. Continuous Releases	liters	4.79E+09	4.83E+09	4.75E+09	5.11E+09	1.94E+10

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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	-	-	-	-	-
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Cr-51	Ci	-	6.23E-05	5.80E-05	-	1.20E-04
Mr-54	Ci	-	1.48E-04	6.30E-05	-	2.11E-04
Fe-55	Ci	-	-	1.61E-04	4.52E-05	2.06E-04
Co-58	Ci	-	6.67E-05	1.27E-04	-	1.93E-04
Co-60	Ci	1.16E-04	2.24E-03	5.38E-04	1.49E-04	3.04E-03
Ni-63	Ci	-	1.42E-03	1.54E-04	7.75E-04	2.34E-03
Zr-95	Ci	-	9.57E-06	3.80E-05	-	4.75E-05
Nb-95	Ci	-	9.52E-05	1.03E-04	-	1.98E-04
Sb-124	Ci	-	1.01E-05	2.94E-05	-	3.95E-05
Sb-125	Ci	-	1.04E-04	4.26E-04	5.27E-05	5.82E-04
Cs-137	Ci	-	4.74E-05	3.48E-05	1.76E-05	9.98E-05
Total for Period	Ci	1.16E-04	4.40E-03	1.73E-03	1.04E-03	7.28E-03
B. Tritium						
H-3	Ci	2.11E+02	1.20E+02	4.33E+01	4.33E+01	4.17E+02
C. Dissolved & Entrained Gases						
Xe-133	Ci	-	2.41E-04	-	-	2.41E-04
Total for Period	Ci	0.00+00	2.41E-04	0.00+00	0.00+00	2.41E-04
Gross Alpha						
D. Total for Period	Ci	0.00+00	0.00+00	0.00+00	0.00+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 1/1/2021 - 12/31/2021

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.

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

V. <u>Batch Releases</u>

A. Liquid Effluents

			Jan - Jun	**Jul - Dec**
1.	Number of Batch Releases	=	25	23
2.	Total Time Period for Batch Releases	=	1.99E+04 min	1.77E+04 min
3.	Maximum Time Period for a Batch Release	=	9.60E+02 min	8.85E+02 min
4.	Average Time Period for a Batch Release	=	7.95E+02 min	7.71E+02 min
5.	Minimum Time Period for a Batch Release	=	7.20E+02 min	6.32E+02 min
6.	Average Stream Flow During Release Periods	=	1.01E+04 gpm	9.62E+03 gpm

B. Gaseous Effluents

			Jan - Jun	**Jul - Dec**
1.	Number of Batch Releases	=	9	0
2.	Total Time Period for Batch Releases	=	7.29E+03 min	0.00E+00 min
3.	Maximum Time Period for a Batch Release	=	3.68E+03 min	0.00E+00 min
4.	Average Time Period for a Batch Release	=	8.10E+02 min	0.00E+00 min
5.	Minimum Time Period for a Batch Release	=	1.22E+02 min	0.00E+00 min

VI. <u>Abnormal Releases</u>

See Attachment 5, Unplanned Offsite Releases.

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Carbon-14

The Shearon Harris Nuclear Power Plant 2021 ARERR contains estimates of C-14 radioactivity released in 2021, and estimates of public dose resulting from the C-14 effluent. The concentration and offsite dose from C-14 has been estimated by using a calculation approach, assuming typical or maximum values for the various calculation parameters. Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2).

The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). The Shearon Harris Nuclear Power Plant UFSAR Section 11.1.5 states the expected C-14 generation to be 7.3 Curies assuming 292 effective full power days (EFPD) in a calendar year. For the Shearon Harris Nuclear Power Plant 2021 ARERR, a source term scaling factor using actual EFPD of 338.23 days is assumed. Using the source term scaling factor from Shearon Harris Nuclear Power Plant in 2021 results in a site total C-14 gaseous release estimate to the environment of 8.46 Curies. Due to the reducing environment of a Pressured Water Reactor, only 30% of the C-14 is assumed to be released in the Carbon Dioxide (CO_2) form. Dose is not expected from other forms (methane, etc). 70% of the C-14 gaseous effluent is assumed to be from batch releases and the remaining 30% is assumed to be from continuous releases through the plant vent (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004).

The resultant offsite doses were based upon this source term and the dose calculations described in NRC Regulatory Guide 1.109, Revision 1, and the Shearon Harris Nuclear Power Plant ODCM. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Shearon Harris Nuclear Power Plant in 2021 is well below the 10CFR 50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit). The Harris Nuclear Plant Land Use Census did not provide sufficient detail for ages groups at the residences. Therefore, a Child was assumed to be at each residence for the C-14 dose calculation. The receptor location of 2.91 km NNE and the Critical Age of a Child was the most restrictive receptor and age group out of the sixteen sectors.

	Units	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Year
1. EFPD	Days	89.84	64.49	91.95	91.95	338.23
2. C-14 Activity Released	Ci	2.25E+00	1.61E+00	2.30E+00	2.30E+00	8.46E+00
3. C-14 Total Body Dose	mREM	1.33E-02	9.28E-03	1.32E-02	1.32E-02	4.89E-02
4. C-14 Organ Dose	mREM	6.69E-02	4.67E-02	6.65E-02	6.65E-02	2.46E-01

Receptor Location ***2.91*** km ***NNE***
Critical Age ***CHILD***
Critical Organ ***BONE***

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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 2021*". 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 2021.

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
1. H-3 Activity Released	Ci	5.71E-01	4.80E-01	3.12E-01	2.56E-01	1.62E+00
2. H-3 Dose	mREM	7.31E-04	6.14E-04	4.03E-04	3.31E-04	2.08E-03

Receptor Location ***2.91*** km ***NNE***
Critical Age ***CHILD***
Critical Organ ***N/A*** *

Harris Lake Evaporation

Evaporation of water containing tritium in Harris Lake creates an exposure pathway to a member of the public. Murray and Trettle, Inc. was contracted to perform an evaluation of the dose to a member of the public from evaporation of tritium in Harris Lake. Results of the evaluation are contained in report "*Impact of Tritium Release from the Water Reservoir (Lake Harris) at the Harris Nuclear Plant for 2021*". Using the methodology described in ODCM 2.3.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2021.

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
1. H-3 Activity Released	Ci	1.41E+01	2.59E+01	2.36E+01	1.20E+01	7.58E+01
2. H-3 Dose	mREM	1.61E-02	2.99E-02	2.69E-02	1.37E-02	8.65E-02

Receptor Location ***6.65*** km ***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 2021, 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 2021.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	1.77E+03
2. H-3 Dose	mREM	4.86E-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

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 2021, 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 2021.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	3.89E+03
2. H-3 Dose	mREM	7.72E-03

Critical Age ***ADULT***
Critical Organ ***N/A*** *

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

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Overall Estimate of Error for Gaseous Effluent Radioactivity Release Reported

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

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

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

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

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

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

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

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Overall Estimate of Error for Liquid Effluent Radioactivity Release Reported

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

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

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

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

Overall Estimate of Error for Solid Waste Radioactivity Reported

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

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

Attachment 2
Supplemental Information

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2021 Land Use Census was performed July 12 - 13, 2021. The following are changes to residences, gardens, and milk animals from the previous year.

RESIDENCES

- The Residence in the ESE sector was replaced with a closer residence (2.56 mi).
- The Residence in the NW sector was replaced with a residence at the same mileage (2.11 mi.). EnRad has opted to be less intrusive to the public and obtain GPS reading from the mailbox, however three homes all have the same mileage, so driveways were driven up to detennine which residence was the closest. In 2020, when the closest residence change occurred due to previous closest residence being unoccupied, it was noted that the residence being used for 2021 LUC would be the closest to HNP but the home was for sale and unoccupied in 2020. The new closest residence in the NW sector at 2.11 miles is occupied by members of the public in 2021.

GARDENS

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

- A new, more distant garden was located in the SSE sector at 4.82 miles this year. The previous garden was not present.

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 2021 census.

- The meat animal in the N sector (2.21 miles) was present in 2021..

MILK ANIMALS

- The milk animals (goats) located in the N sector (4.14 miles) were still present, and the owner indicated they are now processing enough milk to participate in the REMP. This dairy is not required to be added to the REMP due to HNP already having a dairy within 5 km (3.11 miles) and the dose being <1.0 mRem/year.
- The milk animals (goats) located in the W sector (2.82 miles) were still present, and currently participate in the HNP REMP Environmental Program. The goat milk is used to feed goat kids during the breeding months, and the remainder is consumed by the family. They also give the non-consumable milk to someone who makes soap..

The changes observed in the 2021 Land Use Census from the previous year's survey are listed above.
Based upon the 2021 HNP Land Use Census and subsequent site dose evaluation, there are no changes identified or needed to the Harris REMP at this time.

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 1/1/2021 - 12/31/2021

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

NOTE: Values reported in Table 3 section 1.A.a, b, c & 1.B.a, b, c, d refers to radioactive solid waste materials shipped in 2021 to a vendor for processing and subsequent burial.

A. Type of Waste

a. Spent resins.

Note: Waste shipped in 2021 for processing and subsequent burial

Number of Shipments	5
Activity Shipped	3.57E+01 Curies
Estimated Total Error	96%
Quantity Shipped	22.05 m^3
Solidification Agent	N/A
Container Type	NRC/DOT-Approved Package
Shipment Form	Dewatered, Compacted

b. Dry Active Waste (DAW), mechanical filters, contaminated equipment, etc.
Note: Waste shipped in 2021 for processing and subsequent burial.

Number of Shipments	2
Activity Shipped	1.43E-01 Curies
Estimated Total Error	96%
Quantity Shipped	118.48 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: Waste shipped in 2021 for processing and subsequent burial.

Number of Shipments	1
Activity Shipped	8.81E-02 Curies
Estimated Total Error	96%
Quantity Shipped	0.62 m^3
Solidification Agent	N/A
Container Type	General Design
Shipment Form	Compacted, Non-Compacted

d. Other: GAC Vessels

Note: Note: Waste shipped in 2021 for processing and subsequent burial.

Number of Shipments	1	
Activity Shipped		1.35E-01 Curies
Estimated Total Error	96%	
Quantity Shipped	1.7 m^3	
Solidification Agent	N/A	
Container Type		General Design
Shipment Form		Compacted, Non-Compacted

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

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

      a. Spent Radwaste Bead Resin.

      Note: Waste shipped in 2021 for processing and subsequent burial.

Class A Spent Resin Totals

Isotope	Activity (Mci)	Activity (Ci)	Abundance
Be-7	1.15E+02	1.15E-01	0.32%
C-14	6.48E+01	6.48E-02	0.18%
Ce-144	1.59E+01	1.59E-02	0.04%
Co-57	4.94E+00	4.94E-03	0.01%
Co-58	2.39E+01	2.39E-02	0.07%
Co-60	4.20E+03	4.20E+00	11.77%
Cs-137	1.96E+03	1.96E+00	5.50%
Fe-55	1.33E+04	1.33E+01	37.20%
Fe-59	0.00E+00	0.00E+00	0.00%
H-3	4.91E+02	4.91E-01	1.38%
I-129	5.59E-01	5.59E-04	0.00%
Mn-54	1.58E+03	1.58E+00	4.44%
Nb-95	1.52E+01	1.52E-02	0.04%
Ni-63	1.37E+04	1.37E+01	38.35%
Sb-125	2.04E+02	2.04E-01	0.57%
Sn-113	7.35E+00	7.35E-03	0.02%
Sr-89	0.00E+00	0.00E+00	0.00%
Sr-90	2.31E+01	2.31E-02	0.06%
Tc-99	1.19E+00	1.19E-03	0.00%
Zr-95	7.02E+00	7.02E-03	0.02%
Am-241	5.79E-01	5.79E-04	0.00%
Sb-124	2.45E-01	2.45E-04	0.00%
Grand Total	**3.57E+04**	**3.57E+01**	**100.00%**

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

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

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

      Note: Waste shipped in 2021 for processing and subsequent burial.

Class A DAW Totals

DAW			
Isotope	**Activity(mCi)**	**Activity (Ci)**	**Abundance**
C-14	4.54E+00	4.54E-03	3.17%
Ce-144	1.78E+00	1.78E-03	1.24%
Co-58	3.24E+00	3.24E-03	2.26%
Co-60	3.65E+01	3.65E-02	25.46%
Cs-137	4.94E-01	4.94E-04	0.34%
H-3	1.53E+01	1.53E-02	10.69%
I-129	9.06E-02	9.06E-05	0.06%
Mn-54	1.68E+00	1.68E-03	1.17%
Nb-95	2.14E+01	2.14E-02	14.94%
Ni-63	3.69E+01	3.69E-02	25.75%
Tc-99	4.57E+00	4.57E-03	3.19%
Zr-95	1.68E+01	1.68E-02	11.73%
Grand Total	**1.43E+02**	**1.43E-01**	**100.00%**

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

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

      c. Irradiated components, control rods, etc.

      Note: Waste shipped in 2021 for processing and subsequent burial

	Irradiated Components		
Isotope	**Activity (Mci)**	**Activity (Ci)**	**Abundance**
C-14	6.70E-03	6.70E-06	0.01%
Ce-144	1.18E-05	1.18E-08	0.00%
Co-58	3.75E-01	3.75E-04	0.43%
Co-60	2.48E+01	2.48E-02	28.14%
Cr-51	2.22E+01	2.22E-02	25.16%
Cs-137	2.80E-05	2.80E-08	0.00%
Fe-55	3.74E+01	3.74E-02	42.42%
Fe-59	7.30E-01	7.30E-04	0.83%
H-3	8.30E-03	8.30E-06	0.01%
I-129	7.09E-07	7.09E-10	0.00%
Mn-54	2.18E-01	2.18E-04	0.25%
Nb-95	2.97E-04	2.97E-07	0.00%
Ni-63	8.99E-01	8.99E-04	1.02%
Tc-99	8.53E-06	8.53E-09	0.00%
Zr-95	1.96E-04	1.96E-07	0.00%
Ni-59	6.46E-03	6.46E-06	0.01%
Zn-65	1.52E+00	1.52E-03	1.73%
Nb-94	5.09E-05	5.09E-08	0.00%
Grand Total	**8.81E+01**	**8.81E-02**	**100.00%**

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

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

      d. Other (GAC Vessels)

      Note: Waste shipped in 2021 for processing and subsequent burial

	GAC Vessels		
Isotope	**Activity(mCi)**	**Activity (Ci)**	**Abundance**
C-14	1.06E+00	1.06E-03	0.79%
Ce-144	1.10E-01	1.10E-04	0.08%
Co-57	3.58E-02	3.58E-05	0.03%
Co-58	8.28E-02	8.28E-05	0.06%
Co-60	4.12E+01	4.12E-02	30.60%
Cs-137	2.17E-01	2.17E-04	0.16%
Fe-55	3.12E+01	3.12E-02	23.14%
H-3	3.12E+01	3.12E-02	23.20%
I-129	3.04E-02	3.04E-05	0.02%
Mn-54	1.62E+00	1.62E-03	1.21%
Ni-63	2.60E+01	2.60E-02	19.34%
Sb-125	1.63E+00	1.63E-03	1.21%
Tc-99	2.32E-01	2.32E-04	0.17%
Grand Total	**1.35E+02**	**1.35E-01**	**100.00%**

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

   C. Solid Waste Disposal

Number of Shipments	9
Mode of Transportation	Truck
Destination	Energy Solutions

Note: Waste shipped in 2021 for processing and subsequent burial

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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.

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

   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 1/1/2021 - 12/31/2021

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

A. Type of Waste

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

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

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

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

c. Irradiated Components, Control Rods, etc.

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

d. Other (Describe)

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

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

N/A

C. Solid Waste Disposal

N/A

Attachment 3
Solid Radioactive Waste Disposal

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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).

Attachment 4
Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	1.01-1.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.26-1.50	0	0	0	0	0	1	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	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	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	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	1	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	1	0	0	0	0	1	2	0	1	1	0	0	2	0
	2.01-3.00	2	0	2	2	0	0	1	3	5	2	1	4	4	1	2	1
	3.01-4.00	3	1	7	0	0	0	0	4	5	2	6	7	2	1	1	3
	4.01-5.00	2	0	0	0	0	0	0	0	0	3	5	3	1	1	6	2
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	1	0	2	3	2	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	3	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 1/1/2021 - 12/31/2021

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	1	0	2	0	0
	1.01-1.25	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0
	1.26-1.50	1	0	0	0	0	0	0	0	3	1	1	0	1	1	2	1
	1.51-2.00	3	3	1	2	3	1	4	5	4	3	2	4	5	6	6	3
	2.01-3.00	14	9	13	14	9	3	4	10	29	18	27	22	12	13	23	12
	3.01-4.00	15	3	1	1	1	0	0	4	31	10	13	25	5	9	10	11
	4.01-5.00	7	1	0	0	0	0	0	0	2	4	14	4	0	6	5	1
	5.01-6.00	1	0	0	0	0	0	0	0	0	4	4	2	0	0	1	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.46-0.75	6	2	5	3	3	6	7	2	2	4	2	6	2	5	5	7
	0.76-1.00	8	7	6	11	7	9	11	5	6	15	14	8	12	9	9	5
	1.01-1.25	13	13	13	16	6	8	11	12	6	14	9	10	14	11	11	10
	1.26-1.50	26	33	18	17	11	12	18	19	22	29	18	20	8	11	20	18
	1.51-2.00	61	67	52	42	21	22	53	41	55	69	61	47	23	22	33	38
	2.01-3.00	153	156	76	42	37	21	16	60	96	130	134	106	34	27	61	98
	3.01-4.00	78	51	29	15	0	1	3	27	49	37	66	41	13	16	35	52
	4.01-5.00	14	24	11	5	0	0	1	1	13	21	43	17	4	8	22	18
	5.01-6.00	2	4	1	0	0	0	0	0	0	13	14	8	1	2	4	7
	6.01-8.00	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0
	8.01-10.00	0	1	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 1/1/2021 - 12/31/2021

Stability Class	Wind Speed (m/s)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.46-0.75	13	17	20	13	4	6	13	8	10	15	7	9	10	10	7	15
	0.76-1.00	15	26	18	20	10	7	15	18	21	22	12	15	15	8	21	18
	1.01-1.25	15	23	16	13	10	11	18	16	20	23	11	18	12	7	3	17
	1.26-1.50	28	24	15	14	7	4	18	23	25	31	19	22	7	11	8	21
	1.51-2.00	37	52	19	17	12	12	16	24	41	64	42	25	11	8	18	23
	2.01-3.00	36	33	22	10	10	4	6	20	60	108	56	28	7	10	6	39
	3.01-4.00	2	7	10	4	1	1	0	1	3	34	11	4	0	1	6	8
	4.01-5.00	2	2	0	0	0	0	0	0	1	10	6	1	0	2	1	0
	5.01-6.00	0	1	0	0	0	0	0	0	0	4	2	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.46-0.75	16	18	27	14	7	5	5	3	7	3	12	8	6	3	7	10
	0.76-1.00	16	11	17	21	12	5	7	7	11	10	7	2	13	6	10	11
	1.01-1.25	19	10	11	13	2	1	7	2	5	9	6	6	2	7	7	10
	1.26-1.50	12	4	6	3	0	2	5	4	4	6	9	9	1	7	5	11
	1.51-2.00	16	4	2	1	0	0	1	0	6	15	3	9	0	1	3	8
	2.01-3.00	0	0	0	0	0	0	0	0	2	7	2	0	0	0	1	0
	3.01-4.00	1	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-Max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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	34	37	43	41	10	6	7	4	1	6	2	5	5	12	16	39
	0.76-1.00	20	12	11	10	1	8	3	2	0	7	5	4	6	4	7	14
	1.01-1.25	8	4	2	2	1	0	1	0	2	3	6	2	2	2	1	7
	1.26-1.50	4	2	1	0	0	0	0	1	2	1	0	1	0	0	2	5
	1.51-2.00	0	0	0	0	0	0	0	0	2	1	1	0	0	0	0	3
	2.01-3.00	0	0	0	0	0	0	0	0	2	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 1/1/2021 - 12/31/2021

Shearon Harris Nuclear Power Plant had zero (0) unplanned liquid release in 2021.

Shearon Harris Nuclear Power Plant had zero (0) unplanned gaseous release in 2021.

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 1/1/2021 - 12/31/2021

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Beta Air	mRAD	1.00E-04	0.00E+00	2.31E-03	6.95E-05	2.48E-03
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	20.00
(b) % of Limit		1.00E-03	0.00E+00	2.31E-02	6.95E-04	1.24E-02
2. Maximum Gamma Air	mRAD	3.36E-05	0.00E+00	7.78E-04	2.34E-05	8.35E-04
(a) Limit	mRAD	5.00	5.00	5.00	5.00	10.00
(b) % of Limit		6.73E-04	0.00E+00	1.56E-02	4.67E-04	8.35E-03

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

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	1.19E-01	1.12E-01	8.56E-02	6.87E-02	3.85E-01
(a) Limit	mREM	7.50	7.50	7.50	7.50	15.00
(b) % of Limit		1.58E+00	1.49E+00	1.14E+00	9.16E-01	2.56E+00

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

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	8.21E-02	1.14E-01	9.16E-02	1.98E-02	3.05E-01
(a) Limit	mREM	5.00	5.00	5.00	5.00	10.00
(b) % of Limit		1.64E+00	2.29E+00	1.83E+00	3.96E-01	3.08E+00
2. Maximum Total Body Dose	mREM	8.19E-02	5.35E-02	2.31E-02	2.31E-02	1.82E-01
(a) Limit	mREM	1.50	1.50	1.50	1.50	3.00
(b) % of Limit		5.46E+00	3.57E+00	1.54E+00	1.54E+00	6.05E+00

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

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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 millirem to the total body or any organ with the exception of the thyroid which is limited to 75 millirem. 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 2019 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	
1. Location	2.14 km SW
2. Critical Age	CHILD
3. Critical Organ	Thyroid
4. Organ Dose (mREM)	3.85E-01
5. Total Body Dose (mREM)	3.85E-01
B. Liquid Effluent Dose	
1. Location	2.19 km S
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	3.08E-01
5. Total Body Dose (mREM)	1.82E-01
C. Carbon-14 Dose	
1. Location	2.91 km NNE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	2.46E-01
5. Total Body Dose (mREM)	4.89E-02
D. Cooling Tower Plume H-3 Dose	
1. Location	2.91 km NNE
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	-
5. Total Body Dose (mREM)	2.08E-03
E. Harris Lake Evaporation H-3 Dose	
1. Location	6.65 km SSW
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	-
5. Total Body Dose (mREM)	8.65E-02
F. Drinking Water H-3 Dose	
1. Location	Harris Plant
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	-
5. Total Body Dose (mREM)	4.86E-02
G. H-3 in Fish from Harris Lake	
1. Location	Harris Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	-
5. Total Body Dose (mREM)	7.72E-03

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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 1/1/2021 - 12/31/2021

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

Results from sampling during 2021 are shown in the table below.

Well #	Tritium Concentration (ρCi/L) 1st Half of Yr	Tritium Concentration (ρCi/L) 2nd Half of Yr	# Samples
76	194	357	2
HMW1S	258	304	2
HMW2S	<MDA	<MDA	2
HMW3S	-	<MDA	2
HMW4D	<MDA	<MDA	2
HMW4S	<MDA	<MDA	2
HMW5S	-	<MDA	1
HMW6S	491	486	2
HMW7S	-	<MDA	1
HMW8S	-	<MDA	1
HMW9S	-	<MDA	1
HMW10S	-	<MDA	1
HMW11S	-	<MDA	1

NOTE: Minimum Detectible Activity (MDA) for monitoring wells is approximately 185 ρCi/L

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 2021.

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 1/1/2021 - 12/31/2021

NCR 02342424 - On July 5, 2020 Stack 5A Flowrate Monitor (PNL-*1WV-3547-1) failed MST-I0413. The flowrate monitor was declared inoperable for the MST on 7/5/2020 and exceeded the 30 out of service timeline on 8/5/2020 as documented in NCR 02342424. The delay in restoration was due to the flowrate valve requiring replacement. The valve was identified as being obsolete by the vendor, requiring fabrication and certification from the manufacture. Flowrate monitor remained out of service from 1/1/2021 through 06/22/2021. OWP-RM-15 was implemented and flowrate estimates were performed under OP-118 by Operations. Releases permits continued to be performed by the Chemistry Effluent personnel as release were still being monitored. This condition is being documented in the 2021 HNP ARERR pursuant to ODCM Appendix F, Section F.2. There were no unplanned or unmonitored releases.

NCR 2379780 - Turbine Building Vent Stack Radiation Monitor Compensatory action missed by Chemistry. 3 hour flow check missed on 4/25/2021 @ 1940. Flow not checked until 2240 during compensatory sample. This misses the 4 hour ODCM requirement and the 25% grace period. Required Sample, analysis, and flow verification performed at 2240. Sample flow was unchanged from 1640. Sample flow is estimated to be consistent at 1940. This condition is being documented in the 2021 HNP ARERR pursuant to ODCM Appendix F, Section F.2.

NCR 2385548 - The Plant Vent Stack (PVS) radiation monitor was determined to be inoperatable on 6/5/21 @ 0447. The ODCM requires an estimated flow every 4 hours which is satisfied by the Main Control Room by using OSI-PI point FRM3509B. ERC-009 “Handling Inoperable Monitors” for inoperable gaseous rad monitors requires a check of the Aux sampler operation every 3 hours. On 6/9/21 a check of the aux sampler installed on the PVS was required at 0745, however, the check was missed. The aux sampler was operating satisfactorily at the 0445 and 1045 checks with no indications of malfunction. No ODCM requirements were missed, the Aux sampler operation check was missed IAW ERC-009. * The Chemistry shift tech and Primary Tech were both coached on ensuring the requirements of handling inoperable rad monitors are met and the importance of meeting those requirements. This condition is being documented in the 2021 HNP ARERR pursuant to ODCM Appendix F, Section F.2.

NCR 2386693 - The Plant Vent Stack 1 (PVS-1) flow check and gamma grab sample were due at 0745. The previous flow check was performed at 0445 and the previous gamma grab was performed at 2245 on 6/18/21. At 0843 the Control Rm called to inquire about the checks. Chemistry performed the flow check at 0850. Started the gamma sample at 0850 and finished at 0900. This misses the flow check requirement but meets guidance for gas grab for within 12 hours dictated by ERC-009. Control Room was requested to increase communications with the Chemistry technician on shift in regard to comp action requirements. This will increase accountability and can serve as a reminder of timely comp action performance while Chemistry Technician is completing many daily and weekly tasks alone. This condition is being documented in the 2021 HNP ARERR pursuant to ODCM Appendix F, Section F.2.

No unplanned or unmonitored releases occurred at Shearon Harris Nuclear Plant during 2021.

Shearon Harris Nuclear Power Plant did not experience temporary outside liquid storage tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2021.

ATTACHMENT 9

Summary of Changes to the Offsite Dose Calculation Manual

This attachment includes a summary of changes to the ODCM.

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

I. Description of Change

No revisions or changes were made to the ODCM during the year 2021.

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 1/1/2021 - 12/31/2021

I. Description of Change

There were no changes to the Process Control Program (PCP) for the Shearon Harris Nuclear plant in the year 2021.

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 1/1/2021 - 12/31/2021

There were no major modifications to Shearon Harris Nuclear Power Plant liquid or solid waste treatment systems in 2021.

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 1/1/2021 - 12/31/2021

Summary: Duke Energy was notified by Mirion (OpenEMS effluent permit vendor) that OpenEMS was not calculating liquid doses for the ARERR in accordance with the Offsite Dose Calculation Manual (ODCM). The ODCM liquid dose equation specifies that the dilution flow used in the near field average dilution factor should be the dilution water flow during the period of release. Previously, OpenEMS was using the dilution flow for a larger time frame when calculating liquid dose for the ARERR. The OpenEMS software ARERR liquid dose calculation was corrected to only include dilution during the liquid effluent release in the near field average dilution factor. Liquid doses on release permits were not impacted by this issue. All years were reviewed in OpenEMS. This timeframe included from 2012 to 2020. Years needing amending were 2012 - 2019. Year 2020 did not require amendment as RG 1.21 reports were generated to obtain the necessary data, one with dilution flow factor set to FALSE and one with dilution flow factor set to TRUE. Following the 2022 update to OpenEMS, the affected ARERR pages are attached.

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2019 - 12/31/2019

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	1.01E-02	3.98E-02	1.06E-01	1.22E-01	2.78E-01
(a) Limit	mREM	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		2.03E-01	7.97E-01	2.12E+00	2.44E+00	2.78E+00
2. Maximum Total Body Dose	mREM	9.90E-03	3.66E-02	1.00E-01	7.05E-02	2.17E-01
(a) Limit	mREM	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
(b) % of Limit		6.60E-01	2.44E+00	6.68E+00	4.70E+00	7.24E+00

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

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2019 - 12/31/2019

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirem to the total body or any organ with the exception of the thyroid which is limited to 75 millirem. 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 2019 environmental TLD data. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included below is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from H-3 in the Shearon Harris Nuclear Power Plant Cooling Tower plume, evaporation of H-3 in Harris Lake, H-3 in on-site drinking water, and H-3 in fish from Harris Lake. The combined dose to a maximum exposed individual from effluent releases, combined with the additional dose pathways, is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose		E. Harris Lake Evaporation H-3 Dose	
1. Location	2.14 km SW	1. Location	6.65 km SSW
2. Critical Age	CHILD	2. Critical Age	CHILD
3. Critical Organ	Thyroid	3. Critical Organ	N/A
4. Organ Dose (mREM)	2.80E-01	4. Organ Dose (mREM)	5.22E-02
5. Total Body Dose (mREM)	2.80E-01	5. Total Body Dose (mREM)	5.22E-02
B. Liquid Effluent Dose		F. Drinking Water H-3 Dose	
1. Location	2.19 km S	1. Location	Harris Plant
2. Critical Age	ADULT	2. Critical Age	ADULT
3. Critical Organ	GI-LLI	3. Critical Organ	N/A
4. Organ Dose (mREM)	2.78E-01	4. Organ Dose (mREM)	7.34E-02
5. Total Body Dose (mREM)	2.17E-01	5. Total Body Dose (mREM)	7.34E-02
C. Carbon-14 Dose		G. H-3 in Fish from Harris Lake	
1. Location	2.91 km NNE	1. Location	Harris Lake
2. Critical Age	CHILD	2. Critical Age	ADULT
3. Critical Organ	BONE	3. Critical Organ	N/A
4. Organ Dose (mREM)	2.27E-01	4. Organ Dose (mREM)	8.28E-03
5. Total Body Dose (mREM)	4.51E-02	5. Total Body Dose (mREM)	8.28E-03
D. Cooling Tower Plume H-3 Dose			
1. Location	2.91 km NNE		
2. Critical Age	CHILD		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	2.31E-03		
5. Total Body Dose (mREM)	2.31E-03		

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2018 - 12/31/2018

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Batch Mode						
1. Maximum Organ Dose	mREM	2.05E-01	1.95E-01	9.18E-03	5.72E-03	4.14E-01
(c) Limit	mREM	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(d) % of Limit		4.09E+00	3.89E+00	1.84E-01	1.14E-01	4.14E+00
2. Maximum Total Body Dose	mREM	1.16E-01	3.43E-02	8.79E-03	5.37E-03	1.64E-01
(c) Limit	mREM	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
(d) % of Limit		7.70E+00	2.28E+00	5.86E-01	3.58E-01	5.46E+00

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

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2018 - 12/31/2018

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirem to the total body or any organ with the exception of the thyroid which is limited to 75 millirem. 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 2018 environmental TLD data. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included below is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from H-3 in the Shearon Harris Nuclear Power Plant Cooling Tower plume, evaporation of H-3 in Harris Lake, H-3 in on-site drinking water, and H-3 in fish from Harris Lake. The combined dose to a maximum exposed individual from effluent releases, combined with the additional dose pathways, is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Gaseous Effluent Dose		E. Harris Lake Evaporation H-3 Dose	
1. Location	2.14 km SW	1. Location	6.65 km SSW
2. Critical Age	CHILD	2. Critical Age	CHILD
3. Critical Organ	LUNG	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.60E-01	4. Organ Dose (mREM)	5.59E-02
5. Total Body Dose (mREM)	4.60E-01	5. Total Body Dose (mREM)	5.59E-02
B. Liquid Effluent Dose		F. Drinking Water H-3 Dose	
1. Location	2.19 km S	1. Location	Harris Plant
2. Critical Age	ADULT	2. Critical Age	ADULT
3. Critical Organ	GI-LLI	3. Critical Organ	N/A
4. Organ Dose (mREM)	4.14E-01	4. Organ Dose (mREM)	8.86E-02
5. Total Body Dose (mREM)	1.64E-01	5. Total Body Dose (mREM)	8.86E-02
C. Carbon-14 Dose		G. H-3 in Fish from Harris Lake	
1. Location	2.82 km W	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)	1.69E-01	4. Organ Dose (mREM)	1.48E-02
5. Total Body Dose (mREM)	3.37E-02	5. Total Body Dose (mREM)	1.48E-02
D. Cooling Tower Plume H-3 Dose			
1. Location	2.91 km NNE		
2. Critical Age	CHILD		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	3.20E-03		
5. Total Body Dose (mREM)	3.20E-03		

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2017 - 12/31/2017

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	4.63E-02	5.81E-02	5.43E-03	9.69E-02	2.07E-01
(a) Limit	mREM	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		9.26E-01	1.16E+00	1.09E-01	1.94E+00	2.07E+00
2. Maximum Total Body Dose	mREM	4.63E-03	2.41E-02	8.81E-03	9.00E-02	1.28E-01
(a) Limit	mREM	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
(b) % of Limit		3.09E-01	1.61E+00	5.88E-01	6.00 E+00	4.25E+00

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

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2017 - 12/31/2017

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for 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 2017 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

1. Location	2.14 km SW
2. Critical Age	CHILD
3. Critical Organ	LIVER
4. Organ Dose (mREM)	3.37E-01
5. Total Body Dose (mREM)	3.37E-01

B. Liquid Effluent Dose

1. Location	2.19 km S
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	2.07E-01
5. Total Body Dose (mREM)	1.28E-01

C. Carbon-14 Dose

1. Location	2.75 km W
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	1.98E-01
5. Total Body Dose (mREM)	3.95E-02

D. Cooling Tower Plume H-3 Dose

1. Location	2.91 km NNE
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	5.44E-03
5. Total Body Dose (mREM)	5.44E-03

E. Harris Lake Evaporation H-3 Dose

1. Location	6.70 km SSW
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	9.97E-02
5. Total Body Dose (mREM)	9.97E-02

F. Training Center Drinking Water H-3 Dose

1. Location	OCA
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.18E-01
5. Total Body Dose (mREM)	1.18E-01

G. H-3 in Fish from Harris Lake

1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.21E-02
5. Total Body Dose (mREM)	1.21E-02

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

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

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	1.36E-02	7.87E-02	1.97E-01	4.70E-01	7.59E-01
(a) Limit	mREM	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		2.72E-01	1.57E+00	3.93E+00	9.41E+00	7.59E+00
2. Maximum Total Body Dose	mREM	5.82E-03	7.86E-02	1.65E-01	6.90E-02	3.19E-01
(a) Limit	mREM	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
(b) % of Limit		3.88E-01	5.24E+00	1.10E+01	4.60E+00	1.06E+01

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

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

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

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

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Shearon Harris Nuclear Power Plant includes liquid and gaseous effluent dose contributions from the plant. Direct and air-scatter dose from the reactor building and other onsite structures does not contribute measurable dose to the maximum exposed individual based on review of the 2016 environmental TLD data. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included below is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from H-3 in the Shearon Harris Nuclear Power Plant Cooling Tower plume, evaporation of H-3 in Harris Lake, H-3 in on-site drinking water, and H-3 in fish from Harris Lake. The combined dose to a maximum exposed individual from effluent releases, combined with the additional dose pathways, is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Gaseous Effluent Dose

1. Location	2.14 km SW
2. Critical Age	CHILD
3. Critical Organ	THYROID
4. Organ Dose (mREM)	3.87E-01
5. Total Body Dose (mREM)	3.87E-01

B. Liquid Effluent Dose

1. Location	2.19 km S
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	7.59E-01
1. Total Body Dose (mREM)	3.19E-01

C. Carbon-14 Dose

1. Location	3.07 km NNE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	2.59E-01
5. Total Body Dose (mREM)	5.17E-02

D. Cooling Tower Plume H-3 Dose

1. Location	3.07 km NNE
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	3.84E-03
5. Total Body Dose (mREM)	3.84E-03

E. Harris Lake Evaporation H-3 Dose

1. Location	6.70 km SSW
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	8.72E-02
5. Total Body Dose (mREM)	8.72E-02

F. Training Center Drinking Water H-3 Dose

1. Location	OCA
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.18E-01
5. Total Body Dose (mREM)	1.18E-01

G. H-3 in Fish from Harris Lake

1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.14E-02
5. Total Body Dose (mREM)	1.14E-02

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

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

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	1.07E-01	1.41E-01	3.27E-02	1.24E-01	4.05E-01
(a) Limit	mREM	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
(b) % of Limit		2.15E+00	2.82E+00	6.54E-01	2.48E+00	4.05E+00
2. Maximum Total Body Dose	mREM	9.61E-02	9.05E-02	2.68E-02	6.28E-02	2.76E-01
(a) Limit	mREM	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
(b) % of Limit		6.41E+00	6.03E+00	1.78E+00	4.19E+00	9.21E+00

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

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public
Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2015 - 12/31/2015

<u>40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results</u>

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 2015 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
1. Location — 2.14 km SW
2. Critical Age — CHILD
3. Critical Organ — THYROID
4. Organ Dose (mREM) — 7.08E-01
5. Total Body Dose (mREM) — 7.06E-01

B. Liquid Effluent Dose
1. Location — 2.19 km S
2. Critical Age — ADULT
3. Critical Organ — GI-LLI
4. Organ Dose (mREM) — 4.05E-01
5. Total Body Dose (mREM) — 2.76E-01

C. Carbon-14 Dose
1. Location — 3.07 km NNE
2. Critical Age — CHILD
3. Critical Organ — BONE
4. Organ Dose (mREM) — 4.75E-01
5. Total Body Dose (mREM) — 9.45E-02

D. Cooling Tower Plume H-3 Dose
1. Location — 3.07 km NNE
2. Critical Age — CHILD
3. Critical Organ — N/A
4. Organ Dose (mREM) — 3.11E-03
5. Total Body Dose (mREM) — 3.11E-03

E. Harris Lake Evaporation H-3 Dose
1. Location — 6.12 km SSW
2. Critical Age — CHILD
3. Critical Organ — N/A
4. Organ Dose (mREM) — 7.60E-02
5. Total Body Dose (mREM) — 7.60E-02

F. Training Center Drinking Water H-3 Dose
1. Location — OCA
2. Critical Age — ADULT
3. Critical Organ — N/A
4. Organ Dose (mREM) — 1.28E-01
5. Total Body Dose (mREM) — 1.28E-01

G. H-3 in Fish from Harris Lake
1. Location — Lake
2. Critical Age — ADULT
3. Critical Organ — N/A
4. Organ Dose (mREM) — 1.36E-02
5. Total Body Dose (mREM) — 1.36E-02

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Discussion - Section 9

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2014 - 12/31/2014

During the period of January 1, 2014, through December 31, 2014, the estimated maximum individual offsite dose due to radioactivity released in effluents was:

Liquid Effluents:	Limit
1.20E-01 mrem, Total Body	3.0 E+00 mrem
2.36E-01 mrem, Max Organ (GI-LLI)	1.0 E+01 mrem
Gaseous Effluents:	Limit
Noble Gases	
2.83 E-04 mrad, Beta	2.0 E+01 mrad
9.52 E-05 mrad, Gamma	1.0 E+01 mrad
Tritium, Radioiodine 131, 133, and Particulates with greater than an 8 Day Half Life:	
7.40 E-01 mrem, Critical Organ (Lung)	1.5 E+01 mrem(*)
Carbon 14	
5.32 E-01 mrem, Critical Organ (Bone)	1.5 E+01 mrem(*)

(*) Limit applies to Tritium, Radioiodines, and Particulates with greater than an 8-Day Half Life:

These doses are in addition to what is received from natural background in the area surrounding the Harris Nuclear Plant (approximately 300 mrem per year).

Appendix 8: Assessment of Radiation Doses (Continued)
ODCM Operational Requirement F.2
Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2014 - 12/31/2014

Liquid

The dose from the liquid pathway is based on fish consumption from Harris Lake (parts of the lake are within the site boundary) plus drinking water from Lillington.

	1ST Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Total Body Dose (mrem)	5.06E-03	1.70E-02	5.53E-03	9.19E-02	1.20E-01
10CFR50 Appendix I Limit (mrem)	1.50 E+00	1.50 E+00	1.50 E+00	1.50 E+00	3.00 E+00
Critical Organ Dose (mrem)	3.64E-02	5.49E-02	3.87E-02	1.06E-01	2.36E-01
10CFR50 Appendix I Limit (mrem)	5.00 E+00	5.00 E+00	5.00 E+00	5.00 E+00	1.00 E+01

40CFR190 Uranium Fuel Cycle Dose Calculation Results
The 40CFR190 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)

Maximum Total Body Dose = 8.60 E-01 mrem
Maximum Location: 1.33 Miles, South-SouthWest Sector
Critical Age: Child
Liquid Effluent Dose = 1.20E-01 mrem
Gas Effluent Dose = 7.40 E-01 mrem
40CFR190 Limit = 25

Maximum Organ Dose = 1.50 E+00 mrem
Maximum Location: 1.33 Miles, South-SouthWest Sector
Critical Age: Child
Critical Organ: GI-LLI
Liquid Effluent Dose = 2.36E-01 mrem
Gas Effluent Dose = 1.27 E+00 mrem
40CFR190 Limit = 75 mrem (thyroid), 25 mrem (all other organs)

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Discussion - Section 9
Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2013 - 12/31/2013

During the period of January 1, 2013, through December 31, 2013, the estimated maximum individual offsite dose due to radioactivity released in effluents was:

Liquid Effluents:	Limit
2.92 E-01 mrem, Total Body	3.0 E+00 mrem
5.40 E-01 mrem, Max Organ (GI-LLI)	1.0 E+01 mrem

Gaseous Effluents:	Limit
Noble Gases	
4.89 E-04 mrad, Beta	2.0 E+01 mrad
5.63 E-04 mrad, Gamma	1.0 E+01 mrad
Tritium, Radioiodine 131, 133, and Particulates with greater than an 8 Day Half Life:	
6.96 E-01 mrem, Critical Organ (Lung)	1.5 E+01 mrem(*)
Carbon 14	
2.27 E-01 mrem, Critical Organ (Bone)	1.5 E+01 mrem(*)

(*) Limit applies to Tritium, Radioiodines, and Particulates with greater than an 8-Day Half Life:

These doses are in addition to what is received from natural background in the area surrounding the Harris Nuclear Plant (approximately 300 mrem per year).

Appendix 8: Assessment of Radiation Doses (Continued)
ODCM Operational Requirement F.2
Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2013 - 12/31/2013

Liquid

The dose from the liquid pathway is based on fish consumption from Harris Lake (parts of the lake are within the site boundary) plus drinking water from Lillington.

	1ST Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Total Body Dose (mrem)	2.60 E-02	1.06 E-01	7.41 E-02	8.54 E-02	2.92 E-01
10CFR50 Appendix I Limit (mrem)	1.50 E+00	1.50 E+00	1.50 E+00	1.50 E+00	3.00 E+00
Critical Organ Dose (mrem)	5.63 E-02	1.14 E-01	1.39 E-01	2.30 E-01	5.40 E-01
10CFR50 Appendix I Limit (mrem)	5.00 E+00	5.00 E+00	5.00 E+00	5.00 E+00	1.00 E+01

40CFR190 Uranium Fuel Cycle Dose Calculation Results
The 40CFR190 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)

Maximum Total Body Dose = 9.88 E-01 mrem
Maximum Location: 1.33 Miles, South-SouthWest Sector
Critical Age: Child
Liquid Effluent Dose = 2.92 E-01 mrem
Gas Effluent Dose = 6.96 E-01 mrem
40CFR190 Limit = 25

Maximum Organ Dose = 1.46 E+00 mrem
Maximum Location: 1.33 Miles, South-SouthWest Sector
Critical Age: Child
Critical Organ: GI-LLI
Liquid Effluent Dose = 5.40 E-01 mrem
Gas Effluent Dose = 9.23 E-01 mrem
40CFR190 Limit = 75 mrem (thyroid), 25 mrem (all other organs)

Attachment 12
Errata to a Previous Year's ARERR

Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2021 - 12/31/2021

Discussion - Section 9
Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2012 - 12/31/2012

During the period of January 1, 2012, through December 31, 2012, the estimated maximum individual offsite dose due to radioactivity released in effluents was:

Liquid Effluents:	Limit
2.69 E-01 mrem, Total Body	3.0 E+00 mrem
3.66 E-01 mrem, Max Organ (GI-LLI)	1.0 E+01 mrem Gaseous
Effluents:	Limit
Noble Gases	
3.01 E-04 mrad, Beta	2.0 E+01 mrad
1.09 E-04 mrad, Gamma	1.0 E+01 mrad
Tritium, Radioiodine 131, 133, and Particulates with greater than an 8 Day Half Life:	
8.09 E-01 mrem, Critical Organ (Lung)	1.5 E+01 mrem(*) Carbon 14
6.52 E-01 mrem, Critical Organ (Bone)	1.5 E+01 mrem(*)

(*) Limit applies to Tritium, Radioiodines, and Particulates with greater than an 8-Day Half Life:

These doses are in addition to what is received from natural background in the area surrounding the Harris Nuclear Plant (approximately 300 mrem per year).

Appendix 8: Assessment of Radiation Doses (Continued)
ODCM Operational Requirement F.2
Shearon Harris Nuclear Power Plant Unit 1
Period 1/1/2012 - 12/31/2012

Liquid

The dose from the liquid pathway is based on fish consumption from Harris Lake (parts of the lake are within the site boundary) plus drinking water from Lillington.

	1ST Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Total Body Dose (mrem)	1.29 E-01	7.98 E-02	4.73 E-02	1.30 E-02	2.69 E-01
10CFR50 Appendix I Limit (mrem)	1.50 E+00	1.50 E+00	1.50 E+00	1.50 E+00	3.00 E+00
Critical Organ Dose (mrem)	1.26 E-01	1.32 E-01	6.71 E-02	4.17 E-02	3.66 E-01
10CFR50 Appendix I Limit (mrem)	5.00 E+00	5.00 E+00	5.00 E+00	5.00 E+00	1.00 E+01

40CFR190 Uranium Fuel Cycle Dose Calculation Results
The 40CFR190 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)

Maximum Total Body Dose = 1.07 E+00 mrem
Maximum Location: 1.33 Miles, South-SouthWest Sector
Critical Age: Child
Liquid Effluent Dose = 2.69 E-01 mrem
Gas Effluent Dose = 8.09 E-01 mrem
40CFR190 Limit = 25

Maximum Organ Dose = 1.82 E+00 mrem
Maximum Location: 1.33 Miles, South-SouthWest Sector
Critical Age: Child
Critical Organ: Bone
Liquid Effluent Dose = 3.66 E-01 mrem
Gas Effluent Dose = 1.46 E+00 mrem
40CFR190 Limit = 75 mrem (thyroid), 25 mrem (all other organs)

ENCLOSURE 4: **MNS Annual Radioactive Effluent Release Report**

McGuire Nuclear Station
Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2021 through December 31, 2021

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 1/1/2021- 12/31/2021

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 1/1/2021- 12/31/2021

Gaseous Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
1. Total Release	Ci	5.82E-01	5.27E-01	6.22E-01	5.35E-01	2.27E+00
2. Avg. Release Rate	µCi/sec	7.48E-02	6.70E-02	7.83E-02	6.73E-02	7.19E-02
B. Iodine-131						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Release Rate	µCi/sec	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	1.02E+01	1.35E+01	3.47E+01	2.80E+01	8.65E+01
2. Avg. Release Rate	µCi/sec	1.31E+00	1.72E+00	4.37E+00	3.53E+00	2.74E+00
E. Carbon-14						
1. Total Release	Ci	5.38E+00	5.55E+00	4.89E+00	5.27E+00	2.11E+01
2. Avg. Release Rate	µCi/sec	6.92E-01	7.06E-01	6.15E-01	6.63E-01	6.69E-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 1/1/2021- 12/31/2021

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 1/1/2021- 12/31/2021

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 1/1/2021- 12/31/2021

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						
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. Tritium						
H-3	Ci	1.02E+01	1.35E+01	3.45E+01	2.66E+01	8.47E+01
E. Carbon-14 *						
C-14	Ci	1.61E+00	1.66E+00	1.47E+00	1.58E+00	6.33E+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 1/1/2021- 12/31/2021

Gaseous Effluents - Ground Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
AR-41	Ci	5.22E-01	4.95E-01	5.85E-01	4.89E-01	2.09E+00
XE-133	Ci	5.18E-02	3.00E-02	3.71E-02	3.91E-02	1.58E-01
XE-135	Ci	7.78E-03	2.58E-03	0.00E+00	6.64E-03	1.70E-02
Total for Period	Ci	5.82E-01	5.27E-01	6.22E-01	5.35E-01	2.27E+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	3.13E-02	2.83E-02	2.51E-01	1.49E+00	1.80E+00
E. Carbon-14*						
C-14	Ci	3.77E+00	3.88E+00	3.42E+00	3.69E+00	1.48E+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 1/1/2021- 12/31/2021

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 1/1/2021- 12/31/2021

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 1/1/2021- 12/31/2021

Liquid Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products *						
1. Total Release	Ci	3.34E-03	3.51E-03	6.41E-03	7.24E-03	2.05E-02
2. Avg. Diluted Conc.	µCi/ml	3.93E-12	3.65E-12	6.94E-12	7.88E-12	5.61E-12
3. Batch Releases	µCi/ml	3.93E-12	3.65E-12	6.94E-12	7.88E-12	5.61E-12
B. Tritium						
1. Total Release	Ci	2.90E+02	2.12E+02	3.95E+02	2.78E+02	1.17E+03
2. Avg. Diluted Conc.	µCi/ml	3.41E-07	2.20E-07	4.27E-07	3.02E-07	3.21E-07
3. Batch Releases	µCi/ml	3.41E-07	2.20E-07	4.27E-07	3.01E-07	3.21E-07
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Diluted Conc.	µCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3. Batch Releases	µCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Gross Alpha						
1. Total Release	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2. Avg. Diluted Conc.	µCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3. Batch Releases	µCi/ml	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E. Volume of Liquid Waste						
1. Continuous Releases	liters	6.26E+07	6.07E+07	2.17E+08	8.73E+07	4.28E+08
2. Batch Releases	liters	7.53E+05	1.19E+06	2.01E+06	2.04E+06	6.00E+06
F. Volume of Dilution Water						
1. Continuous Releases	liters	2.26E+12	1.54E+12	1.06E+12	8.52E+11	5.71E+12
2. Batch Releases	liters	8.51E+11	9.63E+11	9.23E+11	9.19E+11	3.66E+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 1/1/2021- 12/31/2021

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	9.00E-02	1.96E-01	6.95E-01	7.98E-01	1.78E+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 1/1/2021- 12/31/2021

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Ag-108m	Ci	0.00E+00	2.02E-06	0.00E+00	0.00E+00	2.02E-06
Ag-110m	Ci	0.00E+00	0.00E+00	0.00E+00	4.62E-06	4.62E-06
Br-82	Ci	0.00E+00	0.00E+00	0.00E+00	1.67E-06	1.67E-06
Co-57	Ci	0.00E+00	0.00E+00	0.00E+00	8.36E-07	8.36E-07
Co-58	Ci	6.28E-04	3.30E-04	2.56E-04	1.12E-03	2.34E-03
Co-60	Ci	9.43E-04	9.44E-04	1.30E-03	1.69E-03	4.88E-03
Cr-51	Ci	0.00E+00	0.00E+00	6.11E-04	5.70E-04	1.18E-03
Cs-137	Ci	1.98E-04	3.48E-04	7.43E-04	6.12E-04	1.90E-03
Fe-55	Ci	9.62E-05	9.57E-05	1.80E-04	2.33E-04	6.05E-04
Mn-54	Ci	4.68E-05	1.41E-05	1.48E-05	5.19E-05	1.28E-04
Nb-95	Ci	0.00E+00	0.00E+00	2.83E-06	1.08E-05	1.36E-05
Ni-63	Ci	1.04E-03	1.22E-03	2.01E-03	1.89E-03	6.17E-03
Sb-124	Ci	3.04E-06	2.49E-06	0.00E+00	0.00E+00	5.54E-06
Sb-125	Ci	3.88E-04	5.45E-04	1.29E-03	1.05E-03	3.27E-03
Te-131m	Ci	0.00E+00	6.08E-06	0.00E+00	0.00E+00	6.08E-06
Zr-95	Ci	0.00E+00	0.00E+00	0.00E+00	2.27E-06	2.27E-06
Total for Period	Ci	3.34E-03	3.51E-03	6.41E-03	7.24E-03	2.05E-02
B. Tritium						
H-3	Ci	2.90E+02	2.12E+02	3.94E+02	2.77E+02	1.17E+03
C. Dissolved & Entrained Gases						
None	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
D. Gross Alpha						
Total for Period	Ci	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

ATTACHMENT 2

Supplemental Information

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

Attachment 2
Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	=	221
2. Total Time (min) for Batch Releases	=	3.30E+05
3. Maximum Time (min) for a Batch Release	=	4.38E+04
4. Average Time (min) for Batch Releases	=	1.49E+03
5. Minimum Time (min) for a Batch Release	=	1.60E+01
6. Average Dilution Water Flow During Release (lpm)	=	1.84E+06

B. Gaseous Effluents

1. Total Number of Batch Releases	=	32
2. Total Time (min) for Batch Releases	=	1.05E+06
3. Maximum Time (min) for a Batch Release	=	4.48E+04
4. Average Time (min) for Batch Releases	=	3.27E+04
5. Minimum Time (min) for a Batch Release	=	1.62E+02

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2
Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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 2021 ARERR contains estimates of C-14 radioactivity released in 2021, and estimates of public dose resulting from the C-14 effluent.

Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2). The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). Many documents provide information related to the magnitude of C-14 in typical effluents from commercial nuclear power plants. Those documents suggest that nominal annual releases of C-14 in gaseous effluents are approximately 5 to 7.3 curies from PWRs (Ref. Reg. Guide 1.21, Rev. 2). A more recent study recommends a higher C-14 gaseous source term scaling factor of approximately 9.0 to 9.8 Ci/GWe-yr for a PWR (Westinghouse) (Ref. EPRI 1021106). For the McGuire Nuclear Station 2020 ARERR a source term scaling factor of 9.4 Ci/GWe-yr is assumed. Using a source term scaling factor of 9.4 Ci/GWe-yr and actual electric generation (MWe-hrs) from McGuire Nuclear Station in 2020 results in a site total C-14 gaseous release estimate to the environment of 2.101+01 Curies. 70% of the C-14 gaseous effluent is assumed to be from batch releases and 30% of C-14 gaseous effluent is assumed to be from continuous releases through the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004; EPRI 1021106).

C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. Since the PWR operates with a reducing chemistry, most, if not all, of the C-14 species initially produced are organic (e.g., methane). As a general rule, C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment (e.g. during shutdown or refueling), a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic with an average of 80% organic with the remainder being CO_2 (Ref. EPRI TR-105715). For the McGuire Nuclear Station 2021 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 2021 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Attachment 2
Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Overall Estimate of Error for Effluent Radioactivity Release Reported

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

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

Attachment 2
Supplemental Information

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2021 Land Use Census was performed May 26-27, 2021, and the results were certified and made available for use on June 16, 2021. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

No changes to the nearest residence in each sector.

Gardens

The non-irrigated garden in the ESE sector (1.10 miles) was replaced with a non-irrigated garden at 1.26 miles.

The non-irrigated garden in the SSE sector (1.06 miles) was replaced with a non-irrigated garden at 1.22 miles.

The non-irrigated garden in the S sector (3.11 miles) was replaced with a non-irrigated garden at 3.17 miles.

The non-irrigated garden in the SSW sector (3.02 miles) was replaced with a non-irrigated garden at 3.30 miles.

The non-irrigated garden in the SW sector (2.31 miles) was replaced with a non-irrigated garden at 1.14 miles.

The non-irrigated garden in the WSW sector (1.10 miles) was replaced with a non-irrigated garden at 1.33 miles.

Milk Animals

No changes to nearest milk animal in each sector.

Environmental Monitoring Locations

No changes to environmental monitoring locations in each sector.

<u>ATTACHMENT 3</u>

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 1/1/2021 - 12/31/2021

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)	5	5	C	B	14.2	897
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)	8	25	A	DBP	456	0.298
e. Sealed Sources / Smoke Detectors	None					
f. Sealed Sources	None					
g. Irradiated Components	None					
3. Total Waste	**13**	**30**			**470**	**897**

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Type of Waste Shipped	Radionuclide	% Abundance

1. Waste from Liquid Systems

Type of Waste Shipped	Radionuclide	% Abundance
a. Dewatered Powdex Resin (brokered)	No shipments in 2021	
b. Dewatered Powdex Resin	No shipments in 2021	
c. Dewatered Bead Resin (brokered)	No shipments in 2021	
d. Dewatered Bead Resin	No shipments in 2021	
e. Dewatered Radwaste System Resin (brokered)	No shipments in 2021	
f. Dewatered Primary Bead Resins (brokered)		

a. RSR#MNS21-0001

Radionuclide	% Abundance
H-3	0.03%
C-14	1.32%
Mn-54	0.16%
Fe-55	3.86%
Co-57	0%
Co-60	14.73%
Ni-59	0.58%
Ni-63	76.85%
Zn-65	0.05%
Sr-90	0.02%
Tc-99	0%
Sb-125	0.29%
Cs-137	2.09%
Ce-144	0.01%
Pu-238	0%
Pu-239	0%
Pu-241	0%
Am-241	0%
Cm-243	0%

b. RSR#MNS21-0004

Radionuclide	% Abundance
H-3	0.03%
C-14	1.33%
Mn-54	0.15%
Fe-55	3.79%
Co-57	0%
Co-60	14.62%
Ni-59	0.59%
Ni-63	77.03%
Zn-65	0.04%
Sr-90	0.02%
Tc-99	0%
Sb-125	0.29%
Cs-137	2.09%
Ce-144	0.01%
Pu-238	0%
Pu-239	0%
Pu-241	0%
Am-241	0%
Cm-243	0%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

c. RSR#MNS21-0008

Radionuclide	% Abundance
H-3	0.03%
C-14	1.33%
Mn-54	0.14%
Fe-55	3.71%
Co-57	0%
Co-60	14.49%
Ni-59	0.59%
Ni-63	77.25%
Zn-65	0.04%
Sr-90	0.02%
Tc-99	0%
Sb-125	0.28%
Cs-137	2.09%
Ce-144	0.01%
Pu-238	0%
Pu-239	0%
Pu-241	0%
Am-241	0%
Cm-243	0%

d. RSR#MNS21-0009

Radionuclide	% Abundance
H-3	0.03%
C-14	1.33%
Mn-54	0.14%
Fe-55	3.7%
Co-57	0%
Co-60	14.47%
Ni-59	0.59%
Ni-63	77.3%
Zn-65	0.04%
Sr-90	0.02%
Tc-99	0%
Sb-125	0.28%
Cs-137	2.09%
Ce-144	0.01%
Pu-238	0%
Pu-239	0%
Pu-241	0%
Am-241	0%
Cm-243	0%

e. RSR#MNS21-0010

Radionuclide	% Abundance
H-3	0.03%
C-14	1.34%
Mn-54	0.14%
Fe-55	3.67%
Co-57	0%
Co-60	14.42%
Ni-59	0.59%
Ni-63	77.38%
Zn-65	0.04%
Sr-90	0.02%
Tc-99	0%
Sb-125	0.28%
Cs-137	2.1%
Ce-144	0.01%
Pu-238	0%
Pu-239	0%
Pu-241	0%
Am-241	0%
Cm-243	0%

g. Dewatered Mechanical Filter Media — No shipments in 2021

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

h.	Dewatered Mechanical Filter Media (brokered)	No shipments in 2021	
i.	Solidified Waste	No shipments in 2021	

2. Dry Solid Waste

a.	Dry Active Waste (compacted)	Compaction no longer	performed on site
b.	Dry Active Waste (non-compacted)	No shipments in 2021	
c.	Dry Active Waste (brokered / compacted)		

a. RSR#MNS21-0005

Radionuclide	% Abundance
H-3	0.32%
C-14	0.02%
Sc-46	0.01%
Cr-51	4.27%
Mn-54	4.1%
Fe-55	30.55%
Fe-59	0.26%
Co-57	0.1%
Co-58	13.09%
Co-60	23.04%
Ni-63	2.12%
Zn-65	0.96%
Sr-90	0.02%
Zr-95	6.58%
Nb-95	13.01%
Ag-110m	0.04%
Sn-113	0.3%
Sb-124	0.26%
Sb-125	0.79%
Cs-137	0.03%
Ce-144	0.09%
Hf-181	0.02%

b. RSR#MNS21-0006

Radionuclide	% Abundance
H-3	0.39%
C-14	0.48%
Cr-51	0%
Mn-54	1.64%
Fe-55	21.05%
Fe-59	0%
Co-57	0.03%
Co-58	0.02%
Co-60	66.33%
Ni-63	7.53%
Zn-65	0.24%
Sr-90	0.03%
Zr-95	0%
Nb-95	0%
Sn-113	0%
Sb-124	0%
Sb-125	2.08%
Cs-137	0.12%
Ce-144	0.05%
Hf-181	0%

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

c. RSR#MNS21-0011

Radionuclide	% Abundance
Cr-51	16.45%
Mn-54	4.4%
Fe-55	9.2%
Fe-59	0.59%
Co-57	0.11%
Co-58	17.64%
Co-60	28.2%
Ni-63	1.45%
Zn-65	0.89%
Zr-95	6.46%
Nb-95	13.6%
Sn-113	0.24%
Sb-124	0.12%
Sb-125	0.61%
Cs-137	0.04%

d. RSR#MNS21-0012

Radionuclide	% Abundance
Cr-51	17.19%
Mn-54	4.33%
Fe-55	8.99%
Fe-59	0.6%
Co-57	0.11%
Co-58	17.75%
Co-60	27.52%
Ni-63	1.42%
Zn-65	0.87%
Zr-95	6.52%
Nb-95	13.71%
Sn-113	0.24%
Sb-124	0.12%
Sb-125	0.6%
Cs-137	0.04%

e. RSR#MNS21-0013

Radionuclide	% Abundance
Cr-51	49.24%
Mn-54	1.92%
Fe-55	3.51%
Fe-59	0.8%
Co-57	0.05%
Co-58	14.86%
Co-60	10.42%
Ni-63	0.52%
Zn-65	0.41%
Zr-95	5.95%
Nb-95	11.82%
Sn-113	0.15%
Sb-124	0.12%
Sb-125	0.23%
Cs-137	0.02%

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

f. RSR#MNS21-0014

Radionuclide	% Abundance
Cr-51	45.18%
Mn-54	2.16%
Fe-55	4%
Fe-59	0.8%
Co-57	0.06%
Co-58	15.63%
Co-60	11.93%
Ni-63	0.6%
Zn-65	0.46%
Zr-95	6.2%
Nb-95	12.42%
Sn-113	0.16%
Sb-124	0.12%
Sb-125	0.26%
Cs-137	0.02%

g. RSR#MNS21-0025

Radionuclide	% Abundance
Cr-51	35.58%
Mn-54	2.79%
Fe-55	5.34%
Fe-59	0.78%
Co-57	0.07%
Co-58	17.12%
Co-60	16.04%
Ni-63	0.81%
Zn-65	0.58%
Zr-95	6.64%
Nb-95	13.55%
Sn-113	0.19%
Sb-124	0.13%
Sb-125	0.35%
Cs-137	0.02%

h. LQS#MNS21-0013

Radionuclide	% Abundance
H-3	0.04%
C-14	0%
Sc-46	0.01%
Cr-51	48.45%
Mn-54	1.64%
Fe-55	6.18%
Fe-59	0.75%
Co-57	0.04%
Co-58	14.55%
Co-60	7.92%
Ni-63	0.52%
Zn-65	0.38%
Sr-90	0%
Zr-95	7.22%
Nb-95	11.58%
Ag-110m	0.01%
Sn-113	0.17%
Sb-124	0.25%
Sb-125	0.22%
Cs-137	0.01%
Ce-144	0.02%
Hf-181	0.04%

d. Sealed Sources / Smoke Detectors — No shipments in 2021

Attachment 3
Solid Radioactive Waste Disposal

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

e.	Sealed Sources	No shipments in 2021
f.	Irradiated Components	No shipments in 2021

ATTACHMENT 4

Meteorological Data

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

Attachment 4
Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	1	0	0	0	0	0	0	0	0	0	0	0	1
	0.76-1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	14	1	0	0	1	0	0	0	0	0	2	0	0	4	2	4
	1.26-1.50	24	11	4	2	0	0	1	1	1	2	2	1	3	1	2	4
	1.51-2.00	67	52	19	6	1	0	2	3	5	2	1	3	4	7	6	15
	2.01-3.00	29	42	27	7	3	3	3	0	3	8	5	4	5	5	5	7
	3.01-4.00	7	20	6	4	0	0	1	0	0	5	1	2	1	0	6	6
	4.01-5.00	4	11	5	5	1	0	0	0	0	2	1	1	2	0	2	6
	5.01-6.00	6	5	0	1	0	0	0	0	0	0	0	0	0	0	0	3
	6.01-8.00	12	2	0	0	0	0	0	0	0	0	1	0	0	0	0	3
	8.01-10.00	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
	10.01-max	0	1	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	1
	0.76-1.00	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	4	2	1	0	0	0	0	0	0	0	0	0	0	1	0	2
	1.26-1.50	16	9	0	0	0	1	0	0	0	0	2	0	2	3	1	4
	1.51-2.00	12	15	9	4	2	0	2	2	1	0	3	0	7	5	2	3
	2.01-3.00	8	11	13	15	3	6	1	2	2	13	9	8	6	3	1	1
	3.01-4.00	4	11	18	4	1	2	3	0	0	4	2	10	1	2	3	2
	4.01-5.00	5	5	10	5	1	0	0	1	0	3	12	8	3	0	0	7
	5.01-6.00	5	1	5	1	0	0	0	0	0	0	3	1	1	0	1	4
	6.01-8.00	4	6	1	0	0	0	0	0	0	0	1	0	0	0	0	4
	8.01-10.00	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	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 1/1/2021 - 12/31/2021

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	2	0	0	0	0	0	0	0	0	0	0	0	0	2	1
	1.01-1.25	1	4	0	0	0	0	0	0	0	0	1	1	0	0	4	2
	1.26-1.50	5	7	2	3	1	0	1	0	1	1	1	1	2	3	2	1
	1.51-2.00	13	12	17	2	4	1	2	0	2	2	4	8	10	4	2	4
	2.01-3.00	8	12	16	11	7	9	3	3	10	5	9	14	18	3	3	1
	3.01-4.00	4	4	16	8	4	3	2	1	0	4	14	12	4	3	3	5
	4.01-5.00	5	3	9	6	2	0	0	0	0	2	14	11	1	1	5	5
	5.01-6.00	14	2	2	3	0	0	0	0	0	1	13	7	0	0	3	8
	6.01-8.00	8	6	1	0	0	0	0	0	0	0	3	4	2	1	3	13
	8.01-10.00	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	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	1	1	1	1	0	1	0	1	0	0	2	1	1	0
	0.76-1.00	6	6	2	0	2	1	0	2	0	1	1	1	4	2	3	4
	1.01-1.25	12	6	8	16	4	3	5	8	7	5	3	7	4	6	5	10
	1.26-1.50	16	16	16	16	7	3	11	11	17	6	5	16	13	9	14	10
	1.51-2.00	35	38	51	35	27	24	32	40	37	28	27	45	30	18	15	11
	2.01-3.00	78	68	193	153	91	72	118	42	53	122	180	153	49	21	28	44
	3.01-4.00	37	47	227	109	75	68	31	11	12	76	287	112	21	18	18	42
	4.01-5.00	31	30	116	35	14	5	7	3	3	13	178	47	15	7	19	30
	5.01-6.00	22	30	31	3	1	0	4	1	0	3	80	26	4	6	21	21
	6.01-8.00	5	1	5	0	0	0	0	1	0	0	39	17	2	7	8	21
	8.01-10.00	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1	3
	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 1/1/2021 - 12/31/2021

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	0	0	2	0	2	3	3	3	1	1	0	1
	0.76-1.00	2	4	2	1	1	3	2	4	17	5	9	8	6	8	5	4
	1.01-1.25	8	1	4	4	2	6	4	6	13	14	9	15	15	10	5	3
	1.26-1.50	9	7	3	5	5	5	11	15	28	22	15	27	13	14	7	6
	1.51-2.00	5	10	19	17	9	9	26	24	46	62	46	71	28	13	13	11
	2.01-3.00	11	7	7	15	20	16	59	20	28	127	148	77	19	14	17	13
	3.01-4.00	1	5	1	0	1	3	3	1	1	12	97	16	3	6	10	5
	4.01-5.00	0	0	0	0	0	0	0	0	0	1	18	1	4	2	6	3
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	2
	6.01-8.00	0	0	0	0	0	0	0	0	1	0	1	0	0	0	4	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	1	0	3	0	0	3	0	2	1	4	7	3	5	0	1	0
	0.76-1.00	0	0	0	1	0	2	1	1	10	14	16	23	12	3	6	3
	1.01-1.25	0	0	1	1	0	0	1	1	16	18	13	8	9	8	3	1
	1.26-1.50	0	2	1	1	0	0	4	7	28	25	11	8	13	3	1	2
	1.51-2.00	3	0	0	1	1	0	2	6	33	56	30	14	12	2	1	0
	2.01-3.00	0	0	0	0	1	0	1	4	3	26	42	16	2	4	0	0
	3.01-4.00	1	0	0	0	0	0	0	0	0	0	1	0	1	1	2	1
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	1	2	1	16	15	17	3	5	3	0
	0.76-1.00	2	1	0	1	0	0	1	3	6	42	58	30	11	1	0	1
	1.01-1.25	0	0	2	0	1	0	0	1	8	36	24	16	5	1	0	0
	1.26-1.50	1	0	0	0	0	0	0	1	10	27	15	8	3	0	0	0
	1.51-2.00	0	0	0	0	0	0	1	0	9	14	10	4	1	1	0	0
	2.01-3.00	0	0	0	0	0	0	0	0	2	1	5	2	1	1	1	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	1	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 1/1/2021 - 12/31/2021

McGuire Nuclear Station had no unplanned liquid releases in 2021.

McGuire Nuclear Station had one unplanned gaseous release in 2021. As documented in Nuclear Condition Reports 02370810 and 02371540, the Unit 2 Gland Steam Exhauster experienced a mechanical failure which resulted in the Turbine Steam Gland Seal rupture causing an unplanned Main Steam Release. The Gland Steam Condenser Fan tripped offline 02/20/2021 0246 and remained offline until 02/22/2021 0013. During this offline period steam was released into the general turbine building atmosphere. The Gland Steam Condenser Fan 100% flow rate is 1400cfm. The steam on the seal is saturated steam at 18 psia. The most recent Tritium analysis from the Final Feedwater system was on 2/16/2021 with an activity of 4.685E-06 uCi/ml. For conservatism, the maximum flow rate for the Gland Steam Condenser Fan was used to calculate Ci's of Tritium released over a duration of 2,727 minutes and generate a release permit. The total activity released was 5.060E-01 Ci. Gamma air dose from the unplanned release was 3.439E-03 mRad. Beta air dose from the unplanned release was 1.232E-03 mRad.

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 1/1/2021 - 12/31/2021

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	4.57E-03	4.32E-03	5.10E-03	4.28E-03	1.83E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.57E-02	4.32E-02	5.10E-02	4.28E-02	9.14E-02
2. Maximum Beta Air	mRAD	1.67E-03	1.55E-03	1.83E-03	1.55E-03	6.61E-03
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		8.35E-03	7.76E-03	9.16E-03	7.77E-03	1.65E-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	1.81E-01	1.86E-01	1.64E-01	1.77E-01	7.08E-01
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		1.20E+00	1.24E+00	1.09E+00	1.18E+00	2.36E+00

Receptor Location ***0.5*** miles ***ENE***
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 1/1/2021 - 12/31/2021

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode						
1. Maximum Organ Dose	mREM	3.63E-02	2.46E-02	4.88E-02	3.49E-02	1.44E-01
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		3.63E-01	2.46E-01	4.88E-01	3.49E-01	7.19E-01
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	Liver	Liver	Liver	Liver
2. Maximum Total Body Dose	mREM	3.54E-02	2.33E-02	4.57E-02	3.23E-02	1.36E-01
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.18E+00	7.75E-01	1.52E+00	1.08E+00	2.27E+00
(c) Critical Age		Child	Child	Child	Child	Child
B. Continuous Mode						
1. Maximum Organ Dose	mREM	4.12E-06	1.33E-05	6.91E-05	9.89E-05	1.30E-04
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.12E-05	1.33E-04	6.91E-04	9.89E-04	6.52E-04
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	Liver	Liver	Liver	Liver
2. Maximum Total Body Dose	mREM	4.12E-06	1.33E-05	6.91E-05	9.89E-05	1.30E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.37E-04	4.42E-04	2.30E-03	3.30E-03	2.17E-03
(c) Critical Age		Child	Child	Child	Child	Child

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

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for McGuire Nuclear Station includes liquid and gaseous effluent dose contributions from McGuire Nuclear Station and direct and air-scatter dose from the onsite ISFSI. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose calculations is an estimate of the dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose from the ISFSI is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Maximum Organ Dose (other than TB)	7.222E-01
1. Location	0.5 miles ENE
2. Critical Age	Child
3. Critical Organ	Bone
4. Gas Contribution %	9.804E+01
5. Liquid Contribution %	1.964E+00
B. Maximum Total Body Dose	3.767 E-01
1. Location	0.5 miles ENE
2. Critical Age	Child
3. Gas non-NG Contribution %	5.930E+01
4. Gas Contribution %	4.610E+00
5. Liquid Contribution %	3.609E+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 06. Spent Fuels Group Engineering has evaluated and determined an additional 5.66 mrem to be added to account for the 10 MAGNASTOR® casks outside of the most recent 10 CFR 72.212 Evaluation Report. The maximum dose rate to the nearest real individual from the ISFSI is conservatively calculated to be less than 12 mrem/yr.

The attached excerpt from the 10 CFR 72.212 Evaluation Report, MAGNASTOR®, Revision 06 is provided to document the method used to calculate the dose from ISFSI as less than 12 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 15 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 06

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 MNS ISFSI.

6.2 Evaluation

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

6.2.1 §72.104(a) – Dose Limits

Duke Energy Engineering Instruction MCEI-0400-241 determined that the distance from the nearest residence to the ISFSI is 0.65 miles (1046 meters). Hence, it is conservative to assume that the closest real individual is at least 700 meters from the ISFSI.
Enercon determined the annual total dose (gamma plus neutron) at a distance of 700 meters from all currently loaded casks (10 TN-32A casks and 28 NAC-UMS® casks) to be approximately 1.62 mrem. The evaluation was based on actual cask average burn-up (as loaded) and considering cooling time on the storage pads as of September 1, 2010. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.
NAC International determined the annual total dose (gamma plus neutron) at a distance of 700 meters from a (future) 2x6 array of MAGNASTOR® casks to be approximately 1.01 mrem (2.02 mrem for two arrays). The evaluation was conservatively based on full cask loads of 37 fuel assemblies at the maximum allowable heat load of 35.5 kW. The distance at which this dose is calculated (700 meters) is conservative compared to the distance to the closest real individual.
The total calculated annual public dose from liquid and gaseous effluent pathways averaged over a ten-year period is less than 4 mrem. No other uranium fuel cycle facility contributes significantly to the dose received by the closest real individual.
Based on the above, the calculated annual dose (performed in December 2015 per Reference 10) revised the 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 two 2x6 arrays of MAGNASTOR® casks (*see Note below*), is determined to be less than 4 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 8 mrem) is within the 10 CFR 72.104(a) limit.
Note: As stated above, up to two 2x6 arrays of MAGNASTOR® casks *are assumed in this evaluation. The first eight MAGNASTOR® casks are planned to be 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 pad (the second 2x6 array). Hence, this §72.104(a) evaluation bounds up to 20 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 1/1/2021 - 12/31/2021

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 98 wells, 7 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 2021. Results from sampling during 2021 confirmed existing knowledge of tritium concentrations in site ground water.

Results from sampling during 2021 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 2021.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	2.89E+02	NS	2.67E+02	2
M-101	MNS GWPI / M-101 / SE of WC	NS	2.02E+02	NS	<MDA	2
M-102	MNS GWPI / M-102 / SW of WC	9.43E+02	7.32E+02	8.85E+02	8.37E+02	4
M-103	MNS GWPI / M-103 / S of WC	4.47E+02	4.39E+02	3.16E+02	5.15E+02	4
M-103R	MNS GWPI / M-103R / S of WC	NS	4.84E+02	NS	5.03E+02	2
M-104DR	MNS GWPI / M-104DR / W of WC	NS	6.55E+02	NS	6.55E+02	2
M-104R	MNS GWPI / M-104R / W of WC	9.25E+02	7.98E+02	8.02E+02	7.98E+02	4
M-105	MNS GWPI / M-105 / Landfarm	NS	2.17E+02	NS	3.19E+02	2
M-20	MNS GWPI / M-20 / S of Hwy. 73	NS	3.60E+02	NS	3.28E+02	2
M-20R	MNS GWPI / M-20R / S of Hwy. 73	NS	NS	NS	4.76E+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.	6.20E+03	6.03E+03	4.79E+03	2.87E+03	27
M-48DR	MNS GWPI / M-48DR / U-2 SFP	NS	<MDA	NS	<MDA	2
M-48R	MNS GWPI / M-48R / U-2 SFP	NS	5.08E+02	NS	5.26E+02	2
M-53	MNS GWPI / M-53 / N of plant	NS	4.80E+02	NS	6.14E+02	2
M-55	MNS GWPI / M-55 / NAB	NS	<MDA	NS	<MDA	2
M-59	MNS GWPI / M-59 / U-2 Doghouse	9.78E+02	7.82E+02	1.12E+03	7.73E+02	4
M-60	MNS GWPI / M-60 / MOC Parking	NS	NS	NS	<MDA	1
M-62	MNS GWPI / M-62 / S of RWF	2.20E+02	<MDA	<MDA	1.99E+02	4
M-64	MNS GWPI / M-64 / Rdwst. Bldg.	NS	3.40E+02	NS	3.29E+02	2
M-66	MNS GWPI / M-66 / S of SSF	5.11E+02	3.81E+02	4.16E+02	4.97E+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	3.61E+02	3.44E+02	3.67E+02	3.24E+02	4
M-70	MNS GWPI / M-70 / U-1 SFP	2.69E+02	4.40E+02	3.40E+02	3.40E+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	2.06E+02	NS	2.24E+02	2
M-72	MNS GWPI / M-72 / Rdwst. Trench	5.23E+02	4.80E+02	5.44E+02	3.56E+02	4
M-76	MNS GWPI / M-76 / W of U-1 SFP	3.06E+02	3.75E+02	3.41E+02	3.96E+02	4
M-82	MNS GWPI / M-82 / River	NS	NS	NS	4.33E+02	1
M-84	MNS GWPI / M-84 / River	NS	NS	NS	6.45E+02	1
M-84R	MNS GWPI / M-84R / River	NS	NS	NS	9.76E+02	1
M-85	MNS GWPI / M-85 / River	NS	NS	NS	3.54E+02	1
M-87	MNS GWPI / M-87 / Landfarm	NS	NS	NS	3.00E+02	1
M-89	MNS GWPI / M-89 / Landfarm	NS	NS	NS	2.89E+02	1

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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	3.17E+02	1
M-91	MNS GWPI / M-91 / E of WC	NS	4.04E+02	NS	2.35E+02	2
M-91R	MNS GWPI / M-91R / E of WC	NS	NS	NS	2.98E+02	1
M-92	MNS GWPI / M-92 / N of WC Ponds	NS	3.61E+02	NS	1.96E+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	4.45E+02	NS	3.82E+02	2
M-93R	MNS GWPI / M-93R / N of IHUP	NS	NS	NS	1.82E+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	2.88E+02	NS	2.71E+02	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	1.90E+02	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	1.52E+03	NS	1.21E+03	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	2.46E+02	NS	3.83E+02	2
MS-3	MNS GWPI / MS-3 / Surface Water	NS	<MDA	NS	2.75E+02	2

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
MS-4	MNS GWPI / MS-4 / Surface Water	NS	3.74E+02	NS	3.05E+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 1/1/2021 - 12/31/2021

McGuire Nuclear Station experienced one instance of inoperable equipment relevant to effluent monitoring in excess of SLC limits during 2021. 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 2021.

SLC # from Table 16.11.2-1	Title	Completion Time	Determination and Data Reviewed
2.a	2EMF-31	30 Days	For 2EMF-31, out of service time for 2021 is 37.38 days (11/24/2021 to 1/1/2022*) LCOTR A-2-21-02092

For 2021, 2EMF-31 was non-functional from 11/24/2021 to 1/1/2022*. During Channel calibration of 2EMF31, the acceptance criteria of the detector was unable to be met and detector replacement is required. Following detector replacement, channel calibration will be performed on 2EMF31.

*2EMF-31 remained non-functional through the end of the year 2021. Additional non-functional time will be accounted for in the 2022 ARERR.

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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 1/1/2021 - 12/31/2021

The McGuire ODCM was not revised in 2021. The most recent revision is 60 and was provided with the 2018 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 16.11.2, Radioactive Liquid Effluent Monitoring Instrumentation, and 16.11.7, Radioactive Gaseous Effluent Monitoring Instrumentation, were revised in 2021. Both SLC 16.11.2 and 16.11.7 were revised to extend the instrumentation channel operations testing frequency to be one-half the frequency of calibration.

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

SELECTED LICENSEE COMMITMENTS (SLC)
LOES
SLCs ARE REVISED PER SECTION

SECTION	REVISION NUMBER	DATE
16.1	REVISION 168	4/23/18
16.2	REVISION 174	7/26/18
16.3	REVISION 134	3/6/13
16.4	Not Issued	
16.5.1	REVISION 165	9/20/17
16.5.2	REVISION 148	2/27/15
16.5.3	REVISION 188	5/20/22
16.5.4	REVISION 148	2/27/15
16.5.5	REVISION 148	2/27/15
16.5.6	DELETED - REVISION 120	12/30/10
16.5.7	REVISION 183	8/13/20
16.5.8	REVISION 192	12/15/21
16.5.9	REVISION 108	06/10/09
16.5.10	REVISION 194	01/27/22
16.6.1	REVISION 0	12/14/99
16.6.2	DELETED - REVISION 43	6/11/03
16.6.3	REVISION 190	8/19/21
16.6.4	REVISION 27	06/12/02
16.7.1	REVISION 149	2/25/15
16.7.2	REVISION 134	3/6/13
16.7.3	REVISION 136	4/26/13
16.7.4	REVISION 134	3/6/13
16.7.5	REVISION 134	3/6/13
16.7.6	REVISION 189	08/12/21
16.7.7	REVISION 134	3/6/13
16.7.8	REVISION 134	3/6/13
16.7.9	REVISION 134	3/6/13
16.7.10	REVISION 134	3/6/13
16.7.11	REVISION 192	12/15/21
16.7.12	REVISION 163	6/8/17
16.7.13	REVISION 157	1/23/17
16.7.14	REVISION 160	3/28/17
16.8.1	REVISION 192	12/15/21
16.8.2	REVISION 186	12/17/20
16.8.3	REVISION 184	8/27/20
16.9.1	REVISION 192	12/15/21
16.9.2	REVISION 179	12/17/18
16.9.3	REVISION 179	12/17/18
16.9.4	REVISION 166	12/6/17
16.9.5	REVISION 179	12/17/18
16.9.6	REVISION 179	12/17/18
16.9.7	REVISION 180	1/10/19

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

SELECTED LICENSEE COMMITMENTS (SLC)
LOES
SLCs ARE REVISED PER SECTION

SECTION	REVISION NUMBER	DATE
16.9.8	REVISION 134	3/6/13
16.9.9	REVISION 180	1/10/19
16.9.10	DELETED – REVISION 13	2/26/01
16.9.11	REVISION 22	2/25/02
16.9.12	REVISION 177	8/22/18
16.9.13	DELETED – REVISION 13	2/26/01
16.9.14	REVISION 177	8/22/18
16.9.15	REVISION 175	7/26/18
16.9.16	REVISION 179	12/17/18
16.9.17	REVISION 86	1/17/07
16.9.18	REVISION 183	8/13/20
16.9.19	REVISION 181	3/6/20
16.9.20	REVISION 8	11/30/00
16.9.21	REVISION 155	11/10/16
16.9.22	REVISION 109	8/13/09
16.9.23	REVISION 171	5/24/18
16.9.24	DELETED – REVISION 74	6/27/05
16.9.25	REVISION 87	1/17/07
16.9.26	REVISION 187	2/3/21
16.9.27	REVISION 179	12/17/18
16.10.1	REVISION 56	4/6/04
16.11.1	REVISION 137	5/13/13
16.11.2	REVISION 189	08/12/21
16.11.3	REVISION 0	12/14/99
16.11.4	REVISION 134	3/6/13
16.11.5	REVISION 0	12/14/99
16.11.6	REVISION 137	5/13/13
16.11.7	REVISION 190	08/19/21
16.11.8	REVISION 0	12/14/99
16.11.9	REVISION 0	12/14/99
16.11.10	REVISION 134	3/6/13
16.11.11	REVISION 179	12/17/18
16.11.12	REVISION 67	2/28/05
16.11.13	REVISION 137	5/13/13
16.11.14	REVISION 21	1/17/02
16.11.15	REVISION 21	1/17/02
16.11.16	REVISION 134	3/6/13
16.11.17	REVISION 143	5/30/14
16.11.18	REVISION 0	12/14/99
16.11.19	REVISION 0	12/14/99
16.11.20	REVISION 0	12/14/99
16.12.1	REVISION 0	12/14/99

SELECTED LICENSEE COMMITMENTS (SLC)
LOES
SLCs ARE REVISED PER SECTION

SECTION	REVISION NUMBER	DATE
16.12.2	REVISION 0	12/14/99
16.13.1	REVISION 191	11/18/21
16.13.2	DELETED – REVISION 75	7/20/05
16.13.3	DELETED – REVISION 75	7/20/05
16.13.4	REVISION 193	1/13/22
16.14.1	REVISION 0	12/14/99
16.14.2	REVISION 179	12/17/18

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

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16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.1 Liquid Effluents – Concentration

COMMITMENT The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 16.11.1-1) shall be limited:

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

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

APPLICABILITY At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.1.1 --------------------------------NOTE------------------------------- The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits. --- Sample and analyze radioactive liquid wastes according to Table 16.11.1-1.	According to Table 16.11.1-1

TABLE 16.11.1-1
(Page 1 of 3)

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLING FREQUENCY	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LOWER LIMIT OF DETECTION (LLD) microCi/ml (1)
1. Batch Waste Release Tanks (WMT and RMT)(4)	P Each Batch	P Each Batch	Principal Gamma Emitters(6)	5×10^{-7}
			I-131	1×10^{-6}
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma emitters)(7)	1×10^{-5}
	P Each Batch	M Composite(2)	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	P Each Batch	Q Composite(2)	Sr-89, Sr-90	5×10^{-8}
2. Continuous Releases (VUCDT discharge, CWWTS outlet and Turbine Building Sump to RC)(5)	Continuous(3)	W Composite(3)	Principal Gamma Emitters (6)	5×10^{-7}
			I-131	1×10^{-6}
	M Grab Sample	M	Dissolved and Entrained Gases (Gamma emitters)(7)	1×10^{-5}
	Continuous(3)	M Composite(3)	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	Continuous(3)	Q Composite(3)	Sr-89, Sr-90	5×10^{-8}

TABLE 16.11.1-1
(Page 2 of 3)

NOTES:

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

For a particular measurement system (which may include radiochemical separation):

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

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.

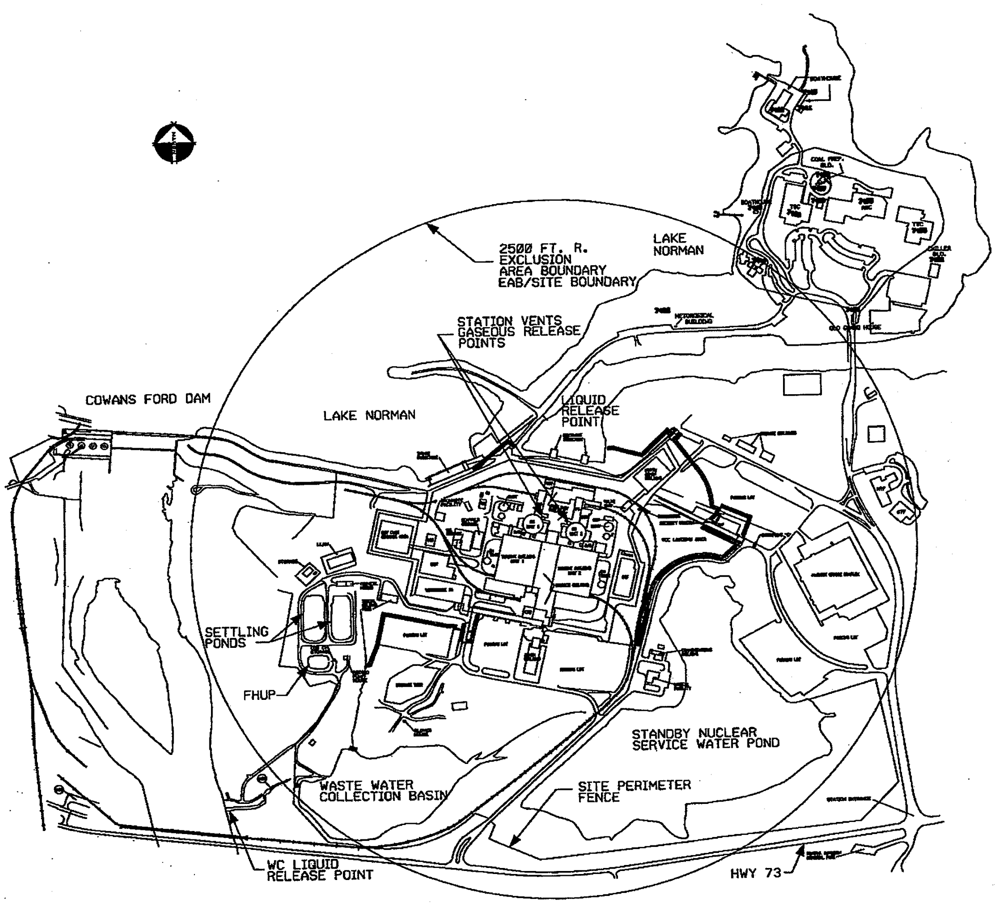

FIGURE 16.11.1-1 SITE BOUNDARY / EXCLUSION AREA BOUNDARY

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
	<u>AND</u>	
	C.1.2 Perform independent verification of the discharge line valving.	Prior to initiating a release
	<u>AND</u>	
	C.1.3.1 Perform independent verification of manual portion of the computer input for the release rate calculations performed by computer.	Prior to initiating a release
	<u>OR</u>	
	C.1.3.2 Perform independent verification of entire release rate calculations for calculations performed manually.	Prior to initiating a release
	<u>AND</u>	
	C.1.4 Restore channel to FUNCTIONAL status.	14 days
	<u>OR</u>	
	C.2 Suspend the release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more channels non-functional.	D.1 Obtain grab samples from the effluent pathway. <u>AND</u> D.2 Perform an analysis of grab samples for radioactivity. <u>AND</u> D.3 Restore the channel to FUNCTIONAL status.	Once per 12 hours during releases. To meet LLD requirements per Table 16.11.1-1. 30 days
E. One or more flow rate measurement channels non-functional.	E.1 -------------NOTE--------------- Pump performance curves generated in place may be used to estimate flow. ----------------------------------- Estimate the flow rate of the release. <u>AND</u> E.2 Restore the channel to FUNCTIONAL status.	Once per 4 hours during releases 30 days
F. RC minimum flow interlock non-functional.	F.1 Verify that the number of pumps providing dilution is greater than or equal to the number of pumps required. <u>AND</u> F.2 Restore the channel to FUNCTIONAL status.	Once per 4 hours during releases 30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. Required Action and associated Completion Time of Condition C, D, E or F not met.	G.1 Explain why the non-functionality was not corrected within the specified Completion Time in the Annual Radioactive Effluent Release Report.	In the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

-----NOTE-----
Refer to Table 16.11.2-1 to determine which TRs apply for each Radioactive Liquid Effluent Monitoring channel.

TEST	FREQUENCY
TR 16.11.2.1 Perform CHANNEL CHECK.	24 hours
TR 16.11.2.2 -----NOTE----- The CHANNEL CHECK shall consist of verifying indication of flow. ----- Perform CHANNEL CHECK.	Every 24 hours during periods of release
TR 16.11.2.3 Perform SOURCE CHECK.	Prior to each release
TR 16.11.2.4 Perform SOURCE CHECK.	31 days
TR 16.11.2.5 Perform CHANNEL OPERATIONAL TEST.	9 months
TR 16.11.2.6 Perform a CHANNEL CALIBRATION.	18 months

(continued)

TESTING REQUIREMENTS (continued)

TEST		FREQUENCY
TR 16.11.2.7	----------------------------NOTE------------------------------------ The initial CHANNEL CALIBRATION shall be performed using standards certified by the National Institute of Standards and Technology (NIST) or using standards obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used. -- Perform a CHANNEL CALIBRATION.	24 months
TR 16.11.2.8	--------------------------------NOTES------------------------------- 1. For Instrument 1, the COT shall also demonstrate that automatic isolation of the pathway occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint. 2. For Instruments 1 and 2, the COT shall also demonstrate that control room alarm annunciation occurs if the instrument indicates measured levels above the Alarm/Trip Setpoint; circuit failure and, a downscale failure. -- Perform a CHANNEL OPERATIONAL TEST	12 months

TABLE 16.11.2-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
1. Radioactivity Monitors Providing Alarm And Automatic Termination of Release				
a. Waste Liquid Effluent Line (EMF-49)	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)	1	A, D, G	At all times	TR 16.11.2.1 TR 16.11.2.4 TR 16.11.2.8 TR 16.11.2.7
d. EMF-44 Minimum Flow Device (2)	1	D, G	At all times	TR 16.11.2.8 TR 16.11.2.7
2. Radioactivity Monitors Providing Alarm But Not Automatic Termination of Release				
a. Conventional Waste Water Treatment Line or Turbine Building Sump to RC (EMF- 31)	1	A, D, G	At all times	TR 16.11.2.1 TR 16.11.2.4 TR 16.11.2.8 TR 16.11.2.7
b. EMF-31 Minimum Flow Device (2)	1	D, G	At all times	TR 16.11.2.8 TR 16.11.2.7
3. Continuous Composite Samplers				
a. Containment Ventilation Unit Condensate Line	1	D, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
b. Conventional Waste Water Treatment Line	1 per station	D, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
c. Turbine Building Sump to RC	1	D, G	At all times	TR 16.11.2.2 TR 16.11.2.6

(Continued)

4. Flow Rate Measurement Devices				
a. Waste Liquid Effluent Line	1 per station	E, G	During liquid effluent releases	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
b. Containment Ventilation Unit Condensate Line	1	E, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
c. Conventional Waste Water Treatment Line	1 per station	E, G	At all times	TR 16.11.2.2 TR 16.11.2.5 TR 16.11.2.6
d. Turbine Building Sump to RC	1	E, G	At all times	TR 16.11.2.2 TR 16.11.2.6
5. RC Minimum Flow Interlock (1)	1 per station	F, G	At all times	TR 16.11.2.5

NOTES:
1. Minimum flow dilution is assured by an interlock which terminates waste liquid release if the number of RC pumps running falls below the number of pumps required for dilution. The required number of RC pumps for dilution is determined per station procedures.

2. Radioactivity Monitor (EMF) shall not be declared functional unless both the EMF and the associated EMF's Minimum Flow Device are rendered functional.

BASES

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The minimum flow devices for EMFs listed in Table 16.11.2-1 are required to provide assurance of representative sampling during actual or potential releases of liquid effluents. An interlock between the EMF's minimum flow device and its associated flow rate measurement device disables the remove alarm during non-release timeframes for the purpose of the control room black board annunciator criteria that disable expected alarms. An EMF flow rate measurement device measures total flow of the effluent while the EMF minimum flow device measures the sample flow rate through the EMF. The Alarm/Trip Setpoints of these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the Alarm/Trip will occur prior to exceeding the limits stated in SLC 16.11.1. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50. The Turbine Building Sump to RC Discharge Flow Measurement and Sampler Devices are for monitoring only and do not alarm or have any controls that require a COT.

REFERENCES

1. McGuire Nuclear Station Offsite Dose Calculation Manual (ODCM)

2. 10 CFR Part 50, Appendix A

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.3 Dose - Liquid Effluents

COMMITMENT — The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from each unit to UNRESTRICTED AREAS (see Figure16.11.1-1) shall be limited:

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

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

APPLICABILITY — At all times.

REMEDIAL ACTIONS

--NOTES--

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

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

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.3.1 Determine cumulative dose contributions from liquid effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The commitment implements the guides set forth in Section II.A of Appendix I. The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." Also, for fresh water sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. These requirements are applicable only if the drinking water supply is taken from the river 3 miles downstream of the plant discharge.

The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This commitment applies to the release of liquid effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 40 CFR Part 141, Safe Drinking Water Act

3. 10 CFR Part 50, Appendix I

4. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

5. Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.4 Liquid Radwaste Treatment System

COMMITMENT The Liquid Radwaste Treatment System shall be FUNCTIONAL and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent from each unit to UNRESTRICTED AREAS (see Figure16.11.1-1) would exceed 0.06 mrem to the total body or 0.2 mrem to any organ in a 31 day period.

APPLICABILITY At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

--NOTE--
The Liquid Radwaste Treatment System shall be demonstrated FUNCTIONAL by meeting SLC 16.11.1 and16.11.3.

TEST		FREQUENCY
TR 16.11.4.1	Project liquid release doses from each unit to UNRESTRICTED AREAS, in accordance with the methodology and parameters in the ODCM, when water systems are being released without being processed by its radwaste treatment system.	31 days

BASES

The requirement that the appropriate portions of this system be used, when specified, provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

This commitment applies to the release of liquid effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50

3. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.5 Chemical Treatment Ponds

COMMITMENT

The quantity of radioactive material contained in each chemical treatment pond shall be limited by the following expression (excluding tritium and dissolved or entrained noble gases):

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

Where:

A_j = pond inventory limit for single radionuclide "j", in Curies

C_j = 10 CFR 20, Appendix B, Table 2, Column 2, concentration for single radionuclide "j", microCuries/ml;

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

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

APPLICABILITY

At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in any of the chemical treatment ponds exceeding above limit.	A.1 Suspend all additions of radioactive material to the pond.	Immediately
	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]	1×10^{-4}
2. Containment Purge	P Each PURGE Grab Sample	P Each PURGE	Principal Gas Gamma Emitters[6]	1×10^{-4}
		M	H-3	1×10^{-6}
3. Unit Vent	W[2] Grab Sample	W	Principal Gas Gamma Emitters[6]	1×10^{-4}
			H-3	1×10^{-6}
4.a. Radwaste Facility Vent b. Waste Handling Building c. Equipment Staging Building	W Grab Sample	W	Principal Gas Gamma Emitters[6]	1×10^{-4}
			H-3	1×10^{-6}
5. Unit Vents	Continuous[5]	W[8] Charcoal Sample	I-131	1×10^{-12}
			I-133	1×10^{-10}
	Continuous[5]	W[8] Particulate Sample	Principal Gamma Emitters[6] (I-131, Others)	1×10^{-11}
	Continuous[5]	M Composite Particulate Sample	Gross Alpha[7]	1×10^{-11}
	Continuous[5]	Q Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}

TABLE 16.11.6-1
(Page 2 of 4)

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)(1) (μCi/ml)
6. All Release Types as listed in 4 above.	Continuous(5)	W(8) Charcoal Sample	I-131	$1x10^{-12}$
			I-133	$1x10^{-10}$
	Continuous(5)	W(8) Particulate Sample	Principal Gamma Emitters(6) (I-131, Others)	$1x10^{-11}$
	Continuous(5)	M Composite Particulate Sample	Gross Alpha(7)	$1x10^{-11}$
	Continuous(5)	Q Composite Particulate Sample	Sr-89, Sr-90	$1x10^{-11}$

TABLE 16.11.6-1
(Page 3 of 4)

NOTES:

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

   For a particular measurement system (which may include radiochemical separation):

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

Where:

LLD	=	the “a priori” lower limit of detection as defined above (as microCurie per unit mass or volume);
s_b	=	the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute);
E	=	the counting efficiency (as counts per disintegration);
V	=	the sample size (in units of mass or volume);
$2.22\ x10^6$	=	the number of disintegrations per minute per microCurie;
Y	=	the fractional radiochemical yield (when applicable);
λ	=	the radioactive decay constant for the particular radionuclide;
Δt	=	the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples); and
T	=	The background and sample counting time in minutes.

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

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

TABLE 16.11.6-1
(Page 4 of 4)

NOTES:

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

3. Not used.

4. Not used.

5. The ratio of the sample flow volume to the sampled stream flow volume shall be known for the time period covered by each dose or dose rate calculation made in accordance with SLCs 16.11.6, 16.11.8 and 16.11.9.

6. The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, and Ce-141 in iodine and particulate releases. The LLD for Ce-144 is $5x10^{-9}$ microCi/ml. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report.

7. The composite filter(s) will be analyzed for alpha activity by analyzing the filter media used during the collection period.

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

BASES

Specific release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrem/year to the whole body, and 3000 mrem/year to the skin from noble gases, and 1500 mrem/year to any organ from Iodine 131, Iodine 133, tritium, and all radionuclides in particulate form with half-lives greater than eight days. This commitment applies to the release of gaseous effluents from all reactors at the site. The Exclusion Area Boundary (Site Boundary) is set as the boundary for gaseous effluent release limits. The Exclusion Area Boundary (EAB) is formed by a 2500 ft radius centered on the Reactor Buildings' centerlines as shown on Figure 16.11.1-1.

The basic requirements for the Selected Licensee Commitments concerning effluents from nuclear power reactors are stated in 10CFR50.36a. These requirements indicate that compliance with effluent Selected Licensee Commitments will keep average annual releases of radioactive material in effluents to small percentages of the limits specified in the old 10CFR20.106 (new 10CFR20.1301). These requirements further indicate that operational flexibility is allowed, compatible with considerations of health and safety, which may temporarily result in releases higher than such small percentages, but still within the limits specified in the old 10CFR20.106 which references Appendix B, Table II concentrations (MPCs). These referenced concentrations are specific values which relate to an annual dose of 500 mrem. It is further indicated in 10CFR50.36a that when using operational flexibility, best efforts shall be exerted to keep levels of radioactive materials in effluents as low as is reasonably achievable (ALARA) as set forth in 10CFR50, Appendix I.

As stated in the Introduction to Appendix B of the new 10CFR20, the effluent concentration (EC) limits given in Appendix B, Table 2, Column 1, are based on an annual dose of 50 mrem for isotopes for which inhalation or ingestion is limiting or 100 mrem for isotopes for which submersion (noble gases) is limiting. Since release concentrations corresponding to limiting dose rates of less than or equal to 500 mrem/year to the whole body, 3000 mrem/year to the skin from noble gases, and 1500 mrem/year to any organ from Iodine 131, Iodine 133, tritium and for all radionuclides in particulate form with half-lives greater than eight days at the site boundary has been acceptable as a SLC limit for gaseous effluents to assure that the limits of 10CFR50, Appendix I and 40CFR190 are not likely to be exceeded, it should not be necessary to restrict the operational flexibility by incorporating the EC value for isotopes based on ingestion/inhalation (50 mrem/year) or for isotopes with the EC based on submersion (100 mrem/year).

Having sufficient operational flexibility is especially important in establishing a basis for effluent monitor setpoint calculations. As discussed above, the concentrations stated in the new 10CFR20, Appendix B, Table 2, Column 1, relate to a dose of 50 or 100 mrem in a year. When applied on an instantaneous basis, this corresponds to a dose rate of either 50 or 100 mrem/year. These low values are impractical upon which to base effluent monitor setpoint calculations for many effluent release situations when monitor background, monitor sensitivity, and monitor performance must be taken into account. Therefore, to accommodate operational flexibility needed for effluent releases, the limits associated with SLC 16.11.6 will be maintained at the current dose rate limit for noble gases of 500 mrem/year to the whole body and 3000 mrem/year to the skin, for Iodine 131, Iodine 133, tritium and all radionuclides in particulate form with half-lives greater than eight days an instantaneous dose rate limit of 1500 mrem/year to any organ.

BASES (continued)

Compliance with the limits of the new 10CFR20.1301 will be demonstrated by operating within the limits of 10CFR50, Appendix I and 40CFR190. Operational history at Catawba/McGuire/Oconee has demonstrated that the use of the dose rate values listed above (i.e. 500 mrem/year, 3000 mrem/year and 1500 mrem/year) as SLC limits has resulted in calculated maximum individual doses to members of the public that are small percentages of the limits of 10CFR50, Appendix I and 40CFR190.

The required detection capabilities for radioactive materials in gaseous waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD, and other detection limits can be found in HASL Procedures Manual, HASL-300 (revised annually), Currie, L.A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry," Anal. Chem. 40, 586-93· (1968), and Hartwell, J. K. "Detection Limits for Radioanalytical Counting Techniques," Atlantic Richfield Hanford Company Report ARH-SA-215 (June 1975).

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual
2. 10 CFR Part 20, Appendix B
3. 10 CFR Part 20
4. 10 CFR Part 50

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.7 Radioactive Gaseous Effluent Monitoring Instrumentation

COMMITMENT

The radioactive gaseous effluent monitoring instrumentation channels shown in Table 16.11.7-1 shall be FUNCTIONAL with Alarm/Trip Setpoints set to ensure that the limits of SLC 16.11.6 are not exceeded.

AND

The Alarm/Trip setpoints shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

---NOTE-------------------------------------
Brief periods of routine sampling (not to exceed 15 minutes) do not make the instrumentation non-functional.

APPLICABILITY

As shown in Table 16.11.7-1.

REMEDIAL ACTIONS

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more radioactive gaseous effluent monitoring channels Alarm/Trip setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel.	Immediately
	OR	
	A.2 Declare the channel non-functional.	Immediately
	OR	
	A.3 Adjust setpoint to within limit.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. One or more radioactive gaseous effluent monitoring instrument channels non-functional.	B.1 Enter the Remedial Action specified in Table 16.11.7-1 for the channel(s).	Immediately
C. One channel non-functional.	C.1.1 Analyze two independent samples of the tank contents.	Prior to initiating a release
	AND	
	C.1.2 Perform independent verification of the discharge valve lineup.	Prior to initiating a release
	AND	
	C.1.3.1 Perform independent verification of manual portion of the computer input for the release rate calculations performed by computer.	Prior to initiating a release
	OR	
	C.1.3.2 Perform independent verification of entire release rate calculations for calculations performed manually.	Prior to initiating a release
	AND	
	C.1.4 Restore channel to FUNCTIONAL status.	14 days
	OR	
	C.2 Suspend the release of radioactive effluents via this pathway.	Immediately

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. One or more flow rate measurement channels non-functional.	D.1 Estimate the flow rate of the release. <u>AND</u> D.2 Restore the channel to FUNCTIONAL status.	Once per 4 hours during releases 30 days
E. One or more noble gas activity monitor channels non-functional.	E.1 Obtain grab samples from the effluent pathway. <u>AND</u> E.2 Perform an analysis of grab samples for radioactivity. <u>AND</u> E.3 Restore the channel to FUNCTIONAL status.	Once per 12 hours during releases To meet LLD requirements per Table 16.11.6-1 30 days
F. Noble gas activity monitor providing automatic termination of release non-functional.	F.1 Suspend PURGING or VENTING of radioactive effluents via this pathway.	Immediately
G. One or more sampler channels non-functional.	G.1 Perform sampling with auxiliary sampling equipment as required by Table 16.11.6-1. <u>AND</u> G.2 Restore the channel to FUNCTIONAL status.	Continuously 30 days

(continued)

REMEDIAL ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
H. One or more Sampler Minimum Flow Device Channels non-functional.	H.1 Verify flow through the sampling apparatus. 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 (Low Range- EMF-50 or 1EMF-36, low-range)	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 (EMF-41 or 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
6. Fuel Storage Area Ventilation System - Noble Gas Activity Monitor (EMF-42 or 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
7. Contaminated Parts Warehouse Ventilation System				
a. Noble Gas Activity Monitor (EMF-53)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-53 Sampler Minimum Flow Device (1)	1 per station	H,I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
8. Radwaste Facility Ventilation System				
a. Noble Gas Activity Monitor (EMF-52)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-52 Sampler Minimum Flow Device (1)	1 per station	H, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7

(continued)

TABLE 16.11.7-1
(Page 3 of 3)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENTS	MINIMUM CHANNELS FUNCTIONAL	REMEDIAL ACTION	APPLICABILITY	TESTING REQUIREMENTS
9. Equipment Staging Building Ventilation System				
a. Noble Gas Activity Monitor (EMF-59)	1 per station	A, E, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7
b. Flow Rate Monitor	1 per station	D, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
c. EMF-59 Sampler Minimum Flow Device (1)	1 per station	H, I	During gaseous effluent releases.	TR 16.11.7.3 TR 16.11.7.6 TR 16.11.7.7
10. Containment Air Release and Addition System - Noble Gas Activity Monitor (EMF-39L or EMF-36L)	1	A, E, I	At all times except when isolation valve is closed & locked.	TR 16.11.7.3 TR 16.11.7.5 TR 16.11.7.6 TR 16.11.7.7

NOTES:

1. Radioactivity monitor (EMF) shall not be declared FUNCTIONAL unless both the EMF and the associated EMF's Minimum Flow Device are rendered FUNCTIONAL.

BASES

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The instrumentation consists of monitoring and sampling instrumentation. Monitors provide continuous display of process parameters with appropriate alarms and trip setpoints established. Samplers collect a portion of the desired process for subsequent laboratory analysis, and do not have alarm/trip capability. Samplers and the analysis program provide a method to assure that long term effluent release quantities do not exceed the requirements of SLC 16.11.6. Monitors provide assurance that instantaneous effluent releases do not exceed the requirements of SLC 16.11.6. The minimum flow devices for EMFs listed in Table 16.11.7-1 are required to provide assurance of representative sampling during actual or potential releases of gaseous effluents. The flow rate monitor quantifies the total gaseous effluent (both non-radioactive and radioactive) released to the environment. During routine sampling, instrumentation may be turned off for short periods of time (not to exceed 15 minutes) in order to meet analysis requirements of SLC 16.11.6. This is considered to be a normal function of the equipment. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the Alarm/Trip will occur prior to exceeding the limits stated in SLC 16.11.6. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

REFERENCES

1. McGuire Nuclear Station, Offsite Dose Calculation Manual

2. 10 CFR Part 50, Appendix A

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.8 Noble Gases

COMMITMENT

Air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure16.11.1-1) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation, and

b. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

APPLICABILITY

At all times.

REMEDIAL ACTIONS

---NOTES--

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

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

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.8.1 Determine cumulative dose contributions from noble gases in gaseous effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.B of Appendix I.

The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable."

The TESTING REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially under-estimated.

The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977.

The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This commitment applies at all times to the release of gaseous effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.9 Dose - Iodine-131 and 133, Tritium and Radioactive Materials in Particulate Form

COMMITMENT The dose to a MEMBER OF THE PUBLIC from Iodine-131 and 133, tritium, and all radioactive materials in particulate form with half-lives greater than 8 days in gaseous effluents released from each unit to areas at and beyond the SITE BOUNDARY (see Figure 16.11.1-1) shall be limited to the following:

a. During any calendar quarter: less than or equal to 7.5 mrem to any organ, and

b. During any calendar year: less than or equal to 15 mrem to any organ.

APPLICABILITY At all times.

REMEDIAL ACTIONS

---NOTES---

Enter applicable Conditions and Required Actions of SLC 16.11.12, "Total Dose," when the limits of this SLC are exceeded by twice the specified limit.

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

Dose - Iodine-131 and 133, Tritium and Radioactive Materials in Particulate Form
16.11.9

TESTING REQUIREMENTS

TEST		FREQUENCY
TR 16.11.9.1	Determine cumulative dose contributions for Iodine 131 and 133, tritium, and radioactive material in particulate form with half lives greater than 8 days in gaseous effluents for current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This commitment is provided to implement the requirements-of Sections- II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Conditions for Operation are the guides set forth in Section II.C of Appendix I.

The REMEDIAL ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable.

The ODCM calculational methods specified in the TESTING REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors, Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of these calculations were: (1) individual inhalation of airborne radionuclides; (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man; (3) deposition onto grassy areas where milk animals and meat-producing animals graze with consumption of the milk and meat by man; and, (4) deposition on the ground with subsequent exposure of man.

BASES (continued)

This commitment applies at all times to the release of gaseous effluents from each reactor at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with the guidance given in NUREG 0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50, Appendix I

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.10 Gaseous Radwaste Treatment System

COMMITMENT

The VENTILATION EXHAUST TREATMENT and WASTE GAS HOLDUP SYSTEMS shall be FUNCTIONAL and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 16.11.1-1) would exceed:

a. 0.2 mrad to air from gamma radiation, or

b. 0.4 mrad to air from beta radiation, or

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

APPLICABILITY

At all times.

REMEDIAL ACTIONS

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

TESTING REQUIREMENTS

---NOTE--
The installed Gaseous Radwaste Treatment System shall be demonstrated FUNCTIONAL by meeting SLC 16.11.6, 16.11.8 and16.11.9.

TEST		FREQUENCY
TR 16.11.10.1	Project gaseous release doses from each unit to areas at and beyond the SITE BOUNDARY, in accordance with the methodology and parameters in the ODCM, when gaseous systems are being released without being processed by its radwaste treatment system.	31 days

BASES

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

This commitment implements the requirements of 19 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Section II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

This commitment applies at all times to the release of radioactive materials in gaseous effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system in accordance with NUREG-0133, Chapter 3.1.

REFERENCES

1. McGuire Nuclear Station, Off site Dose Calculation Manual

2. 10 CFR Part 50, Appendix I

3. 10 CFR Part 50

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.11 Solid Radioactive Waste

COMMITMENT

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

The Solid Radwaste System or an approved alternative process shall be used in accordance with a PROCESS CONTROL PROGRAM (PCP) for the solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10CFR61 licensed disposal site. Wastes shipped for off site processing in accordance with the processor's specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements.

- The PCP describes administrative and operational controls used for the solidification of liquid or wet solid radioactive wastes in order to meet applicable 10CFR61 waste form requirements.
- The PCP describes the administrative and operational controls used for the dewatering of wet radioactive wastes to meet 10CFR61 free standing water requirements.
- The process parameters used in establishing the PCP shall be based on demonstrated processing of actual or simulated liquid or wet solid wastes and must adequately verify that the final product of solidification or dewatering meets all applicable Federal, State and disposal site requirements.

APPLICABILITY

At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Applicable regulatory requirements for solidified or dewatered wastes are not satisified.	A.1 Suspend shipments of defectively packaged solid radioactive wastes from the site. <u>AND</u> A.2 Initiate action to correct the PROCESS CONTROL PROGRAM, procedures, or solid waste equipment as necessary to prevent recurrence.	Immediately Prior to next shipment for disposal of solidified or dewatered wastes.
B. A solidification test as described in the PCP fails to verify Solidification.	B.1 Suspend solidification of the batch under test and follow PCP guidance for test failures. <u>AND</u> 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	Immediately 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
	AND	
	A.2 --------------NOTE------------ Only required to be performed if the total dose limit is exceeded. ----------------------------------- Prepare and submit a Special Report to the NRC which identifies corrective actions to be taken to reduce subsequent releases to prevent recurrence and schedule for achieving conformance with specified limits.	30 days

TESTING REQUIREMENTS

--NOTE--

Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with SLC 16.11.3, 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
	<u>AND</u>	
	C.2 Identify the cause of the unavailability of samples and identify new location(s) for obtaining replacement samples in the next Annual Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).	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
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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
b. Fish and Invertebrates	One sample each commercially and recreationally important species in vicinity of plant discharge area.	Sample in season, or semiannually if they are not seasonal	Gamma isotopic analysis[5] on edible portions
	One sample of same species in areas not influenced by plant discharge.		
c. Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest[10]	Gamma isotopic analyses[5] on edible portion.
	Samples of three different kinds of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed.	Monthly, when available.	Gamma isotopic[5] and I-131 analysis.
	One sample of each of the similar broad leaf vegetation grown 15 to 30 km distant in the least prevalent wind direction if milk sampling is not performed.	Monthly, when available.	Gamma isotopic[5] and I-131 analysis.

TABLE 16.11.13-1

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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

ANALYSIS	REPORTING LEVELS				
	WATER (pCi/l)	AIRBOURNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	BROAD LEAF VEGETATION (pCi/kg, wet)
H-3	20,000[(1)]	N/A	N/A	N/A	N/A
Mn-54	1,000	N/A	30,000	N/A	N/A
Fe-59	400	N/A	10,000	N/A	N/A
Co-58	1,000	N/A	30,000	N/A	N/A
Co-60	300	N/A	10,000	N/A	N/A
Zn-65	300	N/A	20,000	N/A	N/A
Zr-Nb-95	400	N/A	N/A	N/A	N/A
I-131	2	0.9	N/A	3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140	200	N/A	N/A	300	N/A

NOTES:

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

TABLE 16.11.13-3
(Page 1 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD) (1)(2)(3)

ANALYSIS	WATER (pCi/l)	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)	MILK (pCi/l)	BROAD LEAF VEGETATION (pCi/kg, wet)	SEDIMENT (pCi/kg, dry)
Gross Beta	4	0.01	N/A	N/A	N/A	N/A
H-3	2000*	N/A	N/A	N/A	N/A	N/A
Mn-54	15	N/A	130	N/A	N/A	N/A
Fe-59	30	N/A	260	N/A	N/A	N/A
Co-58, 60	15	N/A	130	N/A	N/A	N/A
Zn-65	30	N/A	260	N/A	N/A	N/A
Zr-95	15	N/A	N/A	N/A	N/A	N/A
Nb-95	15	N/A	N/A	N/A	N/A	N/A
I-131	1(4)	0.07	N/A	1	60	N/A
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	15	N/A	N/A	15	N/A	N/A
La-140	15	N/A	N/A	15	N/A	N/A

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

TABLE 16.11.13-3
(Page 2 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

NOTES:

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

   For a particular measurement system (which may include radiochemical separation):

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

   Where:

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

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

   E is the counting efficiency (as counts per disintegration),

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

   2.22 is the number of disintegrations per minute per picoCurie,

   Y is the fractional radiochemical yield (when applicable),

   λ is the radioactive decay constant for the particular radionuclide,

   Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting (for environmental samples, not plant effluent samples), and

   T is the background and sample counting time in minutes.

   It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

TABLE 16.11.13-3
(Page 3 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)

NOTES (continued):

2. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report.

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

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

BASES

The Radiological Environmental Monitoring Program is established to monitor the radiation and radionuclides in the environs of the plant. The program provides representative measurements of radioactivity in the highest potential exposure pathways, and verification of the accuracy of the effluent monitoring program and modeling of environmental exposure pathways. The program is contained in SLC 16.11.13 – 16.11.16 and conforms to the guidance of Appendix I to 10 CFR Part 50. The program includes the following:

1. Monitoring, sampling, analysis, and reporting of radiation and radionuclides in the environment in accordance with the methodology and parameters in the ODCM,

2. A Land Use Census to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census, and

3. Participation in an Interlaboratory Comparison Program to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring.

The portion of the Radiological Environmental Monitoring Program required by this commitment provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the Radiological Effluent Monitoring Program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. The initially specified monitoring program will be effective for at least the first 3 years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 16.11.13-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

With the level of radioactivity in an environmental sampling medium at a specified location exceeding the reporting levels of Table 16.11.13-3 when averaged over any calendar quarter, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that defines the corrective actions to be

BASES (continued)

taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of SLCs 16.11.6, 16.11.8, and 16.11.9. When more than one of the radionuclides in Table 16.11.13-2 are detected in the sampling medium, this report shall be submitted if:

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

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
	AND	
	A.2 Reduce the tank contents to within limit.	48 hours
	AND	
	A.3 Describe the events leading to this condition in the next Annual Radioactive Effluent Release Report.	Within the next scheduled Annual Radioactive Effluent Release Report

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.18.1 Verify the quantity of radioactive material contained in unprotected outdoor radwaste tanks is within limits by analyzing a representative sample of the tank’s contents when radioactive materials are being added to the tank.	7 days

BASES

The tanks applicable to this SLC include all those outdoor radwaste tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the Liquid Radwaste Treatment System.

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

REFERENCES

None

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.19 Explosive Gas Mixture

COMMITMENT The concentration of oxygen in the WASTE GAS HOLDUP SYSTEM shall be limited to ≤ 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 ≤ 4% by volume.	A.1 Reduce oxygen concentration to within limits.	48 hours
B. Concentration of oxygen in the WASTE GAS HOLDUP SYSTEM > 4% and hydrogen concentration > 4% by volume.	B.1 Suspend all additions of waste gases to the system.	Immediately
	AND	
	B.2 Reduce the concentration of oxygen to ≤ 4% by volume.	Immediately
	AND	
	B.3 Reduce oxygen concentration to within limits.	48 hours

TESTING REQUIREMENTS

TEST		FREQUENCY
TR 16.11.19.1	Verify the concentrations of hydrogen and oxygen in the WASTE GAS HOLDUP SYSTEM is within limits by monitoring waste gases in the WASTE GAS HOLDUP SYSTEM with the hydrogen and oxygen monitors required by SLC 16.7.8.	During WASTE GAS HOLDUP SYSTEM operation

BASES

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

REFERENCES

None

16.11 RADIOLOGICAL EFFLUENT CONTROLS

16.11.20 Gas Storage Tanks

COMMITMENT The quantity of radioactivity contained in each gas storage tank shall be limited $\leq$ 49,000 Curies noble gases (considered as Xe-133).

APPLICABILITY At all times.

REMEDIAL ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Quantity of radioactive material in tank not within limit.	A.1 Suspend all additions of radioactive material to the tank.	Immediately
	AND	
	A.2 Reduce the tank contents to within limit.	48 hours

TESTING REQUIREMENTS

TEST	FREQUENCY
TR 16.11.20.1 Verify the quantity of radioactive material contained in each gas storage tank is within limit when radioactive materials are being added to the tank.	24 hours

BASES

This SLC considers postulated radioactive releases due to a waste gas system leak or failure, and limits the quantity of radioactivity in each pressurized gas storage tank in the WASTE GAS HOLDUP SYSTEM to assure that a release would be substantially below the dose guideline values of 10 CFR Part 100 for a postulated event.

Restricting the quantity of radioactivity contained in each gas storage tank provides assurance that in the event of an uncontrolled release of the tank's contents, the resulting total body exposure to a MEMBER OF THE PUBLIC at the nearest exclusion area boundary will not exceed 0.5 rem. This is consistent with Standard Review Plan 11.3, Branch Technical Position ETSB 11-5, "Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure," in NUREG-0800, July 1981.

REFERENCES

None

ATTACHMENT 10

Summary of Changes to the Process Control Program

This attachment includes a summary of changes to the PCP.

Attachment 10
Summary of Changes to the Process Control Program

McGuire Nuclear Station Units 1 & 2
Period 1/1/2021 - 12/31/2021

The McGuire Nuclear Station PCP was not revised in 2021. The most recent revision was provided with the McGuire Nuclear Station 2018 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 1/1/2021 - 12/31/2021

No major modifications to McGuire Nuclear Station liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2021.

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 1/1/2021 - 12/31/2021

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

ENCLOSURE 5: ONS Annual Radioactive Effluent Release Report

Oconee Nuclear Station
Units 1, 2, and 3

Annual Radioactive Effluent Release Report

January 1, 2021 through December 31, 2021

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 1/1/2021 - 12/31/2021

Gaseous Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
1. Total Release	Ci	1.56E+01	1.00E+00	1.33E+00	2.16E+00	2.01E+01
2. Avg. Release Rate	µCi/sec	2.00E+00	1.27E-01	1.67E-01	2.71E-01	6.36E-01
B. Iodines and Halogens						
1. Total Release	Ci	0.00E+00	5.21E-08	0.00E+00	2.41E-03	2.41E-03
2. Avg. Release Rate	µCi/sec	0.00E+00	6.62E-09	0.00E+00	3.03E-04	7.63E-05
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
1. Total Release	Ci	1.09E+01	1.24E+01	1.29E+02	3.74E+01	1.90E+02
2. Avg. Release Rate	µCi/sec	1.40E+00	1.57E+00	1.62E+01	4.71E+00	6.01E+00
E. Carbon-14						
1. Total Release	Ci	6.11E+00	6.16E+00	6.10E+00	5.48E+00	2.39E+01
2. Avg. Release Rate	µCi/sec	7.86E-01	7.84E-01	7.67E-01	6.89E-01	7.56E-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 1/1/2021 - 12/31/2021

Gaseous Effluents - Mixed Mode - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	1.56E+01	9.19E-01	1.30E+00	6.93E-01	1.85E+01
Total for Period	Ci	1.56E+01	9.19E-01	1.30E+00	6.93E-01	1.85E+01
B. Iodines and Halogens						
I-131	Ci	0.00E+00	0.00E+00	0.00E+00	1.53E-05	1.53E-05
I-132	Ci	0.00E+00	0.00E+00	0.00E+00	2.39E-03	2.39E-03
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	2.41E-03	2.41E-03
C. Particulates Half-Life ≥ 8 days						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
H-3	Ci	8.89E+00	1.15E+01	1.26E+02	2.12E+01	1.68E+02
E. Carbon-14						
C-14	Ci	1.83E+00	1.85E+00	1.83E+00	1.64E+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. See Attachment 2, Supplemental Information, of this report.

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Mixed Mode Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	0.00E+00	3.84E-03	3.01E-02	1.09E+00	1.12E+00
Kr-85m	Ci	0.00E+00	0.00E+00	0.00E+00	4.12E-05	4.12E-05
Xe-131m	Ci	0.00E+00	0.00E+00	0.00E+00	2.02E-04	2.02E-04
Xe-133	Ci	2.61E-03	6.22E-03	4.77E-03	3.73E-01	3.87E-01
Xe-133m	Ci	4.09E-05	2.95E-05	2.28E-05	5.90E-04	6.83E-04
Xe-135	Ci	0.00E+00	5.96E-05	6.05E-06	2.84E-03	2.90E-03
Total for Period	Ci	2.65E-03	1.01E-02	3.49E-02	1.46E+00	1.51E+00
B. Iodines and Halogens						
I-131	Ci	0.00E+00	0.00E+00	0.00E+00	5.72E-09	5.72E-09
I-133	Ci	0.00E+00	0.00E+00	0.00E+00	4.01E-09	4.01E-09
Br-82	Ci	0.00E+00	5.21E-08	0.00E+00	0.00E+00	5.21E-08
Total for Period	Ci	0.00E+00	5.21E-08	0.00E+00	9.73E-09	6.18E-08
C. Particulates Half-Life ≥ 8 days						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
H-3	Ci	1.04E-05	1.67E-02	8.56E-02	5.83E-01	6.85E-01
E. Carbon-14						
C-14	Ci	4.28E+00	4.31E+00	4.27E+00	3.83E+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. See Attachment 2, Supplemental Information, of this report.

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	0.00E+00	7.05E-02	0.00E+00	0.00E+00	7.05E-02
Total for Period	Ci	0.00E+00	7.05E-02	0.00E+00	0.00E+00	7.05E-02
B. Iodines and Halogens						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Tritium						
H-3	Ci	1.99E+00	8.56E-01	2.51E+00	1.56E+01	2.10E+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 1/1/2021 - 12/31/2021

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	3.21E-02	2.27E-02	2.93E-02	1.10E-02	9.51E-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 1/1/2021 - 12/31/2021

Liquid Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products*						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	1.49E-05	1.49E-05
2. Avg. Diluted Conc	µCi/ml	0.00E+00	0.00E+00	0.00E+00	1.74E-12	4.38E-13
3. Batch Releases	µCi/ml	0.00E+00	0.00E+00	0.00E+00	1.74E-12	4.38E-13
B. Tritium						
1. Total Release	Ci	9.00E+01	9.61E+01	5.24E+02	3.66E+02	1.08E+03
2. Avg. Diluted Conc	µCi/ml	1.07E-05	1.13E-05	6.11E-05	4.26E-05	3.16E-05
3. Batch Releases	µCi/ml	1.07E-05	1.13E-05	6.11E-05	4.26E-05	3.16E-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	1.17E+06	1.07E+06	1.38E+06	2.97E+06	6.59E+06
2. Continuous Volume	liters	7.12E+08	5.63E+08	6.04E+08	6.86E+08	2.56E+09
F. Dilution Volume						
1. Batch Volume	liters	8.39E+09	8.48E+09	8.58E+09	8.58E+09	3.40E+10
2. Continuous Volume	liters	8.39E+09	8.48E+09	8.58E+09	8.58E+09	3.40E+10

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

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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	2.23E-01	2.16E-01	2.87E-01	2.13E-01	9.39E-01
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

Liquid Effluents - Batch 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	1.49E-05	1.49E-05
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	1.49E-05	1.49E-05
B. Tritium						
H-3	Ci	8.97E+01	9.59E+01	5.24E+02	3.66E+02	1.08E+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 1/1/2021 - 12/31/2021

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	=	73
2. Total Time (min) for Batch Releases	=	1.37E+04
3. Maximum Time (min) for a Batch Release	=	2.10E+02
4. Average Time (min) for Batch Releases	=	1.87E+02
5. Minimum Time (min) for a Batch Release	=	1.38E+02
6. Average Dilution Water Flow During Release (lpm)	=	6.47E+04

B. Gaseous Effluents

1. Total Number of Batch Releases	=	49
2. Total Time (min) for Batch Releases	=	4.63E+04
3. Maximum Time (min) for a Batch Release	=	4.59E+03
4. Average Time (min) for Batch Releases	=	9.45E+02
5. Minimum Time (min) for a Batch Release	=	2.00E+01

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2
Supplemental Information

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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 2021 ARERR contains estimates of C-14 radioactivity released in 2021, 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 2015 ARERR a source term scaling factor of 9.4 Ci/GWe-yr is assumed. Using a source term scaling factor of 9.4 Ci/GWe-yr and actual electric generation (MWe-hrs) from Oconee Nuclear Station in 2021 results in a site total C-14 gaseous release estimate to the environment of 2.34E+01 Curies. 70% of the C-14 gaseous effluent is assumed to be from batch releases and 30% of C-14 gaseous effluent is assumed to be from continuous releases through the unit vents (ref. IAEA Technical Reports Series no. 421, "Management of Waste Containing Tritium and Carbon-14", 2004).

C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. Since the PWR operates with a reducing chemistry, most, if not all, of the C-14 species initially produced are organic (e.g., methane). As a general rule, C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment (e.g. during shutdown or refueling), a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic with an average of 80% organic with the remainder being CO_2 (Ref. EPRI TR-105715). For the Oconee Nuclear Station 2021 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 2021 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

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 2021 Land Use Census was performed May 16-17, 2021, and the results were certified and made available for use on June 21, 2021. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

No new residences closer to the site boundary were identified by the land use census.

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 new milk animals were identified by the land use census.

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
- Type of shipping container
- Solidification agent or absorbent
- Number of shipments
- Other relevant information as necessary

Attachment 3
Solid Radioactive Waste Disposal

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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.)	12	Type A	None	80.6	7.63E+01
2. Dry radioactive waste (e.g., trash, paper, discarded protective clothing, etc.)	20	GDP	None	835	6.8E+00
3. Activated or contaminated metal or equipment, etc.	24	GDP	None	145	1.04E+00
4. Other radioactive waste (e.g., bulk waste, soil, rubble, etc.)	0	NA	NA	0	0.00E+00

Attachment 3
Solid Radioactive Waste Disposal

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

Type of Waste Shipped	Radionuclide	% Abundance
1. Wet Radioactive Waste	C-14	4.54
	Mn-54	3.83
	Fe-55	27.85
	Co-58	6.57
	Co-60	19.2
	Ni-63	28.41
	Zn-65	1.44
	Cs-137	5.04
2. Dry Radioactive Waste	H-3	47.86
	C-14	1.89
	Co-58	11.67
	Co-60	4.13
	Ni-63	26.4
	Zr-95	1.19
	Nb-95	2.61
	Cs-137	3.25
3. Activated or Contaminated Metal or Equipment	C-14	1.56
	Fe-55	2.77
	Ni-63	89.07
	Tc-99	4.88
	Cs-137	1.71
4. Other Radioactive Waste	NA	NA

ATTACHMENT 4

Meteorological Data

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

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
	0.76-1.00	1	0	1	2	0	0	0	1	2	0	0	0	0	0	0	0
	1.01-1.25	0	0	1	1	0	0	2	2	0	0	1	0	1	1	1	0
	1.26-1.50	0	8	3	1	1	0	0	0	5	9	16	4	3	4	1	1
	1.51-2.00	3	8	6	5	6	0	2	3	16	39	78	27	15	3	3	3
	2.01-3.00	4	0	11	12	2	1	0	4	8	78	76	22	6	4	0	0
	3.01-4.00	0	0	0	3	3	1	0	0	1	16	13	3	8	3	1	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	1	0	0	3	3	2	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.46-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1
	1.01-1.25	2	1	1	0	1	0	1	0	0	1	2	1	0	2	0	1
	1.26-1.50	1	0	3	1	3	0	0	1	0	2	6	6	4	3	1	3
	1.51-2.00	8	1	3	4	3	2	0	3	9	27	33	16	1	3	4	1
	2.01-3.00	0	0	2	15	6	2	3	5	2	59	46	10	4	1	2	0
	3.01-4.00	0	0	3	6	1	1	0	0	0	15	10	1	1	2	0	0
	4.01-5.00	1	0	0	1	0	0	0	0	0	1	4	0	1	2	2	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	2	2	1	0	1	0	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	1	0	3	2	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

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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	2	1	1	0	1	0	0	0	0	0	0	0	0	2	0	3
	1.01-1.25	0	3	5	0	0	0	2	0	2	2	0	3	1	0	0	0
	1.26-1.50	3	3	4	4	4	2	2	2	2	6	9	1	0	3	2	3
	1.51-2.00	5	4	7	9	4	1	4	5	11	19	35	14	11	3	2	4
	2.01-3.00	0	3	7	9	13	4	0	3	9	48	27	18	3	5	3	0
	3.01-4.00	0	0	2	5	1	0	0	0	0	14	10	0	2	3	0	0
	4.01-5.00	0	0	1	0	0	0	0	0	0	3	8	1	0	4	2	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	4	1	3	0	4	2	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.46-0.75	2	0	5	0	0	0	4	4	1	1	0	2	1	2	1	5
	0.76-1.00	16	8	5	5	8	7	6	8	12	16	22	15	14	9	17	18
	1.01-1.25	26	23	12	14	10	16	13	10	18	24	29	10	20	20	26	17
	1.26-1.50	28	37	33	33	22	13	28	14	30	30	32	35	24	22	11	17
	1.51-2.00	14	20	66	104	70	29	36	38	53	73	81	48	24	11	10	6
	2.01-3.00	7	23	81	161	69	12	14	25	32	132	133	45	24	23	20	11
	3.01-4.00	1	3	34	35	7	3	3	1	6	54	101	30	13	29	19	16
	4.01-5.00	2	0	2	5	0	0	0	0	1	8	33	27	13	10	9	7
	5.01-6.00	1	0	0	0	0	0	0	0	0	0	8	14	2	8	6	1
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	5	1	2	4	1
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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	37	32	9	7	14	11	12	9	6	7	11	21	34	37	43	39
	0.76-1.00	105	64	52	38	42	44	36	26	29	38	54	52	71	43	90	134
	1.01-1.25	62	38	37	24	41	45	43	32	34	35	42	39	41	31	52	118
	1.26-1.50	28	20	34	72	47	45	47	61	31	23	24	34	16	32	32	44
	1.51-2.00	21	21	48	96	64	29	39	79	60	39	40	42	18	13	11	23
	2.01-3.00	8	12	32	65	25	3	8	13	25	56	69	35	20	20	19	14
	3.01-4.00	1	0	1	6	0	0	1	0	0	10	32	17	12	7	8	4
	4.01-5.00	0	0	0	0	0	0	0	0	0	1	11	8	3	1	1	4
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	1	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	2	1	2	2	0	0	1	1	2	2	1	5	5	10	7	4
	0.76-1.00	5	3	5	3	5	2	2	7	4	3	9	12	9	36	18	6
	1.01-1.25	0	4	1	4	6	3	5	3	1	2	3	6	4	43	26	4
	1.26-1.50	1	0	0	1	9	13	7	4	2	6	5	2	1	17	13	2
	1.51-2.00	0	0	1	4	1	9	5	2	2	5	0	1	0	1	4	1
	2.01-3.00	0	0	0	0	0	0	0	0	0	1	3	0	1	1	1	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	0	2	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 1/1/2021 - 12/31/2021

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	0	0	0	0	1	0	3	0	0
	0.76-1.00	0	0	0	0	0	0	0	0	0	1	1	2	7	13	6	2
	1.01-1.25	0	0	0	0	0	0	0	0	1	0	1	2	7	22	5	0
	1.26-1.50	0	0	0	0	0	0	0	0	0	0	1	1	1	10	6	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	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	3.01-4.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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	1	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	1	0	0	1	0	0	0	0	0	0	0	1	1	1
	1.01-1.25	1	0	0	0	0	0	1	0	0	0	1	2	1	1	0	1
	1.26-1.50	0	3	2	0	0	0	1	0	0	4	6	2	4	3	0	0
	1.51-2.00	2	4	2	3	1	0	0	2	7	11	22	18	2	1	1	2
	2.01-3.00	3	6	9	3	5	1	2	6	14	52	64	19	4	1	1	1
	3.01-4.00	2	4	9	12	2	0	0	0	9	55	45	2	3	1	2	0
	4.01-5.00	1	0	0	2	0	1	0	1	3	20	11	1	4	3	0	1
	5.01-6.00	0	0	0	3	3	1	0	1	1	21	10	1	5	3	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	2	9	10	0	1	4	1	0
	8.01-10.00	0	0	0	0	0	0	0	0	2	0	0	0	0	3	1	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	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	1	0	0	0	0	0	0	2	0	0	0	2	0
	1.01-1.25	0	1	0	0	0	0	1	0	0	1	0	0	1	2	0	3
	1.26-1.50	1	0	2	2	0	0	0	0	0	0	0	4	2	0	1	2
	1.51-2.00	2	3	1	1	3	0	0	1	2	5	17	2	4	4	0	0
	2.01-3.00	3	3	2	4	4	2	0	5	11	29	34	17	0	2	1	2
	3.01-4.00	0	1	0	7	2	3	0	3	5	32	11	1	1	0	1	0
	4.01-5.00	0	0	1	6	8	1	2	0	4	25	2	3	0	1	2	0
	5.01-6.00	0	0	0	4	2	0	0	0	2	14	14	0	1	0	0	0
	6.01-8.00	1	0	0	2	1	0	0	0	0	8	7	1	0	1	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	2	6	3	1	2	3	1
	10.01-max	0	0	0	0	0	0	0	0	0	1	2	1	1	2	0	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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	1	0	0	0	0	1	0	0	0	0	2	0	1	0	1
	1.01-1.25	2	0	1	0	0	2	0	0	0	0	1	1	0	1	3	0
	1.26-1.50	1	5	0	1	0	1	0	0	1	2	3	0	0	0	1	1
	1.51-2.00	5	6	8	1	0	4	1	6	5	6	14	10	10	1	1	1
	2.01-3.00	3	6	6	6	7	2	5	3	11	25	35	11	0	1	1	2
	3.01-4.00	0	3	4	9	10	2	1	1	5	22	14	1	1	1	1	0
	4.01-5.00	0	1	2	3	2	2	0	1	8	18	6	2	2	3	2	0
	5.01-6.00	0	0	2	3	2	0	0	0	1	9	6	0	1	1	0	0
	6.01-8.00	0	0	0	2	1	0	0	0	0	6	13	1	0	10	2	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	2	7	3	1	2	2	1
	10.01-max	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
D	0.46-0.75	2	0	0	0	1	0	0	0	1	1	0	1	0	0	2	0
	0.76-1.00	8	3	2	2	1	2	3	3	2	8	9	8	6	9	9	4
	1.01-1.25	12	5	2	4	4	5	0	2	10	5	10	8	12	12	9	4
	1.26-1.50	16	11	8	4	2	9	10	7	10	11	25	15	19	15	18	12
	1.51-2.00	34	28	26	16	9	11	18	14	24	33	30	34	24	15	19	14
	2.01-3.00	29	49	65	56	42	28	29	39	46	61	62	38	10	8	13	15
	3.01-4.00	8	37	75	88	61	21	19	19	27	75	67	16	11	12	7	1
	4.01-5.00	3	11	58	73	42	4	3	2	21	64	53	24	8	23	24	5
	5.01-6.00	4	4	34	33	12	1	2	3	10	34	78	19	5	18	20	13
	6.01-8.00	3	1	12	18	5	2	2	2	4	30	114	36	14	27	10	8
	8.01-10.00	0	0	0	1	0	0	0	0	0	1	27	19	2	11	12	2
	10.01-max	0	0	0	0	0	0	0	0	0	0	8	0	0	3	2	0

Attachment 4
Meteorological Data

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

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	4	0	2	0	2	2	0	1	0	2	0	2	0	4	3	4
	0.76-1.00	20	12	5	4	3	3	5	9	4	2	3	8	6	10	18	9
	1.01-1.25	31	14	12	8	7	6	4	5	6	4	10	9	13	30	29	25
	1.26-1.50	61	17	7	8	6	8	6	7	8	8	7	24	34	39	67	51
	1.51-2.00	160	55	25	10	19	22	22	14	25	20	40	48	57	48	93	141
	2.01-3.00	227	141	86	51	40	36	37	34	49	43	97	50	21	29	37	162
	3.01-4.00	29	35	73	68	44	16	10	30	51	45	60	24	14	15	11	21
	4.01-5.00	8	16	26	31	18	0	2	19	23	42	45	18	9	12	23	9
	5.01-6.00	1	7	10	13	8	1	2	0	8	16	39	18	6	6	9	6
	6.01-8.00	0	0	0	3	2	0	1	0	0	9	50	16	13	9	6	4
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	12	5	1	1	1	2
	10.01-max	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
F	0.46-0.75	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0
	0.76-1.00	4	2	0	1	2	1	1	0	1	1	0	0	1	2	2	4
	1.01-1.25	1	5	1	0	2	1	1	0	2	1	3	0	4	1	3	1
	1.26-1.50	10	10	1	1	1	0	0	1	0	3	2	3	2	3	5	9
	1.51-2.00	22	15	9	4	5	1	3	1	3	5	3	10	7	4	6	13
	2.01-3.00	45	27	3	2	2	4	3	2	7	9	9	5	3	1	7	5
	3.01-4.00	10	3	0	0	3	0	2	6	2	5	11	1	1	0	4	0
	4.01-5.00	1	1	0	1	2	0	1	1	0	6	1	1	0	0	1	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	2	1	1	0	1	1	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	1	2	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 1/1/2021 - 12/31/2021

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	1	0	0	0	0	0	0	0	0	0
	0.76-1.00	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.01-1.25	0	0	0	1	0	0	0	1	0	0	0	0	1	0	2	0
	1.26-1.50	0	0	1	1	0	2	0	0	0	0	1	1	3	2	1	1
	1.51-2.00	7	2	0	0	0	0	1	0	1	2	2	3	1	0	1	7
	2.01-3.00	11	3	0	1	0	0	1	1	2	2	5	1	1	1	2	4
	3.01-4.00	1	0	0	0	0	0	0	0	0	1	4	0	1	0	0	0
	4.01-5.00	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0
	5.01-6.00	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
	6.01-8.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8.01-10.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10.01-max	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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 1/1/2021 - 12/31/2021

Oconee Nuclear Station had zero (0) unplanned liquid offsite release radioactive effluents in 2021.

Oconee Nuclear Station had zero (0) unplanned gaseous offsite release of radioactive effluents in 2021.

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 1/1/2021 - 12/31/2021

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mrad	2.91E-04	2.25E-05	3.92E-05	5.56E-04	9.09E-04
(a) Limit	mrad	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		1.94E-03	1.50E-04	2.61E-04	3.71E-03	3.03E-03
2. Maximum Beta Air	mrad	8.67E-04	6.18E-05	7.77E-05	2.49E-04	1.25E-03
(a) Limit	mrad	3.00E+01	3.00E+01	3.00E+01	3.00E+01	6.00E+01
(b) % of Limit		2.89E-03	2.06E-04	2.59E-04	8.29E-04	2.09E-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	9.11E-02	9.18E-02	9.08E-02	8.16E-02	3.55E-01
(a) Limit	mrem	2.25E+01	2.25E+01	2.25E+01	2.25E+01	4.50E+01
(b) % of Limit		4.05E-01	4.08E-01	4.04E-01	3.63E-01	7.89E-01

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

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

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch Mode & Continuous Mode						
1. Maximum Organ Dose	mrem	1.24E-02	1.33E-02	7.25E-02	5.06E-02	1.49E-01
(a) Limit	mrem	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		8.29E-02	8.86E-02	4.83E-01	3.37E-01	4.96E-01
(c) Critical Age		Child	Child	Child	Child	Child
(d) Critical Organ		Liver	Liver	Liver	GI-Lli	GI-Lli
2. Maximum Total Body Dose	mrem	1.24E-02	1.33E-02	7.25E-02	5.06E-02	1.49E-01
(a) Limit	mrem	4.50E+00	4.50E+00	4.50E+00	4.50E+00	9.00E+00
(b) % of Limit		2.76E-01	2.95E-01	1.61E+00	1.12E+00	1.65E+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 1/1/2021 - 12/31/2021

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)	3.55E-01 mrem
1. Location	1.0 miles SW
2. Critical Age	Child
3. Critical Organ	Bone
4. Gas Contribution %	100.00%
5. Liquid Contribution %	0.00%
B. Maximum Total Body Dose	2.80E-01 mrem
1. Location	1.0 miles SW
2. Critical Age	Child
3. Gas non-NG Contribution %	46.59%
4. Gas Contribution %	0.29%
5. Liquid Contribution %	53.12%

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 1/1/2021 - 12/31/2021

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 2021. 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 2021. Results from sampling during 2021 confirmed existing knowledge of tritium concentrations in site ground water.

Results from sampling during 2021 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 2021.

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 1/1/2021 - 12/31/2021

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	3.48E+02	2
A-11	ONS GWPI / A-11 / CTP 3	NS	<MDA	NS	<MDA	2
A-13	ONS GWPI / A-13 / CTP 1/2	NS	4.63E+02	NS	3.65E+02	2
A-14	ONS GWPI / A-14 / CTP 1/2	NS	<MDA	NS	NS	1
BG-4	ONS GWPI / BG-4 / Ball Field	NS	<MDA	NS	<MDA	2
GM-10	ONS GWPI / GM-10 / 525 kv Sw Yard	<MDA	<MDA	<MDA	<MDA	4
GM-10R	ONS GWPI / GM-10R / 525 kv Sw Yard	NS	<MDA	NS	NS	1
GM-11	ONS GWPI / GM-11 / ONS Garage	NS	<MDA	NS	NS	1
GM-11R	ONS GWPI / GM-11R / ONS Garage	NS	<MDA	NS	NS	1
GM-12	ONS GWPI / GM-12 / E of Access Rd.	NS	<MDA	NS	NS	1
GM-12R	ONS GWPI / GM-12R / E of Access Rd.	NS	<MDA	NS	NS	1
GM-13	ONS GWPI / GM-13 / 525 kv Sw Yard	NS	<MDA	NS	NS	1
GM-13R	ONS GWPI / GM-13R / 525 kv Sw Yard	NS	<MDA	NS	NS	1
GM-14	ONS GWPI / GM-14 / Mnt. Trg. Facility	NS	<MDA	NS	NS	1
GM-14R	ONS GWPI / GM-14R / Mnt. Trg. Facility	NS	<MDA	NS	NS	1
GM-15	ONS GWPI / GM-15	NS	<MDA	NS	<MDA	2
GM-15R	ONS GWPI / GM-15R	NS	<MDA	NS	NS	1
GM-16DDR	ONS GWPI / GM-16DDR	NS	<MDA	NS	NS	1
GM-16DR	ONS GWPI / GM-16DR	4.51E+03	4.14E+03	4.25E+03	3.79E+03	4
GM-16R	ONS GWPI / GM-16R	1.22E+03	1.46E+03	1.69E+03	1.61E+03	4
GM-17DR	ONS GWPI / GM-17DR	1.17E+03	1.20E+03	1.35E+03	9.92E+02	4
GM-17R	ONS GWPI / GM-17R	3.82E+03	4.23E+03	4.14E+03	3.49E+03	4
GM-18R	ONS GWPI / GM-18R	2.68E+03	2.44E+03	2.65E+03	2.27E+03	4
GM-19	ONS GWPI / GM-19	9.50E+02	5.59E+02	7.72E+02	3.52E+02	4
GM-19R	ONS GWPI / GM-19R	1.63E+03	1.56E+03	1.56E+03	1.22E+03	4
GM-1R	ONS GWPI / GM-1R / CTP 1/2	<MDA	<MDA	<MDA	<MDA	4
GM-20	ONS GWPI / GM-20	NS	<MDA	NS	NS	1
GM-20R	ONS GWPI / GM-20R	NS	<MDA	NS	NS	1
GM-21	ONS GWPI / GM-21	NS	<MDA	NS	NS	1
GM-22	ONS GWPI / GM-22	NS	1.85E+02	NS	NS	1
GM-23	ONS GWPI / GM-23	<MDA	3.27E+02	3.18E+02	2.90E+02	4
GM-24R	ONS GWPI / GM-24R	1.54E+03	1.69E+03	1.60E+03	1.43E+03	4
GM-25R	ONS GWPI / GM-25R	NS	2.45E+02	NS	3.51E+02	2
GM-2DR	ONS GWPI / GM-2DR / U-1/2 SFP	2.25E+02	2.12E+02	2.70E+02	<MDA	4
GM-2R	ONS GWPI / GM-2R / U-1/2 SFP	4.73E+02	8.62E+02	6.62E+02	4.32E+02	4
GM-3DR	ONS GWPI / GM-3DR / U-3 SFP	NS	3.61E+02	NS	1.99E+02	2
GM-3R	ONS GWPI / GM-3R / U-3 SFP	2.06E+02	2.84E+02	3.84E+02	3.17E+02	4
GM-4	ONS GWPI / GM-4 / Rad. Mat. WH	5.33E+02	6.80E+02	6.15E+02	4.75E+02	4
GM-5	ONS GWPI / GM-5 / Rdwst. Bldg.	<MDA	<MDA	2.10E+02	<MDA	4
GM-5R	ONS GWPI / GM-5R / Rdwst. Bldg.	NS	<MDA	NS	NS	1
GM-6	ONS GWPI / GM-6 / Outflow to CTP-3	<MDA	<MDA	<MDA	<MDA	4
GM-6R	ONS GWPI / GM-6R / Outflow to CTP-3	NS	<MDA	NS	NS	1
GM-7	ONS GWPI / GM-7 / 525 kv Sw Yard	NS	2.16E+02	NS	<MDA	2
GM-7DR	ONS GWPI / GM-7DR	NS	<MDA	NS	NS	1
GM-7R	ONS GWPI / GM-7R / 525 kv Sw Yard	1.37E+03	1.18E+03	1.17E+03	2.47E+03	4

GM-8	ONS GWPI / GM-8 / E of U-3 TB	2.28E+02	2.23E+02	2.71E+02	2.52E+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	2.50E+02	4.49E+02	4.84E+02	2.39E+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	3.44E+02	3.51E+02	2.85E+02	3.57E+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 1/1/2021 - 12/31/2021

Oconee Nuclear Station did not experience inoperable equipment relevant to effluent monitoring in excess of SLC limits during 2021.

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 2021.

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 1/1/2021 - 12/31/2021

ODCM Revision 60

The most recent ODCM revision is 60 and was provided with the 2020 ARERR.

Radiological Effluent Controls (SLC 16.11)

The Oconee Nuclear Station Radiological Effluent Controls are contained in SLC 16.11 and are attached. SLC 16.11 was not revised in 2021.

Oconee Nuclear Station
Selected Licensee Commitments Revised 6/8/2021

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16.0	005	08/16/17
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16.2	000	08/25/14
16.3	001	06/29/15
16.4	---	PENDING
16.5.1	000	11/26/12
16.5.2	000	11/15/12
16.5.3	000	02/21/07
16.5.4	---	Deleted 03/28/18
16.5.5	---	Deleted 05/16/09
16.5.6	---	Deleted 02/10/14
16.5.7	000	12/13/06
16.5.8	000	01/31/07
16.5.8a	---	Deleted 05/19/05
16.5.9	---	Deleted 06/06/19
16.5.10	000	10/08/03
16.5.11	000	01/31/00
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16.6.1	001	12/05/19
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16.11.7	000	01/31/00
16.11.8	000	12/21/09

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16.12.3	000	05/01/03
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16.14.4.a	000	03/15/11
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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.

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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
	AND		
	E.1.2	Conduct two independent data entry checks for release rate calculations	Prior to initiating subsequent release
	AND		
	E.1.3	Conduct two independent valve lineups of the effluent pathway.	Prior to initiating subsequent release
	OR		
	E.2	Suspend release of radioactive effluents by this pathway.	Immediately
F. As required by Required Action B.1 and referenced in Table 16.11.3-1. (RIA-54)	F.1	Suspend release of radioactive effluents by this pathway.	Immediately
	OR		
	F.2	Collect and analyze grab samples for gross radioactivity (beta and/or gamma) at a lower limit of detection of at least 10^{-7} μCi/ml.	Prior to each discrete release of the sump

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. As required by Required Action B.1 and referenced in Table 16.11.3-1. (Liquid Radwaste Effluent Line Flow Rate Monitor)	-----------------NOTE------------------ Not required during short, controlled outages of liquid effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	G.1 Suspend release of radioactive effluents by this pathway.	Immediately
	OR	
	G.2 Estimate flow rate during actual releases.	Immediately AND 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
	OR	
	L.2.1 -----------NOTE----------- The collection time of each sample shall not exceed 7 days. ------------------------------- Collect samples continuously using auxiliary sampling equipment.	Immediately
	AND	
	L.2.2 Analyze each sample.	48 hours from end of each sample collection

CONDITION	REQUIRED ACTION	COMPLETION TIME
M. As required by Required Action C.1 and referenced in Table 16.11.3-2 for effluent from ventilation system or condenser air ejectors. (RIA-40)	-----------------NOTE------------------ Not required during short, controlled outages of gaseous effluent monitoring instrumentation. Short controlled outages are defined as planned removals from service for durations not to exceed 1 hour, for purposes of sample filter changeouts, setpoint adjustments, service checks, and/or routine maintenance procedures. This guidance may be applied successively, provided that time between successive short, controlled outages is always at least equal to duration of immediately preceding outage. ---	
	M.1 Continuously monitor release through the unit vent.	Immediately
	<u>OR</u>	
	M.2 Suspend release of radioactive effluents by this pathway.	Immediately
	<u>OR</u>	
	M.3.1 Collect grab sample.	Immediately <u>AND</u> Once per 8 hours
	<u>AND</u>	
	M.3.2 Analyze grab sample for gross activity (beta and/or gamma).	24 hours from collection of grab sample

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.3.1	------------------------NOTE--------------------------- The Channel Response check shall consist of verifying indications during periods of release. Channel response checks shall be made at least once per calendar day on days in which continuous, periodic or batch releases are made. --- Perform Channel Response Check.	During each release via this pathway
SR 16.11.3.2	------------------------NOTE--------------------------- The Channel Response check shall consist of verifying indications during periods of release. Channel response checks shall be made at least once per calendar day on days in which continuous, periodic or batch releases are made. --- Perform Channel Response Check.	24 hours
SR 16.11.3.3	Perform Source Check.	24 hours
SR 16.11.3.4	Perform Source Check.	31 days
SR 16.11.3.5	Perform Source Check.	92 days

SURVEILLANCE		FREQUENCY
SR 16.11.3.6	-----------------------NOTE---------------------------- The CHANNEL FUNCTIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room annunciation occurs if any of the following conditions exist: 1. Instrument indicates measured levels above the alarm/trip setpoint. 2. Circuit failure (downscale only). --- Perform CHANNEL FUNCTIONAL TEST.	92 days
SR 16.11.3.7	------------------------NOTE---------------------------- The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room annunciation occurs if any of the following conditions exist: 1. Instrument indicates measured levels above the alarm/trip setpoint. 2. Circuit failure (downscale only). --- Perform CHANNEL FUNCTIONAL TEST.	92 days
SR 16.11.3.8	Perform CHANNEL FUNCTIONAL TEST.	92 days

SURVEILLANCE		FREQUENCY
SR 16.11.3.9	-------------------------NOTE--------------------------- The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Bureau of Standards or using standards that have been obtained from suppliers that participate in measurement assurance activities with the National Institute of Standards and Technology (NIST). The standards shall permit calibrating the system over its intended range of energy and measurement. For subsequent CHANNEL CALIBRATION, sources that have been related to the initial calibration shall be used. (Operating plants may substitute previously established calibration procedures for these requirements.) -- Perform CHANNEL CALIBRATION.	12 months
SR 16.11.3.10	Perform CHANNEL CALIBRATION.	12 months
SR 16.11.3.11	Perform leak test.	When cylinder gates or wicket gates are reworked
SR 16.11.3.12	Perform Source Check.	Within 24 hours prior to each release via associated pathway

Table 16.11.3-1
LIQUID EFFLUENT MONITORING INSTRUMENTATION
OPERATING CONDITIONS AND SURVEILLANCE REQUIREMENTS

INSTRUMENT	MINIMUM OPERABLE CHANNELS	APPLICABILITY	SURVEILLANCE REQUIREMENTS	CONDITION REFERENCED FROM REQUIRED ACTION B.1
1. Monitors Providing Automatic Termination of Release				
a. Liquid Radwaste Effluent Line Monitor, RIA-33	1	At all times	SR 16.11.3.1 SR 16.11.3.3 SR 16.11.3.6 SR 16.11.3.9	E
b. Turbine Building Sump, RIA-54	1	At all times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	F
2. Monitors not Providing Automatic Termination of Release				
Low Pressure Service Water RIA-35	1	At all times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	H
3. Flow Rate Measuring Devices				
a. Liquid Radwaste Effluent Line Flow Rate Monitor (0LW CR0725 or 0LW SS0920)	1	At all times	SR 16.11.3.1 SR 16.11.3.10	G
b. Liquid Radwaste Effluent Line Minimum Flow Device	NA	NA	SR 16.11.3.1 SR 16.11.3.10	NA
c. Turbine Building Sump Minimum Flow Device	NA	NA	SR 16.11.3.1 SR 16.11.3.10	NA
d. Low Pressure Service Water Minimum Flow Device	NA	NA	SR 16.11.3.1 SR 16.11.3.10	NA

Table 16.11.3-1
LIQUID EFFLUENT MONITORING INSTRUMENTATION
OPERATING CONDITIONS AND SURVEILLANCE REQUIREMENTS

	INSTRUMENT	MINIMUM OPERABLE CHANNELS	APPLICABILITY	SURVEILLANCE REQUIREMENTS	CONDITION REFERENCED FROM REQUIRED ACTION B.1
e.	Keowee Hydroelectric Tailrace Discharge [(a)]	NA	NA	SR 16.11.3.11	NA
4.	Continuous Composite Sampler				
	#3 Chemical Treatment Pond Composite Sampler and Sampler Flow Monitor (Turbine Building Sumps Effluent)	1	At all times	SR 16.11.3.2 SR 16.11.3.10	H

(a) Flow is determined from the number of hydro units operating. If no hydro units are operating, leakage flow will be assumed to be 38 cfs based on historical data.

Table 16.11.3-2
GASEOUS EFFLUENT MONITORING INSTRUMENTATION
OPERATING CONDITIONS AND SURVEILLANCE REQUIREMENTS

INSTRUMENT	MINIMUM OPERABLE CHANNELS (PER RELEASE PATH)	APPLICABILITY	SURVEILLANCE REQUIREMENTS	CONDITION REFERENCED FROM REQUIRED ACTION C.1
1. Unit Vent Monitoring System				
a. Noble Gas Activity Monitor Providing Alarm and Automatic Termination of Containment Purge Release (RIA-45 - Purge Isolation Function)	1	At All Times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	I
b. Noble Gas Activity Monitor Providing Alarm. (RIA-45 - Vent Stack Monitor Function)	1	At all times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	K
c. Iodine Sampler	1	At All Times	SR 16.11.3.2	L
d. Particulate Sampler	1	At All Times	SR 16.11.3.2	L
e. Effluent Flow Rate Monitor (Unit Vent Flow) (MSC CR0001)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	J
f. Sampler Flow Rate Monitor [(a)] (Annunciator)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	NA
g. Effluent Flow Rate Monitor (Containment Purge)(MSC CR0001)	1	During Containment Purge Operation	SR 16.11.3.2 SR 16.11.3.10	J
h. CSAE Off Gas Monitor (RIA-40)	1	During Operation of CSAE	SR 16.11.3.2 SR 16.11.3.5 SR 16.11.3.8 SR 16.11.3.9	M
2. Interim Radwaste Building Ventilation Monitoring System				
a. Noble Gas Activity Monitor (RIA - 53)	1	At All Times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	K
b. Iodine Sampler	1	At All Times	SR 16.11.3.2	L
c. Particulate Sampler	1	At All Times	SR 16.11.3.2	L
d. Effluent Flow Rate Monitor (Interim Radwaste Exhaust) (GWD FT0082)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	J
e. Sampler Flow Rate Monitor[(a)] (Annunciator)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	NA

Table 16.11.3-2
GASEOUS EFFLUENT MONITORING INSTRUMENTATION
OPERATING CONDITIONS AND SURVEILLANCE REQUIREMENTS

		INSTRUMENT	MINIMUM OPERABLE CHANNELS (PER RELEASE PATH)	APPLICABILITY	SURVEILLANCE REQUIREMENTS	CONDITION REFERENCED FROM REQUIRED ACTION C.1
3.	Hot Machine Shop Ventilation Sampling System					
	a.	Iodine Sampler	1	At All Times	SR 16.11.3.2	L
	b.	Particulate Sampler	1	At All Times	SR 16.11.3.2	L
	c.	Effluent Flow Rate Monitor (Hot Machine Shop Exhaust) (Totalizer)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	J
	d.	Sampler Flow Rate Monitor [(a)] (Annunciator)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	NA
4.	Radwaste Facility Ventilation Monitoring System					
	a.	Noble Gas Activity Monitor (4-RIA-45)	1	At All Times	SR 16.11.3.2 SR 16.11.3.4 SR 16.11.3.7 SR 16.11.3.9	K
	b.	Iodine Sampler	1	At All Times	SR 16.11.3.2	L
	c.	Particulate Sampler	1	At All Times	SR 16.11.3.2	L
	d.	Effluent Flow Rate Monitor (Radwaste Facility Exhaust) (0VS CR2060)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	J
	e.	Sampler Flow Rate Monitor [(a)] (Annunciator)	1	At All Times	SR 16.11.3.2 SR 16.11.3.10	NA
5.	Waste Gas Holdup Tanks					
	a.	Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (RIA-37,-38)[b]	1	During Waste Gas Holdup Tank Releases	SR 16.11.3.1 SR 16.11.3.6 SR 16.11.3.9 SR 16.11.3.12	I
	b.	Effluent Flow Rate Monitor (Waste Gas Discharge Flow) (MSC CR0001)	1	During Waste Gas Holdup Tank Releases	SR 16.11.3.1 SR 16.11.3.10	J

(a)Alarms indicating low flow may be substituted for flow measuring devices.
(b)Either Normal or High Range monitor is required dependent upon activity in tank being released.

BASES

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases. The alarm/trip setpoints for these instruments shall be calculated in accordance with NRC approved methods in the ODCM to assure that the alarm/trip will occur prior to exceeding 10 times the limits of 10 CFR Part 20. The operability and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases. The alarm/trip setpoints for these instruments shall be calculated in accordance with NRC approved methods in the ODCM to assure that the alarm/trip will occur prior to exceeding applicable dose limits in SLC 16.11.2. The operability end use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

For certain applicable cases, grab samples or flow estimates are required at frequencies between every 4 hours end every 12 hours upon RIA removal from service. SLC 16.11.3 does not explicitly require Action (grab samples or flow estimates) to be initiated immediately upon RIA removal from service, when removal is for the purposes of sample filter changeouts, setpoint adjustments, service checks, or routine maintenance. Therefore, during the defined short, controlled outages, Action is not required.

For the cases in which Action is defined as continuous sampling by auxiliary equipment (Action L) initiation of continuous sampling by auxiliary sampling equipment requires approximately 1 hour. One hour is the accepted reasonable time to initiate collect and change samples. Therefore. for the defined short, controlled outages (not to exceed 1 hour), Action is not required.

Failures such as blown instrument fuses, defective indicators, and faulted amplifiers are, in many cases, revealed by alarm or annunciator action. Comparison of output and/or state of independent channels measuring the same variable supplements this type of built-in surveillance. Based on experience in operation of both conventional and nuclear systems, when the unit is in operation, the minimum checking frequency stated is deemed adequate.

REFERENCES:

1. 10 CFR Part 20.
2. 10 CFR Part 50, Appendix A.
3. Offsite Dose Calculation Manual.
4. UFSAR, Section 7.2.3.4.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.4 Operational Safety Review

COMMITMENT Required sampling should be performed as detailed in Table 16.11.4-1.

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. NA	A.1 NA	NA

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 16.11.4.1 N/A	N/A

Table 16.11.4-1
Minimum Sampling Frequency and Analysis Program

Item		Check		Frequency	Lower Limit of Detection[b] of Lab Analysis for Waste
1.	Decant Monitor Tank, Turbine Building Sump Monitor Tanks, Waste and Recycle Monitor Tanks	a.	Principal Gamma Emitters[c] including Dissolved Noble Gases	Composite Grab Sample prior to release of each batch[h]	<5E-06 µCi/ml (Ce-144) <5E-07 µCi/ml (Other Gamma Nuclides) <1E-05 µCi/ml (Dissolved Gases) <1E-06 µCi/ml (I-131)
		b.	Radiochemical Analysis Sr-89 and Sr-90	Quarterly from all composited batches[f]	<5E-08 µCi/ml
		c.	Tritium	Monthly Composite	<1E-05 µCi/ml
		d.	Gross Alpha Activity	Monthly Composite	<1E-07 µCi/ml
2.	Unit Vent Sampling (Includes Waste Gas Decay Tanks, Reactor Building Purges, Auxiliary Building Ventilation, Spent Fuel Pool Ventilation, Air Ejectors)	a.	Iodine Spectrum[a]	Continuous monitor, weekly sample[e]	<1E-10 µCi/cc (I-133)[j] <1E-12 µCi/cc (I-131)[j]
		b.	Particulates[a]		
		i.	Ce-144 & Mo-99	Weekly Composite[e]	<5E-10 µCi/cc[j][k]
		ii.	Other Principle Gamma Emitters[d]	Weekly Composite[e]	<1E-11 µCi/cc[j]
		iii.	Gross Alpha Activity	Monthly, using composite samples of one week	<1E-11 µCi/cc
		iv.	Radiochemical Analysis Sr-89, Sr-90	Quarterly Composite	<1E-11 µCi/cc
		c.	Gases by Principle Gamma Emitters[d]	Weekly Grab Sample	<1E-04 µCi/cc
		d.	Tritium	Weekly Grab Sample	<1E-06 µCi/cc
3.	Waste Gas Decay Tank	a.	Principle Gamma Emitters[d]	Grab Sample prior to release of each batch	<1E-04 µCi/cc (gases) <1E-10 µCi/cc (particulates and iodines) <5E-09 µCi/cc (Ce-144 and Mo-99)
		b.	Tritium	Grab Sample prior to release of each batch	<1E-06 µCi/cc
4.	Reactor Building	a.	Principle Gamma Emitters[d]	Grab sample each purge	<1E-04 µCi/cc (gases) <1E-10 µCi/cc (particulates and iodines) <5E-09 µCi/cc (Ce-144 and Mo-99)
		b.	Tritium	Grab sample each purge	<1E-06 µCi/cc

Table 16.11.4-1
Minimum Sampling Frequency and Analysis Program

Item		Check		Frequency	Lower Limit of Detection[(b)] of Lab Analysis for Waste
5.	Not Used				
6.	#3 Chemical Treatment Pond Effluent[(i)]	a.	Principle Gamma Emitters[(c)]	Weekly Continuous Composite[(g)]	<5E-07 µCi/ml
		b.	I-131	Weekly Continuous Composite[(g)]	<1E-06 µCi/ml
		c.	Tritium	Monthly Continuous Composite[(g)]	<1E-05 µCi/ml
		d.	Gross Alpha Activity	Monthly Continuous Composite[(g)]	<1E-07 µCi/ml
		e.	Sr-89 & Sr-90	Quarterly Continuous Composite[(g)]	<5E-08 µCi/ml
		f.	Dissolved and Entrained gases (Gamma Emitters)	Monthly Grab	<1E-05 µCi/ml
7.	Radwaste Facility Ventilation	a.	Iodine Spectrum[(a)]	Continuous monitor, weekly sample[(e)]	(I-133) <1E-09 µCi/cc (I-131) <1E-11 µCi/cc
		b.	Particulate[(a)]		
		i.	Ce-144 and Mo-99	Weekly Composite[(e)]	<5E-10 µCi/cc[(j)]
		ii.	Other Principle Gamma Emitters[(d)]	Weekly Composite[(e)]	<1E-11 µCi/cc[(j)]
		iii.	Gross Alpha Activity	Monthly, using composite samples of one week	<1E-11 µCi/cc
		iv.	Radiochemical Analysis Sr-89, Sr-90	Quarterly Composite	<1E-11 µCi/cc
		c.	Gases by Principle Gamma[(d)] Emitters	Weekly Grab Sample	<1E-04 µCi/cc
		d.	Tritium	Weekly Grab Sample	<1E-06 µCi/cc

Table 16.11.4-1
Minimum Sampling Frequency and Analysis Program

Item		Check		Frequency	Lower Limit of Detection(b) of Lab Analysis for Waste
8.	Hot Machine Shop Ventilation	a.	Iodine Spectrum	Weekly Sample(e)	(I-133) <1E-10 μCi/cc(j) (I-131) <1E-12 μCi/cc(j)
		b.	Particulate		
		i.	Ce-144 and Mo-99	Weekly Composite(e)	<5E-10 μCi/cc(j)(k)
		ii.	Other Principle Gamma Emitters (d)	Weekly Composite(e)	<1E-11 μCi/cc(j)
		iii.	Gross Alpha Activity	Monthly, using composite samples of one week	<1E-11 μCi/cc
		iv.	Radiochemical Analysis Sr-89, Sr-90	Quarterly Composite	<1E-11 μCi/cc
		c.	Gases by Principle Gamma Emitters	NA	NA
		d.	Tritium	NA	NA
9.	Interim Radwaste Building Ventilation	a.	Iodine Spectrum	Weekly sample(e)	(I-133) <1E-10 μCi/cc(j) (I-131) <1E-12 μCi/cc(j)
		b.	Particulate		
		i.	Ce-144 and Mo-99	Weekly Composite(e)	<5E-10 μCi/cc(j)
		ii.	Other Principle Gamma Emitters(d)	Weekly Composite(e)	<1E-11 μCi/cc(j)
		iii.	Gross Alpha Activity	Monthly, using composite samples of one week	<1E-11 μCi/cc
		iv.	Radiochemical Analysis Sr-89, Sr-90	Quarterly Composite	<1E-11 μCi/cc
		c.	Gases by Principle Gamma(d) Emitters	Weekly Grab Sample	<1E-04 μCi/cc
		d.	Tritium	Weekly Grab Sample	<1E-06 μCi/cc

(a) Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or after removal from sampler. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup, or THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if (1) analyses show that the DOSE EQUIVALENT I-131 concentration in the reactor coolant has not increased more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

(b) The LLD is defined for purposes of these commitments as the smallest concentration of radioactive material in a sample that would be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation) :

$$LLD = \frac{(2.71 / T) + 4.65\, s_b}{E \times V \times 2.22E06 \times Y \times \exp(-\lambda \Delta t)}$$

Where:

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

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

E is the counting efficiency (as counts per disintegration),

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

2.22E06 is the number of disintegrations per minute per micro Curie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular nuclide

Δ t is the elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples). NOTE: This assumes decay correction is applied (at the time of analysis) for the duration of sample collection, for the time between collection and analysis, and for the duration of the counting. Additionally, it does not apply to isolated systems such as Waste Gas Decay Tanks and Waste Monitor Tanks.

T is the sample counting time in minutes

Typical values of E, V, Y and Δ t should be used in the calculation.

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

(c) The principal gamma emitters for which the LLD control applies include the following radionuclides: Mn-54. Fe-59, Co-58, Co-60. Zn-65, Mo-99, Cs-134, Cs-137. and Ce-141. Ce-144 shall also be measured, but with a LLD of 5E-06 µCi/ml. This list does not mean that only these nuclides are to be considered. 0ther gamma peaks that are identifiable, together with the above nuclides shall also be analyzed and reported in the Annual Radioactive Effluent Release Report.

(d) The principal gamma emitters for which the LLD commitment applies exclusively are the following radionuclides: Kr-87. Kr-88, Xe-133. Xe-133m, Xe-135. and Xe-138 for gaseous emissions and Mn-54, Fe-59. Co-58, Co-60, Zn-65. Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for particulates. This list does not mean that only these nuclides are to be detected and reported. 0ther peaks which are measurable and identifiable, together with the above nuclides shall also be identified and reported.

(e) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with SLC 16.11.2.a, SLC 16.11.2.b.1, and SLC 16.11.2.b.2.

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

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

(h) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analysis, each batch shall be isolated, and then thoroughly mixed, to assure representative sampling.

(i) A continuous release is the discharge of liquid wastes of a non-discrete volume, e.g., from a volume of a system that has an input flow during the continuous release. Samples shall be analyzed within 48 hours after changing (on or after removal from sampler).

(j) When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. Samples shall be analyzed within 48 hours after changing (on or after removal from sampler).

(k) Ce-144 and Mo-99 LLD as approved by NRC SER dated January 16, 1984 (Reference 1).

BASES

N/A

REFERENCES:

1. Safety Evaluation Report dated January 16, 1984, supporting Amendment Nos. 125, 125, and 122 for Oconee Nuclear Station to revise Technical Specifications to incorporate changes to the Radiological Effluent Technical Specifications (RETS) in order to bring them into compliance with Appendix I of 10 CFR Part 50.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.5 Solid Radioactive Waste

COMMITMENT

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

The Solid Radwaste System or an approved alternative process shall be used in accordance with a Process Control Program (PCP), for the solidification of liquid or wet radioactive wastes or the dewatering of wet radioactive wastes to be shipped for direct disposal at a 10 CFR 61 licensed disposal site. Wastes shipped for off site processing in accordance with the processor's specifications and transportation requirements are not required to be solidified or dewatered to meet disposal requirements.

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

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Applicable regulatory requirements for solidified or dewatered wastes are not satisfied.	A.1 Suspend shipments of defectively packaged solid radioactive wastes from the site. AND A.2 Initiate action to correct PCP, procedures, or solid waste equipment as necessary to prevent recurrence.	Immediately 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. AND B.2 The PCP shall be modified as required to assure Solidification of subsequent batches of waste.	Immediately 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. 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.	Prior to shipment for disposal of the inadequately processed waste that requires solidification or dewatering
D. With the solid waste equipment incapable of meeting commitment or not in service.	D.1 Restore the equipment to OPERABLE status or provide for alternative capability to process wastes as necessary to satisfy all applicable disposal requirements.	In a time frame that supports the commitment

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.5.1	The Process Control Program shall be used to verify the solidification of at least one representative test specimen from at least every tenth batch of each type of radioactive waste to be solidified for disposal at a 10 CFR 61 disposal site.	Every tenth batch of each type of radioactive waste to be solidified.

BASES

This commitment implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of 10 CFR Part 50, Appendix A and requirements to use a Process Control Program to meet applicable 10CFR61 waste form criteria for solidified and dewatered radioactive wastes.

REFERENCES:

1. 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities”.
2. 10 CFR Part 50, Appendix A.
3. 10 CFR20, “Standards for Protection Against Radiation”.
4. 10 CFR61, “Licensing Requirements for Land Disposal of Radioactive Waste”.
5. 10 CFR71, “Packaging and Transportation of Radioactive Materials”.
6. DPCo Process Control Program Manual.
7. NRC Generic Letter 87-12, “Compliance with 10 CFR Part 61 And Implementation Of the Radiological Effluent Technical Specifications (Rets) and Attendant Process Control Program (PCP)”.
8. NRC Generic Letter 89-01, “Implementation of Programmatic Controls for Radiological Effluent Technical Specifications In the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of Rets to the Offsite Dose Calculation Manual or to the Process Control Program”.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.6 Radiological Environmental Monitoring

COMMITMENT

a. The radiological environmental monitoring samples shall be collected in accordance with Table 16.11.6-1 and shall be analyzed pursuant to the requirements of Tables 16.11.6-1 and 16.11.6-2.

b. A land use census shall be conducted and shall identify the location of the nearest milk animal and the nearest residence in each of the 16 meteorological sectors within a distance of eight kilometers (five miles). Broad leaf vegetation sampling shall be performed at the site boundary in the direction sector with the highest D/Q in lieu of the garden census.

c. Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program. A summary of the results obtained as part of the Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report. The Interlaboratory Comparison Program shall be described in the Annual Radiological Environmental Operating Report.

d. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report.

---NOTE--
If samples required by Commitment part a, become permanently unavailable from any of the required sample locations, the locations from which samples were unavailable may then be deleted from the program provided replacement samples were obtained and added to the environmental monitoring program, if available. These new locations will be identified in the Annual Radioactive Effluent Release Report.

APPLICABILITY: At all times

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. Radiological environmental monitoring program is not conducted as required.	A.1	Submit a description of the reason for not conducting the program as required and plans to prevent a recurrence shall be included in the Annual Radiological Environmental Operating Report.	May 15 of following calendar year
B. Land use census identifies a Location which yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than a location from which samples are currently being obtained.	B.1	-----------NOTE----------- The sampling location having the lowest calculated dose or dose commitment (via the same exposure pathway) may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted. -------------------------------	
		Add new location to the radiological environmental monitoring program.	30 days
	<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

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

When radionuclides other than those in Table 16.11.6-3 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.

REFERENCES:

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. <u>AND</u> 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

<u>BASES</u>

The dose commitment is provided to assure that the release of radioactive material in liquid and gaseous effluents will be kept "as low as is reasonably achievable." The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I in that conformance with the guides of Appendix I is to be shown by calculations and procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated.

REFERENCES:

1. 10 CFR Part 20.
2. 40 CFR Part 190.
3. Offsite Dose Calculation Manual.
4. 10 CFR Part 50, Appendix I.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.8 Reports

COMMITMENT Special reports shall be submitted to the Regional Administrator, Region II, within the time period specified for each report. These reports shall be submitted covering the activities identified below pursuant to the requirements of the applicable SLC:

a. Radioactive Liquid Effluents,
Dose, SLC 16.11.1.b
Liquid Waste Treatment, SLC 16.11.1.c

b. Radioactive Gaseous Effluents,
Dose, SLC 16.11.2.b
Gaseous Radwaste Treatment, SLC 16.11.2.c

c. Radiological Environmental Monitoring Program, SLC 16.11.6.a, b, and c

d. Land Use Census, SLC 16.11.6.d

e. Dose Calculations, SLC 16.11.7

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Individual milk samples show I-131 concentrations of 10 picocuries per liter or greater.	A.1 Submit plan advising the NRC of the proposed action to ensure the plant related annual doses will be within the design objective of 45 mrem/yr to the thyroid of any individual.	7 days

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Milk samples collected over a calendar quarter show I-131 average concentrations of 4.8 picoCuries per liter or greater	B.1 Submit a plan advising the NRC of the proposed action to ensure the plant related annual doses will be within the design objective of 45 mrem/yr to the thyroid of any individual.	30 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.8.1	NA	NA

BASES

Reference applicable commitments.

REFERENCES:

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

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.9 Radioactive Effluent Release Report

COMMITMENT

The Annual Radioactive Effluent Release Report covering the operation of the unit during the previous calendar year shall be submitted before May 1 of each year.

A single submittal may be made for a multiple unit station. The submittal shall combine those sections that are common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the release of radioactive material from each unit.

The Annual Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the station during the reporting period.

The annual Radioactive Effluent Release Report shall include a summary of the meteorological conditions concurrent with the release of gaseous effluents during each quarter.

The Annual Radioactive Effluent Release Report shall include the following information for all unplanned releases to unrestricted areas of radioactive materials in gaseous and liquid effluents:

a. A description of the event and equipment involved;

b. Cause(s) for the unplanned release;

c. Actions taken to prevent recurrence; and,

d. Consequences of the unplanned release.

The Annual Radioactive Effluent Release Report shall include an assessment of radiation doses from the radioactive liquid and gaseous effluents released from the station during each calendar quarter. In addition, the unrestricted area boundary maximum noble gas gamma air and beta air doses shall be evaluated. The annual average meteorological conditions shall be used for determining the gaseous pathway doses. Approximate and conservative approximate methods are acceptable. The assessment of radiation doses shall be performed in accordance with the Offsite Dose Calculation Manual.

The Annual Radioactive Effluent Release Report shall include an explanation of why the inoperability of liquid or gaseous effluent monitoring instrumentation out of service for greater than 30 days was not corrected in a timely manner per SLC 16.11.3.

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

a. Total container volume (cubic meters);

b. Total curie quantity (determined by measurement or estimate);

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

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

e. Number of shipments; and,

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

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

The Annual Radioactive Effluent Release Report shall include any changes made during the reporting period to the Offsite Dose Calculation Manual (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census.

The Annual Radioactive Effluent Release Report shall also include an assessment of radiation doses to the likely most exposed Member of the Public from reactor releases and other nearby uranium fuel cycle sources (including doses from primary effluent pathways and direct radiation) for the previous calendar year to show conformance with 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Operation. Methods for calculating the dose contribution from liquid and gaseous effluents are given in the ODCM.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. N/A	A.1 N/A	N/A

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 16.11.9.1 N/A	N/A

BASES

N/A

REFERENCES:

1. Oconee ITS.
2. Offsite Dose Calculation Manual.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.10 Radiological Environmental Operating Report

COMMITMENT

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

The Annual Radiological Environmental Operating Report shall include summaries, interpretations. and statistical evaluation of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, operational controls (as appropriate), and previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of the land use censuses. If harmful effects are detected by the monitoring, the report shall provide an analysis of the problem and a planned course of action to alleviate the problem.

The Annual Radiological Environmental Operating Report shall include a summary of the results obtained as part of the required Interlaboratory Comparison Program. The Interlaboratory Comparison Program shall be described in the Annual Radiological Environmental Operating Report.

The Annual Radiological Environmental Operating Report shall include summarized and tabulated results of the radiological environmental samples required by SLCs taken during the report period. In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as practical in a supplementary report.

The initial report shall also include the following: a summary description of the radiological environmental monitoring program including sampling methods for each sample type, size and physical characteristics of each sample type, sample preparation methods, analytical methods, and measuring equipment used; a map of all sampling locations keyed to a table giving distances and directions from one reactor; and, the result of land use censuses. Subsequent reports shall describe all substantial changes in these aspects.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. NA	A.1 NA	NA

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 16.11.10.1 NA	NA

BASES

NA

REFERENCES:

1. Oconee ITS
2. Offsite Dose Calculation Manual

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.11 Iodine Radiation Monitoring Filters

COMMITMENT Assure that the iodine radiation monitoring filters perform their intended function.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. NA	A.1 NA	NA

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.11.1	Remove and replace iodine radiation monitoring filters in RIA-44.	30 days of operation
SR 16.11.11.2	Discard spare iodine radiation monitoring filters.	After manufacturer expiration date.

BASES

The purpose of this commitment is to assure the reliability of the iodine radiation monitoring charcoal filters. Plant procedures prevent the use of spare filters after the manufacturer expiration date.

REFERENCES:

1. Oconee CTS Amendment No. 3/3 SER date July, 1974.

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.12 Radioactive Material in Outside Temporary Tanks Exceeding Limit

COMMITMENT The quantity of radioactive material in outside temporary storage tanks shall not exceed the limit specified in ITS 5.5.13.c.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The quantity of radioactive material in outside temporary storage tank not within limit.	A.1 Suspend addition of radioactive material to tank.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.12.1	Verify the quantity of radioactive material contained in each of the outside temporary tanks is within the limit by analyzing a representative sample of the tanks' contents.	Within 7 days after addition of radioactive materials to an outside temporary tank
	<u>OR</u>	
	Verify the quantity of radioactive material in each of the outside temporary tanks does not result in exceeding the limit by analyzing a representative sample of radioactive material to be added.	Prior to addition of radioactive materials to an outside temporary tank.

BASES

The requirement(s) of this SLC section were relocated from CTS 3.9.1.c during the conversion to ITS.

The tanks included in this specification are all those outdoor radwaste liquid storage tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system. Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of a tank's contents, the resulting concentrations would be less than the limits of 10CFR Part 20, Appendix B, Table II, Column 2, at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

REFERENCES

N/A

16.11 RADIOLOGICAL EFFLUENTS CONTROL

16.11.13 Radioactive Material in Waste Gas Holdup Tank Exceeding Limit

COMMITMENT The quantity of radioactive material in the Waste Gas Holdup tanks shall not exceed the limit specified in ITS 5.5.13.b.

APPLICABILITY: At all times.

ACTIONS

--NOTE--

Separate Condition Entry is allowed for each tank.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The quantity of radioactive material in the Waste Gas Holdup tank not within limit.	A.1 Suspend addition of radioactive material to tank. <u>AND</u> A.2 Reduce tank contents to within limit.	Immediately 48 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.13.1	Verify quantity of radioactive materials in each tank is within limit.	24 hours when tank is being filled

<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 ≤ 3% by volume.

APPLICABILITY: At all times.

ACTIONS

--NOTE--
Separate Condition Entry is allowed for each tank.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Concentration of Hydrogen in Waste Gas Holdup tank is > 3% and ≤ 4% by volume.	A.1 Reduce Concentration of Hydrogen to within limit.	48 hours
B. Concentration of Hydrogen in Waste Gas Holdup tank is > 4% by volume.	B.1 Suspend addition of waste gases to tank.	Immediately
	AND	
	B.2 Reduce Concentration of Hydrogen to within limit.	24 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 16.11.14.1	Verify Hydrogen concentration in Waste Gas Holdup Tank is ≤ 3% by volume.	5 times/week on each tank when in service <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 1/1/2021 - 12/31/2021

The Oconee Nuclear Station PCP was not revised in 2021. The most recent revision was provided with the Oconee Nuclear Station 2018 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 1/1/2021 - 12/31/2021

No major modifications to Oconee Nuclear Station liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2021.

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 1/1/2021 - 12/31/2021

There is one (1) change to a previous year's ARERR.

The following contains amended pages to the Oconee Nuclear Station 2020 ARERR. Specific changes are identified with change bars in right margin. (Reference NCR 02412872).

Attachment 3
Solid Radioactive Waste Disposal

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2020 - 12/31/2020

Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Solidification Agent	Volume (m^3)	Total Activity (Curies)
1. <u>Waste from Liquid Systems</u>							
a. Dewatered Secondary Resins	None	-	-	-	-	-	-
b. Dewatered Primary Resins	4	4	2 A-S 2 B	Type A	None	10.31	98.51
c. Evaporator Concentrates	None	-	-	-	-	-	-
d. Dewatered Mechanical Filters	2	2	C	Type A	None	1.37	18.28
e. Dewatered Demineralizers	None	-	-	-	-	-	-
f. Solidified (cement) Acids, Oils, Sludge	None	-	-	-	-	-	-
2. <u>Dry Solid Waste</u>							
a. Dry Active Waste (compacted)	None	-	-	-	-	-	-
b. Dry Active Waste (non-compacted)	69	117	A-U	GDP	-	1289	4.07
c. Dry Active Waste (brokered)	None	-	-	-	-	-	-
d. Irradiated Components	None	-	-	-	-	-	-
3. <u>Total Solid Waste</u>	**75**	**123**	**-**	**-**	**-**	**1300.68**	**120.86**

Attachment 12
Errata to a Previous Year's ARERR

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2021 - 12/31/2021

Attachment 3
Solid Radioactive Waste Disposal

Oconee Nuclear Station Units 1, 2, & 3
Period 1/1/2020 - 12/31/2020

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Dewatered Secondary Resins	N/A	N/A
b. Dewatered Primary Resins	Ag-110m	2.51E-01
	Be-7	8.91E-01
	C-14	1.56E+00
	Co-57	2.31E-01
	Co-58	9.84E+00
	Co-60	2.20E+01
	Cs-137	1.51E+00
	Fe-55	3.38E+01
	H-3	1.01E-01
	Mn-54	6.76E+00
	Nb-95	1.03E+00
	Ni-63	1.83E+01
	Zn-65	2.88E+00
	Zr-95	4.31E-01
c. Evaporator Concentrates	N/A	N/A
d. Dewatered Mechanical Filters	Ag-110m	2.55E-01
	Ce-144	3.82E-01
	C-14	2.00E+01
	Co-58	2.71E+00
	Co-60	9.50E+00
	Cs-134	5.63E-01
	Cs-137	2.54E+00
	Fe-55	4.71E+00
	H-3	4.16E+01
	Mn-54	7.52E-01
	Nb-95	9.50E-01
	Ni-63	1.40E+01
	Pu-241	3.38E-01
	Tc-99	8.75E-01
	Zn-65	3.35E-01
	Zr-95	4.37E-01
e. Dewatered Demineralizers	N/A	N/A
f. Solidified (cement) Acids, Oils, Sludge	N/A	N/A
2. Dry Solid Waste		
a. Dry Active Waste (compacted)	N/A	N/A
b. Dry Active Waste (non-compacted)	C-14	1.58E+00
	Co-57	1.63E-02
	Co-58	9.24E-01
	Co-60	3.12E-01
	Fe-55	2.85E+00
	Cs-137	1.82E+00
	H-3	3.16E+00
	Mn-54	5.99E-02
	Nb-95	2.07E-01
	Ni-63	8.4E+01
	Tc-99	4.5E+00
	Zr-95	9.51E-02
c. Dry Active Waste (brokered)	N/A	N/A
d. Irradiated Components	N/A	N/A

ENCLOSURE 6: **RNP Annual Radioactive Effluent Release Report**

H.B. Robinson Steam Electric Plant
Unit 2

Annual Radioactive
Effluent Release Report

January 1, 2021 through December 31, 2021

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 1/1/2021 - 12/31/2021

Gaseous Effluents - Summation of All Releases

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
1. Total Release	Ci	3.61E-02	3.58E-02	3.95E-02	8.72E-01	9.83E-01
2. Avg. Release Rate	µCi/sec	4.58E-03	4.54E-03	5.01E-03	1.11E-01	3.12E-02
B. Iodine-131						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	0.00E+00	0.00E+00	7.03E-07	2.59E-06	3.29E-06
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	8.84E-08	3.25E-07	1.03E-07
D. Tritium						
1. Total Release	Ci	1.22E+00	2.24E+00	3.06E+00	4.13E+00	1.07E+01
2. Avg. Release Rate	µCi/sec	1.56E-01	2.84E-01	3.85E-01	5.19E-01	3.36E-01
E. Carbon-14						
1. Total Release	Ci	2.13E+00	2.15E+00	2.18E+00	2.18E+00	8.64E+00
2. Avg. Release Rate	µCi/sec	2.70E-01	2.73E-01	2.77E-01	2.77E-01	2.60E-01
F. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Release Rate	µCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Elevated Releases - Continuous Mode *7

	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 1/1/2021 - 12/31/2021

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 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground & Mixed-Mode Releases - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Xe-133	Ci	0.00E+00	0.00E+00	0.00E+00	7.48E-01	7.48E-01
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	7.48E-01	7.48E-01
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
Co-56	Ci	0.00E+00	0.00E+00	2.50E-07	0.00E+00	2.50E-07
Co-58	Ci	0.00E+00	0.00E+00	3.32E-07	2.49E-06	2.82E-06
Te-123m	Ci	0.00E+00	0.00E+00	0.00E+00	4.12E-08	4.12E-08
Total for Period	Ci	0.00E+00	0.00E+00	5.82E-07	2.53E-06	3.11E-06
D. Tritium						
H-3	Ci	1.06E+00	1.60E+00	1.86E+00	2.65E+00	7.17E+01
E. Carbon-14						
C-14	Ci	1.31E+00	1.33E+00	1.34E+00	1.34E+00	5.32E+00
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

Gaseous Effluents - Ground & Mixed Mode Releases - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Gases						
Ar-41	Ci	3.61E-02	3.31E-02	3.89E-02	8.23E-02	1.90E-01
Xe-131m	Ci	0.00E+00	2.80E-05	0.00E+00	1.70E-04	1.98E-04
Xe-133m	Ci	0.00E+00	3.88E-05	0.00E+00	4.78E-04	5.17E-04
Xe-133	Ci	0.00E+00	2.66E-03	6.33E-04	4.04E-02	4.37E-02
Xe-135	Ci	0.00E+00	2.99E-06	0.00E+00	5.88E-04	5.91E-04
Total for Period	Ci	3.61E-02	3.58E-02	3.95E-02	1.24E-01	2.35E-01
B. Iodines						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Particulates Half-Life ≥ 8 days						
Co-58	Ci	0.00E+00	0.00E+00	7.41E-08	5.38E-08	1.28E-07
Co-60	Ci	0.00E+00	0.00E+00	4.63E-08	0.00E+00	4.63E-08
Total for Period	Ci	0.00E+00	0.00E+00	1.20E-07	5.38E-08	1.74E-07
D. Tritium						
H-3	Ci	1.58E-01	6.31E-01	1.20E+00	1.48E+00	3.47E+00
E. Carbon-14						
C-14	Ci	8.16E-01	8.25E-01	8.34E-01	8.34E-01	3.31E+00
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

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	2.46E-03	1.75E-03	2.75E-03	1.87E-03	8.83E-03
2. Avg. Diluted Conc.	μCi/ml	1.11E-11	7.48E-12	1.08E-11	8.10E-12	9.38E-12
B. Tritium						
1. Total Release	Ci	1.01E+01	1.62E+01	1.13E+02	3.32E+02	4.71E+02
2. Avg. Diluted Conc.	μCi/ml	4.55E-08	6.92E-08	4.45E-07	1.44E-06	5.01E-07
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	2.60E-05	1.63E-04	1.89E-04
2. Avg. Diluted Conc.	μCi/ml	0.00E+00	0.00E+00	1.02E-13	7.06E-13	2.01E-13
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	9.42E+06	9.39E+04	2.30E+05	2.54E+06	1.23E+07
F. Volume of Dilution Water						
1. Total	liters	2.22E+11	2.34E+11	2.54E+11	2.31E+11	9.41E+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 1/1/2021 - 12/31/2021

Liquid Effluents - Continuous Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Co-58	Ci	5.41E-04	0.00E+00	0.00E+00	0.00E+00	5.41E-04
Total for Period	Ci	5.41E-04	0.00E+00	0.00E+00	0.00E+00	5.41E-04
B. Tritium						
H-3	Ci	0.00E+00	0.00E+00	0.00E+00	1.03E-02	1.03E-02
C. Dissolved & Entrained Gases						
None	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

Liquid Effluents - Batch Mode

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Fission and Activation Products						
Mn-54	Ci	0.00E+00	0.00E+00	0.00E+00	1.40E-06	1.40E-06
Fe-55	Ci	9.31E-05	3.26E-04	1.39E-03	6.87E-04	2.50E-03
Fe-59	Ci	3.13E-06	0.00E+00	0.00E+00	0.00E+00	3.13E-06
Co-57	Ci	9.24E-06	1.30E-05	1.09E-05	5.71E-06	3.89E-05
Co-58	Ci	1.60E-03	8.82E-04	5.90E-04	6.05E-04	3.68E-03
Co-60	Ci	1.20E-04	1.48E-04	1.62E-04	1.33E-04	5.63E-04
Ni-63	Ci	8.67E-05	3.77E-04	5.95E-04	4.23E-04	1.48E-03
Se-75	Ci	0.00E+00	1.60E-06	0.00E+00	0.00E+00	1.60E-03
Ag-110m	Ci	0.00E+00	0.00E+00	8.86E-06	9.97E-06	1.88E-05
Sb-125	Ci	0.00E+00	0.00E+00	2.38E-06	0.00E+00	2.38E-06
Ba-133	Ci	0.00E+00	0.00E+00	0.00E+00	1.59E-06	1.59E-06
Total for Period	Ci	1.92E-03	1.75E-03	2.75E-03	1.87E-03	8.29E-03
B. Tritium						
H-3	Ci	1.01E+01	1.62E+01	1.13E+02	3.32E+02	4.71E+02
C. Dissolved & Entrained Gases						
Xe-133	Ci	0.00E+00	0.00E+00	2.60E-05	1.63E-04	1.89E-04
Total for Period	Ci	0.00E+00	0.00E+00	2.60E-05	1.63E-04	1.89E-04
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

ATTACHMENT 2

Supplemental Information

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

Attachment 2
Supplemental Information

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

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	=	13	27
2. Total Time (min) for Batch Releases	=	2.60E+03	6.12E+03
3. Maximum Time (min) for a Batch Release	=	2.54E+02	4.10E+02
4. Average Time (min) for Batch Releases	=	2.00E+02	2.27E+02
5. Minimum Time (min) for a Batch Release	=	1.18E+02	1.64E+02
6. Average Dilution Water Flow During Release (gpm)	=	3.65E+05	3.61E+05

B. Gaseous Effluents		**Jan - Jun**	**Jul - Dec**
1. Total Number of Batch Releases	=	46	62
2. Total Time (min) for Batch Releases	=	1.64E+04	3.76E+04
3. Maximum Time (min) for a Batch Release	=	5.75E+02	1.01E+04
4. Average Time (min) for Batch Releases	=	3.56E+02	6.06E+02
5. Minimum Time (min) for a Batch Release	=	2.70E+01	7.00E+00

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Carbon-14

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

In Regulatory Guide 1.21, Revision 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste", the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2. H.B. Robinson Steam Electric Plant 2021 ARERR contains estimates of C-14 radioactivity released in 2021 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 2021 ARERR, a source term scaling factor using actual EFPD of 345.2 days is assumed. Using the source term scaling factor from H.B. Robinson Steam Electric Plant in 2021 results in a site total C-14 gaseous release estimate to the environment of 8.63 Curies, 3.31 Curies in batch mode and 5.32 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 2021 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 2021 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Attachment 2
Supplemental Information

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

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 2021*". Using the methodology described in ODCM 2.5.3, the following is a summary of tritium activity released through evaporation and resulting dose for 2021.

	Units	Year
1. H-3 Activity Released	Ci	2.46E+01
2. H-3 Dose	mREM	1.23E-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 2021, 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 2021.

	Units	Year
1. Avg. H-3 Concentration	ρCi/L	2.02E+03
2. H-3 Dose	mREM	4.45E-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 1/1/2021 - 12/31/2021

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 1/1/2021 - 12/31/2021

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2021 Land Use Census was performed June 29 – July 1, 2021, and the results were certified and made available for use on September 21, 2021. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

- The residence in the N sector (2.83 miles) was replaced with a new residence at 2.51 miles.
- The residence in the SSW sector (0.42 miles) was replaced with a new residence at 0.43 miles.

Gardens

NOTE: There were no gardens within the 5-mile radius in any of the 16 meteorological sectors identified by the census as being irrigated from plant discharge water. Any of the irrigation sources identified by the census are from other sources, such as wells or public utilities.

- The garden in the N sector (3.27 miles) was replaced with a new garden at 4.34 miles.
- The garden in the SSE sector (2.56 miles) was replaced with a new garden at 2.91 miles.
- The garden in the S sector (0.74 miles) was replaced with a new garden at 2.26 miles.
- The garden in the SSW sector (3.13 miles) was replaced with a new garden at 2.49 miles.
- The garden in the SW sector (2.35 miles) was replaced with a new garden at 2.11 miles.
- The garden in the WNW sector (0.66 miles) was replaced with a new garden at 4.54 miles.
- The garden in the NW sector (1.87 miles) was replaced with a new garden at 1.60 miles.

Meat Animals

NOTE: Meat animals were only identified at the nearest garden or closer in each sector.

- There were meat animals found in the SE sector at 1.96 miles during the 2021 LUC, but there were as no meat animals located closer than the garden during the 2020 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 2021 census.

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 (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 1/1/2021 - 12/31/2021

	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	2	2	A,B	8-120 Poly HIC	N/A	6.82	48.9
	c. Evaporator Concentrates	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	d. Dewatered Mechanical Filters	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	e. Dewatered Demineralizers	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	f. Solidified (cement) Acids, Oils, Sludge	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	g. ***Other (add as necessary)***	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2.	**Dry Solid Waste**							
	a. Dry Active Waste (compacted)	2	2	A-U	20' Sealand, 14-195 Steel Liner	N/A	44.14	0.603
	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**	4	4	N/A	N/A	N/A	50.96	49.503

Attachment 3
Solid Radioactive Waste Disposal

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

Type of Waste Shipped	Radionuclide	% Abundance
1. Waste from Liquid Systems		
a. Dewatered Secondary Resins	N/A	N/A
b. Dewatered Primary Resins	Ni-63	38.5
	Co-60	32.8
	Co-58	12.7
	Fe-55	11.9
	Mn-54	1.90
	Co-57	0.589
	Zn-65	0.588
	Ni-59	0.288
	C-14	0.256
	Cs-137	0.240
	Ce-144	0.144
	Sr-90	0.0177
	H-3	0.0132
	Tc-99	0.00433
	Sr-89	0.00140
	I-129	0.000427
	Cm-243	0.000198
	Pu-238	0.000134
c. Evaporator Concentrates	N/A	N/A
d. Dewatered Mechanical Filters	N/A	N/A
e. Dewatered Demineralizers	N/A	N/A
f. Solidified (cement) Acids, Oils, Sludge	N/A	N/A
2.		
a. Dry Active Waste (compacted)	Ni-63	35.2
	Fe-55	30.0
	Co-60	27.4
	Tc-99	3.48
	H-3	1.74
	C-14	1.58
	Ce-144	0.242
	Co-57	0.159
	Ag-108M	0.144
	Cs-137	0.00814
	I-129	0.00412
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

ATTACHMENT 4

Meteorological Data

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

Attachment 4
Meteorological Data

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

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	3	3	4	9	3	2	1	2	1	2	0	0	0
	3.51-7.50	8	10	13	15	9	9	23	34	22	46	66	42	24	11	6	0
	7.51-12.50	12	9	5	0	0	0	0	4	20	43	59	9	7	8	8	1
	12.51-18.50	0	0	0	0	0	0	0	0	0	2	0	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
B	0.75-3.50	0	1	6	7	8	16	20	6	9	6	10	7	3	3	0	0
	3.51-7.50	37	39	26	17	9	9	16	30	26	22	55	27	22	14	17	8
	7.51-12.50	18	8	8	0	0	0	0	0	2	12	22	5	2	1	7	4
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	1	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
C	0.75-3.50	2	9	12	15	12	21	22	14	1	7	8	10	10	11	4	6
	3.51-7.50	38	56	26	20	17	11	12	14	14	22	40	17	13	12	22	15
	7.51-12.50	25	11	4	0	0	0	0	3	6	13	16	2	2	5	5	4
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	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	46	70	129	94	75	69	66	63	63	45	51	38	55	30	24	16
	3.51-7.50	195	274	198	102	71	40	31	92	191	184	154	52	28	35	54	76
	7.51-12.50	87	107	87	1	1	0	0	12	43	51	52	15	9	5	10	48
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	5	2	0	0	0	2
	18.51-25.00	0	0	0	0	0	0	0	1	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 1/1/2021 - 12/31/2021

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	57	39	34	21	23	14	18	46	141	158	149	63	74	43	51	44
	3.51-7.50	78	25	17	15	3	0	2	26	111	130	89	36	27	20	27	128
	7.51-12.50	11	2	2	0	0	0	0	1	2	4	19	10	1	5	1	23
	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	9
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.75-3.50	39	19	8	6	7	3	6	36	90	69	82	58	38	26	45	76
	3.51-7.50	19	2	2	2	0	0	0	1	9	10	14	9	3	5	14	46
	7.51-12.50	2	0	0	0	0	0	0	0	0	0	0	0	0	1	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	87	28	11	6	4	11	26	41	89	72	77	48	45	58	111	144
	3.51-7.50	5	3	0	0	0	0	0	2	1	2	5	2	1	0	1	15
	7.51-12.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ATTACHMENT 5

Unplanned Offsite Releases

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

Attachment 5
Unplanned Offsite Releases

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

H.B. Robinson Steam Electric Plant had zero (0) unplanned liquid release in 2021.

H.B. Robinson Steam Electric Plant had zero (0) unplanned gaseous release in 2021.

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 1/1/2021 - 12/31/2021

Gaseous Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Noble Gases						
1. Maximum Gamma Air	mRAD	8.59E-04	7.91E-04	9.26E-04	2.68E-03	5.25E-03
(a) Limit	mRAD	5.00	5.00	5.00	5.00	10.00
(b) % of Limit		1.72E-02	1.58E-02	1.85E-02	5.36E-02	5.25E-02
2. Maximum Beta Air	mRAD	3.03E-04	2.86E-04	3.28E-04	2.82E-03	3.74E-03
(a) Limit	mRAD	10	10	10	10	20
(b) % of Limit		3.03E-03	2.86E-03	3.28E-03	2.82E-02	1.87E-02

Receptor Location ***0.42*** km ***SSE***

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
B. Iodine, H-3, & Particulates						
1. Maximum Organ Dose	mREM	1.45E-01	1.47E-01	1.48E-01	1.48E-01	5.88E-01
(a) Limit	mREM	7.5	7.5	7.5	7.5	15
(b) % of Limit		1.93E+00	1.95E+00	1.98E+00	1.98E+00	3.92E+00

Receptor Location ***0.42*** km ***SSE***
Critical Age ***CHILD***
Critical Organ ***BONE***

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

Liquid Effluents Dose Summary

	Units	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Year
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	9.99E-05	7.07E-05	3.12E-04	1.08E-03	1.57E-03
(a) Limit	mREM	5	5	5	5	10
(b) % of Limit		2.00E-03	1.41E-03	6.25E-03	2.17E-02	1.57E-02
2. Maximum Total Body Dose	mREM	4.14E-05	5.02E-05	2.96E-04	1.06E-03	1.45E-03
(a) Limit	mREM	1.5	1.5	1.5	1.5	3
(b) % of Limit		2.76E-03	3.34E-03	1.97E-02	7.09E-02	4.84E-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 1/1/2021 - 12/31/2021

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for H.B. Robinson Steam Electric Plant includes liquid and gaseous effluent dose contributions from H.B. Robinson Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI. No other direct or air-scatter source or uranium fuel cycle facility contributes significantly to the maximum exposed individual. Included in the gaseous effluent dose below is the estimated dose contributed by Carbon-14 (Ref. Attachment 2, Supplemental Information, of this report for further information). Also included is dose from evaporation of H-3 in Lake Robinson and H-3 in fish from Lake Robinson. The combined dose to a maximum exposed individual from effluent releases, combined with the additional dose pathways, is below 40 CFR Part 190 limits as shown by the following summary.

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

40 CFR Part 190 Effluent Dose Summary

A. Gaseous Effluent Dose	
1. Location	0.42 km SSE
2. Critical Age	CHILD
3. Critical Organ	BONE
4. Organ Dose (mREM)	5.59E-01
5. Total Body Dose (mREM)	2.58E-01
B. Liquid Effluent Dose	
1. Location	6.76 km NE
2. Critical Age	ADULT
3. Critical Organ	GI-LLI
4. Organ Dose (mREM)	1.57E-03
5. Total Body Dose (mREM)	1.45E-03
C. Lake Robinson Evaporation H-3 Dose*	
1. Location	6.38 km N
2. Critical Age	CHILD
3. Critical Organ	N/A
4. Organ Dose (mREM)	1.71E-01
5. Total Body Dose (mREM)	1.71E-01
D. H-3 in Fish from Lake Robinson*	
1. Location	Lake
2. Critical Age	ADULT
3. Critical Organ	N/A
4. Organ Dose (mREM)	4.45E-03
5. Total Body Dose (mREM)	4.45E-03

* = Ref. Attachment 2, Supplemental Information, of this report.

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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

Dose contributions from Carbon-14 in gaseous effluents have been determined from ODCM 3.16, Methodology for Carbon-14 Dose. The maximum dose rate to the nearest real individual from the release of Carbon-14 in batch and continuous gaseous effluents is conservatively calculated to be less than 5.88E-01 mrem/yr based on 8.63 Curies released in 2021 (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 2021, 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 1/1/2021 - 12/31/2021

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 2021. 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 2021. There were no anomalous results identified in 2021.

Results from sampling during 2021 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 2021. 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 1/1/2021 - 12/31/2021

Well Name	Location / Description	Tritium Concentration (pCi/l) 1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	# of Samples
R42	Unit 1 North Deep Wells	NS	<MDA	NS	<MDA	2
R64	Artesian Well - 0.6 miles SE	<MDA	<MDA	<MDA	<MDA	4
R68	Well A - Between Unit 1 Switchyard and breakroom	NS	2.65E+02	NS	3.16E+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	1.87E+02	2
R72	MW-06 - 0.10 miles E - U/1 North Deep Well Pump	NS	<MDA	NS	<MDA	2
R73	MW-13 - 0.11 miles ENE - Near Discharge Canal	4.22E+02	6.53E+02	<MDA	2.82E+02	4
R75	PSW-02 - 0.05 miles NE - By U/1 boundary fence	NS	<MDA	NS	<MDA	2
R76	PSW-03 - 0.49 miles N - Northeast corner of the MET Tower Station	NS	<MDA	NS	<MDA	2
R77	TS-01B - 0.25 miles SSE - By entrance road to Unit 1	<MDA	<MDA	<MDA	1.97E+02	4
R78	TS-02C - 0.17 miles SSE - Northeast corner by East Settling Pond	NS	<MDA	NS	<MDA	2
R79	TS-07C - 1.0 miles N - South corner by cove & Discharge Canal	<MDA	2.22E+02	<MDA	<MDA	4
R81	TS-17B - 0.19 miles SSE - West of West Settling Pond	<MDA	<MDA	<MDA	<MDA	4
R82	PDW-01 - 0.30 miles SSE - By entrance road to Unit 1	NS	<MDA	NS	<MDA	2
RDW6	Robinson Deep Well #6	4.46E+02	4.14E+02	<MDA	3.21E+02	4
RMW07	MW-07 - Robinson Monitoring Well	NS	NS	NS	<MDA	1
RMW09	MW-09 - Robinson Monitoring Well	NS	<MDA	NS	<MDA	2
RMW-101D	MW-101D - Robinson Monitoring Well	3.43E+02	4.10E+02	2.61E+02	4.06E+02	4
RMW-101S	MW-101S - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-102	MW-102 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-103D	MW-103D - Robinson Monitoring Well	2.62E+02	3.52E+02	<MDA	1.77E+02	4
RMW-103S	MW-103S - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-104	MW-104 - Robinson Monitoring Well	<MDA	1.85E+02	<MDA	2.18E+02	4
RMW-105	MW-105 - Robinson Monitoring Well	<MDA	2.58E+02	<MDA	<MDA	4
RMW-106	MW-106 - Robinson Monitoring Well	8.56E+02	8.41E+02	1.77E+03	2.06E+03	4
RMW-107	MW-107 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-108	MW-108 - Robinson Monitoring Well	8.62E+02	8.11E+02	3.05E+02	2.26E+02	4
RMW-110	MW-110 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW-112	MW-112 - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RMW1RASH	MW-1R (NPDES) ASH - Robinson	<MDA	<MDA	<MDA	<MDA	4
RMW2RASH	MW-2R (NPDES) ASH - Robinson	<MDA	<MDA	<MDA	<MDA	4
RMW3RASH	MW-3R (NPDES) ASH - Robinson	2.81E+02	2.74E+02	2.14E+02	2.36E+02	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	2.96E+02	5.92E+02	5.03E+02	4.93E+02	4
RP2	P2 (South of discharge canal) - Robinson Monitoring Well	<MDA	<MDA	<MDA	<MDA	4
RPSW04	PSW-04	<MDA	<MDA	<MDA	<MDA	4
RPSW05	SW of Plant in a grass area on Entrance Road (Background Well)	NS	<MDA	NS	<MDA	2
RTS04B	RTS04B	NS	<MDA	NS	<MDA	2
U1SDEEP	Unit 1 South Deep Well	<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 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 1/1/2021 - 12/31/2021

H.B. Robinson Steam Electric Plant experienced one (1) instance of inoperable equipment relevant to effluent monitoring in excess of ODCM/TRMS limits during 2021. Details are described below.

H.B. Robinson Steam Electric Plant did not experience permanent or temporary outside liquid storage tanks not surrounded by liners, dikes, or walls, capable of holding the tank's contents and that does not have tank overflows and surrounding area drains connected to the Liquid Waste Disposal System exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases) during 2021.

ODCM # or TRMS #	Title	Completion Time	Description
ODCM 3.10, Condition "Table 3.10-1 Item 1.f."	Plant Vent Flow Rate	30 Days	NCR 02368858: At 1430 hrs. on 1/6/2021, F-14 Plant Vent Flow Monitor was declared out of service following an unsuccessful plant vent flow monitor calibration in accordance with RST-026. OMM-007 has been referenced and an Equipment Inoperable Record (EIR) is required. Component is unavailable, effluent releases via this pathway may continue provided that flow rate is estimated once per 4 hours by Chemistry personnel.

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 1/1/2021 - 12/31/2021

SUMMARY OF CHANGES

The H.B. Robinson Steam Electric Plant Unit 2 Offsite Dose Calculation Manual was not revised in 2021. The most recent revision is Revision 36.

<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

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2021 - 12/31/2021

The H.B. Robinson Steam Electric Plant Unit 2 Process Control Program was not revised in 2021. The most recent revision is #6.

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 1/1/2021 - 12/31/2021

No major modifications to liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred at H.B. Robinson Steam Electric Plant in 2021.

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 1/1/2021 - 12/31/2021

Description:

- The tritium values reported on the Liquid Effluents - Batch Mode Table in the RNP 2020 ARERR report previously submitted to the NRC was incorrect. Corrected page is attached below.

  Curies were reported as follows:

  1st QTR 5.45E+00 - 2nd QTR 2.84E+00 - 3rd QTR 1.75E+02 - 4th QTR 1.01E+02 - Total 2.84E+02

  Versus actual of the following:

  1st QTR 7.89E+00 - 2nd QTR 2.38E+02 - 3rd QTR 2.36E+02 - 4th QTR 1.15E+02 - Total 5.97E+02

  Tritium data from Liquid Effluents - Batch Mode Table was from 2019 ARERR.

- Duke Energy was notified by Mirion (OpenEMS effluent permit vendor) that OpenEMS was not calculating liquid doses for the ARERR in accordance with the Offsite Dose Calculation Manual (ODCM). The ODCM liquid dose equation specifies that the dilution volume used in the near field average dilution factor should be the dilution water volume during the period of release. Previously, OpenEMS was using the dilution volume for a larger time frame when calculating liquid dose for the ARERR. The OpenEMS software ARERR liquid dose calculation was corrected to only include dilution during the liquid effluent release in the near field average dilution factor. Liquid doses on release permits were not impacted by this issue. This software issue was corrected during the generation of the 2021 ARERR, but discovery of corrections for prior ARERR reports is in progress. Errata for prior ARERRs due to this issue will be reported in the next ARERR.

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2020 - 12/31/2020

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	2.66E-04	2.66E-04
Mn-54	Ci	0.00E+00	0.00E+00	0.00E+00	3.85E-06	3.85E-06
Fe-55	Ci	4.65E-04	3.27E-03	1.49E-03	2.54E-03	7.77E-03
Fe-59	Ci	0.00E+00	0.00E+00	0.00E+00	4.63E-05	4.63E-05
Co-57	Ci	9.46E-07	2.73E-06	4.25E-06	1.03E-05	1.82E-05
Co-58	Ci	5.43E-05	6.91E-05	2.23E-04	5.09E-03	5.44E-03
Co-60	Ci	2.35E-05	9.83E-05	1.84E-04	2.89E-04	5.95E-04
Ni-63	Ci	5.05E-07	4.23E-04	7.29E-04	4.76E-04	1.63E-03
Zr-95	Ci	0.00E+00	0.00E+00	0.00E+00	2.11E-05	2.11E-05
Nb-95	Ci	0.00E+00	0.00E+00	0.00E+00	4.13E-05	4.13E-05
Ag-110m	Ci	0.00E+00	0.00E+00	3.13E-05	8.03E-05	1.12E-04
Total for Period	Ci	5.45E-04	3.87E-03	2.66E-03	8.86E-03	1.59E-02
B. Tritium						
H-3	Ci	7.89E+00	2.38E+02	2.36E+02	1.15E+02	5.97E+02
C. Dissolved & Entrained Gases						
Xe-133	Ci	0.00E+00	1.28E-04	2.07E-03	2.29E-03	4.49E-03
Total for Period	Ci	0.00E+00	1.28E-04	2.07E-03	2.29E-03	4.49E-03
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	9.57E-04	8.98E-05	1.05E-03

Attachment 1
Summary of Gaseous and Liquid Effluents

H.B. Robinson Steam Electric Plant Unit 2
Period 1/1/2020 - 12/31/2020

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	2.66E-04	2.66E-04
Mn-54	Ci	0.00E+00	0.00E+00	0.00E+00	3.85E-06	3.85E-06
Fe-55	Ci	4.65E-04	3.27E-03	1.49E-03	2.54E-03	7.77E-03
Fe-59	Ci	0.00E+00	0.00E+00	0.00E+00	4.63E-05	4.63E-05
Co-57	Ci	9.46E-07	2.73E-06	4.25E-06	1.03E-05	1.82E-05
Co-58	Ci	5.43E-05	6.91E-05	2.23E-04	5.09E-03	5.44E-03
Co-60	Ci	2.35E-05	9.83E-05	1.84E-04	2.89E-04	5.95E-04
Ni-63	Ci	5.05E-07	4.23E-04	7.29E-04	4.76E-04	1.63E-03
Zr-95	Ci	0.00E+00	0.00E+00	0.00E+00	2.11E-05	2.11E-05
Nb-95	Ci	0.00E+00	0.00E+00	0.00E+00	4.13E-05	4.13E-05
Ag-110m	Ci	0.00E+00	0.00E+00	3.13E-05	8.03E-05	1.12E-04
Total for Period	Ci	5.45E-04	3.87E-03	2.66E-03	8.86E-03	1.59E-02
B. Tritium						
H-3	Ci	7.89~~5.54~~E+00	2.38~~2.84~~E+02~~0~~	2.36~~1.75~~E+02	1.15~~01~~E+02	5.97~~2.84~~E+02
C. Dissolved & Entrained Gases						
Xe-133	Ci	0.00E+00	1.28E-04	2.07E-03	2.29E-03	4.49E-03
Total for Period	Ci	0.00E+00	1.28E-04	2.07E-03	2.29E-03	4.49E-03
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	9.57E-04	8.98E-05	1.05E-03