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

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 AND 50-324/LICENSE NOS. DPR-71 AND DPR-62
RADIOACTIVE EFFLUENT RELEASE REPORT

Gentlemen:

In accordance with the Code of Federal Regulations, Title 10, Part 50.36a and Technical Specification (TS) 5.6.3, Carolina Power & Light Company submits the enclosed Radioactive Effluent Release Report for the Brunswick Steam Electric Plant. This report, enclosure 1, covers the period from January 1, 2000, through December 31, 2000. During the reporting period, changes were made to the Offsite Dose Calculation Manual (ODCM). Therefore, in accordance with the requirements of TS 5.5.1, the Radioactive Effluent Release Report includes a complete copy of the current ODCM is included in enclosure 2.

Please refer any questions regarding this submittal to Mr. David C. DiCello, Manager – Regulatory Affairs, at (910) 457-2235.

Sincerely,

C. J. Gannon
Plant General Manager
Brunswick Steam Electric Plant

PSJ/psj

Enclosure: 1) Radioactive Effluent Release Report for 2000

2) Offsite Dose Calculation Manual, Revision 25

Brunswick Nuclear Plant
P.O. Box 10429
Southport, NC 28461

IE48
1/1

cc (with enclosure 1,only):

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ENCLOSURE 1

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 AND 50-324
LICENSE NOS. DPR-71 AND DPR-62

RADIOACTIVE EFFLUENT RELEASE REPORT FOR 2000

Brunswick Steam Electric Plant

Radioactive Effluent Release Report

January 1, through December 31, 2000

ATTACHMENT 1

Supplemental Information

January 1, through December 31, 2000

Attachment 1 (cont.)
EFFLUENT AND WASTE DISPOSAL REPORT
Supplemental Information

Facility: Brunswick Steam Electric Plant
Licensee: Carolina Power and Light Company

1. Regulatory Limits

A. Fission and activation gases (Off-Site Dose Calculation Manual Specification (ODCMS) 7.3.8)

(1) Calendar Quarter*

(a) ≤ 10 mrad gamma
(b) ≤ 20 mrad beta

(2) Calendar Year

(a) ≤ 20 mrad gamma
(b) ≤ 40 mrad beta

B. Iodine-131, iodine-133, tritium, and particulates with half-lives greater than eight days (ODCMS 7.3.9)

(1) Calendar Quarter*

(a) ≤ 15 mrem to any organ

(2) Calendar Year

(a) ≤ 30 mrem to any organ

(3) Calendar Quarter for Burning Contaminated Oil*

(a) < 0.1 % of limits for calendar quarter of (1)
(b) 436 μCi (ODCM Appendix H)

(4) Calendar Year for Burning Contaminated Oil

(a) < 0.1 % of limits for calendar year
(b) 872 μCi (ODCM Appendix H)

C. Liquid effluents (ODCMS 7.3.4)

(1) Calendar Quarter**

(a) ≤ 3 mrem to total body
(b) ≤ 10 mrem to any organ

(2) Calendar Year

(a) ≤ 6 mrem to total body
(b) ≤ 20 mrem to any organ

NOTE: Dose calculations are determined in accordance with the ODCM
* Used for percent of ODCMS limit determination in Attachment 2, Table 1A
**Used for percent of ODCMS limit determination in Attachment 2, Table 2A

Attachment 1 (cont.)
EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
Supplemental Information

2. Maximum permissible concentration and dose rates which determine maximum instantaneous release rates.

   A. Fission and activation gases (ODCMS 7.3.7.a)

      (1) $\leq$ 500 mrem/year to total body
      (2) $\leq$ 3000 mrem/year to the skin

   B. Iodine-131, iodine-133, tritium, and particulates with half-lives greater than eight days (ODCMS 7.3.7.b)

      (1) $\leq$ 1500 mrem/year to any organ

   C. Liquid effluents (ODCMS 7.3.3)

   The concentration of radioactive material released in liquid effluents to unrestricted areas after dilution in the discharge canal shall be limited to 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. For dissolved or entrained noble gases, the concentration shall be limited to the value given in the ODCM specifications.

      (1) Tritium: limit = 1.00E-03 µCi/ml**
      (2) Dissolved and entrained noble gases: limit = 2.00E-04 µCi/ml**

3. Measurements and Approximations of Total Radioactivity

   A. Fission and activation gases

      (1) Analyses for specific radionuclides in representative grab samples by gamma spectroscopy.

   B. Iodines

      (1) Analysis for specific radionuclides collected on charcoal cartridges by gamma spectroscopy.

   C. Particulates

      (1) Analysis for specific radionuclides collected on filter papers by gamma spectroscopy.

   D. Particulates for Burning Oil

      (1) Analysis for specific radionuclides by grab samples of each batch of oil to be burned.

   E. Liquid Effluents

      (1) Analysis for specific radionuclides of individual releases by gamma spectroscopy.

** Used as applicable limits for Attachment 2, Table 2A.

Nuclear counting statistics are reported utilizing 1-sigma error. Total error where reported represents a best effort to approximate the total of all individual and sampling errors.

Attachment 1 (cont.)
EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
Supplemental Information

4. Batch Releases

A. Liquid

(1) Number of batch releases:	2.20E+01
(2) Total time period for batch releases:	2.32E+03 Minutes
(3) Maximum time period for a batch release:	2.73E+02 Minutes
(4) Average time period for a batch release:	1.05E+02 Minutes
(5) Minimum time period for a batch release:	4.00E+00 Minutes
(6) Average stream flow during periods of release of effluent into a flowing stream:	8.38E+05 Gallons per Minute

B. Gaseous

(1) Number of batch releases:	0.00E+00
(2) Total time period for batch releases:	0.00E+00 Minutes
(3) Maximum time period for a batch release:	0.00E+00 Minutes
(4) Average time period for a batch release:	0.00E+00 Minutes
(5) Minimum time period for a batch release:	0.00E+00 Minutes

5. Abnormal releases*

A. Liquid

(1) Number of releases:	0.00E+00
(2) Total activity released:	0.00E+00 Curies

B. Gaseous

(1) Number of releases:	0.00E+00
(2) Total activity released:	0.00E+00 Curies

* There were no abnormal releases that exceeded 10 CFR 20 or 10 CFR 50 limits. See page 6 for a discussion of release events that occurred.

Attachment 1 (cont.)
EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
Supplemental Information

Discussion of Tritium in the Storm Drain Collection Pond

Approximately 4.56E+07 gallons containing 1.23E+02 curies of tritium were released from the Storm Drain Collection Pond (SDCP) to the Intake Canal during this reporting period. This resulted in an estimated maximum dose to the individual of 1.69E-04 mrem. The SDCP is a permitted release point.

Summary

SDCP curie totals are included in the quarterly summaries for FISSION AND ACTIVIATION PRODUCTS and TRITIUM on Attachment 2, Table 2A when applicable.

The quantity of rainwater released from the SDCP is not included in the average diluted concentration determination or VOLUME OF WASTE RELEASED on Attachment 2, Table 2A.

ATTACHMENT 2

Brunswick Steam Electric Plant

Effluent and Waste Disposal Data

January 1, through December 31, 2000

Attachment 2 (cont.)
TABLE 1A
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Gaseous Effluents - Summation of all Releases

A. FISSION AND ACTIVATION GASES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total release	Ci	2.30E+02	1.45E+02	1.59E+02	1.63E+02	4.50E+01
2. Average release rate for period	µCi/sec	2.93E+01	1.85E+01	2.00E+01	2.04E+01	NA
3. Percent of ODCM limit	%	5.44E-02	3.18E-02	3.74E-02	3.84E-02	NA

B. IODINES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total Iodine - 131 release	Ci	5.11E-03	3.84E-03	2.89E-03	2.45E-03	3.50E+01
2. Average release rate for period	µCi/sec	6.49E-04	4.88E-04	3.63E-04	3.09E-04	NA

C. PARTICULATES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total release	Ci	1.25E-03	8.07E-04	7.27E-04	9.45E-04	3.50E+01
2. Average release rate for period	µCi/sec	1.59E-04	1.03E-04	9.15E-05	1.19E-04	NA
3. Gross Alpha	Ci	3.07E-06	3.34E-07	1.03E-07	1.36E-06	3.50E+01

D. TRITIUM

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total release	Ci	3.25E+01	2.67E+00	6.58E+01	5.46E+01	3.00E+01
2. Average release rate for period	µCi/sec	4.13E+00	3.40E+00	8.28E+00	6.86E+00	NA

E. IODINE-131, IODINE-133, TRITIUM AND PARTICULATES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1. Total release	Ci	3.25E+01	2.67E+01	6.58E+01	5.46E+01
2. Average release rate for period	µCi/sec	4.14E+00	3.40E+00	8.28E+00	6.86E+00
3. Percent of ODCM limit	%	1.79E-01	1.33E-01	1.05E-01	8.80E-02

Attachment 2 (cont.)
TABLE 1A (cont.)
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Gaseous Effluents - Summation of all Releases

F. PARTICULATES VIA BURINING CONTAMINATED OIL

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1. Total release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Average release rate for period	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Percent of ODCM limit	%	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 2 (cont.)
TABLE 1B
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Gaseous Effluents - Elevated Releases
Continuous Release

Nuclides Released

1. FISSION GASES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
krypton-85m	Ci	3.73E+00	6.88E-01	2.16E-01	4.90E-01
krypton-87	Ci	2.49E+00	3.88E-01	8.05E-02	2.53E+00
krypton-88	Ci	2.19E+00	≤LLD	≤LLD	4.21E-01
xenon-133	Ci	8.47E+00	3.16E+00	2.98E+00	9.15E-01
xenon-135	Ci	1.62E+01	1.05E+01	8.08E+00	8.12E+00
xenon-135m	Ci	2.58E+01	2.07E+01	2.22E+01	2.42E+01
xenon-137	Ci	5.42E+01	4.23E+01	4.44E+01	4.13E+01
xenon-138	Ci	7.30E+01	5.06E+01	6.28E+01	6.04E+01
total for period		1.86E+02	1.28E+02	1.42E+02	1.38E+02

2. GASEOUS IODINES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
iodine-131	Ci	4.85E-03	3.58E-03	2.61E-03	2.33E-03
iodine-132	Ci	1.65E-02	1.81E-02	1.76E-02	1.57E-02
iodine-133	Ci	2.27E-02	1.80E-02	1.53E-02	1.39E-02
iodine-134	Ci	3.68E-02	3.16E-02	3.37E-02	2.81E-02
iodine-135	Ci	3.08E-02	2.97E-02	2.72E-02	2.53E-02
total for period		1.12E-01	1.01E-01	9.64E-02	8.54E-02

3. PARTICULATES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
cobalt-60	Ci	2.05E-05	≤LLD	1.77E-05	≤LLD
strontium-89	Ci	1.78E-04	1.22E-04	1.14E-04	2.09E-04
strontium-90	Ci	1.01E-06	1.01E-06	8.90E-07	1.13E-06
ruthenium-106	Ci	≤LLD	5.09E-05	≤LLD	≤LLD
cesium-137	Ci	≤LLD	1.42E-05	5.99E-06	3.20E-06
barium-140	Ci	3.28E-04	2.24E-04	2.18E-04	2.57E-04
lanthanum-140	Ci	5.46E-04	3.83E-04	3.64E-04	4.25E-04
total for period		1.07E-03	7.83E-04	7.20E-04	8.95E-04

4. TRITIUM

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
hydrogen-3	Ci	8.55E+00	1.36E+01	2.75E+01	2.14E+01

Attachment 2 (cont.)
TABLE 1C
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Gaseous Effluents - Ground Level Releases
Continuous Release

Nuclides Released

1. FISSION GASES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
xenon-133	Ci	7.99E-01	≤LLD	≤LLD	≤LLD
xenon-135	Ci	1.27E+01	6.30E+00	5.47E+00	7.30E+00
xenon-135m	Ci	3.06E+01	1.04E+01	1.19E+01	1.69E+01
total for period		4.41E+01	1.67E+01	1.74E+01	2.42E+01

2. GASEOUS IODINES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
iodine-131	Ci	2.61E-04	2.58E-04	2.82E-04	1.24E-04
iodine-132	Ci	6.56E-04	3.23E-03	3.62E-03	≤LLD
iodine-133	Ci	1.64E-03	2.78E-03	2.82E-03	1.01E-03
iodine-134	Ci	≤LLD	5.13E-03	2.42E-03	≤LLD
iodine-135	Ci	1.61E-03	4.18E-03	4.08E-03	2.71E-04
total for period		4.16E-03	1.56E-02	1.32E-02	1.41E-03

3. PARTICULATES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
chromium-51	Ci	9.67E-05	≤LLD	≤LLD	≤LLD
cobalt-58	Ci	4.94E-06	≤LLD	≤LLD	8.63E-07
cobalt-60	Ci	7.67E-05	1.99E-05	5.87E-06	4.79E-05
zinc-65	Ci	≤LLD	≤LLD	≤LLD	≤LLD
strontium-89	Ci	1.93E-06	4.95E-06	9.33E-07	1.04E-06
total for period		1.80E-04	2.49E-05	6.81E-06	4.98E-05

4. TRITIUM

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
hydrogen-3	Ci	2.40E+01	1.32E+01	3.83E+01	3.32E+01

Attachment 2 (cont.)
TABLE 1D
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Gaseous Effluents - Ground Level Releases
For Burning Contaminated Oil

Nuclides Released

1. PARTICULATES

Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 2 (cont.)
TABLE 2A
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Liquid Effluents - Summation of all Releases

A. FISSION AND ACTIVATION PRODUCTS (NOTE 1)

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total release (excluding tritium, gases, and alpha)	Ci	1.60E-03	1.25E-04	3.81E-04	2.61E-04	4.00E+01
2. Average diluted concentration (NOTE 2)	µCi/ml	1.32E-09	1.35E-10	1.57E-10	9.34E-11	NA
3. Percent of applicable limit	%	2.41E-03	2.23E-04	4.37E-04	3.34E-04	NA

B. TRITIUM (NOTE 1)

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total release	Ci	4.65E+01	2.29E+00	5.56E+01	2.51E+01	4.50E+01
2. Average diluted concentration (NOTE 2)	µCi/ml	3.85E-05	2.47E-06	2.29E-05	9.00E-06	NA
3. Percent of applicable limit	%	3.85E+00	2.47E-01	2.29E+00	9.00E-01	NA

C. DISSOLVED AND ENTRAINED GASES (NOTE 1)

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total release	Ci	≤ LLD	3.67E-04	≤ LLD	≤ LLD	4.00E+01
2. Average diluted concentration (NOTE 2)	µCi/ml	0.00E+00	3.97E-10	0.00E+00	0.00E+00	NA
3. Percent of applicable limit	%	0.00E+00	1.99E-04	0.00E+00	0.00E+00	NA

D. GROSS ALPHA RADIOACTIVITY

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total release	Ci	≤ LLD	≤ LLD	≤ LLD	≤ LLD	4.00E+01

NOTE 1: Includes radionuclides released via abnormal and/or non-routine releases
NOTE 2: Does not include rainwater (i.e. Storm Drain Collection Basin and/or Storm Drain Collection Pond)

Attachment 2 (cont.)
TABLE 2A (cont.)
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Liquid Effluents - Summation of all Releases

E. VOLUME OF WASTE RELEASED (NOTE 2)

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total volume	liters	1.60E+05	1.40E+05	2.63E+05	3.64E+05	1.50E+01

F. VOLUME OF DILUTION WATER

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total volume (used during release for average diluted concentration)	liters	1.21E+09	9.24E+08	2.43E+09	2.79E+09	1.50E+01

G. VOLUME OF COOLING WATER DISCHARGED FROM PLANT

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Estimated Total Percent Error
1. Total volume	liters	3.54E+11	4.81E+11	5.10E+11	4.61E+11	1.50E+01

NOTE 1: Includes radionuclides released via abnormal and/or non-routine releases
NOTE 2: Does not include rainwater (i.e. Storm Drain Collection Basin and/or Storm Drain Collection Pond)

Attachment 2 (cont.)
TABLE 2B
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Liquid Effluents - Batch Mode

Nuclides Released

1. FISSION AND ACTIVATION PRODUCTS

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
chromium-51	Ci	6.15E-06	≤LLD	≤LLD	≤LLD
manganese-54	Ci	3.76E-05	≤LLD	5.54E-06	4.40E-06
iron-55	Ci	1.75E-05	9.69E-06	1.20E-04	7.20E-05
cobalt-58	Ci	1.37E-05	≤LLD	≤LLD	≤LLD
cobalt-60	Ci	9.42E-04	8.65E-05	3.56E-03	1.42E-04
strontium-89	Ci	4.61E-06	≤LLD	≤LLD	≤LLD
strontium-90	Ci	1.56E-06	≤LLD	≤LLD	≤LLD
iodine-131	Ci	3.49E-05	≤LLD	4.79E-07	≤LLD
cesium-134	Ci	1.14E-04	5.68E-06	2.12E-05	4.52E-06
cesium-137	Ci	2.66E-04	2.28E-04	8.60E-05	3.75E-05
total for period	Ci	1.60E-03	1.25E-04	3.81E-04	2.61E-04

2. DISSOLVED AND ENTRAINED GASES

	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4
xenon-133	Ci	≤LLD	6.29E-05	≤LLD	≤LLD
xenon-135	Ci	≤LLD	3.04E-04	≤LLD	≤LLD
total for period	Ci	0.00E+00	3.67E-04	0.00E+00	0.00E+00

Lower Limits of Detection
January 1, through December 31, 2000

Units: μCi/ml

1. LIQUID RELEASES

Alpha	2.16E-08
Cr-51	1.29E-07
Mn-54	1.68E-08
Fe-55	2.43E-08
Co-58	2.05E-08
Fe-59	1.93E-08
Co-60	2.31E-08
Zn-65	3.76E-08
Sr-89	3.38E-08
Sr-90	1.80E-08
Mo-99	1.34E-07
I-131	2.29E-08
Cs-134	2.34E-08
Cs-137	1.94E-08
Ce-141	2.60E-08
Ce-144	9.90E-07
Kr-87	3.89E-08
Kr-88	4.76E-08
Xe-133	4.16E-08
Xe-133m	1.36E-07
Xe-135	1.45E-08
Xe-135m	8.15E-08
Xe-138	1.68E-07

2. GASEOUS RELEASES

Kr-87	1.59E-08
Kr-88	1.62E-08
Xe-133	1.44E-08
Xe-133m	4.29E-08
Xe-135	4.56E-09
Xe-137	7.29E-07
Xe-138	1.88E-07

3. IODINES AND PARTICULATES

Alpha	1.26E-15
Cr-51	5.34E-13
Mn-54	6.13E-14
Co-58	5.00E-14
Fe-59	1.30E-14
Co-60	5.78E-14
Zn-65	1.59E-13
Sr-89	2.80E-15
Sr-90	8.11E-16
Mo-99	4.93E-13
Ru-106	4.87E-13
I-131	3.31E-14
Cs-134	5.71E-14
Cs-137	8.40E-14
Ba-140	1.21E-13
La-140	9.67E-14
Ce-141	6.47E-14
Ce-144	3.44E-13

NOTES:

1. The above values represent typical "a priori" LLDs for isotopes where values of "≤LLD" are indicated in Tables 1A, 1B, 1C, 2A, and 2B. Also included are isotopes specified in ODCMS 7.3.3 and 7.3.7.

2. Where activity for any nuclide is reported as "Less than LLD," that nuclide is considered not present and the LLD activity listed is not considered in the summary data.

Attachment 2 (cont.)
TABLE 3A
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Solid Waste and Irradiated Fuel Shipments

Waste Class A

1. Total volume shipped (cubic meters) 1.22E+02

   Total curie quantity (estimated) 5.76E+01

2. Type of Waste

		Unit	Period	Estimated Total %Error
a.	Spent resins, filter, sludges	meter^3	2.32E+01	
		Curies	5.47E+01	1.00E+01
b.	Dry active waste, compacted/non-compacted	meter^3	9.90E+01	
		Curies	2.94E+00	1.00E+01
c.	Irradiated components	meters^3	0.00E+00	
		Curies	0.00E+00	N/A
d.	Others (describe)	meters^3	0.00E+00	
		Curies	0.00E+00	N/A

3. Estimate of major radionuclides composition

a.

C-14	1.84E+00 %
Fe-55	9.64E+00 %
Co-60	4.57E+01 %
Ni-63	2.60E+01 %
Cs-134	2.07E+00 %
Cs-137	1.44E+01 %

b.

C-14	1.76E+00 %
Fe-55	1.15E+01 %
Co-60	4.53E+01 %
Ni-63	2.50E+01 %
Cs-134	2.03E+00 %
Cs-137	1.39E+01 %

c. N/A

d. N/A

NOTE:

Solid Radioactive Waste listed above was shipped for processing to various waste processing services. The dry active waste (DAW) portion of the waste was shipped for disposal, commingled with other waste generators wastes, at the Envirocare disposal facility in Utah, while the spent resins/filters/sludges portion was shipped to the Barnwell, South Carolina disposal facility for disposal.

Attachment 2 (cont.)
TABLE 3A (cont.)
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Solid Waste and Irradiated Fuel Shipments

4. Cross reference table, waste stream, form, and container type

Stream	Form	Container Type Type A/Type B	No. of shipments
a. Resin	Dewatered & Solidified*	Type A	6.00E+00
b. Dry active waste	Compacted/ Non-compacted	Type A or STP	1.22E+02
c. Irradiated components		N/A	N/A
d. Others (describe)		N/A	N/A

*Solidification agent or absorbent (e.g., cement, urea-formaldehyde)

5. Shipment Disposition

a. Solid Waste

Number of Shipments	Mode of Transportation	Destination
6.00E+00	Highway	Barnwell, SC
1.22E+02	Highway	Envirocare of Utah

b. Irradiated Fuel

Number of Shipments	Mode of Transportation	Destination
0	N/A	N/A

Attachment 2 (cont.)
TABLE 3B
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Solid Waste and Irradiated Fuel Shipments

Waste Class B

1. Total volume shipped (cubic meters) 2.49E+01

   Total curie quantity (estimated) 1.19E+03

2. Type of Waste

		Unit	Period	Estimated Total %Error
a.	Spent resins, filter, sludges	meter^3	2.49E+01	
		Curies	1.19E+03	1.00E+01
b.	Dry active waste, compacted/non-compacted	meter^3	0.00E+00	
		Curies	0.00E+00	N/A
c.	Irradiated components	meters^3	0.00E+00	
		Curies	0.00E+00	N/A
d.	Others (describe)	meters^3	0.00E+00	
		Curies	0.00E+00	N/A

3. Estimate of major radionuclides composition

   a. Mn-54 1.31E+00 %
      Fe-55 1.30E+01 %
      Co-58 1.41E+00 %
      Co-60 7.01E+01 %
      Ni-63 4.40E+00 %
      Zn-65 1.78E+00 %
      Cs-134 1.97E+00 %
      Cs-137 5.19E+00 %

   b. N/A

   c. N/A

   d. N/A

NOTE:

Solid Radioactive Waste was shipped either directly for disposal or to a waste processor for processing and then transported for disposal by the processor.

Attachment 2 (cont.)
TABLE 3B (cont.)
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Solid Waste and Irradiated Fuel Shipments

4. Cross reference table, waste stream, form, and container type

Stream	Form	Container Type Type A/Type B	No. of shipments
a. Resin	Dewatered & Solidified*	Type B	1.30E+01
b. Dry active waste	Compacted/ Non-compacted	N/A	N/A
c. Irradiated components		N/A	N/A
d. Others (describe)		N/A	N/A

*Solidification agent or absorbent (e.g., cement, urea-formaldehyde)

5. Shipment Disposition

a. Solid Waste

Number of Shipments	Mode of Transportation	Destination
1.30E+01	Highway	Barnwell, SC

b. Irradiated Fuel

Number of Shipments	Mode of Transportation	Destination
0	N/A	N/A

Attachment 2 (cont.)
TABLE 3C
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Solid Waste and Irradiated Fuel Shipments

Waste Class C

1. Total volume shipped (cubic meters) 0.00E+00

   Total curie quantity (estimated) 0.00E+00

2. Type of Waste

	Unit	Period	Estimated Total %Error
a. Spent resins, filter, sludges	meter^3	0.00E+00	
	Curies	0.00E+00	N/A
b. Dry active waste, compacted/non-compacted	meter^3	0.00E+00	
	Curies	0.00E+00	N/A
c. Irradiated components	meters^3	0.00E+00	
	Curies	0.00E+00	N/A
d. Others (describe)	meters^3	0.00E+00	
	Curies	0.00E+00	N/A

3. Estimate of major radionuclides composition

   a. N/A

   b. N/A

   c. N/A

   d. N/A

Attachment 2 (cont.)
TABLE 3C (cont.)
Effluent and Waste Disposal Annual Report for January 1, through December 31, 2000
Solid Waste and Irradiated Fuel Shipments

4. Cross reference table, waste stream, form, and container type

Stream	Form	Container Type Type A/Type B	No. of shipments
a. Resin	Dewatered & Solidified*	N/A	N/A
b. Dry active waste	Compacted/ Non-compacted	N/A	N/A
c. Irradiated components		N/A	N/A
d. Others (describe)		N/A	N/A

*Solidification agent or absorbent (e.g., cement, urea-formaldehyde)

5. Shipment Disposition

a. Solid Waste

Number of Shipments	Mode of Transportation	Destination
0	N/A	N/A

b. Irradiated Fuel

Number of Shipments	Mode of Transportation	Destination
0	N/A	N/A

ATTACHMENT 2 (cont.)

Combustion of Waste Oil

January 1, through December 31, 2000

No contaminated waste oil was incinerated during this report period.

ATTACHMENT 3

Environmental Monitoring Program

January 1, through December 31, 2000

Enclosure 1: Milk and Vegetable Sample Location

Enclosure 2: Land Use Census

ATTACHMENT 3 (Cont.)

ENCLOSURE 1

Milk and Vegetation Sample Location

January 1, through December 31, 2000

No milk animals are located in the area evaluated by the last Land Use Census, therefore, no milk sampling locations were available during this time period.

Vegetation sample locations remained unchanged.

ATTACHMENT 3 (Cont.)

ENCLOSURE 2

Land Use Census

January 1, through December 31, 2000

The 2000 Land Use Census did not identify any locations that are reportable in the Annual Radioactive Effluent Release Report. The following is a summary of the nearest resident and garden locations identified within five miles of the plant. No milk or beef animals were identified.

Direction	Residence	Garden
NNE	0.8 miles	1.2 miles
NE	None	None
ENE	None	None
E	None	None
ESE	1.5 miles	None
SE	0.9 miles	None
SSE	1.0 miles	None
S	1.1 miles	1.9 miles
SSW	1.2 miles	1.5 miles
SW	1.0 miles	2.9 miles
WSW	1.2 miles	1.2 miles
W	0.8 miles	1.1 miles
WNW	0.8 miles	1.0 miles
NW	0.9 miles	4.8 miles
NNW	0.8 miles	4.4 miles
N	0.7 miles	0.9 miles

ATTACHMENT 4

Effluent Instrumentation

January 1, through December 31, 2000

Enclosure 1: Radioactive Liquid Effluent Monitoring Instrumentation

Enclosure 2: Radioactive Gaseous Effluent Monitoring Instrumentation

Enclosure 3: Liquid Hold-Up Tank

ATTACHMENT 4 (Cont.)

ENCLOSURE 1

Radioactive Liquid Effluent Monitoring Instrumentation

January 1, through December 31, 2000

No Radioactive Liquid Effluent Monitoring Instruments were inoperable for a period of greater than 30 days.

ATTACHMENT 4 (Cont.)

ENCLOSURE 2

Radioactive Gaseous Effluent Monitoring Instrumentation

January 1, through December 31, 2000

No Radioactive Gaseous Effluent Monitoring Instruments were inoperable for a period of greater than 30 days.

ATTACHMENT 4 (Cont.)

ENCLOSURE 3

Liquid Hold-Up Tank

January 1, through December 31, 2000

No Liquid Hold-Up Tank exceeded the 10 Curie limit of ODCMS 7.3.6 during this reporting period.

ATTACHMENT 5

Major Modification to the Radioactive Waste Treatment Systems

January 1, through December 31, 2000

In accordance with ODCMS 7.5.1, 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 Updated Final Safety Analysis Report (UFSAR) update. Any major modifications to the radioactive waste treatment systems will be submitted with the UFSAR in accordance with 10 CFR 50.71(e).

ATTACHMENT 6

Meteorological Data

January 1, through December 31, 2000

Per Technical Specification 5.6.3 and ODCMS 7.4.2, the annual summary of meteorological data collected over the calendar year was submitted to a file and is available for NRC review upon request.

ATTACHMENT 7

Annual Dose Assessment

January 1, through December 31, 2000

Enclosure 1: 2000 Annual Liquid Dose Assessment

Enclosure 2: 2000 Annual Gaseous Dose Assessment

Enclosure 3: 2000 Dose Assessment Summary

ATTACHMENT 7 (cont.)

ENCLOSURE 1

2000 Annual Liquid Dose Assessment

Included are:

Site Specific Data

Source Term

As Low As Reasonably Achievable Maximum Individual Dose

Summary - Total Integrated and Recreation Population Dose

Site Specific Data

BSEP UNITS 1 AND 2 LIQUID RELEASES 2000,

DISCHARGE = 2.02E+03 CFS SOURCE TERM MULTIPLIER = 1.00E+00

SALTWATER SITE

NO RECONCENTRATION MODEL

50-MILE POPULATION = 3.18E+05 FRACTION --- ADULT=0.71
TEENAGER=0.11
CHILD=0.18

DOSE FACTOR LIBRARY CONTAINS 698 ENTRIES

Source Term

* * * **COST-BENEFIT ANALYSIS** * * *

0 NUCLIDE	RELEASE CI/YR	PERSON-REM DOSE		PERSON-REM PER CURIE	
		TOTAL BODY	THYROID	TOTAL BODY	THYROID
1H 3	1.29E+02	2.59E-03	2.59E-03	2.00E-05	2.00E-05
24CR 51	6.14E-06	1.35E-09	8.00E-10	2.20E-04	1.30E-04
25MN 54	4.76E-05	5.33E-06	4.34E-08	1.12E-01	9.13E-04
26FE 55	3.76E-04	1.30E-04	1.86E-13	3.46E-01	4.96E-10
27CO 58	1.36E-05	5.39E-07	3.57E-09	3.95E-02	2.61E-04
27CO 60	1.32E-03	1.77E-04	1.99E-05	1.34E-01	1.51E-02
38SR 89	4.61E-06	1.97E-08	2.29E-13	4.28E-03	4.97E-08
38SR 90	1.55E-06	1.35E-06	6.50E-15	8.67E-01	4.18E-09
53I 131	3.54E-05	1.54E-07	8.73E-05	4.34E-03	2.47E+00
54XE 133	6.29E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
54XE 135	3.04E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
55CS 134	1.45E-04	1.33E-04	6.52E-07	9.14E-01	4.50E-03
55CS 137	4.13E-04	2.25E-04	3.50E-06	5.46E-01	8.49E-03
0 TOTAL		3.26E-03	2.70E-03		

As Low As Reasonably Achievable Maximum Individual Dose (Page 1 of 2)

1 * * * AS LOW AS REASONABLY ACHIEVABLE * * *

0 **A D U L T D O S E S** (MREM PER YEAR INTAKE)
0

	DOSE						
0PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		1.86E-06	6.75E-06	5.91E-06	4.98E-06	5.10E-06	5.32E-06	7.44E-06
INVERT		2.03E-06	2.91E-06	2.16E-06	1.46E-06	1.22E-06	1.92E-06	6.85E-06
SHORELINE	2.62E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05
SWIMMING		1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08
BOATING		6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09
TOTAL	2.62E-05	2.62E-05	3.20E-05	3.04E-05	2.88E-05	2.86E-05	2.95E-05	3.66E-05

0	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	SHOREWIDTH FACTOR=0.5
FISH	21.0	30.0	24.00	
INVERT	5.0	30.0	24.00	
SHORELINE	500.0	30.0	0.00	
SWIMMING	100.0	30.0	0.00	
BOATING	100.0	30.0	0.00	

0 **T E E N D O S E S** (MREM PER YEAR INTAKE)
0

	DOSE						
0PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
FISH		1.96E-06	5.75E-06	4.52E-06	3.87E-06	4.01E-06	4.35E-06	5.57E-06
INVERT		2.12E-06	2.73E-06	1.88E-06	1.17E-06	9.51E-07	1.81E-06	4.92E-06
SHORELINE	2.62E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05
SWIMMING		1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08
BOATING		6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09
TOTAL	2.62E-05	2.64E-05	3.08E-05	2.87E-05	2.73E-05	2.73E-05	2.85E-05	3.28E-05

0	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)	SHOREWIDTH FACTOR=0.5
FISH	16.0	30.0	24.00	
INVERT	3.8	30.0	24.00	
SHORELINE	500.0	30.0	0.00	
SWIMMING	100.0	30.0	0.00	
BOATING	100.0	30.0	0.00	

As Low As Reasonably Achievable Maximum Individual Dose (Page 2 of 2)

* * * AS LOW AS REASONABLY ACHIEVABLE * * *

0 **C H I L D D O S E S** (MREM PER YEAR INTAKE)
0

0PATHWAY	SKIN	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI
				DOSE				
FISH		2.52E-06	4.95E-06	3.71E-06	3.25E-06	3.32E-06	3.61E-06	3.70E-06
INVERT		2.86E-06	2.58E-06	1.89E-06	1.06E-06	8.16E-07	1.60E-06	2.25E-06
SHORELINE	2.62E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05	2.23E-05
SWIMMING		1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08	1.29E-08
BOATING		6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09	6.47E-09
TOTAL	2.62E-05	2.77E-05	2.98E-05	2.79E-05	2.66E-05	2.64E-05	2.75E-05	2.83E-05

0	USAGE (KG/YR,HR/YR)	DILUTION	TIME(HR)
FISH	6.9	30.0	24.00
INVERT	1.7	30.0	24.00
SHORELINE	500.0	30.0	0.00
SWIMMING	100.0	30.0	0.00
BOATING	100.0	30.0	0.00

SHOREWIDTH FACTOR=0.5

Summary - Total Integrated and Recreation Population Dose

1CP&L
LADTAP

ANNUAL RADIOLOGICAL EFFLUENT REPORTING
RADIATION DOSES FROM LIQUID EFFLUENTS

RUN DATE: 04/03/01
RUN TIME: 13:16:26

TOTAL INTEGRATED AND RECREATION POPULATION DOSES FROM LIQUID EFFLUENTS
(PERSON-REM)

	PATHWAY	BONE	LIVER	TOTAL BODY	THYROID	KIDNEY	LUNG	GI-LLI	SKIN
0	SPORT FISH	1.117E-03	3.563E-03	3.027E-03	2.513E-03	2.630E-03	2.766E-03	3.703E-03	0.000E+00
0	COM FISH	6.156E-05	1.965E-04	1.670E-04	1.376E-04	1.451E-04	1.526E-04	2.042E-04	0.000E+00
0	SPORT INVERT	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	COM INVERT	4.114E-05	5.338E-05	3.939E-05	2.269E-05	2.118E-05	3.493E-05	1.102E-04	0.000E+00
0	DRINKING WATER	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	SHORELINE	2.407E-05	2.407E-05	2.407E-05	2.407E-05	2.407E-05	2.407E-05	2.407E-05	2.828E-05
0	SWIMMING	3.690E-08	3.690E-08	3.690E-08	3.690E-08	3.690E-08	3.690E-08	3.690E-08	0.000E+00
0	BOATING	1.748E-08	1.748E-08	1.748E-08	1.748E-08	1.748E-08	1.748E-08	1.748E-08	0.000E+00
0	IRRI VEG	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	IRRI LEAFY VEG	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	IRRI MILK	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	IRRI MEAT	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0	ALL PATHWAYS	1.244E-03	3.837E-03	3.258E-03	2.697E-03	2.820E-03	2.978E-03	4.041E-03	2.828E-05

ATTACHMENT 7 (cont.)

ENCLOSURE 2

2000 Annual Gaseous Dose Assessment

Included are:

Source term for the three release modes and the site aggregate.

Total 50 mile Integrated Population Dose by pathways and organs.

Hypothetical maximum individual organ dose due to Iodines, Particulates, and Tritium for a cow milk pathway at 4.75 miles Northeast.

Maximum site boundary dose by age group and organs for all pathways.

Estimated individual organ dose using the 2000 Land Use Census for the worst sector and existing pathway.

Maximum site boundary dose due to Iodines, Particulates, and Tritium for existing pathways.

Source Term for the three release modes and the site aggregate (Page 1 of 2)

GR00YREC
GR00YRGC
GR00YRMC
1CP&L

ANNUAL RADIOLOGICAL EFFLUENT REPORTING
GASRPT INPUT SOURCE TERMS

RUN DATE: 04/05/01
RUN TIME: 16:41:24

2000 SOURCE TERM (ELEVATED MODE) BSEP UNITS 1&2

1	H - 3	7.096E+01
27	CO- 60	1.766E-05
36	KR- 85 M	5.122E+00
36	KR- 87	5.484E+00
36	KR- 88	2.615E+00
38	SR- 89	6.227E-04
38	SR- 90	4.045E-06
53	I -131	1.336E-02
53	I -132	6.790E-02
53	I -133	6.989E-02
53	I -134	1.302E-01
53	I -135	1.131E-01
54	XE-133	1.551E+01
54	XE-135	4.361E+01
54	XE-135 M	9.296E+01
54	XE-137	1.822E+02
54	XE-138	2.468E+02
55	CS-137	9.187E-06
56	BA-140	8.026E-04
57	LA-140	1.335E-03

SOURCE TERM (GROUND LEVEL) 2000 BSEP UNITS 1 AND 2

1	H - 3	9.955E+01
38	SR- 89	4.248E-06
53	I -131	4.625E-05
53	I -132	1.080E-04
53	I -133	6.441E-05
53	I -135	5.947E-05
54	XE-133	6.273E-02
54	XE-135	7.289E+00
54	XE-135 M	7.809E-01

Source Term for the three release modes and the site aggregate (Page 2 of 2)

ANNUAL RADIOLOGICAL EFFLUENT REPORTING — RUN DATE: 04/05/01
GASRPT INPUT SOURCE TERMS — RUN TIME: 16:41:24

BRUNSWICK UNITS 1 AND 2, MIXED MODE CONTINUOUS GASEOUS RELEASES, 2000

1	H - 3	9.066E+00
24	CR- 51	9.674E-05
27	CO- 58	5.806E-06
27	CO- 60	1.504E-04
38	SR- 89	4.598E-06
53	I -131	8.785E-04
53	I -132	7.402E-03
53	I -133	8.177E-03
53	I -134	7.555E-03
53	I -135	1.009E-02
54	XE-133	7.359E-01
54	XE-135	2.446E+01
54	XE-135 M	6.909E+01

AGGREGATE SOURCE TERM

1	H - 3	1.7958E+02
24	CR- 51	9.6740E-05
27	CO- 58	5.8056E-06
27	CO- 60	1.6803E-04
36	KR- 85 M	5.1218E+00
36	KR- 87	5.4844E+00
36	KR- 88	2.6149E+00
38	SR- 89	6.3155E-04
38	SR- 90	4.0446E-06
53	I -131	1.4285E-02
53	I -132	7.5410E-02
53	I -133	7.8131E-02
53	I -134	1.3776E-01
53	I -135	1.2322E-01
54	XE-133	1.6312E+01
54	XE-135	7.5358E+01
54	XE-135 M	1.6283E+02
54	XE-137	1.8217E+02
54	XE-138	2.4678E+02
55	CS-137	9.1870E-06
56	BA-140	8.0260E-04
57	LA-140	1.3355E-03

Total 50 mile Integrated Population Dose by pathways and organs

ANNUAL RADIOLOGICAL EFFLUENT REPORTING — RUN DATE: 04/05/01
ALARA ANNUAL INTEGRATED POPULATION DOSE SUMMARY (MANREM) — RUN TIME: 16:41:24

2000 SOURCE TERM (ELEVATED MODE) BSEP UNITS 1&2
SOURCE TERM (GROUND LEVEL) 2000 BSEP UNITS 1 AND 2
BRUNSWICK UNITS 1 AND 2, MIXED MODE CONTINUOUS GASEOUS RELEASES, 2000

	TOTAL BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
** TOTAL **	5.611E-02	5.614E-02	4.886E-03	5.614E-02	5.619E-02	7.153E-02	5.625E-02	6.373E-02
PLUME	4.179E-03	4.179E-03	4.179E-03	4.179E-03	4.179E-03	4.179E-03	4.268E-03	1.175E-02
	7.45%	7.44%	85.52%	7.44%	7.44%	5.84%	7.59%	18.44%
GROUND PLANE	5.224E-04	5.224E-04	5.224E-04	5.224E-04	5.224E-04	5.224E-04	5.224E-04	6.150E-04
	0.93%	0.93%	10.69%	0.93%	0.93%	0.73%	0.93%	0.97%
INHALATION	4.454E-02	4.456E-02	5.108E-05	4.457E-02	4.461E-02	5.439E-02	4.461E-02	4.452E-02
	79.38%	79.38%	1.05%	79.39%	79.39%	76.04%	79.31%	69.85%
VEGETATION	4.424E-03	4.427E-03	1.270E-04	4.423E-03	4.432E-03	9.093E-03	4.407E-03	4.407E-03
	7.88%	7.89%	2.60%	7.88%	7.89%	12.71%	7.84%	6.92%
COW MILK	1.213E-04	1.209E-04	1.459E-06	1.218E-04	1.225E-04	4.802E-04	1.207E-04	1.206E-04
	0.22%	0.22%	0.03%	0.22%	0.22%	0.67%	0.21%	0.19%
MEAT & POULTRY	2.323E-03	2.326E-03	5.446E-06	2.323E-03	2.324E-03	2.863E-03	2.321E-03	2.321E-03
	4.14%	4.14%	0.11%	4.14%	4.14%	4.00%	4.13%	3.64%

Hypothetical maximum individual organ dose due to Iodines, Particulates, and Tritium for a cow milk pathway at 4.75 mile NE

1CP&L ANNUAL RADIOLOGICAL EFFLUENT REPORTING RUN DATE: 04/05/01
GASRPT RADIATION DOSES AT SELECTED LOCATIONS RUN TIME: 16:41:24

2000 SOURCE TERM (ELEVATED MODE) BSEP UNITS 1&2
SOURCE TERM (GROUND LEVEL) 2000 BSEP UNITS 1 AND 2
BRUNSWICK UNITS 1 AND 2, MIXED MODE CONTINUOUS GASEOUS RELEASES, 2000

	SPECIAL LOCATION	METERS	DIR	PL	GR	IN	V	CM	GM	M
#42	COW MILK	7644.0	NE	0	1	1	1	1	0	0

ANNUAL BETA AIR DOSE = 4.725E-04 MILLRADS
ANNUAL GAMMA AIR DOSE = 6.252E-04 MILLRADS

	TOTAL BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
ADULT	3.990E-03	3.992E-03	1.663E-04	3.999E-03	4.026E-03	1.589E-02	3.961E-03	3.966E-03
GROUND PLANE	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	5.196E-05
INHALATION	1.147E-03	1.148E-03	1.604E-06	1.148E-03	1.150E-03	1.457E-03	1.149E-03	1.146E-03
VEGETATION	2.083E-03	2.091E-03	9.212E-05	2.079E-03	2.085E-03	4.804E-03	2.069E-03	2.069E-03
COW MILK	7.151E-04	7.092E-04	2.848E-05	7.274E-04	7.473E-04	9.583E-03	6.985E-04	6.984E-04
TEENAGER	4.521E-03	4.515E-03	2.263E-04	4.541E-03	4.584E-03	2.124E-02	4.481E-03	4.484E-03
GROUND PLANE	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	5.196E-05
INHALATION	1.155E-03	1.156E-03	2.157E-06	1.157E-03	1.159E-03	1.559E-03	1.158E-03	1.154E-03
VEGETATION	2.385E-03	2.390E-03	1.287E-04	2.379E-03	2.384E-03	4.643E-03	2.369E-03	2.369E-03
COW MILK	9.372E-04	9.245E-04	5.132E-05	9.613E-04	9.970E-04	1.500E-02	9.099E-04	9.097E-04
CHILD	6.251E-03	6.199E-03	4.493E-04	6.278E-03	6.340E-03	3.819E-02	6.175E-03	6.178E-03
GROUND PLANE	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	5.196E-05
INHALATION	1.021E-03	1.021E-03	2.791E-06	1.023E-03	1.025E-03	1.518E-03	1.024E-03	1.020E-03
VEGETATION	3.697E-03	3.684E-03	2.787E-04	3.683E-03	3.688E-03	7.155E-03	3.669E-03	3.669E-03
COW MILK	1.488E-03	1.449E-03	1.236E-04	1.527E-03	1.583E-03	2.947E-02	1.438E-03	1.437E-03
INFANT	2.908E-03	2.824E-03	2.942E-04	3.034E-03	3.067E-03	7.139E-02	2.815E-03	2.819E-03
GROUND PLANE	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	4.413E-05	5.196E-05
INHALATION	5.875E-04	5.872E-04	2.059E-06	5.892E-04	5.896E-04	1.041E-03	5.895E-04	5.866E-04
COW MILK	2.276E-03	2.193E-03	2.480E-04	2.400E-03	2.433E-03	7.031E-02	2.181E-03	2.181E-03

Maximum site boundary dose by age group and organs for all pathways (Page 1 of 2)

1CP&L ANNUAL RADIOLOGICAL EFFLUENT REPORTING RUN DATE: 04/05/01
GASRPT RADIATION DOSES AT SELECTED LOCATIONS RUN TIME: 16:41:24

2000 SOURCE TERM (ELEVATED MODE) BSEP UNITS 1&2
SOURCE TERM (GROUND LEVEL) 2000 BSEP UNITS 1 AND 2
BRUNSWICK UNITS 1 AND 2, MIXED MODE CONTINUOUS GASEOUS RELEASES, 2000

	SPECIAL LOCATION	METERS	DIR	PL	GR	IN	V	CM	GM	M
# 3	SITE BOUNDARY	1127.0	NE	1	1	1	1	1	1	1

ANNUAL BETA AIR DOSE = 8.578E-03 MILLRADS
ANNUAL GAMMA AIR DOSE = 7.928E-03 MILLRADS

	TOTAL BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
ADULT	1.213E-01	1.212E-01	7.911E-03	1.216E-01	1.222E-01	4.045E-01	1.207E-01	1.290E-01
PLUME	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.350E-03	1.349E-02
GROUND PLANE	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	6.648E-04
INHALATION	2.335E-02	2.336E-02	4.571E-06	2.336E-02	2.336E-02	2.423E-02	2.336E-02	2.335E-02
VEGETATION	4.232E-02	4.242E-02	1.160E-03	4.228E-02	4.235E-02	7.653E-02	4.215E-02	4.215E-02
COW MILK	1.444E-02	1.436E-02	3.585E-04	1.459E-02	1.484E-02	1.259E-01	1.423E-02	1.423E-02
GOAT MILK	2.929E-02	2.919E-02	5.327E-04	2.948E-02	2.977E-02	1.630E-01	2.903E-02	2.902E-02
MEAT & POULTRY	6.067E-03	6.086E-03	2.683E-05	6.069E-03	6.073E-03	8.985E-03	6.058E-03	6.058E-03
TEENAGER	1.385E-01	1.382E-01	9.083E-03	1.391E-01	1.402E-01	5.590E-01	1.376E-01	1.459E-01
PLUME	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.350E-03	1.349E-02
GROUND PLANE	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	6.648E-04
INHALATION	2.350E-02	2.350E-02	6.180E-06	2.351E-02	2.351E-02	2.464E-02	2.351E-02	2.350E-02
VEGETATION	4.846E-02	4.853E-02	1.623E-03	4.838E-02	4.845E-02	7.685E-02	4.826E-02	4.826E-02
COW MILK	1.888E-02	1.872E-02	6.463E-04	1.918E-02	1.963E-02	1.956E-01	1.853E-02	1.853E-02
GOAT MILK	3.824E-02	3.803E-02	9.575E-04	3.861E-02	3.913E-02	2.503E-01	3.781E-02	3.781E-02
MEAT & POULTRY	3.621E-03	3.629E-03	2.174E-05	3.622E-03	3.626E-03	5.734E-03	3.614E-03	3.614E-03

Maximum site boundary dose by age group and organs for all pathways (Page 2 of 2)

1CP&L ANNUAL RADIOLOGICAL EFFLUENT REPORTING RUN DATE: 04/05/01
GASRPT RADIATION DOSES AT SELECTED LOCATIONS RUN TIME: 16:41:24

2000 SOURCE TERM (ELEVATED MODE) BSEP UNITS 1&2
SOURCE TERM (GROUND LEVEL) 2000 BSEP UNITS 1 AND 2
BRUNSWICK UNITS 1 AND 2, MIXED MODE CONTINUOUS GASEOUS RELEASES, 2000

	SPECIAL LOCATION	METERS	DIR	PL	GR	IN	V	CM	GM	M
#	3 SITE BOUNDARY	1127.0	NE	1	1	1	1	1	1	1

	TOTAL BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
CHILD	1.965E-01	1.953E-01	1.326E-02	1.975E-01	1.990E-01	1.018E+00	1.948E-01	2.030E-01
PLUME	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.350E-03	1.349E-02
GROUND PLANE	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	6.648E-04
INHALATION	2.078E-02	2.078E-02	8.041E-06	2.079E-02	2.079E-02	2.218E-02	2.079E-02	2.078E-02
VEGETATION	7.509E-02	7.494E-02	3.521E-03	7.492E-02	7.498E-02	1.186E-01	7.475E-02	7.474E-02
COW MILK	2.992E-02	2.943E-02	1.558E-03	3.041E-02	3.111E-02	3.817E-01	2.928E-02	2.928E-02
GOAT MILK	6.052E-02	5.992E-02	2.301E-03	6.113E-02	6.194E-02	4.826E-01	5.974E-02	5.973E-02
MEAT & POULTRY	4.375E-03	4.374E-03	3.928E-05	4.377E-03	4.382E-03	7.566E-03	4.365E-03	4.365E-03
INFANT	1.555E-01	1.532E-01	1.348E-02	1.590E-01	1.598E-01	2.038E+00	1.529E-01	1.612E-01
PLUME	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.264E-03	5.350E-03	1.349E-02
GROUND PLANE	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	5.646E-04	6.648E-04
INHALATION	1.195E-02	1.195E-02	5.935E-06	1.196E-02	1.196E-02	1.322E-02	1.196E-02	1.195E-02
COW MILK	4.562E-02	4.458E-02	3.125E-03	4.718E-02	4.760E-02	9.008E-01	4.443E-02	4.442E-02
GOAT MILK	9.209E-02	9.081E-02	4.525E-03	9.402E-02	9.446E-02	1.118E+00	9.064E-02	9.063E-02

Estimated individual organ dose using the 2000 Land Use Census for the worst sector and existing pathway

1CP&L ANNUAL RADIOLOGICAL EFFLUENT REPORTING RUN DATE: 04/05/01
GASRPT RADIATION DOSES AT SELECTED LOCATIONS RUN TIME: 16:41:24

2000 SOURCE TERM (ELEVATED MODE) BSEP UNITS 1&2
SOURCE TERM (GROUND LEVEL) 2000 BSEP UNITS 1 AND 2
BRUNSWICK UNITS 1 AND 2, MIXED MODE CONTINUOUS GASEOUS RELEASES, 2000

	SPECIAL LOCATION	METERS	DIR	PL	GR	IN	V	CM	GM	M
#21	RESIDENCE	1609.0	SSE	1	1	1	0	0	0	0

ANNUAL BETA AIR DOSE = 1.122E-02 MILLRADS
ANNUAL GAMMA AIR DOSE = 9.239E-03 MILLRADS

	TOTAL BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
ADULT	9.045E-02	9.045E-02	6.228E-03	9.045E-02	9.045E-02	9.112E-02	9.056E-02	1.002E-01
PLUME	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.217E-03	1.579E-02
GROUND PLANE	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.414E-04
INHALATION	8.422E-02	8.422E-02	3.192E-06	8.423E-02	8.423E-02	8.490E-02	8.423E-02	8.422E-02
TEENAGER	9.098E-02	9.098E-02	6.229E-03	9.098E-02	9.099E-02	9.184E-02	9.110E-02	1.007E-01
PLUME	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.217E-03	1.579E-02
GROUND PLANE	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.414E-04
INHALATION	8.476E-02	8.476E-02	4.421E-06	8.476E-02	8.476E-02	8.562E-02	8.476E-02	8.476E-02
CHILD	8.117E-02	8.117E-02	6.231E-03	8.118E-02	8.118E-02	8.219E-02	8.129E-02	9.088E-02
PLUME	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.217E-03	1.579E-02
GROUND PLANE	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.414E-04
INHALATION	7.495E-02	7.495E-02	5.908E-06	7.495E-02	7.495E-02	7.597E-02	7.495E-02	7.495E-02
INFANT	4.932E-02	4.932E-02	6.229E-03	4.933E-02	4.933E-02	5.025E-02	4.944E-02	5.903E-02
PLUME	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.105E-03	6.217E-03	1.579E-02
GROUND PLANE	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.201E-04	1.414E-04
INHALATION	4.310E-02	4.310E-02	4.362E-06	4.310E-02	4.310E-02	4.403E-02	4.310E-02	4.310E-02

Maximum site boundary dose due to Iodines, Particulates, and Tritium for existing pathways

1CP&L ANNUAL RADIOLOGICAL EFFLUENT REPORTING RUN DATE: 04/05/01
GASRPT RADIATION DOSES AT SELECTED LOCATIONS RUN TIME: 16:47:27

2000 SOURCE TERM (ELEVATED MODE) BSEP UNITS 1&2
SOURCE TERM (GROUND LEVEL) 2000 BSEP UNITS 1 AND 2
BRUNSWICK UNITS 1 AND 2, MIXED MODE CONTINUOUS GASEOUS RELEASES, 2000

	SPECIAL LOCATION	METERS	DIR	PL	GR	IN	V	CM	GM	M
# 8	SITE BOUNDARY	1127.0	SSE	0	1	1	0	0	0	0

ANNUAL BETA AIR DOSE = 2.169E-02 MILLRADS
ANNUAL GAMMA AIR DOSE = 1.740E-02 MILLRADS

	TOTAL BODY	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
ADULT	1.593E-01	1.593E-01	1.710E-04	1.593E-01	1.593E-01	1.604E-01	1.593E-01	1.593E-01
GROUND PLANE	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.953E-04
INHALATION	1.591E-01	1.591E-01	5.090E-06	1.591E-01	1.591E-01	1.602E-01	1.591E-01	1.591E-01
TEENAGER	1.603E-01	1.603E-01	1.730E-04	1.603E-01	1.603E-01	1.617E-01	1.603E-01	1.603E-01
GROUND PLANE	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.953E-04
INHALATION	1.601E-01	1.601E-01	7.097E-06	1.601E-01	1.601E-01	1.615E-01	1.601E-01	1.601E-01
CHILD	1.417E-01	1.417E-01	1.754E-04	1.417E-01	1.418E-01	1.434E-01	1.418E-01	1.418E-01
GROUND PLANE	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.953E-04
INHALATION	1.416E-01	1.416E-01	9.553E-06	1.416E-01	1.416E-01	1.432E-01	1.416E-01	1.416E-01
INFANT	8.158E-02	8.158E-02	1.729E-04	8.158E-02	8.158E-02	8.308E-02	8.159E-02	8.161E-02
GROUND PLANE	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.659E-04	1.953E-04
INHALATION	8.141E-02	8.141E-02	7.062E-06	8.142E-02	8.142E-02	8.291E-02	8.142E-02	8.141E-02

ATTACHMENT 7 (cont.)

ENCLOSURE 3

2000 Dose Assessment Summary

I. Liquid Effluents:

Maximum Dose to Individual: (mrem)		Limit: (mrem)
Adult GI-LLI	3.66E-05	2.00E+01
Adult Total Body	3.04E-05	6.00E+00

Total Integrated and Recreation Population Dose: (person-rem)

Total Body	3.26E-03

II. Gaseous Effluents

Noble Gas Air Dose at Site Boundary: (mrad)		Limit: (mrad)
Gamma	1.74E-02	2.00E+01
Beta	2.17E-02	4.00E+01

Iodine-131, Iodine-133, Tritium and Particulates: (mrem) Limit: 3.00E+01

Maximum hypothetical dose at site boundary for all pathways (infant thyroid):	2.04E+00
Maximum hypothetical dose due to iodines, particulates, and tritium at 4.75 miles for the cow milk pathway per ODCM (infant thyroid):	7.58E-02
Estimated organ dose due to iodines, particulates, and tritium for existing pathways to maximum exposed individual (teen thyroid):	9.18E-02

Total 50 mile Annual Integrated Population Dose: (person-rem)

Thyroid:	7.15E-02
Total Body:	5.61E-02

ATTACHMENT 8

Off-Site Dose Calculation Manual (ODCM) and

Process Control Program (PCP) Revisions

January 1, through December 31, 2000

The PCP was not revised during the report period.

The ODCM was revised in August 2000 (Revision 25). The enhancements are as follows:

1. The entire document was converted from a text file to a WORD format and corrected for clerical and paginating errors. The list of effective pages denotes the entire document as Revision 25 with an effective date of 8/24/00.
2. Corrected an inconsistency in cfm and scfm for equation 3.1-13 (pg. 3-12) for determining total radioactivity concentration of noble gases.
3. Updated ODCM Table 3.2-2 to reflect the 2000 Land Use and Garden Census (pg. 3-31).
4. Corrected a typographical error found during an assessment on equation 3.3-17 (pg. 3-44) for determining compliance to 10CFR50 for the hypothetical pathway.
5. Clarified sections of Table 4.0-1 (pgs. 4-7 and 8) to more accurately reflect the Improved Technical Specification transfer to the ODCM.
6. Corrected Table 7.3.15-1 (pg. 7.3.15-8) to accurately denote the number of different fish and invertebrates' samples instead of the reference to location.
7. Updated Figure F-1 (pg F-2) for the liquid effluent system to denote the use of the Concentrated Waste Tank.

A complete copy of the ODCM is included. The specific content changes (items 2 through 7 listed above) have been annotated in the attached copy using revision bars located in the margin of the affected pages. The implementation and effective date of the ODCM are the same (e.g. 8/24/00).

ENCLOSURE 2

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 AND 50-324
LICENSE NOS. DPR-71 AND DPR-62

OFFSITE DOSE CALCULATION MANUAL
REVISION 25

BRUNSWICK STEAM ELECTRIC PLANT

OFF-SITE DOSE CALCULATION MANUAL

(ODCM)

REVISION 25

DOCKET NOS. 50-324
50-325

CAROLINA POWER & LIGHT COMPANY

Effective Date 8/24/00

Approved By: _____
PNSC

LIST OF EFFECTIVE PAGES
ODCM

Page(s)	Revision	Page(s)	Revision
i-xi	25	7.3.16-1 - 7.3.16-4	25
1-1	25	7.3.17-1	25
2-1 - 2-15	25	7.4.0-1 - 7.4.0-3	25
3-1 - 3-66	25	7.5.0-1	25
4-1 - 4-11	25	B 7.3.0-1 - B 7.3.0-10	25
5-1 - 5-2	25	B 7.3.1-1	25
6-1 - 6-4	25	B 7.3.2-1 - B 7.3.2-2	25
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7-i - 7-iv	25	B 7.3.4-1	25
7.1.1-1 - 7.1.1-5	25	B 7.3.5-1	25
7.1.2-1 - 7.1.2-3	25	B 7.3.6-1	25
7.1.3-1 - 7.1.3-12	25	B 7.3.7-1	25
7.1.4-1 - 7.1.4-5	25	B 7.3.8-1	25
7.2.0-1	25	B 7.3.9-1	25
7.3.0-1 - 7.3.0-4	25	B 7.3.10-1	25
7.3.1-1 - 7.3.1-7	25	B 7.3.11-1	25
7.3.2-1 - 7.3.2-12	25	B 7.3.12-1	25
7.3.3-1 - 7.3.3-8	25	B 7.3.13-1	25
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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, and 40CFR190 and to assure compliance with ODCM Specifications 7.3.3, 7.3.4, 7.3.5, 7.3.6, 7.3.7, 7.3.8, 7.3.9, 7.3.10, 7.3.11, 7.3.12, 7.3.13, 7.3.14, 7.3.15, 7.3.16, and 7.3.17.

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 the ODCM Specifications (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 radiation doses from radioactive liquid and gaseous effluents using LADTAP and GASPAR software and current meteorology obtained during 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 = Annual average 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 = Minimum acceptable dilution factor (DF_o) made conservative by a factor of 10 per Equation 2.1-2

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

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

d. Calculated concentration at unrestricted area:

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

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 dilution factor at the unrestricted area is less than or equal to 1, then 10CFR Part 20 limits have been met. The following equation must be true:

$$\Sigma_i\,(Conc_i/EC_i) \leq 1 \qquad \text{(Eq. 2.1-7)}$$

Where:

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

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

2. Postrelease

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

a. Actual concentration at unrestricted area:

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

Where:

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

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

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

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

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

Where:

n = Number of operating circulating water pumps

p = Number of operating service water pumps

RPF_{CW} = 1.357 E5 GPM

RPF_{SW} = 8 E3 GPM

t_k = Total release time, min

b. 10CFR Part 20 Postrelease Compliance Check:

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

$$\Sigma_i\,(Conc_{ik}/EC_i) \leq 1 \qquad \text{(Eq. 2.1-9)}$$

Where:

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

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

2.1.2 Continuous Releases

A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume or system that has an input flow during the continuous release. Planned continuous releases do not presently occur at BSEP, although the potential does exist in the service water system. Weekly tests are performed during system operation as specified in Table 7.3.3-1 of the BSEP ODCM Specifications. If a continuous release does occur, 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 again be less than 1.

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

$$\frac{\mu Ci / ml}{cps}$$

$$EF = (E_m)(C_f) \qquad \text{(Eq. 2.1-10)}$$

Where:

E_m = The detector efficiency (dpm/ml/cps) from the appropriate RST

C_f = Conversion factor, (1 μCi/2.22 x 10^6 dpm)

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

$$TLS = TL/EF + Bkg \qquad \text{(Eq. 2.1-11)}$$

Where:

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

= 5.0 x 10^{-6} μCi/ml

Bkg = Monitor background, (cps)

2.1.3 Stabilization Pond Releases

Prerelease and post-release compliance checks similar to those of Section 2.1.1 may be performed for releases from the stabilization pond. Prerelease calculations will be based on a gamma isotopic assay of a grab sample prior to release. Post-release calculations will be based on a composite sample that is collected in proportion to flow during the release period (if possible). 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.)

TABLE 2.1-1

ECs FOR SELECTED RADIONUCLIDES

Radionuclide	EC_i (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. Since only batch releases occur at BSEP, the equations in the following sections pertain only to batch releases. The dose contribution for all batch 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

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

Where:

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

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

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

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

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

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

2.2.2 Projection of Doses

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

The projection of doses for liquid effluents can be accomplished by projecting the dose(s) computed for the current month into the next month. The doses will be projected using Equation 2.2-1. 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.

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-01	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-01	0.00E-01	0.00E-01	1.89E 06
CR 51	0.00E-01	0.00E-01	5.58E 00	3.34E 00	1.23E 00	7.40E 00	1.40E 03
MN 54	0.00E-01	7.06E 03	1.35E 03	0.00E-01	2.10E 03	0.00E-01	2.16E 04
MN 56	0.00E-01	1.78E 02	3.15E 01	0.00E-01	2.26E 02	0.00E-01	5.67E 03
FE 55	5.11E 04	3.53E 04	8.23E 03	0.00E-01	0.00E-01	1.97E 04	2.03E 04
FE 59	8.06E 04	1.90E 05	7.27E 04	0.00E-01	0.00E-01	5.30E 04	6.32E 05
CO 57	0.00E-01	1.42E 02	2.36E 02	0.00E-01	0.00E-01	0.00E-01	3.59E 03
CO 58	0.00E-01	6.03E 02	1.35E 03	0.00E-01	0.00E-01	0.00E-01	1.22E 04
CO 60	0.00E-01	1.73E 03	3.82E 03	0.00E-01	0.00E-01	0.00E-01	3.25E 04
NI 63	4.96E 04	3.44E 03	1.67E 03	0.00E-01	0.00E-01	0.00E-01	7.18E 02
NI 65	2.02E 02	2.62E 01	1.20E 01	0.00E-01	0.00E-01	0.00E-01	6.65E 02
CU 64	0.00E-01	2.14E 02	1.01E 02	0.00E-01	5.40E 02	0.00E-01	1.83E 04
ZN 65	1.61E 05	5.13E 05	2.32E 05	0.00E-01	3.43E 05	0.00E-01	3.23E 05
ZN 69	3.43E 02	6.56E 02	4.56E 01	0.00E-01	4.26E 02	0.00E-01	9.85E 01
BR 83	0.00E-01	0.00E-01	7.25E-02	0.00E-01	0.00E-01	0.00E-01	1.04E-01
BR 84	0.00E-01	0.00E-01	9.39E-02	0.00E-01	0.00E-01	0.00E-01	7.37E-07
BR 85	0.00E-01	0.00E-01	3.86E-03	0.00E-01	0.00E-01	0.00E-01	1.80E-18
RB 86	0.00E-01	6.24E 02	2.91E 02	0.00E-01	0.00E-01	0.00E-01	1.23E 02
RB 88	0.00E-01	1.79E 00	9.49E-01	0.00E-01	0.00E-01	0.00E-01	2.47E-11
RB 89	0.00E-01	1.19E 00	8.34E-01	0.00E-01	0.00E-01	0.00E-01	6.89E-14
SR 89	4.99E 03	0.00E-01	1.43E 02	0.00E-01	0.00E-01	0.00E-01	8.00E 02
SR 90	1.23E 05	0.00E-01	3.01E 04	0.00E-01	0.00E-01	0.00E-01	3.55E 03
SR 91	9.18E 01	0.00E-01	3.71E 00	0.00E-01	0.00E-01	0.00E-01	4.37E 02
SR 92	3.48E 01	0.00E-01	1.51E 00	0.00E-01	0.00E-01	0.00E-01	6.90E 02
Y 90	6.06E 00	0.00E-01	1.63E-01	0.00E-01	0.00E-01	0.00E-01	6.42E 04
Y 91M	5.73E-02	0.00E-01	2.22E-03	0.00E-01	0.00E-01	0.00E-01	1.68E-01
Y 91	8.88E 01	0.00E-01	2.37E 00	0.00E-01	0.00E-01	0.00E-01	4.89E 04
Y 92	5.32E-01	0.00E-01	1.56E-02	0.00E-01	0.00E-01	0.00E-01	9.32E 03
Y 93	1.69E 00	0.00E-01	4.66E-02	0.00E-01	0.00E-01	0.00E-01	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-01	8.02E 00	0.00E-01	1.62E 04
ZR 97	8.81E-01	1.78E-01	8.13E-02	0.00E-01	2.68E-01	0.00E-01	5.51E 04
NB 95	4.47E 02	2.49E 02	1.34E 02	0.00E-01	2.46E 02	0.00E-01	1.51E 06
MO 99	0.00E-01	1.28E 02	2.43E 01	0.00E-01	2.89E 02	0.00E-01	2.96E 02
TC 99M	1.30E-02	3.66E-02	4.66E-01	0.00E-01	5.56E-01	1.79E-02	2.17E 01
TC 101	1.33E-02	1.92E-02	1.88E-01	0.00E-01	3.46E-01	9.81E-03	5.77E-14
RU 103	1.07E 02	0.00E-01	4.60E 01	0.00E-01	4.07E 02	0.00E-01	1.25E 04
RU 105	8.89E 00	0.00E-01	3.51E 00	0.00E-01	1.15E 02	0.00E-01	5.44E 03
RU 106	1.59E 03	0.00E-01	2.01E 02	0.00E-01	3.06E 03	0.00E-01	1.03E 05
AG 110M	1.56E 03	1.45E 03	8.60E 02	0.00E-01	2.85E 03	0.00E-01	5.91E 05
SN 113	2.18E 03	8.43E 01	2.05E 03	2.96E 01	6.16E 01	0.00E 01	3.80E 04
TE 125M	2.17E 02	7.86E 01	2.91E 01	6.52E 01	8.82E 02	0.00E-01	8.66E 02
TE 127M	5.48E 02	1.96E 02	6.68E 01	1.40E 02	2.23E 03	0.00E-01	1.84E 03
TE 127	8.90E 00	3.20E 00	1.93E 00	6.60E 00	3.63E 01	0.00E-01	7.03E 02
TE 129M	9.31E 02	3.47E 02	1.47E 02	3.20E 02	3.89E 03	0.00E-01	4.69E 03
TE 129	2.54E 00	9.55E-01	6.19E-01	1.95E 00	1.07E 01	0.00E-01	1.92E 00
TE 131M	1.40E 02	6.85E 01	5.71E 01	1.08E 02	6.94E 02	0.00E-01	6.80E 03
TE 131	1.59E 00	6.66E-01	5.03E-01	1.31E 00	6.99E 00	0.00E-01	2.26E-01
TE 132	2.04E 02	1.32E 02	1.24E 02	1.46E 02	1.27E 03	0.00E-01	6.24E 03
I 130	3.96E 01	1.17E 02	4.61E 01	9.91E 03	1.82E 02	0.00E-01	1.01E 02
I 131	2.18E 02	3.12E 02	1.79E 02	1.02E 05	5.35E 02	0.00E-01	8.23E 01
I 132	1.06E 01	2.85E 01	9.96E 00	9.96E 02	4.54E 01	0.00E-01	5.35E 00
I 133	7.45E 01	1.30E 02	3.95E 01	1.90E 04	2.26E 02	0.00E-01	1.16E 02
I 134	5.56E 00	1.51E 01	5.40E 00	2.62E 02	2.40E 01	0.00E-01	1.32E-02
I 135	2.32E 01	6.08E 01	2.24E 01	4.01E 03	9.75E 01	0.00E-01	6.87E 01
CS 134	6.84E 03	1.63E 04	1.33E 04	0.00E-01	5.27E 03	1.75E 03	2.85E 02
CS 136	7.16E 02	2.83E 03	2.04E 03	0.00E-01	1.57E 03	2.16E 02	3.21E 02
CS 137	8.77E 03	1.20E 04	7.85E 03	0.00E-01	4.07E 03	1.35E 03	2.32E 02
CS 138	6.07E 00	1.20E 01	5.94E 00	0.00E-01	8.81E 00	8.70E-01	5.12E-05
BA 139	7.85E 00	5.59E-03	2.30E-01	0.00E-01	5.23E-03	3.17E-03	1.39E 01
BA 140	1.64E 03	2.06E 00	1.08E 02	0.00E-01	7.02E-01	1.18E 00	3.38E 03
BA 141	3.81E 00	2.88E-03	1.29E-01	0.00E-01	2.68E-03	1.63E-03	1.80E-09
BA 142	1.72E 00	1.77E-03	1.08E-01	0.00E-01	1.50E-03	1.00E-03	2.43E-18
LA 140	1.57E 00	7.94E-01	2.10E-01	0.00E-01	0.00E-01	0.00E-01	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-01	0.00E-01	0.00E-01	2.68E 02
CE 141	3.43E 00	2.32E 00	2.63E-01	0.00E-01	1.08E 00	0.00E-01	8.86E 03
CE 143	6.04E-01	4.46E 02	4.94E-02	0.00E-01	1.97E-01	0.00E-01	1.67E 04
CE 144	1.79E 02	7.47E 01	9.59E 00	0.00E-01	4.43E 01	0.00E-01	6.04E 04
PR 143	5.79E 00	2.32E 00	2.87E-01	0.00E-01	1.34E 00	0.00E-01	2.54E 04
PR 144	1.90E-02	7.87E-03	9.64E-04	0.00E-01	4.44E-03	0.00E-01	2.73E-09
ND 147	3.96E 00	4.58E 00	2.74E-01	0.00E-01	2.68E 00	0.00E-01	2.20E 04
HF 181	1.72E 02	9.66E-01	1.94E 01	6.14E-01	8.08E-01	0.00E-01	1.27E 04
W 187	9.16E 00	7.66E 00	2.68E 00	0.00E-01	0.00E-01	0.00E-01	2.51E 03
NP 239	3.53E-02	3.47E-03	1.91E-03	0.00E-01	1.08E-02	0.00E-01	7.11E 02
AM 241	4.76E 05	4.44E 05	3.41E 04	0.00E-01	2.56E 05	0.00E 01	4.67E 04
F 18	6.66E 00	0.00E-01	7.38E-01	0.00E-01	0.00E-01	0.00E-01	1.97E-01
SB 124	2.76E 02	5.22E 00	1.09E 02	6.70E-01	0.00E-01	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 3.1-1):*

   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 3.1-1; Turbine Building Vent Release
      - Table 3.1-1; 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 3.1-1, Turbine Building Vent Release; Table 3.1-1, 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

= 7.50 E-6 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

= 2.0 E-7 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 3.1-2.

3. Determine Q_t based upon the skin exposure limit.

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

$L_i + 1.1M_i$ = The total skin dose factor due to emissions from noble gas radionuclide i (mrem/year/μCi/m^3) from Table 3.1-2.

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).

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

NOTE: Use the lower 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)

= 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).

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

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).

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

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

= 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

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 3.1-1):*

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 3.1-1; 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.

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

A_i = The radioactivity of noble gas radionuclide i in gaseous effluent from Table 3.1-1, 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.

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

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 3.1-2

3. Determine Q_t based upon the skin exposure limit.

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

$L_i \overline{(\chi / Q)_s} + 1.1 B_i$ = 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 3.1-2).

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).

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

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).

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

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

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

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

T_m = Fraction of the radioactivity from the site that may be released via the monitored pathway to ensure that the site boundary limit is not exceeded during simultaneous releases from several pathways

= 0.40 for the Stack Monitor

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

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

3.1.3 Condenser Air Ejector Monitor Alarm Setpoint

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

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

   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.

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 2558 MWt)				
Kr-83m	1.1E-3	8.28E-4	1.16E+3	8.3E-1	9.57E+2	2.84E-2
Kr-85m	1.9E-3	1.43E-3	2.00E+3	9.2E-1	1.85E+3	5.49E-2
Kr-85	6.0E-6	4.51E-6	6.31E+0	1.0E+0	6.31E+0	1.87E-4
Kr-87	6.6E-3	4.97E-3	6.94E+3	7.6E-1	5.28E+3	1.57E-1
Kr-88	6.6E-3	4.97E-3	6.94E+3	8.8E-1	6.14E+3	1.82E-1
Kr-89	4.1E-2	3.08E-2	4.31E+4	1.4E-3	5.99E+1	1.78E-3
Kr-90	9.0E-2	6.77E-2	9.46E+4	1.7E-17	1.64E-12	4.88E-17
Xe-131m	4.7E-6	3.54E-6	4.94E+0	1.0E+0	4.93E+0	1.47E-4
Xe-133m	9.0E-5	6.77E-5	9.46E+1	9.9E-1	9.40E+1	2.79E-3
Xe-133	2.6E-3	1.96E-3	2.73E+3	1.0E+0	2.73E+3	8.10E-2
Xe-135m	8.4E-3	6.32E-3	8.83E+3	2.6E-1	2.28E+3	6.78E-2
Xe-135	7.2E-3	5.42E-3	7.57E+3	9.6E-1	7.28E+3	2.16E-1
Xe-137	4.7E-2	3.54E-2	4.94E+4	4.4E-3	2.17E+2	6.44E-3
Xe-138	2.8E-2	2.11E-2	2.94E+4	2.3E-1	6.76E+3	2.01E-1
				TOTAL	3.37E+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; i.e.:

$$\text{*Steam Flow} = (11.088\ \text{E6 lbs/hr})\left(\frac{0.1260\text{gm/sec}}{\text{lbs/hr}}\right) = 1.40\text{E} + 6\ \text{gm/sec}$$

Nuclide	Fraction of Mix t = 30 min	Tech Spec (μCi/sec) t = 30 min	$_{e}$-λt t = 30 min	Tech Spec (μCi/sec) t = 0
Kr-83m	2.84E-2	6.92E+3	8.3E-1	8.37E+3
Kr-85m	5.49E-2	1.34E+4	9.2E-1	1.45E+4
Kr-85	1.87E-4	4.56E+1	1.0E+0	4.56E+1
Kr-87	1.57E-1	3.82E+4	7.6E-1	5.02E+4
Kr-88	1.82E-1	4.44E+4	8.8E-1	5.02E+4
Kr-89	1.78E-3	4.33 E+2	1.4E-3	3.12E+5
Kr-90	4.88E-17	1.19E-11	1.7E-17	6.85E+5
Xe-131m	1.47E-4	3.57E+1	1.0E+0	3.58E+1
Xe-133m	2.79E-3	6.80E+2	9.9E-1	6.85E+2
Xe-133	8.10E-2	1.97E+4	1.0E+0	1.98E+4
Xe-135m	6.78E-2	1.65E+4	2.6E-1	6.39E+4
Xe-135	2.16E-1	5.27E+4	9.6E-1	5.48E+4
Xe-137	6.44E-3	1.57E+3	4.4E-3	3.58E+5
Xe-138	2.01E-1	4.89E+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

= 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 3.1-1

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	*	-	*	-	3.2E+4	2.78E-2
Kr-85m	6.8E+1	1.97E-2	6.0E0	1.73E-2	6.2E+4	5.40E-2
Kr-85	*	-	*	-	2.1E+2	1.83E-4
Kr-87	1.9E+2	5.51E-2	6.0E0	1.73E-2	1.8E+5	1.57E-1
Kr-88	2.3E+2	6.67E-2	6.0E0	1.73E-2	2.1E+5	1.83E-1
Kr-89	*	-	*	-	3.0E+3	2.61E-3
Xe-131m	*	-	*	-	1.7E+2	1.48E-4
Xe-133m	*	-	*	-	3.2E+3	2.78E-3
Xe-133	2.8E+2	8.12E-2	1.3E+2	3.75E-1	9.4E+4	8.18E-2
Xe-135m	6.5E+2	1.88E-1	9.2E+1	2.65E-1	7.6E+4	6.61E-2
Xe-135	6.3E+2	1.83E-1	6.8E+1	1.96E-1	2.5E+5	2.18E-1
Xe-137	*	-	*	-	8.6E+3	7.48E-3
Xe-138	1.4E+3	4.06E-1	1.4E+1	4.03E-2	2.3E+5	2.00E-1
Ar-41	*	-	2.5E+1	7.20E-2	*	-
TOTAL	3.45E+3		3.47E+2		1.15E6	

* < 1.0E-1

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

TABLE 3.1-2

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	2.93E-9	6.57E-7
Kr-85m	1.17E+3	2.81E+3	1.22E-4	2.36E-4
Kr-85	1.61E+1	1.36E+3	1.74E-6	3.64E-5
Kr-87	5.92E+3	1.65E+4	5.39E-4	1.14E-3
Kr-88	1.47E+4	1.91E+4	1.36E-3	2.31E-3
Kr-89	1.66E+4	2.91E+4	9.47E-4	1.81E-3
Xe-131m	9.15E+1	6.48E+2	2.96E-5	6.39E-5
Xe-133m	2.51E+2	1.35E+3	2.23E-5	6.58E-5
Xe-133	2.94E+2	6.94E+2	2.40E-5	4.95E-5
Xe-135m	3.12E+3	4.41E+3	2.94E-4	5.08E-4
Xe-135	1.81E+3	3.97E+3	1.92E-4	3.64E-4
Xe-137	1.42E+3	1.39E+4	8.47E-5	4.46E-4
Xe-138	8.83E+3	1.43E+4	8.60E-4	1.52E-3
Ar-41	8.84E+3	1.29E+4	1.01E-3	1.73E-3

3.2 COMPLIANCE WITH 10CFR20 (GASEOUS)

3.2.1 Noble Gases

The gaseous effluent monitors' setpoints are utilized to show compliance with 10CFR20 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 10CFR20 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 10CFR20.

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 10CFR20.

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

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

where:

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

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

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

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

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 $\mu Ci/sec$

1.1 = The ratio of the tissue to air absorption coefficients over the energy range of the photon of interest, mrem/mrad

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

$\dot{Q}_{i_v}$ = 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 10CFR20, Expressions 3.2-1 and 3.2-2 are now in terms of the actual release points for BSEP.

For the total body dose:

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

*Any effluents due to exfiltration from planned openings in the Turbine Building, Radwaste Building or AOG Building are combined with the Turbine Building's vent releases.

For the skin dose:

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

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 10CFR20 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 NE site boundary.

For the total body:

$$\Sigma_i V_i \dot{Q}_{i_s} + \Sigma_i K_i \left(2.0 \times 10^{-7} \dot{Q}_{i_{rb}} + 2.9 \times 10^{-6} \dot{Q}_{i_{tb}}\right) \leq 500 \text{ mrem/yr} \quad (3.2\text{-}5)$$

For the skin:

$$\Sigma_i \left(2.5 \times 10^{-8} L_i + 1.1 B_i\right) \dot{Q}_{i_s} + \Sigma_i \left[\left(L_i + 1.1 M_i\right) \left(2.0 \times 10^{-7} \dot{Q}_{i_{rb}} + 2.9 \times 10^{-6} \dot{Q}_{i_{tb}}\right)\right] \leq 3000 \text{ mrem/yr} \quad (3.2\text{-}6)$$

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 NE 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 10CFR20, 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

$$= \frac{260 \text{ mrad (radians)}(m^3)(\text{transformation})}{\text{sec(Mev)(Ci)}} \times \frac{16 \text{ sectors}}{2\pi \text{ radians}} \times \frac{10^{-6} \text{ Ci}}{\mu\text{Ci}} \times \frac{3.15 \times 10^7 \text{ sec}}{\text{yr}}$$

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

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_l, meters^{-1}

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

$$V_i = 1.1\, K / r_d \; \Sigma_j \Sigma_k \Sigma_l \; \frac{f_{jk}\; A_{li}\; \mu_a\; E_l |\, e^{-\mu\; T^{Td}}}{\mu_j} \qquad (3.2\text{-}8)$$

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 10CFR20.

$$\Sigma_i P_i (W_s \dot{Q}_{i_s} + W_v \dot{Q}_{i_v}) \leq 1500 \text{ mrem/yr} \quad (3.2\text{-}9)$$

Where:

P_i = Dose parameter for radioiodines and particulates with half-lives greater than 8 days based upon the critical organ and the most restrictive age group (infant)

= mrem/year per $\mu Ci/m^3$ for inhalation pathways and for tritium

= mrem/year per $\mu Ci/sec$ per m^{-2} for food and ground plane pathways

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

$\dot{Q}_{i_v}$ = The release rate of radionuclide i in gaseous effluents from all vents releases, $\mu Ci/sec$

W_v = The highest calculated annual average dispersion parameter for estimating the dose to an individual at the controlling location due to all vent releases

= sec/m^3 for the inhalation pathway

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

*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_s = The highest calculated annual average dispersion parameter for estimating the dose to an individual at the controlling location due to stack releases

= sec/m^3 for the inhalation pathway

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

Radioiodines, particulates, and tritium may be released from the stack, Reactor Buildings, and Turbine Buildings at BSEP. Radioiodines and particulates may also be released from other sources such as decontamination operations and burning of waste oil in the incinerator. Effluents from the decontamination facilities in the Radioactive Materials Container and Storage Building and hot shop, incinerator and any building exfiltration are combined with the Turbine Building's vent releases. To show compliance with 10CFR20, (see Appendix H for waste oil) Expression 3.2-9 is modified to incorporate the various release points for BSEP:

$$\Sigma_i P_i (W_s \dot{Q}_{i_s} + W_{rb} \dot{Q}_{i_{rb}} + W_{tb} \dot{Q}_{i_{tb}}) \leq 1500 \text{ mrem/yr} \qquad (3.2\text{-}10)$$

Where:

W_s = The annual average dispersion parameter for the stack

W_{rb} = The annual average dispersion parameter for the Reactor Buildings

W_{tb} = Annual average dispersion parameter for the Turbine Buildings

$\dot{Q}_{i_{rb}}$ = 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

$\dot{Q}_{i_s}$ = Release of radionuclide i from the stack, μCi/sec

All other terms are the same as those defined previously.

In the calculation to show compliance with 10CFR20, only the inhalation, ground plane, cow milk, and goat milk pathways are considered for BSEP. In determining the dose at a particular location, W is a function of pathway. For the food and ground plane pathways, W is in terms of D/Q (i.e., deposition). If the inhalation pathway is considered, W is in terms of χ/Q. Incorporation of the various pathways into Expression 3.2-10 results in the following:

$$\Sigma_i P_{i_I} \left[\overline{(\chi/Q)_s}\, \dot{Q}_{i_s} + \overline{(\chi/Q)_{rb}}\, \dot{Q}_{i_{rb}} + \overline{(\chi/Q)_{tb}}\, \dot{Q}_{i_{tb}} \right] + \Sigma_i (P_{i_G} + P_{i_M}) \qquad (3.2\text{-}11)$$

$$\left[\overline{(D/Q)_s}\, \dot{Q}_{i_s} + \overline{(D/Q)_{rb}}\, \dot{Q}_{i_{rb}} + \overline{(D/Q)_{tb}}\, \dot{Q}_{i_{tb}} \right] \leq 1500 \text{ mrem/yr}$$

Where:

P_{i_I} = Dose parameter for radionuclide i for the inhalation pathway, mrem/year per μCi/sec^3

P_{i_G} = Dose parameter for radionuclide i for the ground plane pathway, mrem/year per μCi/sec per m^{-2}

P_{i_M} = Dose parameter for radionuclide i for either the cow milk or goat milk pathway, mrem/year per μCi/sec per m^{-2}

$\overline{(\chi/Q)_{rb}}$ = 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, sec/m^3

$\overline{(\chi/Q)_s}$ = Annual average relative concentrations for releases from the stack, sec/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, m^{-2}

$\overline{(D/Q)_{s}}$ = Annual average deposition for releases from the stack, m^{-2}

In the case of tritium, the W parameter for the food pathway (cow or goat milk) is based upon χ/Q. Since tritium is a weak beta emitter, the ground plane contribution is zero for tritium. Therefore, the left-hand side of Expression 3.2-10 can be written as the following:

For tritium:

$$\dot{D}_T = \left(P_{T_I} + P_{T_M}\right)\left[\overline{(\chi/Q)_s}\,\dot{Q}_{T_s} + \overline{(\chi/Q)_{rb}}\,\dot{Q}_{T_{rb}} + \overline{(\chi/Q)_{tb}}\,\dot{Q}_{T_{tb}}\right] \quad (3.2\text{-}12)$$

Where:

$\dot{D}_T$ = Dose rate due to tritium releases, mrem/year

P_{T_I} = Dose parameter for tritium for the inhalation pathway, mrem/year per $\mu Ci/m^3$

P_{T_M} = Dose parameter for tritium for the milk pathway, mrem/year per $\mu Ci/m^3$

$\dot{Q}_{T_s}$ = Release rate of tritium from the stack, $\mu Ci/sec$

$\dot{Q}_{T_{rb}}$ = Release rate of tritium from the two Reactor Buildings, $\mu Ci/sec$

$\dot{Q}_{T_{tb}}$ = Release rate of tritium from the two Turbine Buildings, $\mu Ci/sec$

Since P_{i_I} for tritium equals 647 and P_{i_M} equals 2380, Equation 3.2-12 reduces to:

$$\dot{D}_T = 3.0 \times 10^3 \left[\overline{(\chi/Q)_s}\, \dot{Q}_{T_s} + \overline{(\chi/Q)_{rb}}\, \dot{Q}_{T_{rb}} + \overline{(\chi/Q)_{tb}}\, \dot{Q}_{T_{tb}} \right] \quad (3.2\text{-}13)$$

To show compliance with 10CFR20, Expressions 3.2-11 and 3.2-13 are evaluated first at the limiting site boundary. It should be noted that the sum of the dose rates from radioiodines and particulates and from tritium must be summed and their combined dose rates be less than 1500 mrem/year to show compliance with 10CFR20. If the 1500 mrem/year limit is exceeded at the limiting site boundary when all pathways are considered present at the site boundary but the inhalation pathway contributes less than 1500 mrem/year, then Expressions 3.2-11 and 3.2-13 are evaluated at the limiting real pathway location. The limiting site boundary location is 0.7 miles NE. Expression 3.2-11 becomes:

For radioiodines and particulates:

$$\Sigma_i P_{i_I} (2.5 \times 10^{-8}\ \dot{Q}_{i_s} + 2.0 \times 10^{-7}\ \dot{Q}_{i_{rb}} + 2.9 \times 10^{-6}\ \dot{Q}_{i_{tb}}) +$$

$$\Sigma_i (P_{i_G} + P_{i_M}) (1.4 \times 10^{-9}\ \dot{Q}_{i_s} + 4.3 \times 10^{-9}\ \dot{Q}_{i_{rb}} + 1.9 \times 10^{-8}\ \dot{Q}_{i_{tb}}) \leq 1500 \text{ mrem/yr} \quad (3.2\text{-}14)$$

For BSEP, the limiting "hypothetical" real pathway location is the cow milk pathway 4.75 miles NE. At this location, Expression 3.2-11 becomes:

$$\Sigma_i P_{i_I} (2.4 \times 10^{-8}\ \dot{Q}_{i_s} + 4.1 \times 10^{-8}\ \dot{Q}_{i_{rb}} + 1.4 \times 10^{-7}\ \dot{Q}_{i_{tb}}) + \Sigma_i (P_{i_G} + P_{i_M})$$

$$(2.2 \times 10^{-10}\ \dot{Q}_{i_s} + 2.7 \times 10^{-10}\ \dot{Q}_{i_{rb}} + 5.7 \times 10^{-10}\ \dot{Q}_{i_{tb}}) \leq 1500 \text{ mrem/yr} \quad (3.2\text{-}15)$$

For tritium, at the limiting site boundary, Equation 3.2-13 becomes:

For tritium:

$$\dot{D}_T = 3.0 \times 10^3 \left(2.5 \times 10^{-8} \dot{Q}_{T_s} + 2.0 \times 10^{-7} \dot{Q}_{T_{rb}} + 2.9 \times 10^{-6} \dot{Q}_{T_{tb}}\right) \quad (3.2\text{-}16)$$

At the "hypothetical" limiting real pathway location, Equation 3.2-13 becomes:

For tritium:

$$\dot{D}_T = 3.0 \times 10^3 \left(2.4 \times 10^{-8} \dot{Q}_{T_s} + 4.1 \times 10^{-8} \dot{Q}_{T_{rb}} + 1.4 \times 10^{-7} \dot{Q}_{T_{tb}}\right) \quad (3.2\text{-}17)$$

The determination of controlling location for implementation of 10CFR20 for radioiodines and particulates is a function of the same two parameters as for noble gases plus a third receptor pathway location. The radionuclide mix was again based upon the source terms calculated using the GALE code. The mix and the source terms are presented in Table 3.2-1 as a function of release point.

In the determination of the controlling site boundary location, the highest two or three site boundary χ/Q and D/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 values for χ/Q and D/Q for the NE sector at the site boundary make it the dominant meteorological sector and the control location.

In the determination of receptor controlling location, the highest two or three D/Q values from each release point to the pathway locations of Table 3.2-2 are utilized in conjunction with the radionuclide mix and release rate for each release point. For BSEP, the controlling location is a hypothetical cow milk pathway 4.75 miles NE of the Reactor Building and Turbine Buildings.

Values for P_i were calculated for an infant for various radionuclides for the inhalation, ground plane, cow milk, and goat milk pathways using the methodology of NUREG 0133. The P_i values are presented in Table 3.2-5. The values of P_i reflect, for each radionuclide, the maximum organ dose factor for each individual pathway of exposure. Because the goat milk pathway is not present at BSEP, the cow milk pathway P_i values were utilized in the determination of the various controlling locations. For the case of an infant being present at the site boundary or at the real pathway location, the ground plane pathway is not considered as a reasonable exposure pathway for the infant (i.e., $P_G = 0$). However, P_i values are presented in Table 3.2-5 for completeness. Appendix C presents the methodology which was utilized in calculating P_i values.

Annual average D/Q values at the special locations for the stack, Reactor Building, and Turbine Building release points, respectively, which were utilized in Expressions 3.2-14 through 3.2-17 were obtained from the tables presented in Appendix A. The X/Q values in Expressions 3.2-14 through 3.2-17 were also obtained from the tables presented in Appendix A. D/Q values at the limiting site boundary location and the limiting real pathway location for releases from the Turbine Buildings, the Reactor Buildings, and the stack were obtained from Tables A-3, A-9, and A-15, respectively, of Appendix A. X/Q values at these same locations 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 X/Q and D/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	0	3.2E4
Kr-85m	6.8E1	6.0E0	6.2E4
Kr-85	0	0	2.1E2
Kr-87	1.9E2	6.0E0	1.8E5
Kr-88	2.3E2	6.0E0	2.1E5
Kr-89	0	0	3.0E3
Xe-131m	0	0	1.7E2
Xe-133m	0	0	3.2E3
Xe-133	2.8E2	1.3E2	9.4E4
Xe-135m	6.5E2	9.2E1	7.6E4
Xe-135	6.3E2	6.8E1	2.5E5
Xe-137	0	0	8.6E3
Xe-138	1.4E3	1.4E1	2.3E5
Ar-41	0	2.5E1	0
I-131	1.9E-2	3.4E-1	5.1
I-133	7.6E-2	1.4	2.1E1
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	0	9.5
H-3	0	3.0E1	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	1.2
NE	0.7	4.75*	-	-	-	-
ENE	0.7	-	-	-	-	-
E	0.7	-	-	-	-	-
ESE	0.7	-	-	-	1.5	-
SE	0.7	-	-	-	0.9	-
SSE	0.7	-	-	-	1.0	-
S	0.8	-	-	-	1.1	1.9
SSW	0.8	-	-	-	1.2	1.5
SW	0.7	-	-	-	1.0	2.9
WSW	0.7	-	-	-	1.2	1.2
W	0.7	-	-	-	0.8	1.1
WNW	0.6	-	-	-	0.8	1.0
NW	0.6	-	-	-	0.9	4.8
NNW	0.6	-	-	-	0.8	4.4
N	0.7	-	-	-	0.7	0.9

*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 $\mu Ci/m^3$)	Skin Dose Factor L_i (mrem/yr per $\mu Ci/m^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu Ci/m^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu Ci/m^3$)
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 AN INFANT FOR THE
BRUNSWICK STEAM ELECTRIC PLANT*

Isotope	Inhalation	Ground Plane	Cow Milk	Goat Milk
H-3	6.47E2	0	2.38E3	4.86E3
P-32	2.03E6	0	1.60E11	1.93E11
Cr-51	1.28E4	6.67E6	4.79E6	5.65E5
Mn-54	1.00E6	1.09E9	3.89E7	4.68E6
Fe-59	1.02E6	3.92E8	3.93E8	5.11E6
Co-58	7.77E5	5.29E8	6.06E7	7.28E6
Co-60	4.51E6	4.40E9	2.10E8	2.52E7
Zn-65	6.47E5	6.89E8	1.90E10	2.29E9
Rb-86	1.90E5	1.28E7	2.22E10	2.67E9
Sr-89	2.03E6	3.16E4	1.27E10	2.66E10
Sr-90	4.09E7	-	1.21E11	2.55E11
Y-91	2.45E6	1.52E6	5.26E6	6.32E5
Zr-95	1.75E6	3.48E8	8.28E5	9.95E4
Nb-95	4.79E5	1.95E8	2.06E8	2.48E7
Ru-103	5.52E5	1.55E8	1.05E5	1.27E4
Ru-106	1.16E7	2.99E8	1.44E6	1.73E5
Ag-110m	3.67E6	3.14E9	1.46E10	1.75E9
Sn-113	2.30E5	5.19E7	2.25E7	2.25E6
Te-127m	1.31E6	1.18E5	1.04E9	1.24E8
Te-129m	1.68E6	2.86E7	1.40E9	1.68E8
Cs-134	7.03E5	2.81E9	6.79E10	2.04E11
Cs-136	1.35E5	2.13E8	5.76E9	1.73E10
Cs-137	6.12E5	1.15E9	6.02E10	1.81E11
Ba-140	1.60E6	2.94E7	2.41E8	2.89E7
Ce-141	5.17E5	1.98E7	1.37E7	1.65E6
Ce-144	9.84E6	5.84E7	1.33E8	1.60E7
I-131	1.48E7	2.46E7	1.06E12	1.27E12
I-132	1.69E5	1.78E6	1.39E2	1.64E2
I-133	3.56E6	3.54E6	9.80E9	1.18E10
I-135	6.96E5	3.67E6	2.27E7	2.68E7
Hf-181	6.73E5	4.02E8	6.55E5	7.86E4
Am-241	4.41E5	4.96E7	6.01E7	7.21E6

*Units are mrem/yr per $\mu Ci/m^3$ for H-3 and the inhalation pathway and mrem/yr per $\mu Ci/sec$ per m^{-2} for the food and ground plane pathways.