Exelon Generation.

James A. FitzPatrick NPP
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Richard M. Sullivan
Regulatory Assurance Manager

JAFP-21-0033
April 30, 2021

United States Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

James A. FitzPatrick Nuclear Power Plant
Renewed Facility Operating License No. DPR-59
NRC Docket No. 50-333

Subject: 2020 Annual Radioactive Effluent Release Report

Dear Sir or Madam:

This letter transmits the James A. FitzPatrick Nuclear Power Plant's (JAF) Annual Radioactive Effluent Release Report for the period of January 1, 2020 through December 31, 2020. The enclosure is submitted in accordance with 10 CFR 50.36a and the Reporting Requirements of Technical Specifications Section 5.6.3 and Technical Requirements Manual Appendix H, Offsite Dose Calculation Manual (ODCM), Part 1 Section 6.2, Radioactive Effluent Release Report.

This report (Enclosure 1) includes, as an Addendum, an Assessment of the Radiation Doses to the Public due to the radioactive liquid and gaseous effluents released during the 2020 calendar year. The format used for the effluent data is outlined in Appendix B of Regulatory Guide 1.21, Revision 1. Distribution is in accordance with Regulatory Guide 10.1, Revision 4.

Included in Enclosure 2 is the current revision of the ODCM revision 1, Parts 1 and 2.

There are no new regulatory commitments contained in this letter. If you have any questions concerning the enclosed report, please contact Mr. David Mayer, Chemistry Manager, at (315) 349-6499.

Sincerely,

Sullivan,
Richard M

Digitally signed by Sullivan, Richard M
DN: cn=Sullivan, Richard M
Date: 2021.04.30 06:45:15 -04'00'

Richard M.Sullivan
Regulatory Assurance Manager

WCD/DM/mh

Enclosure 1: Annual Radioactive Effluent Release Report, January 1 – December 31, 2020
Enclosure 2: Offsite Dose Calculation Manual (ODCM) Revision 1, Part 1 and 2

cc: next page

cc:
NRC Regional Administrator, Region I
NRC Resident Inspector
NRC Project Manager

Supervisor, Town of Scriba
Route 8, Box 382
Oswego, NY 13126

JAFP-21-0033

Enclosure 1

Annual Radioactive Effluent Release Report

January 1, 2020 – December 31, 2020

(35 Pages)

EXELON FITZPATRICK, LLC

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

JANUARY 1, 2020 - DECEMBER 31, 2020

DOCKET NO. 50-333

LICENSE NO. DPR-59

EXELON FITZPATRICK, LLC
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
JANUARY 2020 - DECEMBER 2020
SUPPLEMENTAL INFORMATION

FACILITY: JAFNPP **LICENSEE: EXELON FITZPATRICK, LLC**

1. Offsite Dose Calculation Manual Part 1 Radiological Effluent Controls

a. Fission and Activation Gases:

(1) The dose rate at or beyond the site boundary due to radioactive materials released from the plant in gaseous effluent shall be limited as follows:

(a) Less than or equal to 500 mrem/year to the whole body and less than or equal to 3000 mrem/year to the skin from noble gases.

(2) The air dose to areas at or beyond the site boundary from noble gases released from the plant in gaseous effluent shall be limited:

(a) During any calendar quarter, to less than or equal to 5 mrad from gamma radiation, and less than or equal to 10 mrad from beta radiation; and,

(b) During any calendar year, to less than or equal to 10 mrad from gamma radiation and less than or equal to 20 mrad from beta radiation.

b. Tritium, Iodines and Particulates, Half Lives > 8 days:

(1) The dose to a member of the public at or beyond the site boundary from Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days released from the plant in gaseous effluent shall be limited:

(a) During any calendar quarter to less than or equal to 7.5 mrem to any organ; and,

(b) During any calendar year to less than or equal to 15 mrem to any organ.

(c) Less than 0.1% of the limits of ODCM Part 1, Section 3.4 Specification 3.4.1.1 and 3.4.1.2 as a result of burning contaminated oil.

(2) The dose rate at or beyond the site boundary due to radioactive materials released from the plant in gaseous effluents shall be limited as follows:

(a) Less than or equal to 1500 mrem/year to any organ from Iodine-131, Iodine-133, Tritium and for radioactive materials in particulate form with half-lives greater than 8 days (inhalation pathway only).

c. Liquid Effluents:

(1) The concentration of radioactive materials released to the unrestricted areas shall not exceed ten times the values specified in 10 CFR 20.1001-20.2402, Appendix B, Table 2, column 2. For dissolved or entrained noble gases the concentration shall be limited to 2.00E-04 µCi/ml.

(2) The dose to a member of the public from radioactive materials released from the plant in liquid effluents to unrestricted areas shall be limited as follows:

(a) During any calendar quarter, limited to less than or equal to 1.5 mrem to the whole body and to less than or equal to 5 mrem to any organ; and,

(b) During any calendar year, limited to less than or equal to 3 mrem to the whole body and to less than or equal to 10 mrem to any organ.

2. 10X Effluent Concentrations

a. Fission and activation gases: (None specified)

b. Iodines: (None specified)

c. Particulates, half-lives >8 days: (None specified)

d. Liquid effluents:	Quarter 1	Quarter 2	Quarter 3	Quarter 4
(1) Fission and activation products (mixture EC) (µCi/ml)	None	None	None	None
(2) Tritium (µCi/ml)	1.00E-02	1.00E-02	1.00E-02	1.00E-02
(3) Dissolved and entrained gases (µCi/ml)	2.00E-04	2.00E-04	2.00E-04	2.00E-04

SUPPLEMENTAL INFORMATION (continued)

3. Average Energy (None specified)

4. Measurements and Approximations of Total Radioactivity

a. Fission and Activation Gases: Continuous monitor on each release path calibrated to a marinelli grab sample analyzed by gamma spectroscopy; bubbler grab sample analyzed for Tritium.

b. Iodines: Gamma spectral analysis of charcoal cartridge and particulate filter on each release path.

c. Particulates: Gamma spectral analysis of each particulate filter and charcoal cartridge for each release path. A four week per quarter composite of particulate filters for each release path for Strontium-89 and Strontium-90. One week per month particulate filter for each release path for gross alpha.

d. Liquid Effluents: Gamma spectral analysis of each batch discharged, except composite analysis for Strontium-89, Strontium-90, Iron-55, Tritium, and Alpha.

e. Solid Waste: Gamma spectral analysis of a representative sample of each waste shipment. Scaling factors established from offsite composite sample analyses to estimate concentration of non-gamma emitters. Low activity trash shipments curie content is estimated by dose rate measurement and application of appropriate scaling factors.

f. Error Estimation Method: Overall error for sampling and analysis estimated by combining individual errors using error propagation methods. This process is composed of determinate and undeterminate errors.

Determinate - Pump flowrates, volume measurements and analysis collection yields
Undeterminate - Random counting error estimated using accepted statistical calculations

SUPPLEMENTAL INFORMATION (continued)

5. Batch Releases

a. Liquid: Canal

Liquid: Canal	Quarter 1	Quarter 2	Quarter 3	Quarter 4
(1) Number of batch releases:	0.00E+00	1.00E+00	2.00E+00	3.00E+00
(2) Total time period for batch release: (min)	0.00E+00	2.00E+00	3.80E+01	2.05E+02
(3) Maximum time period for batch release: (min)	0.00E+00	2.00E+00	2.00E+01	1.10E+02
(4) Average time period for batch release: (min)	0.00E+00	2.00E+00	1.90E+01	6.83E+01
(5) Minimum time period for batch release: (min)	0.00E+00	2.00E+00	1.80E+01	8.00E+00
(6) Total Activity Released (Ci)	0.00E+00	2.32E-04	7.06E-04	9.24E-02
(7) Total Volume Released (liters)	0.00E+00	6.51E+02	1.40E+04	4.21E+04

b. Liquid: Non-Canal

Liquid: Non-Canal	Quarter 1	Quarter 2	Quarter 3	Quarter 4
(1) Number of batch releases:	1.90E+01	2.60E+01	6.90E+01	1.30E+01
(2) Total time period for batch release: (min)	1.54E+03	5.81E+02	1.25E+03	1.67E+03
(3) Maximum time period for batch release: (min)	3.35E+02	1.04E+02	3.35E+02	4.87E+02
(4) Average time period for batch release: (min)	8.09E+01	2.23E+01	1.81E+01	1.28E+02
(5) Minimum time period for batch release: (min)	1.20E+00	2.40E+00	1.20E+00	1.8E+00
(6) Total Activity Released (Ci)	0.00E+00	6.65E-04	7.02E-04	1.49E-03
(7) Total Volume Released (liters)	5.82E+05	2.20E+05	4.85E+05	6.30E+05

c. Gaseous

There were no gaseous batch releases for this report.

SUPPLEMENTAL INFORMATION (continued)

6. Continuous Releases

a. Liquid: Non-Canal	Quarter 1	Quarter 2	Quarter 3	Quarter 4
(1) Number of releases:	1.20E+01	1.30E+01	1.30E+01	1.90E+01
(2) Total Activity Released (Ci)	5.43E-03	7.56E-03	9.95E-03	1.22E-02
(3) Total Volume Released (liters)	3.88E+06	4.79E+06	2.82E+06	5.22E+06

b. Liquid: Canal	Quarter 1	Quarter 2	Quarter 3	Quarter 4
(1) Number of releases:	0	0	0	0
(2) Total Activity Released (Ci)	N/A	N/A	N/A	N/A

7.

CHANGES TO THE OFFSITE DOSE CALCULATION MANUAL (ODCM)

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls (REC) Section 6.2.3, changes made to the Offsite Dose Calculation Manual (ODCM) during the reporting period shall be included in the Annual Radioactive Effluent Release Report.

The latest revision of the ODCM became effective during calendar year 2020. A copy of this revision is attached. The changes to the ODCM in 2020 are for formatting to Exelon procedure format. Procedure CY-JF-170-301 Revision (1).

Revisions made to the ODCM are listed on pages 2-4.

CY-JF-170-301, Rev
001, OFFSITE DOSE

TABLE 1A
GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QTR 1	QTR 2	QTR 3	QTR 4	EST TOTAL ERROR %
A. FISSION AND ACTIVATION GASES						
1. Total Release	Ci	4.19E+01	1.39E+01	2.62E+01	1.91E+01	≤2.50E+01
2. Average release rate for period	µCi/sec	5.33E+00	1.77E+00	3.30E+00	2.40E+00	
3. Percentage ODCM Limit	%	*	*	*	*	
B. IODINE-131						
1. Total Iodine-131	Ci	2.67E-04	1.18E-04	1.42E-04	8.01E-05	≤2.50E+01
2. Average release rate for period	µCi/sec	3.43E-05	1.50E-05	1.79E-05	1.04E-05	
3. Percentage ODCM Limit	%	*	*	*	*	
C. PARTICULATES						
1. Particulates with half-lives >8 days	Ci	5.04E-06	2.43E-06	1.00E-04	7.94E-06	≤3.60E+01
2. Average release rate for period	µCi/sec	6.41E-07	3.09E-07	1.26E-05	9.98E-07	
3. Percentage ODCM Limit	%	*	*	*	*	
4. Gross alpha radioactivity	Ci	4.69E-07	2.81E-07	2.65E-07	7.90E-06	≤2.50E+01
D. TRITIUM						
1. Total Release	Ci	2.13E+00	4.91E+00	5.94E+00	1.31E+00	≤2.50E+01
2. Average release rate for period	µCi/sec	2.71E-01	6.24E-01	7.48E-01	1.65E-01	
3. Percentage ODCM Limit	%	*	*	*	*	

E. CARBON-14 (See Attachment 8)

***F. PERCENT OF APPLICABLE ODCM LIMITS**

FISSION AND ACTIVATION GASES	UNIT	QTR 1	QTR 2	QTR 3	QTR 4
1. Quarterly gamma air dose limit	%	2.31E-02	9.13E-03	1.61E-02	1.22E-02
2. Quarterly beta air dose limit	%	1.71E-03	3.73E-04	8.02E-04	5.75E-04
3. Yearly gamma air dose limit	%	1.15E-02	1.61E-02	2.41E-02	3.03E-02
4. Yearly beta air dose limit	%	8.53E-04	1.04E-03	1.44E-03	1.73E-03
5. Whole body dose rate limit	%	8.85E-04	3.52E-04	6.14E-04	4.69E-04
6. Skin dose rate limit	%	1.91E-04	7.17E-05	1.27E-04	9.71E-05
HALOGENS, TRITIUM AND PARTICULATES WITH HALF-LIVES >8 DAYS					
7. Quarterly dose limit (organ)	%	2.27E-02	2.37E-02	5.48E-03	5.68E-03
8. Yearly dose limit (organ)	%	1.13E-02	2.32E-02	4.97E-03	4.14E-02
9. Organ dose rate limit	%	4.41E-04	4.50E-04	8.99E-05	1.08E-04

TABLE 1B
GASEOUS EFFLUENTS - ELEVATED RELEASE

CONTINUOUS MODE

NUCLIDES RELEASED

	UNIT	QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4
1. Fission Gases					
Argon-41	Ci	3.37E+00	4.22E+00	5.99E+00	8.99E+00
Krypton-85	Ci	ND	ND	ND	ND
Krypton-85m	Ci	2.71E+00	3.06E+00	4.74E+00	2.25E+00
Krypton-87	Ci	4.41E+00	7.29E-02	2.32E+00	4.95E-01
Krypton-88	Ci	5.40E+00	5.25E+00	9.32E+00	3.92E+00
Krypton-89	Ci	ND	ND	ND	ND
Xenon-133	Ci	9.31E-01	1.21E+00	3.81E+00	6.67E-01
Xenon-133m	Ci	ND	ND	ND	ND
Xenon-135	Ci	4.73E+00	ND	ND	5.35E-01
Xenon-135m	Ci	4.94E+00	ND	ND	5.29E-01
Xenon-137	Ci	ND	ND	ND	ND
Xenon-138	Ci	1.52E+01	ND	ND	1.68E+00
TOTAL	Ci	4.17E+01	1.38E+01	2.62E+01	1.91E+01
2. Iodines					
Iodine-131	Ci	2.05E-04	3.21E-05	3.14E-05	7.32E-05
Iodine-132	Ci	ND	2.67E-06	ND	7.82E-07
Iodine-133	Ci	4.96E-04	9.15E-05	1.15E-04	2.32E-04
Iodine-134	Ci	ND	ND	ND	ND
Iodine-135	Ci	3.37E-04	ND	9.64E-05	ND
TOTAL	Ci	1.04E-03	1.26E-04	2.43E-04	3.06E-04
3. Particulates					
Barium-140	Ci	ND	ND	5.12E-07	ND
Cobalt-60	Ci	ND	ND	8.11E-06	ND
Cesium-137	Ci	ND	ND	ND	ND
Manganese-54	Ci	4.06E-07	ND	5.26E-06	ND
Strontium-89	Ci	2.02E-06	2.43E-06	6.07E-06	5.93E-06
Zinc-65	Ci	ND	ND	ND	ND
Chromium-51	Ci	ND	ND	7.79E-06	2.76E-07
Iron-59	Ci	ND	ND	1.38E-06	ND
Cobalt-58	Ci	ND	ND	1.00E-06	ND
TOTAL	Ci	2.43E-06	2.43E-06	3.01E-05	6.21E-06
4. Tritium					
Hydrogen-3	Ci	3.22E-01	2.41E-01	8.50E-01	1.95E-01

Note: There were no batch releases for this report period.

TABLE 1C
GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

CONTINUOUS MODE

NUCLIDES RELEASED

1. Fission Gases	**UNIT**	**QUARTER 1**	**QUARTER 2**	**QUARTER 3**	**QUARTER 4**
Argon-41	Ci	ND	ND	ND	ND
Krypton-85	Ci	ND	ND	ND	ND
Krypton-85m	Ci	ND	ND	ND	ND
Krypton-87	Ci	ND	ND	ND	ND
Krypton-88	Ci	ND	ND	ND	ND
Xenon-133	Ci	1.95E-02	2.91E-02	1.16E-02	1.83E-03
Xenon-133m	Ci	ND	ND	ND	ND
Xenon-135	Ci	1.38E-02	3.34E-02	4.19E-03	3.46E-03
Xenon-135m	Ci	1.75E-03	2.72E-03	ND	ND
Xenon-137	Ci	ND	ND	ND	ND
Xenon-138	Ci	2.17E-01	ND	ND	ND
TOTAL	Ci	2.52E-01	6.52E-02	1.58E-02	5.29E-03
2. Iodines					
Iodine-131	Ci	6.23E-05	8.57E-05	1.11E-04	6.92E-06
Iodine-132	Ci	ND	ND	ND	ND
Iodine-133	Ci	4.56E-04	6.28E-04	5.49E-04	1.63E-04
Iodine-134	Ci	ND	ND	ND	ND
Iodine-135	Ci	ND	ND	ND	ND
TOTAL	Ci	5.18E-04	7.14E-04	6.60E-04	1.70E-04
3. Particulates					
Chromium-51	Ci	ND	ND	ND	ND
Cobalt-58	Ci	ND	ND	2.42E-06	ND
Cobalt-60	Ci	ND	ND	2.15E-05	ND
Manganese-54	Ci	2.61E-06	ND	1.58E-05	1.73E-06
Iron-59	Ci	ND	ND	ND	ND
Strontium-89	Ci	ND	ND	ND	ND
Zinc-65	Ci	ND	ND	3.03E-05	ND
TOTAL	Ci	2.61E-06	ND	7.00E-05	1.73E-06
4. Tritium					
Hydrogen-3	Ci	1.81E+00	4.67E+00	5.09E+00	1.12E+00

TABLE 2A
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QTR 1	QTR 2	QTR 3	QTR 4	EST TOTAL ERROR %
A. FISSION AND ACTIVATION PRODUCTS						
1. Total Release (not including tritium, gases and alpha)	Ci	ND	ND	ND	6.87E-06	NA
2. Average diluted concentration during period	µCi/ml	ND	ND	ND	2.51E-11	
3. Percentage ODCM Limit	%	NA	NA	NA	NA	
B. TRITIUM						
1. Total Release	Ci	5.43E-03	8.45E-03	1.14E-02	1.06E-01	≤2.50E+01
2. Average diluted concentration during period (Note 1)	µCi/ml	2.64E-08	4.53E-08	3.33E-08	3.87E-07	
3. Percentage ODCM Limit	%	*	*	*	*	
C. DISSOLVED AND ENTRAINED GASES						
1. Total Release	Ci	ND	ND	ND	ND	NA
2. Average diluted concentration during period	µCi/ml	ND	ND	ND	ND	
3. Percentage ODCM Limit	%	NA	NA	NA	NA	
D. GROSS ALPHA RADIOACTIVITY						
1. Total Release	Ci	ND	ND	ND	ND	≤4.20E+01
E. VOLUME OF WASTE RELEASED (PRIOR TO DILUTION)	liters	4.46E+06	5.01E+06	3.30E+06	5.71E+06	
F. VOLUME OF DILUTION WATER USED DURING PERIOD	liters	2.02E+08	1.81E+08	2.92E+07	2.68E+08	
***G. PERCENT OF APPLICABLE ODCM LIMITS**						
1. Quarterly Whole Body Dose	%	1.55E-05	4.64E-05	4.14E-05	5.97E-05	
2. Quarterly Organ Dose	%	4.66E-06	1.39E-05	1.24E-05	1.79E-05	
3. Annual Whole Body Dose	%	7.75E-06	2.32E-05	2.07E-05	2.99E-05	
4. Annual Organ Dose	%	9.32E-06	6.95E-06	6.20E-06	8.95E-06	

Note 1: Concentration includes summation from diluted and undiluted values from Canal and Non-Canal releases (Table 2B).

TABLE 2B
LIQUID EFFLUENTS CANAL

BATCH MODE

NUCLIDES RELEASED	UNIT	QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4
1. Fission and Activation Products					
Beta	Ci	ND	ND	ND	6.87E-06
2. Tritium					
Hydrogen-3	Ci	ND	2.32E-04	7.06E-04	9.24E-02
3. Dissolved and Entrained Gases					
ND	Ci	ND	ND	ND	ND

TABLE 2B
LIQUID EFFLUENTS CANAL

CONTINUOUS MODE

NUCLIDES RELEASED	UNIT	QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4
1. Fission and Activation Products					
ND	Ci	ND	ND	ND	ND
2. Tritium					
Hydrogen-3	Ci	ND	ND	ND	ND
3. Dissolved and Entrained Gases					
ND	Ci	ND	ND	ND	ND

TABLE 2B (SUPPLEMENT)
LIQUID EFFLUENTS NON-CANAL

CONTINUOUS MODE

NUCLIDES RELEASED	UNIT	QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4
1. Fission and Activation Products					
ND	Ci	ND	ND	ND	ND
2. Tritium					
Hydrogen-3	Ci	5.43E-03	7.56E-03	9.95E-03	1.22E-02
3. Dissolved and Entrained Gases					
ND	Ci	ND	ND	ND	ND

TABLE 2B (SUPPLEMENT)
LIQUID EFFLUENTS NON-CANAL

BATCH MODE

NUCLIDES RELEASED	UNIT	QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4
1. Fission and Activation Products					
ND	Ci	ND	ND	ND	ND
2. Tritium					
Hydrogen-3	Ci	ND	6.65E-04	7.02E-04	1.49E-03
3. Dissolved and Entrained Gases					
ND	Ci	ND	ND	ND	ND

TABLE 2B (continued)
ABNORMAL RELEASE
LIQUID EFFLUENTS CANAL

CONTINUOUS MODE

NUCLIDES RELEASED	UNIT	QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4
1. Fission and Activation Products					
ND	Ci	ND	ND	ND	ND
2. Tritium					
ND	Ci	ND	ND	ND	ND
3. Dissolved and Entrained Gases					
ND	Ci	ND	ND	ND	ND

TABLE 3A
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)

1. Type of Waste	UNIT	CLASS A	CLASS B	CLASS C	EST. TOTAL ERROR %
a. Spent resins, filter sludges,	m^3	4.52E+01	0.00E+00	0.00E+00	1.00E+01
evaporator bottoms, etc.	Ci	1.20E+01	0.00E+00	0.00E+00	1.00E+01
b. Dry compressible waste,	m^3	6.41E+02	0.00E+00	0.00E+00	1.00E+01
contaminated equipment, etc.	Ci	2.98E+00	0.00E+00	0.00E+00	1.00E+01
c. Irradiated components,	m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
control rods, etc.	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00
d. Other: Dry compressible	m^3	7.65E+00	0.00E+00	0.00E+00	1.00E+01
waste, contaminated equipment,	Ci	7.36E-03	0.00E+00	0.00E+00	1.00E+01
spent resins for volume reduction.					

2. Estimate of Major Nuclide Composition (by type of waste)

a. Spent resins, filter sludges, evaporator bottoms, etc.

b. Dry compressible waste, contaminated equipment, etc.

Isotope	Percent	Curies	
C-14	0.01	4.24E-04	E
Cr-51	0.07	2.17E-03	E
Mn-54	5.78	1.72E-01	E
Fe-55	60.06	1.79E+00	E
Fe-59	0.08	2.38E-03	E
Co-58	0.05	1.37E-03	E
Co-60	24.14	7.18E-01	E
Ni-63	3.77	1.12E-01	E
Zn-65	3.76	1.12E-01	E
Sr-90	0.02	5.37E-04	E
Tc-99	0.01	2.81E-04	E
Sb-125	0.14	4.23E-03	E
Ce-144	0.02	6.61E-04	E
Cs-137	1.98	5.89E-02	E
Pu-241	0.01	3.02e-03	E

(E- Estimated M- Measured)

TABLE 3A (continued)
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

c. Irradiated components, control rods, etc.
   None

d. Other: Dry compressible waste, contaminated equipment, spent resins, contaminated oil, glycol and water for volume reduction.
   (E- Estimated M- Measured)

   Percentage of nuclides and total activities are based on a combination of direct measurements and scaling for non-gamma emitting nuclides.

TABLE 3A (continued)
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

3. Solid Waste Disposition

No. of Shipments	Mode of Transportation	Destination
14	Trucks	*Energy Solutions Oak Ridge, TN
3	Trucks	*EnergySolutions Services Inc. Kingston, TN
9	Trucks	*Energy Solutions LLC Clive, Utah

B. IRRADIATED FUEL SHIPMENTS (Disposition)

No. of Shipments	Mode of Transportation	Destination
None	-----------	---------------

TABLE 3B
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. NRC CLASS A

SOURCE OF WASTE	PROCESSING EMPLOYED	CONTAINER VOLUME	TYPE OF CONTAINER	NUMBER OF CONTAINERS
Dry compressible Waste (DAW), Contaminated Equipment, etc.	Non-compacted	1280 ft^3 (36.2m^3)	STC	22
Dry compressible Waste (DAW), Contaminated Equipment, etc.	Non-compacted	1033.5 ft^3 (29.3m^3)	STC	1
Dry compressible Waste (DAW), Contaminated Equipment, etc.	Non-compacted	96 ft^3 (2.7m^3)	STC	10
Dry compressible Waste (DAW) Contaminated Equipment	Non-compacted	206.1 ft^3 (5.8m^3)	STC	3
Spent Resins, Filter Sludges, evaporator Bottoms, etc.	Air Drying Non-compacted	205.8 ft^3 (5.8m^3)	HIC	9

B. NRC CLASS B

SOURCE OF WASTE	PROCESSING EMPLOYED	CONTAINER VOLUME	TYPE OF CONTAINER	NUMBER OF CONTAINERS
None				

C. NRC CLASS C

SOURCE OF WASTE	PROCESSING EMPLOYED	CONTAINER VOLUME	TYPE OF CONTAINER	NUMBER OF CONTAINERS
None				

HIC-High Integrity Container, STC-Strong Tight Container

ATTACHMENT NO. 2

SUMMARY OF CHANGES TO THE PROCESS CONTROL PROGRAM

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls Section 6.2.3, changes made to the Process Control Program (PCP) during the reporting period shall be included in the Annual Radioactive Effluent Release Report.

No change in PCP.

ATTACHMENT NO. 3

SUMMARY OF CHANGES TO THE ENVIRONMENTAL MONITORING AND DOSE CALCULATION LOCATIONS

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1, Radiological Effluent Controls Section 6.2.3 a listing of new locations for dose calculation and/or environmental monitoring identified by the land use census shall be included in the Annual Radioactive Effluent Release Report.

During the reporting period, no changes in Dose Calculation Receptor Locations and/or the Environmental Monitoring were required based on the results of the land use census.

ATTACHMENT NO. 4

DEVIATIONS FROM THE REQUIRED ENVIRONMENTAL SAMPLING SCHEDULE

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1, Radiological Effluent Controls Section 6.2.7, the cause for the unavailability of any environmental samples required during the report period shall be included in the Annual Radioactive Effluent Release Report.

The following reports samples that were a deviation from the requirements of ODCM Part 1, Table 5.1-1. ODCM Part Section 5.1.1.c.1 allows for deviations from the program due to hazardous conditions, seasonal unavailability, theft, uncooperative residents, or to a malfunction of automatic sampling equipment.

A. ODCM Program Deviations

The following are deviations from the program specified by the ODCM:

IR 04358953- Per ODCM 3.1, The 17P-4A & B (Offgas Stack Sample Rack Sample Pumps) were out of service for greater than 30 days. The out of service time exceeded 30 days due to filter and the associated housing repair. Chemistry installed alternate pump per SP.03-08STK to maintain rated flow. Flow readings were validated every 12 hours to ensure proper operation. Alternate sample system was used to collect continuous particulate and iodine samples via Stack pathway.

IR 4357799- Milk samples from Location 55 were not available for the second half of July and all of August. A backup sample farm was used for the second half of July. August samples were obtained from the control farm only. The reason cited was the farm was being transitioned to seasonal operation which requires the herd to be synchronized for calving and the milking cows are “dried off” for at least 60 days to build up energy/nutrients. Milking resumed in September. Per ODCM 5.1.3 a description of the reason for not conducting sampling will be included in AREOR report for 2020.

Air Sampling Station Operability Assessment:

Air monitoring stations required by Tech Specification in 2020 were 100% operable.

ATTACHMENT NO. 5

ANNUAL SUMMARY OF HOURLY METEOROLOGICAL DATA

The James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1, Radiological Effluent Controls Section 6.2 and 6.2.2 states in part: The Annual Radioactive Effluent Release Report submitted prior to May 1 of each year may include an annual summary of meteorological data collected over the previous year. If the meteorological data is not included, the licensee shall retain it on file and provide it to the U.S. Nuclear Regulatory Commission upon request.

In accordance with the aforementioned ODCM requirement, meteorological data is not included in this report. It is retained on file and is available upon request.

ATTACHMENT NO. 6

MAJOR MODIFICATIONS TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT SYSTEMS

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls Section 7.0, Major Modifications to Radioactive Waste Treatment Systems (liquid, gaseous and solid) shall be reported in the Annual Radioactive Effluent Release Report for the period in which the modification is completed and made operational.

There were no major modifications to any liquid, gaseous, or solid radioactive waste treatment systems.

ATTACHMENT NO. 7

ONSITE GROUNDWATER MONITORING

In response to the Nuclear Energy Institute (NEI) Groundwater Protection Initiative, James A. FitzPatrick (JAF) instituted a groundwater monitoring program in 2007. JAF's Groundwater Monitoring Well Program consists of twenty-two wells which are sampled quarterly.

In 2019 & 2020, Exelon modified the corporate Radiological Groundwater Protection Program (RGPP) to include the modified sample location designations and modified analytical requirements. These changes were implemented at JAF prior to first quarter 2020 RGPP sampling. The newly adapted RGPP sample location designations include Background, Long-Term Shutdown, Mid-Field, Perimeter, and Source wells. Sample frequency and analyses are outlined below:

- Background – Annually for tritium; and every two years for gamma-radionuclide analyses.
- Long-Term Shutdown – Quarterly for tritium; annually for Fe-55, Ni-63, Sr-89, and Sr-90 analyses; and every two years for gamma-radionuclide and gross-alpha (dissolved and suspended).
- Midfield – Semi-annually for tritium, and every two years for gamma-radionuclide analysis.
- Perimeter - Annually for tritium, and every two years for gamma-radionuclide analyses.
- Source – Quarterly for tritium analysis; annually for strontium 89 & 90 analyses; every two years for gamma-radionuclide, and gross-alpha (dissolved and suspended); and every five years for Fe-55 and Ni-63.

The JAF modified RGPP sampling network consists of twenty-two wells (seven Background wells, eleven Source wells, two Midfield wells, and two Perimeter wells). The changes account for historic tritium results, location of wells and SSCs, additional wells in close proximity, groundwater flow, and lithology.

All Groundwater Monitoring Well samples collected in 2020 yielded results less than the detection limits established in the JAF Offsite Dose Calculation Manual (ODCM) Part 1, Table 5.1-3 and results are reported in the tables on pages 24 and 25. Gross beta analysis was not required per EN-AA-408-4000 and EN-JF-408-4160. No drinking water pathway exists at the James A. FitzPatrick site under normal operating conditions due to the direction and distance of the nearest water intake (Oswego, 8.5 miles west of the JAF discharge). There is no potential to influence any offsite drinking well.

In conclusion, there were no plant related isotopes detected in groundwater monitoring wells during 2020 that are attributable to James A. FitzPatrick, and all concentrations were below any reporting criteria.

ATTACHMENT NO. 7 (continued)

ONSITE GROUNDWATER MONITORING

A) Gamma Isotopic Monitoring & Gross Beta

For 2020, the monitoring wells were sampled according to the modified RGPP. All sample results were below the required lower limits of detection in accordance with the Offsite Dose Calculation Manual (ODCM) Part 1, Table 5.1-3 as provided below.

Radionuclide	LLD Value (pCi/L)
Gross Beta	4
Tritium (H-3)	3000
Manganese-54	15
Cobalt-58	15
Iron-59	30
Cobalt-60	15

Radionuclide	LLD Value (pCi/L)
Zinc-65	30
Zirconium /Niobium-95	15
Iodine-131	15
Cesium-134	15
Cesium-137	18
Barium/Lanthanum-140	15

There were no plant related gamma emitting nuclides detected in 2020 samples.

ATTACHMENT NO. 7 (continued)

ONSITE GROUNDWATER MONITORING

B) Tritium Summary

Well Name	# Samples in 2020	# Samples >3000 pCi/L in 2020	Minimum Positive Concentration	Maximum Positive Concentration
MW-1A	3	0	-	-
MW-1B	1	0	-	-
MW-2A	3	0	-	-
MW-2B	2	0	-	-
MW-3A	3	0	-	-
MW-3B	2	0	-	-
MW-4A	3	0	-	-
MW-4B	3	0	-	-
MW-5	1	0	-	-
MW-6	3	0	-	-
MW-7	3	0	-	-
MW-8	1	0	-	-
MW-9	1	0	-	-
MW-10A	1	0	-	-
MW-10B	1	0	-	-
MW-13	3	0	-	-
MW-14	3	0	-	-
MW-15	3	0	-	-
MW-16	3	0	-	-
MW-19	1	0	-	-
MW-20	1	0	-	-
MW-21	1	0	-	-

Note 1: All results are in pCi/L.
Note 2: A total of 46 samples were analyzed for H-3 in 2020, all results were <LLD in accordance with the ODCM limits in Table 5.1-3.
Note 3: Due to COVID-19, second quarter 2020 RGPP tritium sampling was postponed by Corporate Environmental. This action was taken to limit the need for contractors to enter the site in alignment with the Governor and reduce station burden. Third quarter sampling was conducted as early as possible (7/13/2020 – 7/15/2020) in the 3rd quarter.

ATTACHMENT NO. 8

GASEOUS EFFLUENTS – CARBON-14

a) **Date:** January 01, 2020 – December 31, 2020

b) **Location:** Elevated Release – Main Stack

c) **Duration:** 365 Days

d) **Flow rate:** N/A

e) **Volume Released:** N/A

f) **Nuclides Released:** Carbon-14

g) **Curies Released[1]:**

UNIT	QTR 1	QTR 2	QTR 3	QTR 4
Ci	2.39E+00	2.69E+00	2.09E+00	2.56E+00
μCi/sec	3.44E-01	3.43E-01	3.42E-01	3.44E-01

h) **Resultant Doses:** See Addendum 1—Assessment of Radiation Doses to the Public January-December 2020 Table 1, Section D

i) **Dose Calculations:** Doses were calculated in accordance with the Offsite Dose Calculation Manual (ODCM) Part 2, Section 11.4.1

[1] Curies released calculated using the methodology in EPRI Technical Report 1021106 **"Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents".**

ATTACHMENT NO. 9

EVENTS LEADING TO CONDITIONS WHICH RESULTED IN EXCEEDING RADIOACTIVITY LIMITS.

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls Section 6.2.9, the report shall contain the events leading to the conditions which resulted in exceeding the radioactivity limits for the specified outdoor radioactive radwaste tanks specified in the Technical Requirements Manual, TRM 3.7.E

The radioactivity limits for the specified outdoor radioactive radwaste tanks were not exceeded.

ADDENDUM 1

**ASSESSMENT OF RADIATION DOSES TO THE PUBLIC
JANUARY - DECEMBER 2020**

1. INTRODUCTION

The James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls, requires an assessment of the radiation doses to the likely most exposed member of the public due to radioactive liquid and gaseous effluents. This assessment of doses to the likely most exposed member of the public is based on accepted methodologies found in the Offsite Dose Calculation Manual (ODCM).

2. DOSE LIMITS

A. DOSE FROM LIQUID EFFLUENTS (ODCM, Part 1, Section 2.3)

Applicability

Applies to doses from radioactive material in liquid effluents.

Objective

To ensure that the dose limitations of 10 CFR 50, Appendix I, are met.

Controls

The dose to a member of the public from radioactive materials released from the plant in liquid effluents to Unrestricted Areas shall be limited as follows:

1. During any calendar quarter, limited to less than or equal to 1.5 mrem to the whole body and to less than or equal to 5 mrem to any organ.

2. During any calendar year, limited to less than or equal to 3 mrem to the whole body and to less than or equal to 10 mrem to any organ.

B. GASEOUS DOSE RATES (ODCM, Part 1, Section 3.2)

Applicability

Applies to the radiation dose from radioactive material in gaseous effluents.

Objective

To ensure that the dose rates at or beyond the site boundary from gaseous effluents do not exceed the annual dose limits of 10 CFR 20 for Unrestricted Areas.

ADDENDUM 1 (continued)

Controls

The dose rate at or beyond the Site Boundary due to radioactive materials released from the plant in gaseous effluents shall be limited as follows:

1. Less than or equal to 500 mrem/year to the whole body and less than or equal to 3000 mrem/year to the skin from noble gases; and,

2. Less than or equal to 1500 mrem/year to any organ from Iodine-131, Iodine-133, Tritium and for radioactive materials in particulate form with half-lives greater than 8 days (inhalation pathway only).

C. AIR DOSE, NOBLE GASES (ODCM, Part 1, Section 3.3)

Applicability

Applies to the air dose due to noble gases in gaseous effluents.

Objective

To ensure that the noble gas dose limitations of 10 CFR 50, Appendix I, are met.

Control

The air dose to areas at or beyond the Site Boundary from noble gases released from the plant in gaseous effluents shall be limited:

1. During any calendar quarter, to less than or equal to 5 mrad from gamma radiation, and less than or equal to 10 mrad from beta radiation; and,

2. During any calendar year, to less than or equal to 10 mrad from gamma radiation and less than or equal to 20 mrad from beta radiation.

ADDENDUM 1 (continued)

D. DOSE DUE TO IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM (ODCM, Part 1, Section 3.4)

<u>Applicability</u>

Applies to the cumulative dose from Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents.

Objective

To ensure that the dose limitations of 10 CFR 50, Appendix I, are met.

<u>Controls</u>

The dose to a member of the public at or beyond the Site Boundary from Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days released from the plant in gaseous effluents shall be limited:

a. During any calendar quarter to less than or equal to 7.5 mrem to any organ; and,

b. During any calendar year to less than or equal to 15 mrem to any organ.

c. Less than 0.1% of the limits of ODCM Part 1, Section 3.4, Specifications 3.4.1.1 and 3.4.1.2 as a result of burning contaminated oil.

E. TOTAL DOSE FROM URANIUM FUEL CYCLE (ODCM, Part 1, Section 4.1)

<u>Applicability</u>

Applies to radiation dose from releases of radioactivity and radiation from uranium fuel cycle sources.

<u>Objective</u>

1. To assure that the requirements of 40 CFR 190 are met.

2. To assure that the requirements of 10 CFR 72.104 are met in accordance with Section 3.2.3, Required Action A.2, Certificate of Compliance 1014 Appendix A, Technical Specifications for the Hi-Storm 100 Cask System.

<u>Controls</u>

The dose or dose commitment to any member of the public, due to releases of radioactivity and radiation, from uranium fuel cycle sources shall be limited as follows:

1. Less than or equal to 25 mrem/year to the whole body; and,

2. Less than or equal to 25 mrem/year to any organ except the thyroid which shall be limited to less than or equal to 75 mrem/year.

ADDENDUM 1 (continued)

3. DOSE ASSESSMENT

A. METHODOLOGY

The assessment of radiation doses to the public due to radioactive liquid and gaseous effluents is performed in accordance with the ODCM. The ODCM is based on methodologies and models suggested by the Guidance Manual For "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants" (NUREG-0133) and "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I" (Regulatory Guide 1.109).

B. ASSUMPTIONS

Dose calculations are performed using formulas and constants defined in the ODCM. Specific radioactive release activities used in the dose calculations are listed in the Annual Radioactive Effluent Release Report (1.21 Report) for the period of January 1, 2020 to December 31, 2020. Historical meteorological data was used to generate tables of average dispersion factors. Locations of interest were identified from the 2020 land use census. These tables are available upon request.

C. ASSESSMENT RESULTS SUMMARY

The calculated doses to the public due to radioactive effluents are listed in Table 1. The calculated doses are small fractions of their respective dose limits.

4. 40 CFR 190 DOSE ASSESSMENT

A. METHODOLOGY

Evaluation to demonstrate compliance with the 40 CFR 190 dose limits must be performed when the doses calculated for 10 CFR 50 compliance exceed twice their respective limits. When additional dose assessment is required to demonstrate compliance with 40 CFR 190 it is performed in accordance with the ODCM.

B. RESULTS SUMMARY

The cumulative dose contribution from liquid and gaseous effluents for this report period were calculated and are listed in Table 1. The cumulative dose contribution from direct radiation from the reactor unit and from radwaste storage tanks is measured by environmental thermoluminescent dosimeters for the report period. This data is contained in the Annual Environmental Operating Report. The calculated doses from liquid and gaseous effluents are less than twice their respective 10 CFR 50 limits; therefore, additional calculations are not necessary to demonstrate compliance with 40 CFR 190 dose limits.

ADDENDUM 1 (continued)

TABLE 1
ANNUAL DOSE ASSESSMENT 2020

A. LIQUIDS

QUARTER	1	2	3	4	ANNUAL
	(a)	(a)	(a)	(a)	(a)
Organ (mrem)	2.33E-07	6.97E-07	6.22E-07	8.95E-07	2.45E-06
% of Limit	4.66E-06	1.39E-05	1.24E-05	1.79E-05	2.45E-05
	(b)	(b)	(b)	(b)	(b)
Whole Body (mrem)	2.33E-07	6.96E-07	6.22E-07	8.95E-07	2.45E-06
% of Limit	1.55E-05	4.65E-05	4.15E-05	5.97E-05	8.17E-05

(a) Dose to the Child Liver.
(b) Dose to the Child Whole Body.

ADDENDUM 1 (continued)

TABLE 1 (cont)
ANNUAL DOSE ASSESSMENT 2020

B, C. NOBLE GASES

QUARTER	1	2	3	4	ANNUAL
Total Body (mrem/yr)	6.41E-02	4.21E-03	7.17E-03	4.35E-02	6.41E-02
% of Limit	1.28E-02	8.42E-04	1.43E-03	8.70E-03	1.28E-02
Skin (mrem/yr)	8.32E-02	7.44E-03	8.91E-03	5.66E-02	8.32E-02
% of Limit	2.77E-03	2.48E-04	2.97E-04	1.89E-03	2.77E-03
Gamma (mrad)	9.95E-04	4.20E-04	7.82E-04	2.15E-04	2.41E-03
% of Limit	1.99E-02	8.39E-03	1.56E-02	4.29E-03	2.41E-02
Beta (mrad)	1.48E-04	3.43E-05	7.78E-05	2.21E-05	2.82E-04
% of Limit	1.48E-03	3.43E-04	7.78E-04	2.21E-04	1.41E-03

D. IODINES AND PARTICULATES

QUARTER	1	2	3	4	ANNUAL
	(a)	(a)	(a)	(a)	(a)
Organ (mrem)	7.88E-04	1.27E-03	1.88E-03	1.59E-04	4.10E-03
% of Limit	1.05E-02	1.70E-02	2.51E-02	2.12E-03	5.47E-02
	(a)	(a)	(a)	(a)	(a)
Organ Dose Rate (mrem/yr)	1.67E-02	9.82E-03	1.08E-02	2.19E-03	1.67E-02
% of Limit	1.11E-03	6.55E-04	7.19E-04	1.46E-04	1.11E-03

(a) Dose to the Child Thyroid.

ADDENDUM 1 (continued)

TABLE 1 (cont)
ANNUAL DOSE ASSESSMENT 2020

E. CARBON 14

QUARTER	1	2	3	4	ANNUAL
	(a)	(a)	(a)	(a)	(a)
Organ (mrem)	7.55E-03	8.49E-03	6.60E-03	8.08E-03	3.07E-02
% of Limit	1.01E-01	1.13E-01	8.80E-02	1.08E-01	2.05E-01
					(a)
Organ Dose Rate (mrem/yr)	NA	NA	NA	NA	3.07E-02
% of Limit	NA	NA	NA	NA	2.05E-03

(a) Dose to the Child Bone.

JAFP-21-0033

Enclosure 2

Offsite Dose Calculation Manual (ODCM) Revision 1,

Part 1 and 2

(326 Pages)

JAMES A. FITZPATRICK

NUCLEAR POWER PLANT

OFFSITE DOSE CALCULATION MANUAL

Revision 1

EXELON GENERATION

DOCKET NO. 50-333

(This Manual cannot be changed without PORC and Plant Manager Approval)

Item No.	(old) Rev. 0 Page No. (Section)	(new) Rev. 1 Page No.	Indicator	Description of Change
1	6 (Intro)	5	A	Added Reg Guide 1.21 objectives
2	15 (2.1.4.3.A)	14	A	Changed section 3.3 to 11.3
3	16 (2.1.5)	15	A	Changed section 3.3 to 11.3
4	18 (2.2.4.3.B)	17	A	Changed section 3.2 to 11.2
5	20 (Table 2.2-1 Notes)	19	A	Added equation numbers
6	23 (2.3.4.3)	22	A	Changed section 3.4 to 11.4
7	23 (2.3.4.3)	22	A	Changed monthly to once per 31 days to align with NUREG 1302
8	24 (2.4.4.3)	23	A	Changed section 3.5 to 11.5
9	29 (Table 3.1-2)	28	B	Change Channel Functional Test frequency for the Turbine and Radwaste Bldg Exhaust radiation monitors
10	34 (Table 3.2-1 Notes)	33	A	Added equation numbers
11	66 (9.3)	65	A	Document revision overview
12	140	139	A	Added reference to cals and evaluation to support changing calibration frequency on TR and RW exhaust radiation monitors
13	A-9 (Table A-3)		A	Removed 2 infant tables from listing to align with NUREG 1302 [Freshwater Fish & Lake Shoreline Sediment]
14	A-16 (Table A-3)		A	Removed table. Not required per RG 1.109, Table E-5 (pg 40)[Freshwater Fish - Infant]
15	A-17 (Table A-3)		A	Removed table. Not required per RG1.109, Table E-5 (pg 40) [Lake Shoreline Sediment – Infant]
16	A-18 (Table A-4)	A-16	A	Updated Table of Contents page numbers
17	B-2 (App B)	B-2	A	Updated Table of Contents page numbers
18	B-6 (Table B-3)		A	Removed Table. Not required per NUREG 1302 Bases 3/4.11.2.1 (pg 78) [Inhalation – Teen]

Item No.	(old) Rev. 0 Page No. (Section)	(new) Rev. 1 Page No.	Indicator	Description of Change
19	B-26 (Table B-5)		A	Removed table. Not required per RG1.109, Table E-5 (pg 40) [Vegetation and Cow Milk – Infant]
20	B-27 (Table B-6)	B-25	A	Updated Table of Contents page numbers
21	C-19 (Table C-8)	C-19	A	Corrected 4th column miles value from 1.6 to 1.5
22	H-2 (Appendix H)	H-2	A	Updated figure names and page numbers
23	H-5 – H-10 (Table H-1)	H-5 – H-10	A	Updated Figure numbers based on new figures
24	H-5 – H-10 (Table H-1)	H-5 – H-10	A	Updated footnote for map locations based on new figure numbers
25	H-7 (Table H-1)	H-7	A	Removed Cary farm from Food Product sample location list. Farm not sampled from in > 35 years
26	H-8 (Table H-1)	H-8	A	Added Lawton farm to Food Product sample location list (location 69)
27	H-10 (Table H-1)	H-9	A	Removed landmark 54½ from location 143. Archaic landmark no longer used.
28	H-10 (Table H-1)	H-9	A	Added cross reference to Nine Mile Point ODCM locations
29	H-11 (Figure H-1)	H-11	A	Updated Figure H-1
30	H-12 (Figure H-2)	H-12	A	Updated Figure H-2
31	H-13 (Figure H-3)	H-13	A	Updated Figure H-3
32	H-14 (Figure H-4)	H-14	A	Updated new Figure H-4
33		H-15	A	Updated new Figure H-5 (was H-4)
34		H-15	A	Changed sample location designation from C2 to 145
35	H-14 (Figure H-4)	H-16	A	Changed Figure H-4 to H-6
36	H-15 (Table H-2)	H-17	A	Update map references at bottom of page

Item No.	(old) Rev. 0 Page No. (Section)	(new) Rev. 1 Page No.	Indicator	Description of Change
37	H-16 (Figure H-5)	H-18	A	Updated new Figure H-7 (was H-5)
38	I-3 (Table I-1)	I-3	A	Changed monthly to once per 31 days to align with NUREG 1302

INTRODUCTION

The OFFSITE DOSE CALCULATION MANUAL(ODCM) is a supporting document of the James A. FitzPatrick Nuclear Power Plant (JAF) Technical Specifications and implements JAF radiological effluent controls. The ODCM contains the controls, bases, and surveillance requirements for liquid and gaseous radiological effluents. In addition, the ODCM describes the methodology and parameters to be used in the calculation of offsite DOSES due to radioactive liquid and gaseous effluents. This document also describes the methodology used for calculation of the liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints. Liquid and GASEOUS RADWASTE TREATMENT SYSTEM configurations are also included.

The ODCM is used to define the requirements for the JAF Radiological Environmental Monitoring Program (REMP) and contains a list and graphical description of the specific sample locations used in the REMP.

The ODCM is maintained at the James A. FitzPatrick (JAF) site for use as a reference guide and training document of accepted methodologies and calculations. Changes in the calculation methods or parameters will be incorporated into the ODCM to ensure the ODCM represents the present methodology in all applicable areas. Changes to the ODCM will be implemented in accordance with the JAF Technical Specifications.

The ODCM follows the methodology and models suggested by NUREG-0133, and Regulatory Guide 1.109, Revision 1 for calculation of offsite DOSES due to plant effluent releases.

Per Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste, Revision 2, the radiological effluent control program for a nuclear power plant has the following six basic objectives:

1. Ensure that effluent instrumentation has the functional capability to measure and analyze effluent discharges,
2. Ensure the effluent treatment systems are used to reduce the effluent discharges to ALARA levels,
7/20
3. Establish instantaneous release rate limitations on the concentrations of radioactive material,
4. Limit the annual and quarterly doses or dose commitment of the public in liquid and gaseous effluents to unrestricted areas,
5. Measure, evaluate, and report the quantities of radioactivity in gaseous effluents, liquid effluents, and solid radioactive waste, and
6. Evaluate the dose to members of the public.

Adherence to the processes and methodologies of the ODCM will drive the station to ensure the six objectives above are met.

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LIST OF TABLES

PART 1

RADIOLOGICAL EFFLUENT CONTROLS

PURPOSE

The Radioactive Effluent Controls Program (REC) was added to the OFFSITE DOSE CALCULATION MANUAL(ODCM) in response to NRC Generic Letter 89-01. The program intent is to conform with 10 CFR 50.36a for the control of radioactive effluents and for maintaining the DOSES to members of the public "as low as is reasonably achievable." Generic Letter 89-01 described the NRC's determination that the Radiological Effluent Technical Specifications (RETS) should be simplified to improve Technical Specifications (TS) by implementing programmatic controls into the TS and procedural details into the ODCM.

1. DEFINITIONS

ACTION

ACTION shall be that part of a specification, which prescribes remedial measures, required under designated conditions.

CHANNEL CALIBRATION

See Technical Specifications.

CHANNEL CHECK

See Technical Specifications.

CHANNEL FUNCTIONAL TEST

See Technical Specifications.

DOSE EQUIVALENT I-131

DOSE EQUIVALENT I-131 shall be that concentration of I-131 (microcurie/gram) that alone would produce the same thyroid DOSE as the quantity and isotopic mixture of
I-131, I-132, I-133, I-134 and I-135 actually present. The thyroid DOSE conversion factors used for this calculation shall be those listed in International Commission on Radiological Protection Publication 30 (ICRP-30), “Limits for Intake by Workers”, or in NRC Regulatory Guide 1.109, Revision 1, October 1977.

GASEOUS RADWASTE TREATMENT SYSTEM

A GASEOUS RADWASTE TREATMENT SYSTEM (e.g., the “augmented offgas system”) is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the main condenser evacuation system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

1. DEFINITIONS (continued)

INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) CONTROLLED AREA

The JAFNPP INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) CONTROLLED AREA is defined to be the same area as the JAFNPP Exclusion Area, which is the combined JAFNPP and Nine Mile Point Nuclear Station (NMPNS) reactor site area. The boundary of the JAFNPP exclusion area traces the perimeter of the combined JAFNPP - NMPNS reactor sites. (See Figure 4.1-1, SITE BOUNDARY Map).

LOGIC SYSTEM FUNCTIONAL TEST

See Technical Specifications.

MEMBER(S) OF THE PUBLIC

MEMBER(S) OF THE PUBLIC includes all persons who are not occupationally associated with the facilities on the Nine Mile Point Nuclear Site. This category does not include employees of the utilities, its contractors or vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of the site for recreational, occupational, or other purposes not associated with the plants.

MODE

See Technical Specifications.

OFFSITE DOSE CALCULATION MANUAL

The ODCM describes the methodology and parameters to be used in the calculation of the offsite DOSES resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluents monitoring alarm and trip setpoints, and in the conduct of the Radiological Environmental Monitoring Program.

The ODCM shall also contain the radioactive effluent controls and radiological environmental monitoring activities and descriptions of the information that should be included in the Annual Radiological Environment Operating and Radioactive Effluent Release reports required by Technical Specifications 5.6.2 and 5.6.3.

OPERABLE - OPERABILITY

See Technical Specifications.

1. **DEFINITIONS** (continued)

PROCESS CONTROL PROGRAM (PCP)

The PCP is a document which identifies the current formulas, sampling methods, analyses, tests, and determinations used to control the processing and packaging of solid radioactive wastes. The PCP controls these activities in such a way as to assure compliance with 10 CFR 20, 10 CFR 61, 10 CFR 71, and other applicable regulatory requirements governing the disposal of the radioactive waste.

PURGE - PURGING

PURGE or PURGING shall be any controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

RATED THERMAL POWER

See RATED THERMAL POWER, Technical Specifications.

RESTRICTED AREA

The RESTRICTED AREA means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials

SITE BOUNDARY

The SITE BOUNDARY is that line beyond which the land is not owned, leased, or otherwise controlled by Nine Mile Point Nuclear Facilities. Refer to Figure 4.1-1 for the map of the SITE BOUNDARY with regard to liquid and gaseous releases.

SOLIDIFICATION

SOLIDIFICATION is the conversion of wet wastes into a form that meets shipping and burial ground requirements.

SOURCE CHECK

A SOURCE CHECK is the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

1. **DEFINITIONS** (continued)

SURVEILLANCE FREQUENCY NOTATIONS/INTERVALS

The SURVEILLANCE FREQUENCY NOTATIONS/INTERVALS used in these specifications are defined as follows:

Notifications	Intervals	Frequency
D	Daily	At least once per 24 hours
W	Weekly	At least once per 7 days
M	Monthly	At least once per 31 days
Q	Quarterly	At least once per 92 days (3 months)
SA	Semiannually	At least once per 184 days
A	Annually or Yearly	At least once per 366 days
18M	18 Months	At least once per 18 months (550 days)
R	Operating Cycle	At least once per 24 months (731 days)

THERMAL POWER

THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.

TREATMENT

Any process which effectively reduces the amount of radioactive material released to the environment. This includes such processes as filtration, evaporation/ condensation, settling/decanting, and SOLIDIFICATION.

UNRESTRICTED AREA:

An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY where access is neither limited nor controlled by Exelon for purposes of protecting individuals against undue risk from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes

The definition of UNRESTRICTED AREA used in implementing the radiological effluent and radiological environmental monitoring controls has been expanded over that in 10 CFR 20.1003. The UNRESTRICTED AREA boundary may coincide with the exclusion (fenced) area boundary, as defined in 10 CFR 100.3(a), but the UNRESTRICTED AREA does not include areas over water bodies. The concept of UNRESTRICTED AREAS, established at or beyond the SITE BOUNDARY, is utilized in the Limiting Conditions for Operation to keep levels of radioactive materials in liquid and gaseous effluents as low as is reasonably achievable, pursuant to 10 CFR 50.36a.

1. <u>DEFINITIONS</u> (continued)

VENTILATION EXHAUST TREATMENT SYSTEM

A VENTILATION EXHAUST TREATMENT SYSTEM shall be any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in the effluents by passing ventilation or vent exhaust gases through charcoal absorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Features Atmospheric Cleanup Systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

VENTING

VENTING shall be the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration, or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

RULES FOR LIMITING CONDITION FOR OPERATION AND SURVEILLANCE REQUIREMENTS

The provisions of Technical Specifications LCO 3.0.5 are applicable to Part 1, Radioactive Effluent Controls Program, Limiting Conditions for Operation.

The provisions of Technical Specification SR 3.0.2 and SR 3.0.3 are applicable to the Part 1, Radioactive Effluent Controls Program Surveillance Frequency.

2. RADIOACTIVE EFFLUENT CONTROLS

2.1. LIQUID EFFLUENT MONITORS

2.1.1. Control

The radioactive liquid effluent monitoring instrumentation channels shown in Table 2.1-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Control 2.2.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the OFFSITE DOSE CALCULATION MANUAL(ODCM).

2.1.2. **Applicability**: At all times.

Applies to the instrumentation required for monitoring radioactive liquid effluent discharges to the environment as specified in Table 2.1-1.

2.1.3. ACTIONS

1. The limiting conditions for operation of the instruments that monitor radioactive liquid effluents are given in Table 2.1-1. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip set point less conservative than required by the ODCM (Part 2, Section 11.3), without delay suspend the release of radioactive liquid effluents monitored by the affected channel, or declare the channel INOPERABLE, or change the set point so it is acceptably conservative.
2. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 2.1-1. Take corrective actions to return the instruments to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why the INOPERABILITY was not corrected in a timely manner.

2.1.4. Surveillance Requirements

1. Applicability

   Applies to the instrumentation for monitoring radioactive liquid effluent discharges.

2. Objective

   To ensure that instrumentation required for radioactive liquid effluent discharges are maintained and calibrated.

3. Specifications

   A. The alarm/trip set points of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM (Part 2, Section 11.3).

7/20

   B. The surveillance requirements for the radioactive liquid effluent monitoring instrumentation is shown on Table 2.1-2.

2.1.5. Bases

7/20 The radioactive liquid effluent instrumentation is provided to monitor and control the releases of radioactive materials in liquid effluents during planned or unplanned releases. The alarm/trip set points for these instruments shall be calculated in accordance with methods in the ODCM (Part 2, Section 11.3) to ensure that the alarm/trip will occur prior to exceeding Part 1, Section 2.2.1 Control limits. The OPERABILITY and use of this instrumentation is consistent with the requirements of 10 CFR 50, Appendix A, General Design Criteria 60, 63, and 64.

TABLE 2.1-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Instrument	Minimum Channels OPERABLE	ACTION
Gross radioactivity monitors providing alarm and automatic termination of release Liquid radwaste effluent line	1	(a)
Gross BETA or GAMMA radioactivity monitors providing alarm but not providing automatic termination of release Service water system effluent line	1	(b)
Flow rate measurement devices Liquid radwaste effluent line	1	(c)

NOTES FOR TABLE 2.1-1

(a) With the number of OPERABLE channels less than the required minimum number, effluent releases may continue provided that prior to initiating a release:

1. Two independent samples are analyzed;
2. Two technically qualified members of the facility staff verify the discharge line valving;

Otherwise, suspend release of radioactive effluents via this pathway.

(b) With the number of OPERABLE channels less than the required minimum number, effluent releases in this pathway may continue provided that, at least once per 12 hours, grab samples are collected and analyzed for principal GAMMA emitters at a limit of detection of at least $5x10^{-7}$ microcuries/ml. The principal GAMMA emitters for which the LLD specification applies exclusively are described in Note (c) to Table 2.2-1.

(c) With the number of OPERABLE channels less than the required minimum number, effluent releases via this pathway may continue provided the flow rate is estimated at least once per four hours during actual releases. Pump curves or tank level decreases generated in situ may be used to estimate flow.

TABLE 2.1-2

MINIMUM TEST AND CALIBRATION FREQUENCY
FOR RADIATION MONITORING SYSTEMS[a]

INSTRUMENT CHANNELS	CHANNEL CHECK[b]	CHANNEL FUNCTIONAL TEST[g]	CHANNEL CALIBRATION[g]	LOGIC SYSTEM FUNCTIONAL TEST[f]
Liquid Radwaste Discharge Monitor/Isolation[c][d][e][f]	Daily When Discharging	Quarterly	Once per 18 months	Once per 24 months
Liquid Radwaste Discharge Radioactivity Recorder[d]	Daily	Quarterly	Once per 18 months	---
Liquid Radwaste Discharge Flow Rate Measuring Devices[d]	Daily	Quarterly	Once per 18 months	---
Normal Service Water Effluent	Daily	Quarterly	Once per 18 months	---

NOTES FOR TABLE 2.1-2

(a) Functional tests, calibrations and CHANNEL CHECKS need not be performed when these instruments are not required to be OPERABLE or are tripped.

(b) CHANNEL CHECKS shall be performed at least once per day during these periods when the instruments are required to be OPERABLE.

(c) A SOURCE CHECK shall be performed prior to each release.

(d) Liquid radwaste effluent line instrumentation surveillance requirements need not be performed when the instruments are not required as the result of the discharge path not being utilized.

(e) An instrument CHANNEL CALIBRATION shall be performed with known radioactive sources standardized on plant equipment which has been calibrated with NIST traceable standards.

(f) Simulated automatic actuation shall be performed once per 24 months. Simulated automatic actuation means applying a simulated signal to the sensor to actuate the circuit.

(g) A successful test of the required contact(s) of a channel relay may be performed by the verification of the change of state of a single contact of the relay. This clarifies what is an acceptable CHANNEL FUNCTIONAL TEST of a relay. This is acceptable because all of the other required contacts of the relay are verified by other Technical Specifications and non-Technical Specification tests at least once per refueling interval with the applicable extension.

2.2. CONCENTRATION OF LIQUID EFFLUENTS

2.2.1. **Control**

The concentration of radioactive materials released from the plant to the UNRESTRICTED AREAS shall be limited to ten times the concentration values specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to $2x10^{-4}$ µCi/ml total activity.

2.2.2. **Applicability**: At all times.

1. Objective

To ensure that the concentrations of radioactive materials in liquid effluents are kept to acceptable levels.

2.2.3. **ACTIONS**

With the concentration of radioactive material released from the plant to UNRESTRICTED AREAS exceeding the above limits, restore the concentration to within the above limits or terminate the release.

2.2.4. **Surveillance Requirements**

1. Applicability

Applies to the analysis of radioactive liquid wastes from the plant through a liquid pathway to an UNRESTRICTED AREA.

2. Objective

To ensure that analyses are performed, and concentration determined for radioactive liquid releases.

3. Specifications

A. Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analyses program of Table 2.2-1.

B. The results of the radioactivity analyses shall be used in accordance with the methods in the ODCM (Part 2, Section 11.2) to ensure that the
7/20 concentrations at the point of release are maintained within the limits of Control 2.2.1.

2.2.5. **Bases**

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site to UNRESTRICTED AREAS will be less than ten times the concentration values specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. This limitation provides additional assurance that the levels of radioactive materials in bodies of water outside the site will not result in exposure above (1) the design objectives of 10 CFR 50, Appendix I, Section II. A, to MEMBER(S) OF THE PUBLIC and (2) the limits of 10 CFR 20.1301 to the population. The concentration limit for dissolved or entrained noble gases is based on Xe-135 as the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using methods described in ICRP Publication 2.

TABLE 2.2-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (µCi/ml)
Batch Waste Release Tanks[b]	Prior to each batch	Each batch	Principal GAMMA emitters[c]	5×10^{-7}
			I-131	1×10^{-6}
	One batch per month	Monthly	Dissolved and entrained gases (GAMMA emitters)	1×10^{-5}
	Prior to each batch	Quarterly composite[d]	H-3	1×10^{-5}
			Gross alpha	1×10^{-7}
	Prior to each batch	Quarterly composite[d]	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-5}
Continuous Releases[e]	Continuous[f]	Weekly composite[f]	Principle GAMMA Emitters[c]	5×10^{-7}
			I-131	1×10^{-6}
	Monthly grab sample	Monthly	Dissolved and entrained gases (GAMMA emitters)	1×10^{-5}
	Continuous[f]	Monthly composite[f]	H-3	1×10^{-5}
			Gross alpha	1×10^{-7}
	Continuous[f]	Quarterly composite[f]	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-5}

See notes next page

NOTES FOR TABLE 2.2-1

(a) The LLD (Lower Limit of Detection) is defined, for the purpose of these specifications, as the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability and with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

7/20 Eq. 2.2-1

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

Where:

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

s_b	=	standard deviation of the background counting rate or of the counting rate of a blank sample, as appropriate (in counts per minute);
E	=	counting efficiency (in counts per disintegration);
V	=	sample size (in units of mass or volume);
2.22×10^6	=	number of disintegrations per minute per microCurie;
Y	=	fractional radiochemical yield (when applicable);
λ	=	radioactive decay constant for the particular radionuclide; and
$\Delta\tau$	=	for plant effluents, is the elapsed time between the midpoint of sample collection and time of counting.

Typical values of E, V, Y, and $\Delta\tau$ should be used in the calculations.

Alternative LLD Methodology

An alternative methodology for LLD determination follows and is similar to the above LLD equation:

7/20 Eq. 2.2-2

$$LLD = \frac{\left(2.71 + 4.65\sqrt{B}\right) \times Decay}{E \times q \times b \times Y \times t \left(2.22 \times 10^6\right)}$$

Where:

B	=	background sum (counts)
E	=	counting efficiency, (counts detected/disintegration's)
q	=	sample quantity, (mass or volume)
b	=	abundance, (if applicable)
Y	=	fractional radiochemical yield, coincidence correction, or collection efficiency, (if applicable)
t	=	count time (minutes)
2.22×10^6	=	number of disintegration's per minute per microCurie
$2.71 + 4.65\sqrt{B}$	=	$k2 + (2k \sqrt{2} \sqrt{B})$, and k = 1.645.
		(k=value of the t statistic from the single-tailed t distribution at a significance level of 0.95 and infinite degrees of freedom. This means that the LLD result represents a 95% detection probability with a 5% probability of falsely concluding that the NUCLIDE present when it is not or that the NUCLIDE is not present when it is.)
Decay	=	e λ Δt [λ RT/(1-e- λ RT)] [λ Td/(1-e- λ Td)], (if applicable)
λ	=	radioactive decay constant, (units consistent with Δt, RT and Td)
Δt	=	"delta t", or the elapsed time between sample collection or the midpoint of sample collection and the time the count is started, depending on the type of sample, (units consistent with λ)
RT	=	elapsed real time, or the duration of the sample count, (units consistent with λ)
Td	=	sample deposition time, or the duration of analyte collection onto the sample media, (units consistent with λ)

The LLD may be determined using installed radioanalytical software, if available. In addition to determining the correct number of channels over which to total the background sum, utilizing the software's ability to perform decay corrections (i.e. during sample collection, from sample collection to start of analysis and during counting), this alternate method will result in a more accurate determination of the LLD.

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

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

(c) The principal GAMMA emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144. This list does not mean that only these NUCLIDES are to be detected and reported. Other peaks that are measurable and identifiable, together with the above NUCLIDES, shall also be identified and reported in the Radioactive Effluent Release Report. The LLD for Mo-99, Ce-141, and Ce-144 is 5×10^{-5} µCi/ml.

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

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

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

2.3. LIQUID EFFLUENT DOSE

2.3.1. **Control**

The DOSE to a MEMBER(S) OF THE PUBLIC from radioactive materials released from the plant in liquid effluents to UNRESTRICTED AREAS shall be limited as follows:

1. During any calendar quarter, limited to less than or equal to 1.5 mrem to the whole body and to less than or equal to 5 mrem to any ORGAN; and,
2. During any calendar year, limited to less than or equal to 3 mrem to the whole body and to less than or equal to 10 mrem to any ORGAN

2.3.2. **Applicability**: At all times.

Applies to radiation DOSES from liquid effluents containing radioactive materials.

1. Objective

   To ensure that the DOSE limitations of 10 CFR 50, Appendix I for liquids are not exceeded.

2.3.3. **ACTIONS**

With the calculated DOSE from the release of radioactive materials in liquid effluents exceeding any of the above limits, the following shall be done:

1. Identify the causes for such release rates;
2. Define and initiate a program of corrective action; and
3. Prepare and submit a report to the NRC within 30 days.

2.3.4. **Surveillance Requirements**

1. Applicability

   Applies to the calculation of the radiation DOSE from liquid effluents containing radioactive materials.

2. Objective

   To ensure that the radiation DOSE from radioactive liquid effluents is determined

3. Specifications

   Cumulative DOSE contributions from liquid effluents shall be determined in
   7/20 accordance with the ODCM (Part 2, Section 11.4) at least once per 31 days for the current calendar quarter and current calendar year.

2.3.5. **Bases**

This specification is provided to ensure that the requirements of 10 CFR 50, Appendix I, Section II.A, III.A and IV.A are met. The specification ensures that the guides set forth in 10 CFR 50, Appendix I, Section II.A are met. The specification provides the required operating flexibility and, at the same time, implements the guides set forth in 10 CFR 50, Appendix I, Section IV.A, to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable."

2.4. LIQUID RADIOACTIVE TREATMENT SYSTEM

2.4.1. **Control**

The appropriate portions of the Liquid Radwaste Treatment System shall be used to reduce the radioactive materials in liquid wastes prior to their discharge when the projected DOSES due to the liquid effluent from the unit to UNRESTRICTED AREAS would exceed 0.06 mrem to the total body or 0.2 mrem to any ORGAN in any calendar month

2.4.2. **Applicability**: At all times.

Applies to the OPERABILITY of radioactive liquid processing equipment.

1. Objective

   To ensure Liquid Radwaste Treatment System(s) are operated to prevent exceeding the DOSE limits of Part 1, 2.3.1 Control.

2.4.3. **ACTIONS**

With radioactive liquid waste being discharged without TREATMENT and in excess of the above limits, prepare and submit to the Commission within 30 days a Special Report that includes the following information:

1. Explanation of why liquid radwaste was being discharged without TREATMENT;
2. Identification of any INOPERABLE equipment or subsystems and the reason for the INOPERABILITY;
3. ACTION(S) taken to restore the INOPERABLE equipment to OPERABLE status; and
4. Summary description of ACTION(S) taken to prevent a recurrence.

2.4.4. **Surveillance Requirements**

1. Applicability

   DOSE projections apply to liquid effluents released to UNRESTRICTED AREAS.

2. Objective

   To ensure that action levels to require operation of Waste Treatment Systems are determined.

3. Specifications

   DOSES to individuals in UNRESTRICTED AREAS due to liquid releases shall be projected at least monthly in accordance with the ODCM (Part 2, Section
7/20 11.5).

2.4.5. **Bases**

The requirement that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This specification assures that the requirements of 10 CFR 50.36a, 10 CFR 50, Appendix A, General Design Criterion 60, and design objective of 10 CFR 50, Appendix I, Section II.D are met. The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as a suitable fraction of the DOSE design objectives set forth in 10 CFR 50, Appendix I, Section II.A, for liquid effluents.

3. GASEOUS EFFLUENTS

3.1. RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

3.1.1. Control

The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.1-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of 3.2.1 Control are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the OFFSITE DOSE CALCULATION MANUAL(ODCM).

3.1.2. Applicability

Applies to the instrumentation required for monitoring the radioactive gaseous effluent pathways to the environment.

1. Objective

   To ensure that radioactive gaseous effluent discharges are properly monitored and recorded during release.

   A. Radioactive gaseous wastes released to the environment via the below listed pathways shall be monitored and recorded during release from the respective pathway.

      1. Main Stack Exhaust
      2. Refuel Floor Exhaust
      3. Reactor Building Exhaust
      4. Turbine Building Exhaust
      5. Radwaste Building Exhaust

   B. Each pathway listed above shall also be sampled for iodine and particulate radioactivity on a continuous basis during release from the respective pathway.

3.1.3. ACTIONS

1. If Sections 3.1.2.1.A and 3.1.2.1.B above cannot be met, effluent releases may continue via the respective pathway provided gaseous grab samples are collected in the case of a monitor out of service or auxiliary samplers are used in case a particulate and iodine sampler is out of service:

   A. Return the instrument to OPERABLE status within 30 days; or

   B. Provide an explanation in the next Radioactive Effluent Release Report as to why the INOPERABILITY was not corrected within 30 days.

2. Alarm/Trip Setpoints are determined in accordance with Part 2, Section 12.3.2 to ensure the limits of Section 3.2.1 are not exceeded. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above control:

   A. Without delay, suspend the release of radioactive gaseous effluents monitored by the affected channel; or

   B. Declare the channel INOPERABLE; or

   C. Change the setpoint so it is acceptably conservative.

3.1.4. **Surveillance Requirements**

1. Applicability

   Applies to instrumentation listed in Section 3.1.2.1.A and analyses of gaseous effluent releases.

2. Objective

   To ensure that instrumentation required for gaseous effluent releases is maintained and calibrated and the radioactivity of gaseous releases is determined.

3. Specifications

   A. Operation of the gaseous effluent monitors and recorders shall be verified by performing instrument surveillance as specified on Table 3.1-2.

   B. The iodine cartridge and the particulate filter for each pathway listed in Section 3.1.2.1.A shall be changed out at least weekly.

   C. Grab samples, when required, shall be collected at least once per 12 hours and analyzed within 24 hours of collection. Auxiliary samplers shall run continuously and be changed out at least weekly.

3.1.5. **Bases**

The radioactive gaseous effluent instrumentation is provided to monitor and control the releases of radioactive materials in gaseous effluents during planned or unplanned releases. The alarm/trip setpoints for these instruments shall be calculated in accordance with methods in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of Part 1, Section 3.2.1.

The OPERABILITY and use of this instrumentation are consistent with the requirements of 10 CFR 50, Appendix A, General Design Criteria 60, 63 and 64.

Refer to Technical Specification Bases 3.3.6.2 for references pertaining to surveillance and allowable outage times for selected monitors listed on Table 3.1-1 and Table 3.1-2.

TABLE 3.1-1

RADIATION MONITORING SYSTEMS

Minimum No. of OPERABLE Instrument Channels per Trip System	Function	Alarm/Trip Level Setting	Total No. of Instrument Channels Provided by Design	Action
1	Main Stack Exhaust Monitors	(b)	2	(d)
1(a)(f)	Refuel Area Exhaust Monitors(c)	(g)	2	(d)(e)
1(a)(f)	Reactor Building Area Exhaust Monitors(c)	(g)	2	(d)(e)
1(a)(f)	Turbine Building Exhaust Monitors	(b)	2	(d)
1(a)(f)	Radwaste Building Exhaust Monitors	(b)	2	(d)

NOTES FOR TABLE 3.1-1

(a) A channel may be placed in an INOPERABLE status for up to six hours during periods of required surveillance without placing the Trip System in the tripped condition provided the other OPERABLE channel is monitoring that Trip Function, that is, trip capability is maintained.

(b) Alarm/Trip level setting is in accordance with the methods and procedures of the ODCM (Part 2, Section 12.3.2). These alarm/trip level settings are set to ensure the limits in 3.2.1 Control are not exceeded.

(c) OPERABILITY includes alarm.

(d) Refer to Control 3.1.3.1.A and 3.1.3.1.B.

(e) Refer to Technical Specification 3.3.6.2 for additional Required ACTIONS.

(f) An INOPERABLE channel need not be placed in the tripped condition where this would cause the Trip to occur. In these cases, the INOPERABLE channel shall be restored to OPERABLE status within 24 hours, or the indicated ACTION shall be taken.

(g) The allowable values are specified in Technical Specification Table 3.3.6.2-1.

TABLE 3.1-2

MINIMUM TEST AND CALIBRATION FREQUENCY FOR
RADIATION MONITORING SYSTEMS(a)

Instrument Channels	Channel Check(b)	Channel Functional Test(d)	Channel Calibration(d)	Logic System Functional Test(c)
Main Stack Exhaust Monitors and Recorders	Daily	Quarterly	Quarterly	---
Refuel Area Exhaust Monitors and Recorders	Daily	Quarterly	Quarterly	---
Reactor Building Area Exhaust Monitors, Recorders and Isolation	Daily	Quarterly	Quarterly	R
Turbine Building Exhaust Monitors and Recorders	Daily	One per 24 months	Once per 24months	---
Radwaste Building Exhaust Monitors and Recorders	Daily	Once per 24 months	Once per 24 months	---
Standby Gas Treatment (SBGT) Actuation	---	---	---	R

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NOTES FOR TABLE 3.1-2

(a) CHANNEL CALIBRATIONS and CHANNEL CHECKS need not be performed when these instruments are not required to be OPERABLE or are tripped.

(b) CHANNEL CHECKS shall be performed at least once per day during these periods when the instruments are required to be OPERABLE.

(c) Simulated automatic actuation shall be performed once per 24 months. Simulated automatic actuation means applying a simulated signal to the sensor to actuate the circuit.

(d) A successful test of the required contact(s) of a channel relay may be performed by the verification of the change of state of a single contact of the relay. This clarifies what is an acceptable CHANNEL FUNCTIONAL TEST of a relay. This is acceptable because all of the other required contacts of the relay are verified by other Technical Specification and non-Technical Specification tests at least once per refueling interval with the applicable extension.

TABLE 3.1-3

RADIATION AND EFFLUENT FLOW INSTRUMENTATION

Instrument Channels	Minimum No. of OPERABLE Channels	Applicability	Action
Main Stack Exhaust			
1. Noble Gas Monitor[(a)]	1	All MODES	
2. Iodine & Particulate Sampler[(a)]	1	All MODES	
3. Discharge Flow Rate Monitor	1	All MODES	Note (b)
Refuel Floor Exhaust			
1. Noble Gas Monitor	1	All MODES	
2. Iodine & Particulate Sampler	1	All MODES	
3. Discharge Flow Rate Monitor	1	All MODES	Note (b)
Reactor Building Exhaust			
1.Noble Gas Monitor [(a)]	1	All MODES	
2.Iodine & Particulate Sampler[(a)]		All MODES	
3.Discharge Flow Rate Monitor	1	All MODES	Note (b)
Turbine Building Exhaust			
1. Noble Gas Monitor	1	All MODES	
2. Iodine & Particulate Sampler	1	All MODES	
3. Discharge Flow Rate Monitor	1	All MODES	Note (b)
Radwaste Building Exhaust			
1. Noble Gas Monitor	1	All MODES	
2. Iodine & Particulate Sampler	1	All MODES	
3. Discharge Flow Rate Monitor	1	All MODES	Note (b)

(a) The same instrument is used for the monitor and sampler

(b) With the number of channels OPERABLE less than the required by the minimum channels OPERABLE requirement, effluent releases via this pathway may continue provided the design flow rate is used for all effluent release calculations.

TABLE 3.1-4

MINIMUM TEST AND CALIBRATION FREQUENCY FOR RADIATION MONITORING EFFLUENT FLOW INSTRUMENTATION

Instrument Channels	Calibration [(b)]	Calibration
Main Stack Exhaust		
1. Noble Gas Monitor [(a)]	Quarterly	Once per Operating Cycle
2. Iodine & Particulate Sampler [(a)]	Quarterly	Once per Operating Cycle
3. Discharge Flow Rate Monitor	-----	Once per Operating Cycle
Refuel Floor Exhaust		
1. Noble Gas Monitor	-----	Once per Operating Cycle
2. Iodine & Particulate Sampler	Quarterly	Once per Operating Cycle
3. Discharge Flow Rate Monitor	-----	Once per Operating Cycle
Reactor Building Exhaust		
1. Noble Gas Monitor [(a)]	Quarterly	Once per Operating Cycle
2. Iodine & Particulate Sampler [(a)]	Quarterly	Once per Operating Cycle
3. Discharge Flow Rate Monitor	-----	Once per Operating Cycle
Turbine Building Exhaust		
1. Noble Gas Monitor	-----	Once per Operating Cycle
2. Iodine & Particulate Sampler	Quarterly	Once per Operating Cycle
3. Discharge Flow Rate Monitor	-----	Once per Operating Cycle
Radwaste Building Exhaust		
1. Noble Gas Monitor	-----	Once per Operating Cycle
2. Iodine & Particulate Sampler	Quarterly	Once per Operating Cycle
3. Discharge Flow Rate Monitor	-----	Once per Operating Cycle

(a) The same instrument is used for the monitor and sampler.

(b) This calibration consists of verifying the flowrate with an independent calibrated instrument and adjusting flowrate as necessary.

3.2. GASEOUS EFFLUENT DOSE RATES

3.2.1. **Control**

The DOSE RATE at or beyond the SITE BOUNDARY due to radioactive materials released from the plant in gaseous effluents shall be limited as follows:

1. For noble gases: ≤500 mrem/year to the whole body and ≤3000 mrem/year to the skin, and
2. For Iodine-131, Iodine-133, Tritium and for radioactive materials in particulate form with half-lives greater than 8 days ≤1500 mrem/year to any ORGAN.

3.2.2. **Applicability**

Applies to the radiation DOSE RATE from radioactive material in gaseous effluents from the plant.

1. Objective

   To ensure that the DOSE RATES at or beyond the SITE BOUNDARY from gaseous effluents do not exceed the annual DOSE limits of 10 CFR 20 for UNRESTRICTED AREAS.

3.2.3. **ACTIONS**

With the DOSE RATE(s) exceeding the above limits, immediately restore the release rate to within the above limit(s).

3.2.4. **Surveillance Requirements**

1. Applicability

   Applies to the calculation of the DOSE RATES from radioactive materials in gaseous effluents from the plant.

2. Objective

   To ensure that appropriate calculations are performed to determine the DOSE RATES from gaseous effluents from the plant.

3. Specifications

   A. The DOSE RATE due to noble gases in gaseous effluents shall be determined to be continuously within the limits of Section 3.2.1, in accordance with the methods and procedures of the ODCM (Part 2, Section 12.3.1).

   B. The DOSE RATE due to Iodine-131, Iodine-133, Tritium and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents, shall be determined to be within the above limits in accordance with the methods and procedures of the ODCM (Part 2, Section 12.3.2). This will be done by obtaining representative samples and performing analyses in accordance with the sampling and analyses program specified in Table 3.2-1.

3.2.5. **Bases**

This specification provides reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER(S) OF THE PUBLIC in an UNRESTRICTED AREA, either at or beyond the SITE BOUNDARY in excess of the design objectives of Appendix I to 10CFR50. This specification is provided to ensure that gaseous effluents from the plant will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II.C design objectives of Appendix I to 10CFR50. The specified limits restrict, at all times, the corresponding GAMMA and BETA DOSE RATES above background to an individual at or beyond the exclusion area boundary to ≤ 500 mrem/year to the whole body or to ≤ 3000 mrem/year to the skin. These limits also restrict the corresponding thyroid DOSE RATE above background to a child via the inhalation pathway to ≤ 1500 mrem/year.

TABLE 3.2-1

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (µCi/ml)
Main Stack Refuel Floor VENT Reactor Building VENT Turbine Building VENT Radwaste Building VENT	Monthly Grab Sample[d]	Monthly Noble Gases[b]	Principal GAMMA Emitters[b]	1×10^{-4}
	Quarterly Grab Sample	Quarterly	H-3	1×10^{-6}
	Continuous[c]	Weekly Charcoal Sample[e]	I-131	1×10^{-12}
			I-133	None
	Continuous[c]	Weekly Particulate Sample[e]	Principal GAMMA Emitters[b]	1×10^{-11}
			(I-131, I-133, others)	None
	Continuous[c]	1 Wk/Mo Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous[c]	4 Wk/Qtr Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
	Continuous[c]	Noble Gas Monitor	Noble Gases Gross BETA or GAMMA	1×10^{-5}
Incinerated Oil[f]	Prior to Each Batch[g]	Each Batch[g]	Principal GAMMA Emitters[b]	5×10^{-7}
			I-131	1×10^{-6}

See notes next three pages

NOTES FOR TABLE 3.2-1

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

For a particular measurement system (which may include radiochemical separation):

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Eq. 3.2-1

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

Where:

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

s_b	=	standard deviation of the background counting rate or of the counting rate of a blank sample, as appropriate (in counts per minute);
E	=	counting efficiency (in counts per disintegration);
V	=	sample size (in units of mass or volume);
2.22×10^6	=	number of disintegrations per minute per microcurie;
Y	=	fractional radiochemical yield (when applicable);
λ	=	radioactive decay constant for the particular radionuclide; and
Δt	=	for plant effluents, is the elapsed time between the midpoint of sample collection and time of counting.

Typical values of E, V, Y, and Δt should be used in the calculations.

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

Alternative LLD Methodology

An alternative methodology for LLD determination follows and is similar to the above LLD equation:

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Eq. 3.2-2

$$LLD = \frac{\left(2.71 + 4.65\sqrt{B}\right) \times Decay}{E \times q \times b \times Y \times t \left(2.22 \times 10^6\right)}$$

Where:

B	=	background sum (counts)
E	=	counting efficiency, (counts detected/disintegration's)
q	=	sample quantity, (mass or volume)
b	=	abundance, (if applicable)
Y	=	fractional radiochemical yield, coincidence correction, or collection efficiency, (if applicable)
t	=	count time (minutes)
2.22×10^6	=	number of disintegration's per minute per microCurie
$2.71 + 4.65\sqrt{B}$	=	$k2 + (2k \sqrt{2B} \sqrt{B})$, and k = 1.645. (k=value of the t statistic from the single-tailed t distribution at a significance level of 0.95 and infinite degrees of freedom. This means that the LLD result represents a 95% detection probability with a 5% probability of falsely concluding that the NUCLIDE present when it is not or that the NUCLIDE is not present when it is.)
Decay	=	$e\ \lambda\ \Delta t\ [\lambda\ RT/(1\text{-}e\text{-}\ \lambda\ RT)]\ [\lambda\ Td/(1\text{-}e\text{-}\ \lambda\ Td)]$, (if applicable)
λ	=	radioactive decay constant, (units consistent with Δt, RT and Td)
Δt	=	"delta t", or the elapsed time between sample collection or the midpoint of sample collection and the time the count is started, depending on the type of sample, (units consistent with λ)
RT	=	elapsed real time, or the duration of the sample count, (units consistent with λ)
Td	=	sample deposition time, or the duration of analyte collection onto the sample media, (units consistent with λ)

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

(b) The principal GAMMA emitters for which the LLD specification applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, Xe-135m, and Xe-138 for gaseous emissions; and, Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for particulate emissions. This list does not mean that only these NUCLIDES are to be detected and reported. Other peaks that are measurable and identifiable, together with the above NUCLIDES, shall also be identified and reported in the Radioactive Effluent Release Report. The LLD for Mo-99, Ce-141, and Ce-144 is $5\times10^{-11}\mu Ci/ml$. For oil samples, Table 2.2-1, Note (c) applies.

(c) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each DOSE or DOSE RATE calculation made in accordance with Specifications. This determination shall be made using design flow rates if flow meters are not provided or are INOPERABLE.

(d) Main stack gaseous sampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER change exceeding 20% of RATED THERMAL POWER in one hour.

1. This requirement applies only if:
   - Analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has increased more than a factor of 3; and
   - The noble gas monitor shows that effluent activity has increased more than a factor of 3; and
   - Corrections for increases due to changes in THERMAL POWER level have been made in both cases.

(e) Main stack iodine and particulate sampling shall also be performed daily following each shutdown, startup or THERMAL POWER change exceeding 20% of RATED THERMAL POWER in one hour.

1. Daily sampling is not required for THERMAL POWER changes if the offgas charcoal filters are in service.
2. In addition, this requirement applies only if:
   - Analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has increased more than a factor of 3; and
   - The noble gas monitor shows that effluent activity has increased more than a factor of 3; and
   - Corrections for increases due to changes in THERMAL POWER level have been made in both cases.
3. Daily sampling shall be performed until two consecutive samples show no increase in concentration but not to exceed 7 consecutive days.
4. LLDs may be increased by a factor of 10 for analysis of daily samples.
5. Analysis of daily and weekly samples shall be completed within 48 hours of changing.

(f) Incinerated oil may be discharged via points other than the main stack and building VENTS (i.e., auxiliary boiler). Release shall be accounted for based on pre-release grab sample data.

(g) Samples of incinerated oil releases shall be collected from and representative of filtered oil in liquid form. Whenever oil samples cannot be filtered such as No. 6 bunker fuel oil, raw oil samples shall be collected and analyzed.

3.3. DOSE - NOBLE GASES

3.3.1. **Control**

The air DOSE to areas at or beyond the SITE BOUNDARY from noble gases released from the plant in gaseous effluents shall be limited:

1. During any calendar quarter, to less than or equal to 5 mrad from GAMMA radiation, and less than or equal to 10 mrad from BETA radiation; and,
2. During any calendar year, to less than or equal to 10 mrad from GAMMA radiation and less than or equal to 20 mrad from BETA radiation.

3.3.2. **Applicability**: At all times.

Applies to the air DOSE due to noble gases released from the plant.

1. Objective

   To ensure that the noble gas DOSE limitations of 10 CFR 50, Appendix I, are met.

3.3.3. **ACTIONS**

With the calculated air DOSE from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission, within 30 days, a report that:

1. Identifies the cause(s) for exceeding the limit(s); and
2. Defines the corrective actions that have been taken to reduce the releases; and
3. Identifies the proposed corrective actions to be taken to ensure that subsequent releases will be in compliance with the above limits.

3.3.4. **Surveillance Requirements**

1. Applicability

   Applies to the calculation of the air DOSE due to noble gas effluent.

2. Objective

   To ensure that appropriate calculations are performed to determine the air DOSE from noble gas effluents.

3. Specifications

   Cumulative air DOSE contributions for noble gases shall be calculated at least monthly in accordance with the ODCM (Part 2, Section 12.4.2) for the current calendar quarter and the current calendar year.

3.3.5. **Bases**

This specification is provided to assure that the requirements of 10 CFR 50, Appendix I, Section II.B, III.A and IV.A are met. This specification implements the guides set forth in Appendix I, Section II.B. The specification provides the required operating flexibility and, at the same time, implements the guides set forth in Appendix I, Section IV.A, to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable".

3.4. DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM

3.4.1. **Control**

The DOSE to a MEMBER(S) OF THE PUBLIC at or beyond the SITE BOUNDARY from Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days released from the plant in gaseous effluents shall be limited to the following:

1. During any calendar quarter to less than or equal to 7.5 mrem to any ORGAN; and,
2. During any calendar year to less than or equal to 15 mrem to any ORGAN.
3. Less than 0.1% of the limits of 3.4.1.1 and 3.4.1.2 as a result of burning contaminated oil.

3.4.2. **Applicability**: At all times.

Applies to the cumulative DOSE from Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents.

1. Objective

   To ensure that the DOSE limitations of 10 CFR 50, Appendix I, are met.

3.4.3. **ACTIONS**

With the calculated DOSE from the release of Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days a report that:

1. Identifies the cause(s) for exceeding the limit; and
2. Defines the corrective actions that have been taken to reduce the releases; and
3. Identifies the proposed corrective actions to be taken to ensure that subsequent releases will be in compliance with the above limits.

3.4.4. **Surveillance Requirements**

1. Applicability

   Applies to the calculation of the DOSE due to Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents.

2. Objective

   To ensure that appropriate calculations are performed to determine the DOSE from Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days.

3. Specifications

   Cumulative DOSE contributions shall be calculated at least monthly in accordance with the ODCM (Part 2, Section 12.4.2.3) for the current calendar quarter and the current calendar year.

3.4.5. **Bases**

This specification is provided to assure that the requirements of 10 CFR 50, Appendix I, Section II.C, III.A and IV.A are met. This specification implements the guides set forth in Appendix I, Section II.C. The specification provides the required operating flexibility and, at the same time, implements the guides set forth in Appendix I, Section IV.A, to assure that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable."

3.5. GASEOUS RADWASTE TREATMENT SYSTEM

3.5.1. Control

1. The GASEOUS RADWASTE TREATMENT SYSTEM shall be used to reduce the concentration of radioactive materials in gaseous effluents prior to release from the plant within 24 hours after the start-up of the second turbine driven feedwater pump.
2. The offgas charcoal beds shall be used, when GASEOUS RADWASTE TREATMENT SYSTEM operation is required and the projected DOSES over a 31-day period due to gaseous effluent releases to a MEMBER(S) OF THE PUBLIC at or beyond the SITE BOUNDARY would exceed:
   A. 0.2 mrad for GAMMA radiation; or
   B. 0.4 mrad for BETA radiation; or
   C. 0.3 mrem to any ORGAN

3.5.2. Applicability

Applies to the system installed for reduction of radioactive materials in gaseous waste prior to discharge.

1. Objective

   To minimize concentration of radioactive materials released from the site.

3.5.3. ACTIONS

1. With gaseous effluent from the main condenser being discharged without use of the charcoal beds for greater than seven days when TREATMENT is required, and projected DOSES are in excess of the above limits, prepare and submit to the Commission, within 30 days, a Special Report that includes the following information:
   A. Explanation of why gaseous effluent is being discharged without charcoal bed TREATMENT, identification of any INOPERABLE equipment or subsystems, and the reason for the INOPERABILITY.
   B. ACTION(S) taken to restore the INOPERABLE equipment to OPERABLE status.
   C. Summary description of ACTION(S) taken to prevent a recurrence.

3.5.4. Surveillance Requirements

1. Applicability

   Applies to the calculation of the radiation DOSE from gaseous effluents containing radioactive materials.

2. Objective

   To ensure that TREATMENT of gaseous wastes by the offgas system is implemented when required.

3. Specifications

   A. If the charcoal beds are not in service when the GASEOUS RADWASTE TREATMENT SYSTEM is required, DOSES due to gaseous releases from the site shall be projected at least monthly in accordance with the ODCM (Part 2, Section 12.5).

3.5.5. Bases

This specification is provided to ensure that the system will be available for use when required to reduce projected DOSES due to gaseous releases. This specification assures that the requirements of 10 CFR 50.36a, 10 CFR 50, Appendix A, General Design Criterion 60, and design objective in 10 CFR 50, Appendix I, Section II.D are met. The specified limits governing the use of appropriate portions of the systems are specified as a suitable fraction of the guide values set forth in 10 CFR 50, Appendix I, Sections II.B and II.C, for gaseous effluents.

The requirement for GASEOUS RADWASTE TREATMENT SYSTEM OPERABILITY provides assurance that the release of radioactive materials in gaseous waste will be kept "as low as is reasonably achievable." OPERABILITY of the system is based upon start-up of the second turbine driven feedwater pump. This is due to the fact that excess air in-leakages in the main condenser as a result of operating only one turbine driven feedwater pump will exceed GASEOUS RADWASTE TREATMENT SYSTEM limitations and consequently render the system INOPERABLE. Start-up of the second turbine driven feedwater pump will decrease air in-leakages and assure GASEOUS RADWASTE TREATMENT SYSTEM availability.

3.6. MAIN CONDENSER STEAM JET AIR EJECTOR RADIATION MONITORS

3.6.1. **Control**

Except as specified in ACTIONS 1 and 2 below, both SJAE system radiation monitors shall be OPERABLE with a trip level setting of ≤ 500,000 μCi/sec. The trip time delay setting for closure of the SJAE isolation valve shall be <15 minutes.

3.6.2. **Applicability**

MODE 1, MODES 2 and 3 with any main steam line not isolated and steam jet air ejectors (SJAE) in operation.

Applies to the instrumentation required for monitoring the main condenser offgas steam jet air ejector (SJAE) radiation

1. Objective

   To ensure that the SJAE release rates are maintained at a level compatible for further TREATMENT and release.

3.6.3. **ACTIONS**

1. A channel may be placed in an INOPERABLE status for up to six hours during periods of required surveillance without placing the Trip System in the tripped condition provided the other OPERABLE channel is monitoring that Trip Function. Otherwise, in the event that one of the two SJAE radiation monitors is made or found to be INOPERABLE, continued operation is permissible provided that the INOPERABLE monitor is tripped.
2. Upon the loss of both SJAE system radiation monitors, either:

   A. Monitor radiation levels at the SJAE within 36 hours

   OR

   B. Sample SJAE system daily to ensure the release rate is ≤ 500,000 μCi/sec

   OR

   C. Enter Tech Spec 3.7.5, Main Condenser Steam Jet Air Ejector (SJAE) Offgas

3.6.4. Surveillance Requirements

1. Applicability

   Applies to the instrumentation required for monitoring the main condenser offgas steam jet air ejector (SJAE) radiation when the reactor is in MODE 1, and MODE 2 or 3 with any main steam line not isolated and SJAE is in operation.

2. Objective

   To ensure that the SJAE release rates are properly monitored.

3. Specifications

   Operation of the SJAE radioactive offgas monitors shall be verified by performing instrument surveillance as specified on Table 3.6-1.

3.6.5. Bases

This specification is provided to assure that remedial ACTION is taken to limit the noble gas release rate at the SJAE. The requirement provides reasonable assurance that the amount of noble gas that must be treated and/or released is controlled to a level that prevents exceeding the limits specified in Part 1, Section 3.2.1.

Two air ejector offgas monitors are provided and when their trip point is reached; cause an isolation of the air ejector offgas line. Isolation is initiated when one instrument reaches its high-high trip point and the other has a high-high trip, an inoperative trip or a downscale trip. There is a 15-minute delay before the air ejector offgas isolation valve is closed. This delay is accounted for by the 30-minute holdup time of the offgas before it is released to the stack. Both instruments are required for an isolation of the air ejector offgas line, but the instruments are so designed that any instrument failure gives a downscale or inoperative alarm.

Upon the loss of both SJAE system radiation monitors, installation of temporary monitoring or daily sampling at the SJAE is acceptable. These ACTIONS provide regular monitoring of the system radiation levels If temporary monitoring is not installed or daily sampling is not performed, TS 3.7.5 is entered since the ability to monitor radiation levels (gross GAMMA activity rate of noble gases) is lost.

TABLE 3.6-1

MINIMUM TEST AND CALIBRATION FREQUENCY FOR RADIATION MONITORING SYSTEMS[a]

Instrument Channels	Channel Check[b]	Channel Calibration[e][f]	LOGIC SYSTEM FUNCTIONAL TEST[c][d]
SJAE Radiation Monitors/Offgas Line Isolation	Daily	Quarterly	Once per 24 months

a. CHANNEL CALIBRATIONS and CHANNEL CHECKS need not be performed when these instruments are not required to be OPERABLE or are tripped.

b. CHANNEL CHECKS shall be performed at least once per day during these periods when the instruments are required to be OPERABLE.

c. Simulated automatic actuation shall be performed once every 24 months. Simulated automatic actuation means applying a simulated signal to the sensor to actuate the circuit.

d. The LOGIC SYSTEM FUNCTIONAL TEST shall include a calibration of time delay relay necessary for proper functioning of the trip system.

e. The radiation sensors are excluded from the quarterly calibration. The radiation sensors shall be calibrated every 24 months.

f. A successful test of the required contact(s) of a channel relay may be performed by the verification of the change of state of a single contact of the relay. This clarifies what is an acceptable CHANNEL FUNCTIONAL TEST of a relay. This is acceptable because all of the other required contacts of the relay are verified by other Technical Specifications and non-Technical Specification tests at least once per refueling interval with the applicable extension.

3.7. VENTILATION EXHAUST TREATMENT SYSTEM

3.7.1. **Control**

The VENTILATION EXHAUST TREATMENT SYSTEM shall be OPERABLE and appropriate portions of the VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the projected DOSES in 31 days due to gaseous effluent releases from the site to areas at and beyond the SITE BOUNDARY would exceed:

1. 0.2 mrad to air from GAMMA radiation, or
2. 0.4 mrad to air from BETA radiation, or
3. 0.3 mrem to any ORGAN of a MEMBER OF THE PUBLIC.

3.7.2. **Applicability**: At all times

3.7.3. **ACTIONS**

With radioactive gaseous waste being discharged without TREATMENT and in excess of the above limits, prepare and submit to the NRC within 30 days, a Special Report which includes the following information:

1. Identification of the INOPERABLE equipment or subsystems and the reason for INOPERABILITY,
2. ACTION(S) taken to restore the INOPERABLE equipment to OPERABLE status, and
3. A summary description of ACTION(S) taken to prevent a recurrence.

3.7.4. **Surveillance Requirements**

1. DOSES due to gaseous releases from the unit to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the ODCM when the VENTILATION EXHAUST TREATMENT SYSTEM is not being fully utilized.
2. The installed VENTILATION EXHAUST TREATMENT SYSTEM shall be considered OPERABLE by meeting Controls 3.2.1, and either 3.3.1 or 3.4.1.

3.7.5. **Bases**

The use of the VENTILATION EXHAUST TREATMENT SYSTEM ensures that gaseous effluents are treated as appropriate prior to release to the environment. The appropriate portions of this system provide reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the guide set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

4. TOTAL DOSE

4.1. GASEOUS EFFLUENT MONITORS

4.1.1. Control

The DOSE or DOSE COMMITMENT to any MEMBER(S) OF THE PUBLIC, due to releases of radioactivity and radiation, from uranium fuel cycle sources shall be limited as follows:

1. Less than or equal to 25 mrem/year to the whole body; and,
2. Less than or equal to 25 mrem/year to any ORGAN except the thyroid which shall be limited to less than or equal to 75 mrem/year

4.1.2. Applicability

Applies to radiation DOSE from releases of radioactivity and radiation from uranium fuel cycle sources.

1. Objective
   - A. To assure that the requirements of 40 CFR 190 are met.
   - B. To assure that the requirements of 10 CFR 72.104 are met in accordance with Section 3.2.3, Required Action A.2, Certificate of Compliance 1014, Appendix A, Technical Specifications for the Hi-Storm 100 Cask System.

4.1.3. ACTIONS

With the calculated DOSES from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Section 2.3.1, 3.3.1, 3.4.1.1 or 3.4.1.2, calculations shall be made including an estimate of direct radiation contributions to determine whether the limits of Section 4.1.1 have been exceeded. If this is the case, a report defining corrective actions to be taken to reduce subsequent releases to levels within limits, along with a schedule for achieving conformance, shall be prepared and submitted to the Commission within 30 days. This report, as defined in 10 CFR 20.2203(c), shall include estimates of the radiation exposure (DOSE) to a MEMBER(S) OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentration of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated DOSE(s) exceed(s) the above limits, and if the release condition resulting in violation of 40 CFR 190 and 10 CFR 72.104(a) has not already been corrected, the report shall include a request for variance in accordance with the provisions of 40 CFR 190 and 10 CFR 72. Submittal of the report is considered a timely request, and a variance is granted until staff ACTION on the request is complete.

4.1.4. **Surveillance Requirements**

1. Applicability

   Applies to the calculation of total DOSE due to releases of radioactivity and radiation from uranium fuel cycle sources.

2. Objective

   To ensure that appropriate calculations are performed to determine total DOSE to a MEMBER(S) OF THE PUBLIC.

3. Specifications

   A. DOSE Calculations: Cumulative DOSE contributions from liquid and gaseous effluents shall be determined in accordance with Sections 2.3.4.3, 3.3.4.3, 3.4.4.3, and in accordance with the ODCM (Part 2, Section 13).

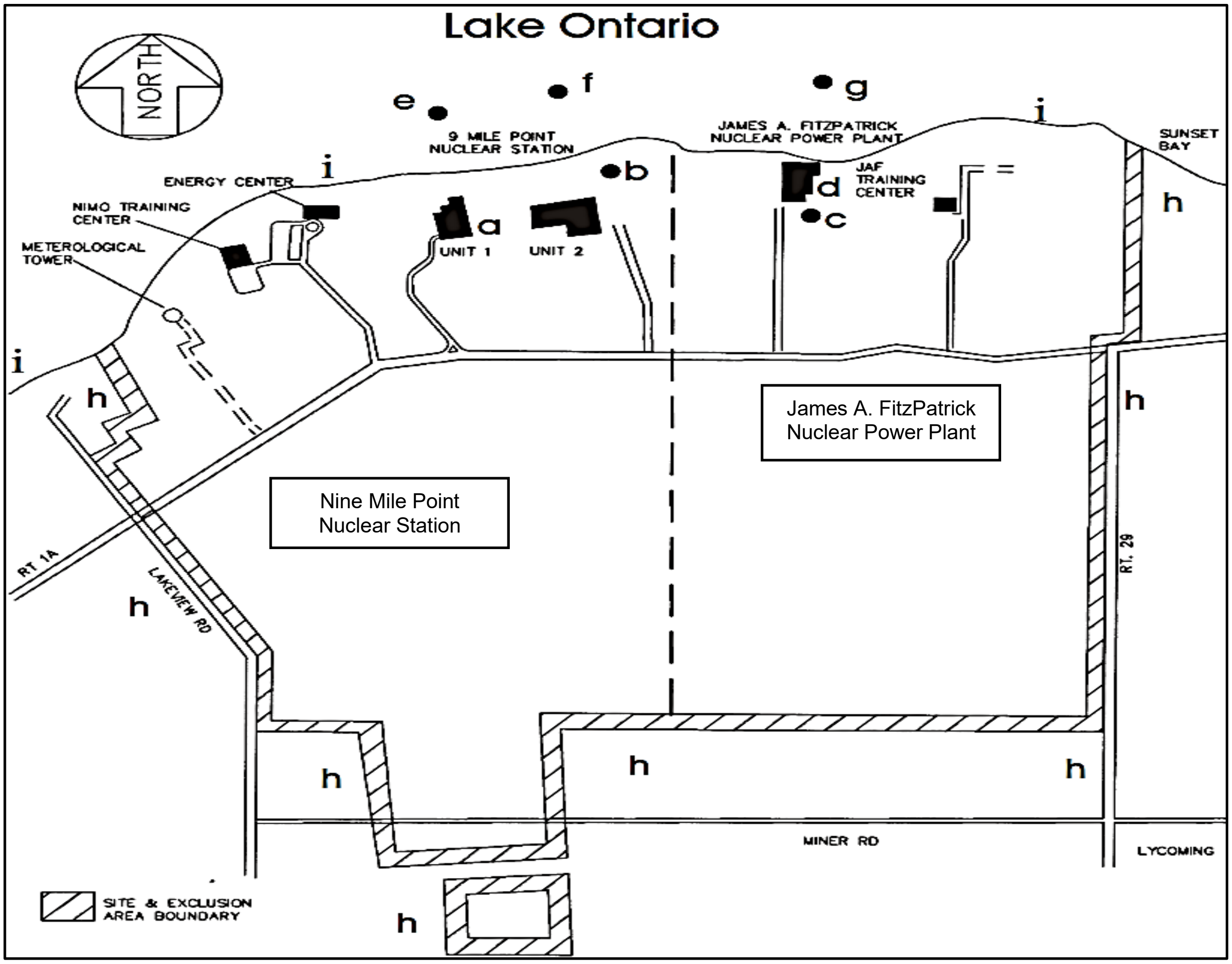
   B. Cumulative DOSE contributions from direct radiation from the reactor units and from radwaste storage tanks shall be determined in accordance with the methodology and parameters in the ODCM (Part 2, Section 13.4). This requirement is applicable only under conditions set forth in Section 4.1.3.

4.1.5. **Bases**

This specification is provided to meet the DOSE limitations of 40 CFR 190 and 10 CFR 72.104(a). This specification requires the preparation and submittal of a report whenever the calculated DOSE from plant radioactive effluents exceed twice the design objective DOSES of 10 CFR 50, Appendix I. The report will describe a course of ACTION that should result in the limitation of the annual DOSE to a MEMBER(S) OF THE PUBLIC to within the limits of 40 CFR 190 and 10 CFR 72.104(a). For the purpose of the report, it may be assumed the DOSE COMMITMENT to the MEMBER(S) OF THE PUBLIC from other uranium fuel cycle sources is negligible. However, DOSE contributions from other nuclear fuel cycle facilities at the same site or within a radius of 5 miles must be considered. If the DOSE to any MEMBER(S) OF THE PUBLIC is estimated to exceed the requirements of 40 CFR 190 or 10 CFR 72.104(a), the report, with a request for variance (provided the release conditions resulting in a violation of 40 CFR 190 or 10 CFR 72.104(a) have not already been corrected), shall be submitted in accordance with provisions of 40 CFR 190.11 and 10 CFR 20.2203(c). This request is considered a timely request and fulfills the requirements of 40 CFR 190 and 10 CFR 72 until NRC staff ACTION is completed. The variance only relates to the limits of 40 CFR 190 or 10 CFR 72.104(a) and does not apply in any way to the requirements for DOSE limitation addressed in Specifications 2.0 and 3.0. An individual is not considered a MEMBER(S) OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

FIGURE 4.1-1

SITE BOUNDARY MAP



NOTES TO FIGURE 4.1-1

(a) NMP1 stack (height is 350 feet)
(b) NMP2 stack (height is 430 feet)
(c) JAFNPP stack (height is 385 feet)
(d) Building VENTS
(e) NMP1 radioactive liquid discharge (Lake Ontario, bottom)
(f) NMP2 radioactive liquid discharge (Lake Ontario, bottom)
(g) JAFNPP radioactive liquid discharge (Lake Ontario, bottom)
(h) SITE BOUNDARY
(i) Lake Ontario shoreline

Additional Information:

- NMP2 Reactor Building VENT is located 187 feet above ground level.
- JAFNPP Reactor and Turbine Building VENTS are located 173 feet above ground level.
- JAFNPP Radwaste Building VENT is 112 feet above ground level.

5. RADIOLOGICAL ENVIRONMENTAL MONITORING

5.1. MONITORING PROGRAM

5.1.1. Control

In accordance with JAF Tech Specs 5.5.1 and 5.6.2, the Radiological Environmental Monitoring Program shall be conducted as specified in Table 5.1-1.

5.1.2. **Applicability**: At all times.

1. Objective

   To evaluate the effects of plant operation on the environs and to verify the effectiveness of the controls on radioactive material.

5.1.3. ACTIONS

1. With the Radiological Environmental Monitoring Program not being conducted as specified in Table 5.1-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

   (Deviations are permitted from the required sampling schedule if samples are unobtainable due to hazardous conditions, seasonal unavailability, theft, uncooperative residents, or to malfunction of automatic sampling equipment. If the latter, efforts shall be made to complete corrective action prior to the end of the next sampling period.)

2. With the level of radioactivity (as the result of plant effluents) in an environmental sampling medium at a specified location exceeding the reporting levels of Table 5.1-2 when averaged over any calendar quarter, prepare and submit to the Commission a report within thirty (30) days from the end of the affected calendar quarter or within thirty (30) days from the time it is determined that a reporting level has been exceeded. This report shall identify the cause(s) for exceeding the limits(s) and define the corrective action(s) to be taken to reduce radioactive effluents so that the calculated annual DOSE to a MEMBER(S) OF THE PUBLIC is less than the calendar year limits of Sections 2.3.1.2, 3.3.1.2, and 3.4.1.2. When more than one of the radionuclides in Table 5.1-2 are detected in the sampling medium, this report shall be submitted if:

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

   When radionuclides other than those in Table 5.1-2 are detected, and are the result of plant effluents, this report shall be submitted if the calculated annual DOSE to an individual is equal to or greater than the calendar year limits of Sections 2.3.1.2, 3.3.1.2, and 3.4.1.2.

This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

3. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 5.1-1, locations for obtaining replacement samples shall be identified and added to the Radiological Environmental Monitoring Program within 30 days. The specific locations from which samples were unavailable may then be deleted from the monitoring program. The cause of the unavailability of samples and the new location(s) for obtaining replacement samples shall be identified in the next Radioactive Effluent Release Report. Also included in the report shall be a revised figure(s) and table for the ODCM reflecting the new location(s).

5.1.4. **Surveillance Requirements**

The radiological environmental monitoring samples shall be collected, pursuant to Table 5.1-1, from the locations given in the table and figure(s) in the ODCM (Appendix H) and shall be analyzed pursuant to the requirements of Table 5.1-1, and the detection capabilities required by Table 5.1-3.

5.1.5. **Bases**

The Radiological Environmental Monitoring Program required by this specification provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures to members of the public resulting from station operation. This monitoring program ensures that 10 CFR 50, Appendix I, Section IV.B.2 is met. It thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected, based on the effluent measurements and the modeling of the environmental exposure pathways. The initial specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the Lower Limit of Detection (LLDs). The LLDs required by Table 5.1-3 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system. The LLD is not a posteriori (after the fact) limit for a particular measurement.

TABLE 5.1-1

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/ or Sample	Number of Samples[a] and Locations	Sampling and Collection Frequency[a]	Type and Frequency of Analysis
AIRBORNE			
Radioiodine and Particulates	Samples from 5 locations: a. 3 samples from offsite locations in different sectors of the highest calculated site average D/Q (based on all licensed site reactors) b. 1 sample from the vicinity of a community having the highest calculated site average D/Q (based on all licensed site reactors) c. 1 sample from a control location 9 to 20 miles distant and in the least prevalent wind direction[d]	Continuous sample operation with sample collection weekly or as required by dust loading, whichever is more frequent	Radioiodine Canisters: Analyze weekly for I-131 Particulate Samples: Gross BETA radioactivity following filter change[b], composite (by location) for GAMMA isotopic[c] quarterly (as a minimum)
Direct Radiation[e]	32 stations with two or more dosimeters placed as follows: a. An inner ring of stations in the general area of the SITE BOUNDARY b. An outer ring in the 4 to 5 mile range from the site with a station in each of the land-based sectors. There are 16 land-based sectors in the inner ring and 8 land-based sectors in the outer ring c. The balance of the stations (8) are placed in special interest areas such as population centers, nearby residences, schools, and in 2 or 3 areas to serve as control stations	Quarterly	GAMMA DOSE monthly or quarterly
WATERBORNE			
Surface[f]	a. 1 sample upstream[d] b. 1 sample from the site's most downstream cooling water intake	Composite sample over one-month period[g]	GAMMA isotopic analysis monthly. Composite for tritium analysis quarterly[c]
Sediment from Shoreline	1 sample from a downstream area with existing or potential recreational value	Twice per year	GAMMA isotopic analysis semi-annually[c]

TABLE 5.1-1 (continued)
OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/ or Sample	Number of Samples[a] and Locations	Sampling and Collection Frequency[a]	Type and Frequency of Analysis
INGESTION			
Milk	a. Samples from milch animals in 3 locations within 3.5 miles distant having the highest calculated site average D/Q. If there are none, then 1 sample from milch animals in each of 3 areas 3.5 to 5.0 miles distant having the highest calculated site average D/Q (based on all licensed site reactors)[h] b. 1 sample from milch animals at a control location (9 to 20 miles distant and in a less prevalent wind direction)[d]	Twice per month, April through December (samples will be collected in January through March, if I-131 is detected in November and December of the preceding year)	GAMMA isotopic and I-131 analysis twice per month when milch animals are on pasture (April through December); monthly (January through March), if required[c]
Fish	a. 1 sample of 2 commercially or recreationally important species in the vicinity of a site discharge point b. 1 sample of 2 species (same as in a. above or of a species with similar feeding habits) from an area at least 5 miles distant from the site[d]	Twice per year	GAMMA isotopic[c] analysis of edible portions
Food Products	a. In lieu of the garden census as specified in Part 1, Section 5.2, samples of at least 3 different kinds of broad leaf vegetation (such as vegetables) grown nearest each of two different offsite locations of highest predicted site average D/Q (Based on all licensed site Reactors) One (1) sample of each of the similar broad leaf vegetation grown at least 9.3 miles distant in a least prevalent wind direction sector[d]	Once during harvest season	GAMMA isotopic[c] analysis of edible portions. (Isotopic to include I-131)

NOTES FOR TABLE 5.1-1

(a) It is recognized that, at times, it may not be possible or practical to obtain samples of the media of choice at the most desired location or time. In these instances, suitable alternative media and locations may be chosen for the particular pathway in question. Actual locations (distance and directions) from the site shall be provided in the Annual Radiological Environmental Operating Report. Calculated site averaged D/Q values and meteorological parameters are based on historical data (specified in the ODCM) for all licensed site reactors.

(b) Particulate sample filters should be analyzed for gross BETA 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross BETA activity in air particulate samples is greater than 10 times a historical yearly mean of control samples, GAMMA isotopic analysis shall be performed on the individual samples.

(c) GAMMA isotopic analysis means the identification and quantification of GAMMA emitting radionuclides that may be attributable to the effluents from the plant.

(d) The purpose of these samples is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites which provide valid background data may be substituted.

(e) One or more instruments, such as a pressurized ion chamber, for measuring and recording DOSE RATE continuously may be used in place of, or in addition to, integrating dosimeters. For the purpose of this table, a thermoluminescent dosimeter may be considered to be one phosphor and two or more phosphors in a packet may be considered as two or more dosimeters. Film badges shall not be used for measuring direct radiation.

(f) The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream sample" shall be taken in an area beyond, but near, the mixing zone, if practical.

(g) Composite samples should be collected with equipment (or equivalent) which is capable of collecting an aliquot at time intervals which are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to ensure that a representative sample is obtained.

(h) A milk sampling location, as required in Table 5.1-1 is defined as a location having at least 10 milking cows present at a designated milk sample location. It has been found from past experience, and as a result of conferring with local farmers, that a minimum of 10 milking cows is necessary to guarantee an adequate supply of milk twice per month for analytical purposes. Locations with less than 10 milking cows are usually utilized for breeding purposes which eliminates a stable supply of milk for samples as a result of suckling calves and periods when the adult animals are dry. In the event that 3 milk sample locations cannot meet the requirement for 10 milking cows, then a sample location having less than 10 milking cows can be used if an adequate supply of milk can reasonably and reliably be obtained based on communications with the farmer.

TABLE 5.1-2

REPORTING LEVELS

FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)
H-3	30,000[(a)]				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr/Nb-95	400				
I-131	20[(a)]	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba/La-140	200			300	

(a) No drinking water pathway exists at the James A. FitzPatrick/Nine Mile Point sites under normal operating conditions due to the distance and direction of the nearest drinking water intake. Therefore, value of 30,000 pCi/liter is used for H-3 (tritium) and 20 pCi/liter is used for I-131 (iodine).

TABLE 5.1-3

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[a]

LOWER LIMIT OF DETECTION (LLD)[b]

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross BETA	4	0.01				
H-3	3,000[c]					
Mn-54	15		130			
Fe-59	30		260			
Co-58,60	15		130			
Zn-65	30		260			
Zr/Nb-95	15					
I-131	15[c]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba/La-140	15			15		

(See notes next page)

NOTES FOR TABLE 5.1-3

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

For a particular measurement system (which may include radiochemical separation),

$$LLD = \frac{4.66_{Sb}}{E \cdot V \cdot 2.22 x\ 10^{6} \cdot Y \cdot exp(-\lambda \Delta \tau)}$$

Where:

LLD is the a priori lower limit of detection, as defined above (in picocurie per unit mass or volume);

sb is the standard deviation of the background counting rate or of the counting rate of a blank sample, as appropriate (in counts per minute);

E	= counting efficiency (in counts per transformation);
V	= sample size (in units of mass or volume);
2.22×10^{6}	= number of transformations per minute per picocurie;
Y	= fractional radiochemical yield (when applicable);
λ	= radioactive decay constant for the particular radionuclide;
$\Delta\tau$	= elapsed time between sample collection (or end of the sample collection period) and time of counting.

Typical values of E, V, Y, and $\Delta\tau$ should be used in the calculations.

Alternative LLD Methodology

An alternative methodology for LLD determination follows and is similar to the above LLD equation:

$$LLD = \frac{\left(2.71 + 4.65\sqrt{B}\right) \text{ x Decay}}{\text{E x q x b x Y x t } \left(2.22 \text{ x } 10^{6}\right)}$$

Where:

B	=	background sum (counts)
E	=	counting efficiency, (counts detected/disintegration's)
q	=	sample quantity, (mass or volume)
b	=	abundance, (if applicable)
Y	=	fractional radiochemical yield, coincidence correction, or collection efficiency, (if applicable)
t	=	count time (minutes)
2.22×10^6	=	number of disintegration's per minute per microCurie
$2.71 + 4.65\sqrt{B}$	=	$k2 + (2k \sqrt{2B} \sqrt{B})$, and k = 1.645.
		(k=value of the t statistic from the single-tailed t distribution at a significance level of 0.95 and infinite degrees of freedom. This means that the LLD result represents a 95% detection probability with a 5% probability of falsely concluding that the NUCLIDE present when it is not or that the NUCLIDE is not present when it is.)
Decay	=	e λΔt [λRT/(1-e- λRT)] [λTd/(1-e- λTd)], (if applicable)
λ	=	radioactive decay constant, (units consistent with Δt, RT and Td)
Δt	=	"delta t", or the elapsed time between sample collection or the midpoint of sample collection and the time the count is started, depending on the type of sample, (units consistent with λ)
RT	=	elapsed real time, or the duration of the sample count, (units consistent with λ)
Td	=	sample deposition time, or the duration of analyte collection onto the sample media, (units consistent with λ)

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

(b) No drinking water pathway exists at the James A. FitzPatrick/ Nine Mile Point sites under normal operating conditions due to the direction and distance of the nearest drinking water intake. Therefore, an LLD value of 15 pCi/liter is used for I-131 and 3,000 pCi/liter is used for tritium.

5.2. LAND USE CENSUS PROGRAM

5.2.1. **Control**

A land use census shall be conducted and shall identify the locations of all milch animals, the nearest residence, and all gardens1 of greater than 50 square meters (500 ft^2) producing fresh leafy vegetables, in each of the 16 meteorological sectors within a distance of 8 km (5 miles) from the site.(1)

(1) Broad leaf vegetation sampling may be performed in lieu of the garden census as specified in Table 5.1-1.

5.2.2. **Applicability**: At all times.

5.2.3. **ACTIONS**

1. With a land use census identifying a milch animal in a location(s) which represents a calculated D/Q value greater than the values currently being used in calculating Surveillance Requirement 3.4.4.3, identify the new location(s) in the next Radioactive Effluent Release Report.
2. With the land use census identifying a milch animal location(s) that represents a calculated D/Q (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with Table 5.1-1, add the new location(s) to the Radiological Environmental Monitoring Program within 30 days. The sampling location(s), excluding the control station location, having the lowest calculated D/Q (via the same exposure pathway) may be deleted from this monitoring program after October 31 of the year in which this land use census is conducted. Identify the new location(s) in the next Radioactive Effluent Release Report and include the additions in the ODCM.

5.2.4. **Surveillance Requirements**

The land use census shall be conducted during the growing season at least once per 12 months using the information that will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities, etc. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report.

5.2.5. **Bases**

This specification is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the monitoring program are made if required by the results of this census. The best survey information, such as that from door-to-door surveys, aerial surveys, consultations with local agricultural authorities, etc., shall be used. This census satisfies the requirements of 10 CFR 50, Appendix I, Section IV.B.3. Restricting the census to gardens of greater than 50 m^2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in Regulatory Guide 1.109, Revision 1, October 1977, for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (i.e. similar to lettuce and cabbage), and, (2) a vegetable yield of 2 kg/m2. In lieu of the garden census the significance of the garden exposure pathway can be evaluated by the sampling of green leafy vegetables as specified in Table 5.1-1.

5.3. INTERLABORATORY COMPARISON PROGRAM

5.3.1. **Control**

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program. Participation in this program shall include all media for which samples are routinely collected and for which intercomparison samples are available.

5.3.2. **Applicability**: At all times.

1. Objective

   To provide quality control of environmental sample analyses.

5.3.3. **Specifications**

1. Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program. Participation in this program shall include all media for which samples are routinely collected and for which intercomparison samples are available.
2. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence in the Annual Radiological Environmental Operating Report.

5.3.4. **Surveillance Requirements**

A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report.

5.3.5. **Bases**

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

6. **REPORTS**

6.1. ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

6.1.1. The Annual Radiological Environmental Operating Report covering the operation of the plant during the previous calendar year shall be submitted by May 15 of each year.

6.1.2. The report shall include summaries, interpretations, and analyses of trends of the results of the Radiological Environmental Monitoring Program for the reporting period. The material provided shall be consistent with the objectives outlined in the OFFSITE DOSE CALCULATION MANUAL(ODCM), and in 10 CFR 50, Appendix I, Sections IV.B.2, IV.B.3, and IV.C. The report shall include a comparison with preoperational studies, operational controls (as appropriate), and environmental surveillance reports from the previous five years, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of the Land Use Census required by Specification 5.2.

6.1.3. The report shall include the results of analyses of all radiological environmental samples and of all environmental radiation measurements taken during the period at the locations specified in Table 5.1-1, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. This missing data shall be submitted in a supplementary report as soon as possible.

6.1.4. The report shall also include the following: A summary description of the Radiological Environmental Monitoring Program; at least two legible maps (one map shall cover stations near the SITE BOUNDARY; a second shall include the more distant stations) covering all sampling locations and keyed to a table giving distances and directions from the centerline of one reactor; the results of participation in the Interlaboratory Comparison Program required by Section 5.3, and discussion of all analyses in which the LLDs required by Table 5.1-3 were not routinely achievable.

6.2. RADIOACTIVE EFFLUENT RELEASE REPORT

The Radioactive Effluent Release Report covering the operation of the plant during the previous year shall be submitted prior to May 1 of each year in accordance with 10 CFR 50.36a.

6.2.1. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the plant. The material provided shall be consistent with the objectives outlined in the ODCM (Part 2) and PROCESS CONTROL PROGRAM and in conformance with 10 CFR 50.36a and 10 CFR 50, Appendix I, Section IV.B.1. The summary can be provided using as guidance Regulatory Guide 1.21, Revision 1, June 1974, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plant", with data summarized on a quarterly basis following the format of Appendix B thereof.

6.2.2. The report may include an annual summary of meteorological data collected over the previous year. If the meteorological data is not included, ENO shall retain it on file and provide it to the US Nuclear Regulatory Commission upon request. This same report shall include an assessment of the radiation DOSES due to the radioactive liquid and gaseous effluents released from the plant during the previous calendar year to the public. All assumptions used in making these assessments (i.e., specific activity, exposure time and location) shall be included in these reports. The assessment of radiation DOSES shall be performed in accordance with the ODCM.

6.2.3. The report shall include any change to the PCP or the ODCM made during the reporting period, as well as a listing of new locations for DOSE calculations and/or environmental monitoring identified by the land use census pursuant to Section 5.2.

6.2.4. The report shall also include an assessment of radiation DOSES to the likely most exposed MEMBER(S) OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources (including DOSES from primary effluent pathways and direct radiation) during the previous calendar year, to show conformance with 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Operations. This assessment of radiation DOSES is performed in accordance with the ODCM.

6.2.5. The report shall include the following information for each class of solid waste (defined by 10 CFR 61) shipped offsite during the report period:

1. Container volume;
2. Total curie quantity (specify whether determined by measurement or estimate);
3. Principal radionuclides (specify whether determined by measurement or estimate);
4. Source of waste and processing employed (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms);
5. Type of container (e.g., LSA, Type A, Large Quantity), and,
6. SOLIDIFICATION agent or absorbent (e.g., cement, Dow media, etc.)

6.2.6. The report shall include a list and description of unplanned releases, to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

6.2.7. The report shall contain the cause for unavailability of any environmental sample required by Table 5.1-1 and shall identify the locations for obtaining replacement samples. This shall also include a revised figure(s) and table for the ODCM reflecting the new location(s). Refer to Section 5.1.3.3.

6.2.8. The report shall contain new locations identified in the land use census in accordance with Sections 5.2.3.1 or 5.2.3.2.

6.2.9. The report shall contain the events leading to the conditions which resulted in exceeding the radioactivity limits for the specified outdoor liquid radwaste tanks specified in the Technical Requirements Manual, TRM 3.7.E.

6.2.10. The report shall contain details of any major modifications to Radioactive Liquid, Gaseous, and Solid Waste Treatment Systems as discussed in Section 7.

7. MAJOR MODIFICATIONS TO RADIOACTIVE LIQUID, GASEOUS, AND SOLID WASTE TREATMENT SYSTEMS*

7.1. The following shall be reported to the Commission in the Radioactive Effluent Release Report for the period in which the modification is completed and made operational. The discussion of each modification shall contain:

- A summary of the evaluation that led to the determination that the modification could be made in accordance with 10 CFR 50.59.
- Sufficient information to support the reason for the modification without benefit of additional or supplemental information.
- A description of the equipment, components, and processes involved and the interfaces with other plant systems.

7.2. The following evaluations shall be reported to the Commission in the Radioactive Effluent Release Report, where such evaluations are required to be performed in order to assure compliance with the requirements of 10 CFR 50.59.

- An evaluation of the modifications, which show the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto.
- An evaluation of the modification, which shows expected maximum exposure to individuals in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto.
- A comparison of the predicted release of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period prior to when the modifications are to be made.

(*) Exelon may elect to submit the information called for in this Section as part of the Annual 10 CFR 50.59 Safety Evaluation Report.

8. PURGING OF THE PRIMARY CONTAINMENT

8.1. CONTROL

The containment shall be PURGED through the Standby Gas Treatment System whenever the primary containment is required to be OPERABLE per the Technical Specifications (TS).

8.2. APPLICABILITY

Whenever the Drywell is PURGED.

8.2.1. Objective

To ensure that the primary containment is PURGED through the Standby Gas Treatment System.

8.3. ACTIONS

8.3.1. If the requirements of the above Control cannot be met, then PURGING shall be discontinued without delay.

8.3.2. With the requirements of Part 1, 8.3.1 not met, enter the applicable TS LCO Conditions and Required ACTIONS.

8.4. SURVEILLANCE REQUIREMENTS

The containment drywell shall be determined to be aligned for PURGING through the Standby Gas Treatment System within 4 hours prior to the start of and at least once per 12 hours during the PURGING of the drywell.

8.5. BASES

Limitations on PURGING the containment are established to maintain releases as low as reasonably achievable.

The TS provide the appropriate ACTIONS and restrictions if the requirements above are not met. The inability to PURGE through the Standby Gas Treatment System could be caused by a number of reasons, and thus, various TS 3.6 Sections could apply. The applicable TS LCO Conditions and Required ACTIONS will be entered as required.

PART 2

OFFSITE DOSE CALCULATION MANUAL

9. INTRODUCTION

9.1. PURPOSE

This manual provides the methodology to calculate radiation DOSES to individuals in the vicinity of the James A. FitzPatrick Nuclear Power Plant. It also provides methodology for calculating effluent monitor setpoints and allowable release rates to ensure compliance with Technical Specifications 5.5.1 and 5.5.4, James A. FitzPatrick Nuclear Power Plant, Docket Number 50-333, and 10 CFR 20 1001-20.2402 release criteria.

9.2. METHODOLOGIES AND PARAMETERS

The ODCM follows the methodology and models suggested by the "Guidance Manual for Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants" (NUREG-0133 October 1978) and "Calculation of Annual DOSES to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I" (Regulatory Guide 1.109, Revision 1 dated October 1977). Simplifying assumptions have been made and justified where applicable to provide a more workable document for implementing programmatic controls in the Technical Specifications 5.5.1 and 5.5.4, as well as the procedural details of Part 1 of this document. Alternate calculating methods to those presented here may be used provided the general methodology is similar, well documented and the results are more precise. Additionally, as available, the most up-to-date revision of the Regulatory Guide 1.109 DOSE conversion factors and site-specific environmental transfer factors may be substituted for those currently included and used in this document.

9.3. DOCUMENT REVISION OVERVIEW

7/20

This is Revision 1 of the ODCM under the procedure designation of CY-JF-170-301. There are 14 revisions of the ODCM under the previous procedure designation of DVP-01.02. There were 9 revisions under the previous procedure designation of CDP-15. This revision constitutes the 25th revision of the ODCM since its inception as Rev. 0 of CDP-15.

10. DEFINITIONS

AGE GROUPS

Infants, children, teens and adults are AGE GROUPS evaluated by this ODCM.

BETA

A BETA particle (electron)

BETA DOSE

The DOSE component to skin DOSE due to BETA emitting radionuclides in air.

cc

Cubic Centimeter

Ci

Curie. A unit of radioactivity equal to 3.7E+10 disintegrations per second. See also microCurie (μCi).

C_i

Concentration of a NUCLIDE in the RELEASE SOURCE. Units of μCi/cc or μCi/ml.

CFR

Code of Federal Regulations

DOSE

A measure of the radiation energy deposited per unit mass (in mrem or mrad), that the ORGAN or the individual receives from exposure to radioactive effluents dispersed in the environment.

DOSE COMMITMENT

The total DOSE delivered to the ORGAN or whole body over a 50-year period resulting from uptake of radioactive material.

DOSE FACTOR

Normally, a factor that converts the effect of ingesting or inhaling radioactive material into the body, to DOSE to a specific ORGAN. Body elimination, radioactive decay, and ORGAN uptake are some of the factors that determine a DOSE FACTOR for a given NUCLIDE.

DOSE PATHWAY

A specific path that radioactive material physically travels through in the environment prior to exposing an individual to its emitted radiation. The grass/cow/milk food chain is a DOSE PATHWAY.

DOSE RATE

The DOSE received per unit time.

10. **DEFINITIONS** (continued)

(d/q)

The short-term atmospheric deposition factor (m^{-2}) for ground-level releases and a specified release duration.

$(\overline{D/Q})$

A long-term relative deposition coefficient. A factor with units of $1/m^2$ which describes the deposition of particulate matter from a plume at a point downrange from the source. It can be thought of as the part of the cloud that will fall out and deposit over one square meter of ground.

ECL

The Effluent Concentration Limit (ECL) is equal to 10 times the effluent concentration values listed in 10 CFR 20, Appendix B, Table 2, Column 2.

GAMMA

A GAMMA photon.

GAMMA DOSE

The DOSE component to skin or whole body DOSE due to GAMMA-emitting radionuclides in air.

GROUND PLANE

Radioactive material deposited uniformly over the ground emits radiation that produces an exposure pathway when an individual is present in the area. It is assumed that an adult receives the same exposure as an infant, regardless of the physical height differences. Only the whole body and skin is considered for the purpose of the ODCM.

H-3

Hydrogen-3, or tritium. An isotope of hydrogen that is a low-energy BETA emitter.

I&8DP

Radioiodines and particulates with half-lives greater than eight days (includes H-3 where applicable).

LLD

Lower Limit of Detection. The smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95 percent probability and with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal.

10. DEFINITIONS (continued)

m^3

Cubic meters

m^2

Square meters

NUCLIDE

An atomic nucleus that contains a specified number of protons and neutrons. NUCLIDE (i) signifies a specific NUCLIDE under consideration (e.g., 1st, 2nd, 3rd, etc.). If NUCLIDE (i) is I-131, then the M_i (DOSE FACTOR) under consideration should be $M_{I\text{-}131}$, for example.

ORGAN

For the purpose of the ODCM, either the bone, liver, thyroid, kidney, lung, GI-LLI, skin or the W. Body (Whole body). W. Body is considered an ORGAN for consistency with the ODCM nomenclature.

$\dot{Q}_i$

denotes a release rate in Ci/sec or µCi/sec for NUCLIDE (i).

Q_i

Denotes Ci of NUCLIDE (i) released over a specified time interval.

RECEPTOR

The individual receiving radiation exposure from effluent releases at JAFNPP at a given location, or who ingests food products contained with trace amounts of radioactive materials. A RECEPTOR can receive DOSE from one or more DOSE PATHWAYS.

RELEASE SOURCE

A subsystem, tank, vent or stack where radioactive material can be released independently of other radioactive release points.

RESTRICTED AREA

An area access to which is limited by Exelon for the purpose of protecting individuals against risks from exposure to radiation and radioactive materials.

µCi

Microcuries. 1 Ci = 1E+6 µCuries. The µCi is the standard unit of radioactivity for all DOSE calculations in the JAFNPP ODCM.

10. DEFINITIONS (continued)

(x/q)

The short-term atmospheric deposition factor (sec/m^3) for ground-level releases and a specified release duration.

$(\overline{X/Q})$

A long-term relative atmospheric dispersion coefficient. It describes the physical dispersion characteristics of a semi-infinite cloud of noble gases as the cloud travels downwind from the release point.

$(\overline{X/Q})_\gamma$

Long-term finite cloud atmospheric dispersion parameter for computation of external GAMMA radiation exposures (sec/m^3). (By definition, the GAMMA (X/Q) is the equivalent relative concentration of radioactivity in a semi-infinite cloud that would yield the same radiation exposure as a finite cloud aloft; it accounts for the actual plume dimensions and elevation above the RECEPTOR, and GAMMA radiation spectra.)

UNRESTRICTED AREA

An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY where access is neither limited nor controlled by Exelon for purposes of protecting individuals against undue risk from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes.

Vent

Building ventilation air exhausts via roof top ducts.

(X/W)

The annual average relative concentration (sec/m^3) for a given liquid pathway (potable water or fish ingestion) for a specified release

11. LIQUID EFFLUENT METHODOLOGY

11.1. APPLICABLE SITE CHARACTERISTICS

The JAFNPP Final Safety Analysis Report (FSAR) contains the official description of the site characteristics. The description that follows is a brief summary for DOSE calculation purposes.

The James A. FitzPatrick Nuclear Power Plant is located on the eastern portion of the Nine Mile Point promontory on Lake Ontario in Oswego County, NY. The site is approximately seven miles northeast of the City of Oswego. Radioactive liquid releases normally enter Lake Ontario where the Circulating Water Discharge Tunnel terminates on the lake bottom approximately 1,400 feet from the shoreline.

11.2. 10 CFR 20, ECL Limits-Determination of the Fraction (F_L) of Release Limits and Minimum Required Dilution

11.2.1. **Requirements**

In accordance with Part 1, Section 2.2.1, the concentration of liquid radioactive material released to UNRESTRICTED AREAS (Appendix G) shall not exceed 10 times the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. Concentration of radionuclides in liquid waste is determined by sampling and analyses in accordance with Part 1, Radiological Effluent Controls, Section 2.2.

In accordance with Part 1, Radiological Effluent Controls, Section 2.2 for dissolved or entrained noble gases, the concentration shall be limited to 2E-4 µCi/ml.

11.2.2. **Methodology**

This section presents the calculating method to be used for determining F_L, the fraction of Part 1, Section 2.2.1 Control limits, of release concentrations of liquid radioactive effluents.

This method addresses the calculation for a specific RELEASE SOURCE. Administrative controls are applied to assure that the summation of F_L values for each RELEASE SOURCE does not exceed the Part 1, Section 2.2.1 Control limit. Normally, all potentially radioactive liquid effluents are released to the UNRESTRICTED AREA through a single monitored release path as indicated in Appendix F. However, the service water system presents a potential release point for radioactive liquid effluents. To assure the combined releases do not exceed Part 1, Section 2.2.1 Control effluent concentration limits (ECLs), the alarm setpoint, as determined in Section 11.3 includes a conservatism factor of 0.5.

The basic equation which determines the fraction (F_L) of the ECL is:

Eq. 3-1

$$F_L = \left[\frac{f_1}{f_2}\right] x \sum_{i=1}^{n} \left[\frac{C_i}{ECL_i}\right]$$

Where:

F_L = The fraction of ECLs resulting from the RELEASE SOURCE being discharged (dimensionless)

f_1 = The undiluted release rate of the RELEASE SOURCE as measured at the liquid effluent monitor location, in gpm.

f_2 = The discharge structure exit flow in gpm. (Summation of circulating water pump and service water pump discharge flow; minus the flow redirected for tempering)

C_i = Each undiluted concentration of NUCLIDE (i) in µCi/ml (includes both GAMMA and BETA emitters)

ECL_i = The ECL for NUCLIDE (i) in µCi/ml. The ECL_i is equal to 10 times the corresponding effluent concentration value listed in 10 CFR 20, Appendix B, Table 2, Column 2.

Using this approach, the fraction of the ECL is determined using a NUCLIDE-by-NUCLIDE evaluation.

11.2.3. Calculating Process for Determining $\left(\frac{f_1}{f_2}\right)$

The following section provides a procedure for determining the minimum required dilution factor $\left(\frac{f_1}{f_2}\right)$ to ensure that $F_L \leq 1$during the actual release. With $F_L \leq 1$, the minimum required dilution factor can be expressed as:

Eq. 3-2

$$\left(\frac{f_2}{f_1}\right)_{min} = \sum_{i=1}^{n} \frac{C_i}{ECL_i}$$

1. Obtain C_i, the undiluted assay value of NUCLIDE (i), in µCi/ml.
2. From Appendix A, Table A-1, obtain the corresponding ECL_i for NUCLIDE (i) in µCi/ml. The ECL_i is equal to 10 times the corresponding effluent concentration value listed in 10 CFR 20, Appendix B, Table 2, Column 2.
3. Divide C_i by ECL_i.
4. Repeat steps b and c above for each NUCLIDE and sum the totals.
5. Enter only the total GAMMA activity and the minimum required dilution factor $\left(\frac{f_2}{f_1}\right)_{min}$ on the liquid release permit.

11.3. Determination of Setpoints for Radioactive Liquid Effluent Monitors

11.3.1. **Requirements**

Part 1, Section 2.2.1 Control requires that the radioactive liquid effluent monitor be OPERABLE and set to initiate an alarm and/or trip in the event that the limits of Part 1, Section 2.2.1 Control are approached. The alarm and/or trip setpoints shall be determined and adjusted by the methodology which follows. The setpoint values should be applied above normal background levels.

The alarm setpoint for the liquid effluent radiation monitor is derived from the ECLs applied at the UNRESTRICTED AREA boundary where the discharge tunnel flows into Lake Ontario.

A Change Management Plan as defined in HU-AA-1101 shall be initiated and included in any ODCM revision whenever the methodology for calculating liquid setpoints is changed and the change in methodology results in a new calculated setpoint.

11.3.2. **Methodology**

The alarm setpoints do not consider dilution, dispersion, or decay of radioactive material beyond the UNRESTRICTED AREA boundary (i.e., the alarm setpoints are based on a concentration limit at the end of the discharge tunnel).

11.3.3. **Radwaste Liquid Effluent Monitor**

1. A sample of each batch of liquid radwaste is analyzed for I-131 and other principal GAMMA emitters prior to release. The fraction F_L of 10 CFR 20, ECLs, and the minimum required dilution factor to achieve $F_L = 1$ is determined in accordance with the preceding section for the activity to be released. For cases other than minimum dilution calculation, $F_L < 0.5$.

2. A conservative alarm and/or trip setpoint (µCi/ml) is determined in accordance with the following equation:

Eq. 3-3

$$S=0.5 \times \frac{C_g}{F_L}$$

Where:

S = The alarm and/or trip setpoint above background corresponding to the limiting concentration of undiluted liquid effluent (µCi/ml).

0.5 = Conservatism factor to account for releases from multiple points, and to allow for NUCLIDES not detected by the monitor.

C_g = Total undiluted concentration of GAMMA emitters in µCi/ml as determined in the laboratory.

F_L = The fraction of the Part 1, Section 2.2.1 Control ECLs for UNRESTRICTED AREAS resulting from the RELEASE SOURCE being discharged.

3. Calculating Process

The following section provides a procedure for determining the radwaste liquid effluent monitor setpoint. Typical parameter values are used for illustration.

A. Determine the undiluted GAMMA concentrations from laboratory analysis of the liquid effluent sample. For the purpose of this example, assume only Co-60 is present at a concentration of 3.0E-05 µCi/ml.

B. Determine the BETA activity from the most recent composite results (Cb). For the purposes of this example, assume only H-3 is present at a concentration of 2.2E-02 µCi/ml.

C. Determine f_2 from pump curves and current plant operating configuration. A typical value is 3.78E+5 gpm.

D. Determine the minimum required dilution factor in accordance with equation 3-2.

$$\left(\frac{f_2}{f_1}\right)_{min} = \sum_{i=1}^{n} \frac{C_i}{ECL_i}$$

For this example, ECL values for Cobalt-60 and Tritium are obtained from Appendix A, Table A-1 (ECLs):

$$\left[\frac{f_2}{f_1}\right]_{min} = \frac{3E\text{-}05 \text{ uCi/ml}}{3E\text{-}05 \text{ uCi/ml}} + \frac{2.2E\text{-}02 \text{ uCi/ml}}{1E\text{-}2 \text{ uCi/ml}}$$

$$\left(\frac{f_2}{f_1}\right)_{min} = 3.2$$

E. Determine or calculate the required f_1 at the liquid effluent monitor location. A typical value is 100 gpm.

F. A typical value of the dilution factor from current plant operating conditions is:

(3.78E+5 gpm)/100 gpm = 3,780, which is >3.2. Therefore, the release can be made at the current release rates and concentrations maintained within the 10 CFR 20 Part 1, Section 2.2.1 Control ECLs.

G. Determine F_L, the fraction of 10 CFR 20 ECLs resulting from the RELEASE SOURCE being discharged at a dilution factor of 3,780, in accordance with equation 3-1.

Eq. 3-1

$$F_L = \left[\frac{f_1}{f_2}\right] x \sum_{i=1}^{n} \left[\frac{C_i}{ECL_i}\right]$$

= (100/3.78E+5) x 3.2 (from 11.3.3.3.D)

= (2.65E-4) x 3.2

= 8.47E-4

H. The liquid effluent monitor setpoint, S in µCi/ml, from equation 3-3 is:

Eq. 3-3a

$$S = 0.5 \text{ x } \frac{C_g}{F_L}$$

= 0.5 x [(3E-5)/(8.47E-4)]

= 1.77E-2

I. Appropriate calibration factors are applied to this limiting concentration determined in step 11.3.3.3.G to determine an effluent monitor alarm potentiometer setpoint.

11.3.4. Service Water Liquid Effluent Monitor

1. A conservative alarm setpoint (cps) for the service water liquid effluent monitor is determined in accordance with the following methodology:

Eq. 3-3b

$$DF=\left(\frac{f_2}{f_1}\right)$$

Where:

DF = dilution factor resulting from the flow rate in the discharge structure divided by the undiluted release rate of the effluent RELEASE SOURCE.

f1 = the undiluted release rate of the effluent source measured at the service water liquid effluent monitor (gpm).

f2 = the discharge structure flow rate in gpm (summation of circulating water pumps and service water pumps discharge flows; minus the flow redirected for tempering).

Eq. 3-3c

$$SP = \frac{0.5 \text{ x } ECL_W \text{ x } DF}{Eff} + Bkg$$

Where:

SP = setpoint of liquid effluent monitor in cps.

0.5 = conservatism factor to account for releases from multiple points or a reduction in the DF value due to changes in discharge canal flow, and to allow for NUCLIDES not detected by the monitor.

Cg = Total undiluted concentration of GAMMA emitters in µCi/ml

ECL_w = weighted ECL for historical NUCLIDE mix (11.3.4.2)

$$= \frac{C_g}{\sum_{i=1}^{n}\left[\frac{C_i}{ECL_i}\right]}$$

Eff = efficiency of the liquid effluent monitor in µCi/ml/cps.

Bkg = normal monitor background (cps).

2. Those NUCLIDES present in previous batch releases from the liquid radwaste effluent system, NUCLIDES present in historical Radioactive Effluent Release Reports or those NUCLIDES present in the service water system may be used to calculate the ECL_w value. Other values for ECL_w may be used based on plant conditions (i.e. in the event of known leakage into the RBCLC system).

11.4. DOSE Determination for Radioactive Liquid Effluents

11.4.1. Annual DOSE Assessment-Radioactive Effluent Release Report Submittal

1. Requirements

   Technical Specification 5.6.3 requires a Radioactive Effluent Release Report to be submitted that includes an assessment of the radiation DOSES to the public due to the radioactive liquid and gaseous effluents released from the unit during the previous calendar year. The DOSE assessment required by this report is due prior to May 1 of each year in accordance with 10 CFR 50.36a.

2. Methodology

   This section provides the methodology to calculate the DOSES to all AGE GROUPS and ORGANS from all radionuclides identified in the liquid effluents. The method is based on the methodology suggested by NUREG-0133, October 1978, Sections 4.3 and 4.3.1 and Regulatory Guide 1.109. The determination of viable liquid DOSE PATHWAYS is described in Appendix A, Table A-4.3. The site-related DOSE FACTORS for all viable pathways are listed in Appendix A, Tables A-2 and A-3. Table A-3 DOSE FACTORS are compiled by AGE GROUPS, for all ORGANS and radionuclides common to a Boiling Water Reactor (BWR).

   The following equation provides for a DOSE calculation to the whole body or any ORGAN for a given AGE GROUP based on actual release conditions during a calendar year for radioactive liquid releases. The equation for $D_{i\tau}$ is to be summed over all i NUCLIDES:

Eq. 3-4a

$$D_{i\tau} = \frac{A_{i\tau}\, \Delta_{t1}\, D_{i1}}{(DF)_1}$$

Eq. 3-4b

$$D_{\tau} = \sum_{i=1}^{n} D_{i\tau}$$

Where:

D_τ = Total DOSE COMMITMENT for ORGAN τ of an AGE GROUP.

$D_{i\tau}$ = DOSE COMMITMENT in mrem received by ORGAN τ of AGE GROUP (to be specified) resulting from releases during time interval Δ_{t1} for NUCLIDE (I).

$A_{i\tau}$ = The site-related DOSE COMMITMENT factor to the whole body or any ORGAN τ for each identified radionuclide (i). The $A_{i\tau}$ values listed in Appendix A, Tables A-2 and A-3 are site specific, in mrem/hr per µCi/ml. DOSE COMMITMENT factors are compiled by AGE GROUPS, for ORGANS and radionuclides common to a BWR environment. The derivation of $A_{i\tau}$ values is described in Appendix A, Table A-4.1.

Δ_{t1} = The number of hours in the calendar year.

Qi_1 = The total quantity of NUCLIDE (i) released during the time period Δ_{t1}, in µCi.

$(DF)_1$ = The total volume of dilution released during Δ_{t1} (i.e., summation of circulating water pump and service water pump discharge flow; minus the flow redirected for tempering).

By entering the appropriate annual parameter values onto a form similar to that shown in Table 11.4-2, whole body or ORGAN DOSES may be calculated as outlined in step 11.4.2.3.

In addition, more realistic assumptions may be made concerning the dilution and ingestion of fish and potable water by individuals who live and fish in the area.

11.4.2. Monthly DOSE Assessment - Verification of Compliance with 10 CFR 50, Appendix I Limits

1. Requirements

Part 1, Section 2.3.4 Surveillance Requirements requires an assessment to be performed at least once every month in any quarter in which radioactive effluent is discharged, to verify that radioactive liquid effluents from the plant do not result in a cumulative DOSE in excess of 1.5 mrem to the whole body and 5 mrem to any ORGAN in a calendar quarter, and to verify that radioactive liquid effluents from the plant do not result in a cumulative DOSE in excess of 3.0 mrem to the whole body and 10 mrem to any ORGAN during a calendar year.

2. Methodology

This section presents the calculating method to be used for the 10 CFR 50 Appendix I compliance verification. The method is based on the models suggested by NUREG-0133 October 1978 Sections 4.3 and 4.3.1 and Regulatory Guide 1.109.

A. General Approach

The general approach used is similar to that described for use in calculations for the Annual DOSE Assessment Report. The liquid effluent DOSE PATHWAYS considered are freshwater fish, potable water and lake shoreline deposits (Appendix D). These pathways need to be considered for verifying compliance with the requirements specified above.

Site-specific DOSE FACTORS for the freshwater fish, potable water and shoreline pathways are provided in Appendix A, Tables A-2 and A-3.

For JAFNPP, both the adult and teenager are normally the most limiting AGE GROUPS (Appendix D), but the DOSE for child and infant may also be calculated by this method using the appropriate DOSE FACTORS from Appendix A, Table A-3.

The following equation is used to determine a DOSE to the whole body or any ORGAN for a given AGE GROUP based on actual release conditions during a specified time interval for radioactive liquid releases. The equation for $D_{i\tau}$ is to be summed over all i NUCLIDES:

Eq. 3-5a

$$D_{i\tau} = \frac{A_{i\tau}\ \Delta_{t1}\ Q_{i1}}{(DF)_1}$$

Eq. 3-5b

$$D_T = \sum_{i=1}^{n} D_{iT}$$

Where:

D_T = DOSE COMMITMENT for ORGAN T of an AGE GROUP.

D_{iT} = DOSE COMMITMENT in mrem received by ORGAN T of AGE GROUP (to be specified) from release time interval Δt1 for NUCLIDE (i).

A_{iT} = The DOSE FACTOR for the freshwater fish, potable water lake shoreline deposits pathways for NUCLIDE (i) for ORGAN T of AGE GROUP (to be specified). (Appendix A, Tables A-2 and A-3 for A_{iTf}, A_{iTW} and A_{iTsh}).

Δ_{t1} = The number of hours in the reporting period.

Q_{i1} = The total quantity of NUCLIDE (i) released during the time period Δt1 in μCi.

$(DF)_1$ = The total volume of dilution released during Δt1 (i.e., the summation of circulating water pumps and service water pumps discharge volumes; minus the volume redirected for tempering).

B. Limited Analysis Approach

Based on the radionuclide distribution typical in radioactive effluents at JAFNPP, the calculated DOSE to individuals are dominated by the radionuclides, Cs-134, Cs-137, Zn-65, Mn-54, and Co-60. From 1980 through 1987, these NUCLIDES, in the freshwater fish and potable water pathways, contributed at least 92 percent of the adult's whole-body DOSE and at least 81 percent of the teenager's liver DOSE, which is the critical ORGAN. Liquid effluent for the years 2002 through 2009 were also reviewed. Liquid releases have decreased dramatically as compared to 1980 – 1987. H-3 liquid releases have decreased; however, not as dramatically as the other NUCLIDES and is added to this list. Therefore, the DOSE COMMITMENT due to radioactivity in liquid effluents may be reasonably evaluated by limiting the DOSE calculating process to these six radionuclides for the adult's whole body and the teenager's liver DOSE.

To allow for any unexpected variability in the radionuclide distribution, a conservatism factor of 0.8 is introduced into the equation. After calculating the DOSE based on these six NUCLIDES, the cumulative DOSE should therefore be divided by 0.8. (Refer to Appendix D for a detailed evaluation and explanation of this limited analysis approach).

If the limited analysis approach is used, the calculation should be limited to the adult's whole-body DOSE and teenager's liver DOSE from the fish and potable water pathways. Only the five previously specified NUCLIDES need be evaluated.

C. Approach Selection Criteria

The limited analysis approach fully satisfies the requirements and can thus be used for routine releases. The more general approach may be used for more refined calculations for routine releases.

For non-routine releases, i.e., other than through the discharge canal, Section 11.4.3 is to be used.

3. Calculating Methodology

The methodology that follows is a step-by-step breakdown to calculate DOSES based on equation 3-5a. If the limited analysis approach is used, the calculation should be limited to the adult whole-body DOSE and teenager's liver DOSE from the fish and potable water pathways. Only the five previously specified radionuclides need to be evaluated for the limited approach.

NOTE: Table 11.4-2 provides a convenient form for compiling the DOSE accounting information.

A. Determine (Δ_{t1}) the number of hours of the reporting period.

B. Obtain $(DF)_1$ for the time period Δ_{t1} for the RELEASE SOURCE(s) of interest. DF1 is the total volume of dilution, (i.e. the circulating water flow multiplied by the time) in milliliters.

C. Obtain Q_{i1} (μCi) for NUCLIDE (i) for the time period Δ_{t1}).

D. Obtain $A_{i\tau}$ from the appropriate Liquid DOSE FACTOR Table: Appendix A, Table A-2 for the fish and potable water pathways; Appendix A, Table A-3 for all other pathways.

E. Solve for DOSE (i)

Eq. 3-6a

$$D_{i\tau} = \frac{A_{i\tau}\ \Delta_{t1}\ Q_{i1}}{(DF)_1}$$

F. Repeat steps C through E above for each NUCLIDE reported and each ORGAN required. If the limited analysis method is used, limit the radionuclides to H-3, Co-60, Mn-54, Zn-65, Cs-134, and Cs-137 and determine the adult's whole-body DOSE and the teenager's liver DOSE.

G. Sum the $D_{i\tau}$ values to obtain the total DOSE. If the limited analysis method is being used, divide the cumulative DOSE by a conservatism factor of 0.8 to account for any unexpected variability in radionuclide distribution and any contribution from the lake shoreline deposits pathway.

Eq. 3-6b

$$D_\tau = \frac{\sum_{i=1}^{n} D_{i\tau}}{(0.8^*)}$$

* When limited analysis method is used

TABLE 11.4-2

FISH PATHWAY

Time/Date Start: ____________________ Time/Date Stop: _________________ Δ_{t1} hours

Total Dilution Volume $(DF)_1$: ___________________________ mls

AGE GROUP: __________ ORGAN: ________________ DOSE FACTOR Table No. _________

NUCLIDE(i)	Q_{i1}	$A_{i\tau}$	DOSE(i) mrem
H-3			
Mn-54			
Co-60			
Zn-65			
Cs-134			
Cs-137			
Others:			

Total DOSE τ =	mrem
Eq.3-6a based on limited analysis, divided by 0.8	mrem

11.4.3. DOSE Assessment - Methodology for Liquid Releases Through the Storm Drain

This section provides the methodology to calculate the DOSES to all AGE GROUPS and ORGANS from liquid releases other than routine releases through the discharge canal, such as releases via the storm drain.

11.4.4. Requirements

Non-routine liquid releases, when they occur, are to be added into the Radioactive Effluent Release Report(s) and the annual DOSE assessment report (Section 11.4.1) and the verification of compliance with 10 CFR 50 Appendix I regulatory guidelines (Section 11.4.2). The following are the Technical Specification requirements for non-routine liquid releases, other than through the discharge canal.

Technical Specification 5.6.3 requires a Radioactive Effluent Release Report to be submitted prior to May 1 of each year in accordance with 10 CFR 50.36a that includes an assessment of the radiation DOSES to the public due to the radioactive liquid and gaseous effluents released from the unit during the previous calendar year.

Part 1, Section 2.3.4 Surveillance Requirement requires an assessment to be performed at least once every month in any quarter in which radioactive effluent is discharged, to verify that radioactive liquid effluents from the plant do not result in a cumulative DOSE in excess of 1.5 mrem to the whole body and 5 mrem to any ORGAN in a calendar quarter, and to verify that radioactive liquid effluents from the plant do not result in a cumulative DOSE in excess of 3.0 mrem to the whole body and 10 mrem to any ORGAN during a calendar year.

1. Methodology

   Exposure pathways of interest are the ingestion of contaminated fish and drinking of contaminated water. Exposure from shoreline deposits following non-routine releases was determined to be insignificant and has been excluded from this section.

   The model used accommodates (in a single unified approach) releases ranging from instantaneous (slug) to continuous (steady-state).

   The method of analysis selected for dilution of the released radioactivity in the lake makes use of the continuous-release model in Regulatory Guide 1.113, adapted to provide annual average concentrations for releases of shorter duration (including instantaneous). The model assumes an exposure interval of one year, regardless of the duration of the release.

   For the fish-ingestion pathway, the fish is assumed to be adjacent to the release point for the duration of the release, and then to follow the radioactive plume for an overall exposure interval of one year. For the potable water pathway, the water supply is at 8.5 miles west of the plant (Oswego water intake) and is assumed to be continuously contaminated as a result of frequent current reversals.

   The following equations present the annual DOSE due to the potable water and freshwater fish pathways for any given release, regardless of the release duration. These DOSES are to be assigned to an appropriate reporting interval (e.g., quarter) during which the release occurred.

Potable Water Pathway

Eq. 3-7a

$$D_{i\tau} = K_a \times U_f \times DF_{i\tau} \times C_i \times \dot{q} \times (X/W) \times \Delta\tau$$

Eq. 3-7b

$$D_{\tau} = \sum_{i=1}^{n} D_{i\tau}$$

Where:

D_{τ} = DOSE COMMITMENT for ORGAN τ of an AGE GROUP (mrem).

$D_{i\tau}$ = DOSE COMMITMENT received by ORGAN τ of an AGE GROUP (to be specified) for NUCLIDE i (mrem).

K_a = Is the unit conversion factor, 1.0E+09 (ml-pCi per liter-µCi).

U_f = Is the water consumption rate for the AGE GROUP of interest, as follows:

Adult: 730 liters/yr

Teen: 410 liters/yr

Child: 510 liters/yr

Infant: 330 liters/yr

$DF_{i\tau}$ = DOSE conversion factor (mrem per pCi ingested) for radionuclide i, for ORGAN τ and AGE GROUP of interest, from Tables E-11 through E-14 of Regulatory Guide 1.109.

C_i = The average activity concentration of NUCLIDE i in the effluent at the release point into the lake (µCi/ml).

$\dot{q}$ = The volumetric discharge rate of the effluent (m3/sec). q is equal to the total volume of contaminated liquid release (m3) divided by the duration of the release.

(X/W) = The annual average relative concentration (sec/m3) for the potable water pathway, as shown in Table 11.4-3 for a list of release durations. Release durations were selected to accommodate a change of no more than 20% between consecutive X/Ws.

$\Delta\tau$ = The exposure period which is one year (yr).

Freshwater Fish Pathway

Eq. 3-8a

$$D_{i\tau} = K_a \times U_f \times BF_i \times DF_{i\tau} \times C_i \times \dot{q} \times (X/W) \times \Delta\tau$$

Eq. 3-8b

$$D_{\tau} = \sum_{i=1}^{n} D_{i\tau}$$

Where:

D_{τ} = DOSE COMMITMENT of ORGAN τ of an AGE GROUP (mrem).

$D_{i\tau}$ = DOSE COMMITMENT received by ORGAN τ of an AGE GROUP (to be specified) for NUCLIDE i (mrem).

K_a = Is the unit conversion factor, 1.0E+09 (ml-pCi per liter-µCi).

U_f = Is the freshwater fish consumption rate for the AGE GROUP of interest, as follows:

Adult: 21 (kg/yr)

Teen: 16 (kg/yr)

Child: 6.9 (kg/yr)

BF_i = The bioaccumulation factor for radionuclide i, in freshwater fish (pCi/kg per pCi/liter), from Table A-1 of Regulatory Guide 1.109.

$DF_{i\tau}$ = DOSE conversion factor (mrem per pCi ingested) for radionuclide i, for ORGAN and AGE GROUP of interest, from Tables E-11 through E-14 of Regulatory Guide 1.109.

C_i = The average activity concentration of NUCLIDE i in the effluent (µCi/ml) at the release point into the lake.

$\dot{q}$ = The volumetric discharge rate of the effluent (m3/sec). q is equal to the total volume of contaminated liquid released (m3) divided by the duration of the release.

(X/W) = The annual average relative concentration (sec/m3) for the fish ingestion pathway, as shown in Table 11.4-3 for a list of release durations. Release durations were selected to accommodate a change of no more than 20% between consecutive X/Ws.

$\Delta\tau$ = The exposure period which is one year (yr).

TABLE 11.4-3

RELEASE INTERVAL VERSUS ANNUAL AVERAGE CONCENTRATION (X/W)

Release Duration (days)	(X/W) (sec/m^3)	
	Fish Ingestion	**Potable Water**
0.0	3.49E-04*	1.84E-04*
> 0.0 - 0.5	3.89E-04	1.88E-04
> 0.5 - 1.0	4.28E-04	1.92E-04
> 1.0 - 1.5	4.68E-04	1.96E-04
> 1.5 - 2.5	5.47E-04	2.04E-04
> 2.5 - 3.5	6.26E-04	2.12E-04
> 3.5 - 5.0	7.44E-04	2.25E-04
> 5.0 - 6.5	8.62E-04	2.37E-04
> 6.5 - 8.5	1.02E-03	2.54E-04
> 8.5 - 11.0	1.22E-03	2.75E-04
> 11.0 - 13.5	1.41E-03	2.95E-04
> 13.5 - 17.0	1.69E-03	3.24E-04
> 17.0 - 21.0	2.01E-03	3.57E-04
> 21.0 - 25.5	2.36E-03	3.95E-04
> 25.5 - 31.0	2.80E-03	4.40E-04
> 31.0 - 38.0	3.35E-03	4.98E-04
> 38.0 - 46.0	3.98E-03	5.64E-04
> 46.0 - 56.0	4.77E-03	6.47E-04
> 56.0 - 68.0	5.71E-03	7.46E-04
> 68.0 - 82.0	6.82E-03	8.61E-04
> 82.0 - 99.0	8.16E-03	1.00E-03
> 99.0 - 119.5	9.77E-03	1.17E-03
> 119.5 - 144.0	1.17E-02	1.37E-03
> 144.0 - 173.5	1.40E-02	1.62E-03
> 173.5 - 209.0	1.68E-02	1.91E-03
> 209.0 - 251.5	2.02E-02	2.25E-03
> 251.5 - 302.5	2.42E-02	2.67E-03
> 302.5 - 365.0	2.90E-02**	3.13E-03**

* Instantaneous release (for reference)

** Continuous release

11.5. DOSE Projections - Determination of Need to Operate Liquid Radwaste Treatment System

11.5.1. **Requirements**

Part 1, Section 2.4.1 Control requires that appropriate subsystems of the Liquid Radwaste Treatment System be used to reduce radioactive material in untreated liquid effluents when the projected monthly DOSE due to liquid releases to UNRESTRICTED AREAS, averaged over 31 days, would exceed 0.06 mrem to the whole body or 0.2 mrem to any ORGAN. DOSES are to be projected at least once per month.

11.5.2. **Calculating Methodology**

The method is based on whole body DOSE and limiting ORGAN DOSE (liver) as calculated for the Monthly DOSE Assessment. The adult is normally the limiting AGE GROUP to be used for the DOSE projection to the whole body. The teen is normally the limiting AGE GROUP to be used for the DOSE projection to the liver. Other AGE GROUPS and/or limiting ORGANS may be used if previous DOSE calculations indicate that the adult and teen are not the limiting AGE GROUPS and the liver is not the limiting ORGAN.

The following calculating methodology is provided for performing this DOSE projection.

1. Monthly DOSE Projection

   Each month the expected DOSE to man shall be projected. Projections shall be based on historical or prior month DOSE/Curie and historical or prior month concentration conversion factors. The historical factors are calculated from historical release data for both a refuel outage year and a non-refuel outage year. The current historical factors are on file within the Chemistry Department.

   A. Each month make an estimate of the volume of liquid radwaste to be discharged during that month. The following variables should be considered in estimating radwaste volumes to be released:

      1. Projected plant operational status (run, shutdown, refuel, etc.).
      2. Status of radwaste TREATMENT equipment. Equipment which is INOPERABLE, such as the waste concentrator, should be factored into the source term or volume of liquid waste to be discharged from the plant.
      3. Additional factors indicating that actual liquid releases could differ significantly in the next month.
      4. Historical liquid waste discharge volumes.

B. Determine which DOSE/Ci and Ci/gal conversion factors should be used. Historical conversion factors can be used. Prior month conversion factors may be used if they are more representative of current release conditions. In the event that there was no release of liquid radwaste during the prior month, then the historical conversion factors can be used if liquid releases are expected during the projection month.

1. The prior month DOSE/Ci conversion factors are calculated by obtaining the results of the prior month adult whole body and teen liver DOSE calculation.

2. Divide the DOSES by the total number of Curies released from the plant during this same time period. This calculation yields a DOSE per Curie conversion factor for the adult whole body and teen liver for the most recent prior calendar month.

3. The prior month Ci/gal concentration factor is calculated by obtaining the total number of Curies released from the plant during the prior month. Divide the Curie total by the total number of gallons of waste discharged during this same time period. This calculation yields the Ci/gal concentration conversion factor for the most recent month.

C. Multiply the estimated volume of liquid radwaste to be discharged, by the historical or prior month DOSE/Ci and Ci/gal conversion factors. This calculation yields a DOSE estimate to the adult whole body and teen liver for the projected month.

1. Adult Whole-Body DOSE

$$TD_{tb} = T_v \times C_g \times D_{ctb} \qquad \text{Eq. 3-9a}$$

2. Teen Liver DOSE

$$TD_l = T_v \times C_g \times D_{cl} \qquad \text{Eq. 3-9b}$$

Where:

T_v = Total volume of radwaste to be discharged during the month in gallons (estimated)

C_g = Curies per gallon conversion factor (historical or prior month)

D_{ctb} = DOSE per Curies adult whole body (historical or prior month) in mrem

TD_{tb} = Total DOSE for adult whole body in mrem

D_{cl} = DOSE per Curies teen liver (historical or prior month) in mrem

TD_l = Total DOSE for teen liver in mrem

If the calculated DOSES are greater than 0.06 mrem to the whole body or 0.2 mrem to the liver, the appropriate subsystems of the liquid radwaste system shall be used to reduce the radioactivity levels prior to release.

2. Monthly DOSE Projection – Alternative Method

Offsite DOSES due to projected releases of radioactive materials in liquid effluents are calculated using Equation 3-5b. Projected radionuclide release concentrations are used in place of measured concentrations, Ci. A DOSE projection is performed at least once per 31-days using the following equations:

A. Whole Body DOSE — Eq. 3-10a

$$D_{proj_{tb}} = \frac{t_d D_{tbq}}{d}$$

B. ORGAN DOSE — Eq. 3-10b

$$D_{proj_{ORGAN}} = \frac{t_d D_{oq}}{d}$$

Where

$D_{proj_{tb}}$ = Maximum whole-body DOSE projection for the current 31-day period in mrem

$D_{proj_{ORGAN}}$ = Maximum ORGAN DOSE projection for the current 31-day period in mrem

D_{tbq} = Maximum total body DOSE to date for current calendar quarter as obtained by equation 3-5b in mrem

D_{oq} = Maximum ORGAN DOSE to date for current calendar quarter as obtained from equation 3-5b in mrem

d = Number of days in current calendar quarter at the end of the release

t_d = 31, the conservative number of days in a month

Sections 11.5.2.1.B.2 and 11.5.2.1.B.3 do not apply if the alternative method is used, as this method is applicable to both batch and continuous DOSE projections. If the calculated DOSES are greater than 0.06 mrem to the whole body or 0.2 mrem to the maximum ORGAN, the appropriate subsystems of the liquid radwaste system shall be used to reduce the radioactivity levels prior to release.

3. Batch DOSE Projections

The projected DOSE due to release of each batch can be made prior to the release of the batch. The projection of the DOSE related to each batch allows for an accurate method of estimating the DOSE from each batch prior to release and confirms the need to operate the subsystems of the radwaste system. The projection of DOSE based on each batch release helps to eliminate any inaccuracies as a result of using historical or estimated values in the monthly projection. The use of this DOSE projection on a batch release basis is not required by the technical specification and is used at the discretion of the Chemistry/Environmental Management.

The method is based on whole body DOSE and limiting ORGAN DOSE (liver) as calculated in Section 11.4.2. The adult is the limiting AGE GROUP for projecting DOSE to the whole body and the teen is the limiting AGE GROUP for projecting DOSE to the liver.

The following calculating methodology is provided for performing this DOSE projection:

A. Obtain the latest result of the monthly calculation of the adult whole body and teen liver DOSE (Section 11.4.2).

B. Divide the DOSES by the total number of Curies released from the plant during the month. This yields a DOSE per Curie conversion factor for the adult whole body and teen liver for the most recent calendar month.

C. Maintain a running total of the Curies released during the past 30 days. Add to this the Curie content of the current batch to be released (31-day total).

D. Multiply the 31-day total from step (3), above by the DOSE per Curie conversion factors calculated in step (2), above. This yields the 31-day, whole body and liver DOSES projected for the release of the current batch.

E. If the calculated DOSES are greater than 0.06 mrem to the whole body or 0.2 mrem to the liver, the appropriate subsystems of the liquid radwaste system shall be used to reduce the radioactivity levels prior to release.

4. Continuous Liquid Release DOSE Projections

Each month that a continuous liquid release is in progress, or is anticipated, the expected DOSE to man can be projected. The projection shall be based on historical, prior month or current DOSE/Curie and NUCLIDE concentration (Curie/gallon) conversion factors. The historical conversion factors are calculated from prior releases. The prior month conversion factors are calculated from the prior month continuous liquid releases if such releases occurred. Current conversion factors are calculated from samples obtained at or near the beginning of the DOSE projection month.

A. Determine which DOSE/Ci and Ci/gal conversion factors should be used. Historical conversion factors can be used. Prior month or current conversion factors should be used if they are more representative of current release conditions.

1. The current month Ci/gal concentration is calculated by using current sample results for radionuclide concentration and converting the results to Ci/gal.

2. The current month estimated Curies released is calculated by multiplying the concentration by the known or expected flow rates for the effluent pathway times the period of release.

3. Using the DOSE assessment methodology specified in Section 11.4, calculate the adult whole body and teen liver DOSES using known or estimated flow rates and dilution factors.

4. Divide the DOSES calculated in section (c) above by the estimated number of Curies to be released. This calculation yields a DOSE per Curie conversion factor for the current release parameters.

5. The prior month DOSE/Ci conversion factors are calculated by obtaining the results of the prior month adult whole body and teen liver DOSE calculations.

6. Divide the DOSES by the total number of Curies released from the plant via continuous releases during this same time period. This calculation yields a DOSE per Curie conversion factor for the adult whole body and teen liver for the most recent prior calendar month.

7. The prior month Ci/gal concentration factor is calculated by obtaining the total number of Curies released from the plant via continuous releases during the prior month. Divide the Curie total by the total number of gallons of waste discharged during this same time period. This calculation yields the Ci/gal concentration conversion factor for the most recent month.

B. Multiply the estimated volume of continuous liquid effluent to be discharged by the historical, prior month or current DOSE/Ci and Ci/gal conversion factors. This calculation yields DOSE estimates to the adult whole body and teen liver for the projected month.

1. Adult Whole-Body DOSE

$TD_{tb} = T_v \times C_g \times D_{ctb}$

2. Teen Liver DOSE

$TD_l = T_v \times C_g \times D_{cl}$

Where:

T_v = Total volume of radwaste to be discharged during the month in gallons (estimated)

C_g = Curies per gallon conversion factor (historical, prior month or current)

D_{ctb} = DOSE per Curies adult whole body (historical, prior month or current) in mrem

TD_{tb} = Total DOSE for adult whole body in mrem

D_{cl} = DOSE per Curies teen liver (historical or prior month) in mrem

TD_l = Total DOSE for teen liver in mrem

If the calculated DOSES are greater than 0.06 mrem to the whole body or 0.2 mrem to the liver or other critical ORGAN, efforts should be made to reduce the effluent release rate or concentration.

5. Total Liquid Release DOSE Projections

DOSES from continuous releases, when they occur, should be added to DOSES from batch releases to ensure that the limits, 0.06 mrem to the whole body or 0.2 mrem to any ORGAN, are not exceeded.

12. GASEOUS EFFLUENT METHODOLOGY

12.1. Gaseous Waste Streams

James A. FitzPatrick Nuclear Power Plant (JAFNPP) discharges gaseous effluents through a stack, and discharges ventilation air from the reactor building, turbine building, radwaste building, and refuel floor through separately monitored VENT release points. There are three VENT release locations. The refuel floor and reactor building VENT is a combined release point. Normal gaseous effluent streams, and effluent discharge points are tabulated in Appendix F, Table F-1.

For the purpose of estimating offsite radionuclide concentrations and radiation DOSES, radionuclide concentrations are first measured in gaseous effluents and ventilation air exhausted from the plant. Part 1, Radiological Effluent Controls, Table 3.2-1 identifies the specific radionuclides in gaseous discharges for which sampling and analysis is done.

12.2. Data Requirements for Gaseous Effluent Calculations

DOSE calculations to demonstrate compliance with Part 1, Sections 3.2, 3.3 and 3.4 are normally performed using historical meteorological data and RECEPTOR location(s). Historical meteorological data for use in performing DOSE calculations are provided in Appendix C. DOSE calculations to show conformance with Part 1 DOSE limits may be performed using real meteorological data, real RECEPTOR locations, and sector wind frequency distribution if desired.

Historical meteorological data factors are calculated and used in DOSE calculations for the Radioactive Effluent Release Report. The report shall be submitted prior to May 1 of each year in accordance with 10 CFR 50.36a. Historical information and conservative RECEPTOR assumptions, are also used for ease of Part 1, Control DOSE limit calculations. JAFNPP uses an elevated release model for stack discharges and mixed MODE model for reactor, turbine, radwaste and refuel floor VENTS. Those radionuclides that appear in the gaseous effluent DOSE FACTOR tables are representative of BWR isotopes that may be considered in DOSE calculations.

The historical meteorological data and associated dispersion factors (X/Q, D/Q) are found in Appendix C. The dispersion factors used for RECEPTOR DOSE calculations are calculated based on site meteorological data and plant specific release point parameters.

12.3. Instantaneous Release Rate and Set Point Determination

12.3.1. Determining Instantaneous Noble Gas Release Rates

1. Requirements

Part 1, Radiological Effluent Controls, Section 3.2.1 Control, limit the DOSE RATE from noble gases in airborne releases from the plant to $\leq$500 mrem/yr - whole body, and $\leq$3,000 mrem/yr - skin.

The results of the sampling and analysis program of Part 1, Radiological Effluent Controls, Table 3.2-1 are used to demonstrate compliance with these limits.

2. Methodology

The instantaneous DOSE RATES to the whole body and skin from noble gases are evaluated to determine gaseous effluent release rates and alarm and/or trip setpoints.

The following calculating method is provided for determining the instantaneous DOSE RATES to the whole body and skin from noble gases in all monitored airborne release paths from JAFNPP. Conservatism factors in the instantaneous release rate equations are adequate to account for simultaneous releases from the NMP stack and VENT. JAFNPP discharges gaseous effluents through a stack, and ventilation air from the reactor building, turbine building, radwaste building, and refuel floor through monitored VENT release points.

The calculating methods are in accordance with NUREG-0133, October 1978, Section 5.1 and 5.2.

The equations for computing instantaneous DOSE RATES are:

Whole Body DOSE RATE

Vent — Eq. 4-1a

$$DR_{TB} = \sum_{i=1}^{n} K_i \times \left(\overline{X/Q}\right) \times \dot{Q}_i$$

Elevated Stack — Eq. 4-1b

$$DR_{TB} = \sum_{i=1}^{n} K_i \times \left(\overline{X/Q}\right)_{\gamma} \times \dot{Q}_i$$

The equations for DR_{TB} are to be summed over all VENT and elevated stack RELEASE SOURCES.

Skin DOSE RATE

Vent — Eq. 4-2a

$$DR_{SKIN} = \sum_{i=1}^{n} [L_i + 1.1\,M_i]\left(\overline{X/Q}\right) x\,\dot{Q}_i$$

Elevated Stack — Eq. 4-2b

$$DR_{SKIN} = \sum_{i=1}^{n} \left[L_i\left(\overline{X/Q}\right) + 1.1\,M_i\left(\overline{X/Q}\right)_{\gamma}\right]\ x\,\dot{Q}_i$$

Where:

DR_{TB} = Whole body DOSE RATE from noble gases in airborne releases, in mrem/sec.

DR_{SKIN} = Skin DOSE RATE from noble gases in airborne releases in mrem/sec.

K_i = The whole-body DOSE FACTOR due to GAMMA emissions for each noble gas NUCLIDE (i) reported in the RELEASE SOURCE, in mrem-m^3/μCi-sec.

L_i = The skin DOSE FACTOR due to BETA emissions for each noble gas NUCLIDE (i) reported in the assay of the RELEASE SOURCE in mrem-m^3/μCi-sec.

M_i = The air DOSE FACTOR due to GAMMA emissions for each noble gas NUCLIDE (i) reported in the assay of the RELEASE SOURCE. The constant 1.1 converts 'mrad' to 'mrem' since the units of M_i are in: (mrad-m^3/μCi-sec)

$\left(\frac{\overline{X}}{Q}\right)$ = For VENT or elevated stack releases, the highest annual average, concentration X/Q, calculated using long-term historic meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/m^3 (Appendix C, Table C-1).

$\left(\frac{\overline{X}}{Q}\right)_{\gamma}$ = For elevated stack releases, the highest annual average, finite cloud X/Q, calculated using long-term historic meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/m^3 (Appendix C, Table C-2).

$\dot{Q}_i$ = The release rate of noble gas NUCLIDE (i) from the RELEASE SOURCE of interest, in μCi/sec.

The equations for DR_{SKIN} are to be summed over all VENT and elevated stack RELEASE SOURCES.

3. **Limited Analysis Approach** - Instantaneous Noble Gas Release Rate

The above methodology can be simplified to provide for a rapid determination of cumulative noble gas release limits based on the requirements specified above. For ease of calculation and without unduly reducing the conservatism of the calculations, all releases may be treated as if discharged from two release points, an elevated stack and the reactor VENT. The reactor VENT is used to represent the combined discharge of the reactor building, turbine building, radwaste building, and refuel floor VENTS. Beginning with equations 4-1a and 4-1b, the simplification proceeds as follows.

From an evaluation of past releases, an effective whole-body DOSE FACTOR (K_{eff}) can be derived. This DOSE FACTOR is, in effect, a weighted average whole-body DOSE FACTOR (i.e., weighted by the radionuclide distribution typical of past operation). See Appendix E for a detailed explanation and evaluation of K_{eff}. The value of K_{eff} has been derived from the radioactive noble gas effluents for the years 1985 through 1991 for the plant VENTS and the years 1999 through 2003 for the elevated stack RELEASE SOURCES.

To compensate for any unusual variability in the radionuclide distribution, 3 sigma was added to the average K_{eff} values and are as follows:

K_{eff} = 9.27E-5 + 3σ

= 9.27E-5 + (3 X 4.78E-5)

= 2.36E-4 (mrem-m^3)/(μCi-sec)

(Vent Releases based on 1985 through 1991 Vent Release Data)

K_{eff} = 2.32E-4 + 3σ

= 2.32E-4 + (3 x 1.38E-5)

= 2.73E-4 (mrem-m^3/μCi-sec)

(Stack Releases)

Either of these values, as appropriate, may be used in conjunction with the total noble gas release rate (ΣQ_i) to verify that the instantaneous DOSE RATE is within the allowable limits. The simplified DOSE equations are as follows:

Vent Eq. 4-3a

$$DR_{TB} = K_{eff} \times \left(\overline{X/Q}\right) \times \sum_{i=1}^{n} \dot{Q}_i$$

Elevated Stack Eq. 4-3b

$$DR_{TB} = K_{eff} \times \left(\overline{X/Q}\right)_\gamma \times \sum_{i=1}^{n} \dot{Q}_i$$

Where:

DR_{TB} = Whole body DOSE RATE from noble gases in airborne releases, in mrem/sec.

$\left(\overline{X/Q}\right)$ = For VENT releases, the highest annual average reactor VENT concentration X/Q, calculated using long-term historic meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/m^3. (Appendix C, Table C-1)

$\left(\overline{X/Q}\right)_\gamma$ = For elevated stack releases, the highest annual average finite cloud X/Q, calculated using long-term historic meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/m^3. (Appendix C, Table C-2)

$\sum_{i=1}^{n} \dot{Q}_i$ = The total release rate of all noble gas NUCLIDES from the RELEASE SOURCE of interest, in μCi/sec.

A single cumulative (or gross) noble gas release rate limit for elevated stack releases (Q stack) and VENT releases (Q vent) may be derived by combining equations 4-3a and 4-3b.

Eq. 4-4a

$$DR_{TB} = \left[K_{eff}\,(\text{vent}) \times \left(\overline{X/Q}\right) \times \dot{Q}\,(\text{vent})\right] + \left[K_{eff}\,(\text{stack}) \times \left(\overline{X/Q}\right)_\gamma \times \dot{Q}\,(\text{stack})\right]$$

These limits may be determined by taking the highest calculated annual average $\left(\overline{X/Q}\right)_\gamma$ for elevated stack releases and the highest calculated annual average reactor VENT $\left(\overline{X/Q}\right)$ for VENT releases, at any of the land-based sectors, at or beyond the SITE BOUNDARY. From Appendix C, Tables C-1 and C-2, these values are:

$\left(\overline{X/Q}\right)_\gamma$ = 1.16E-7 $\frac{sec}{m^3}$ (Stack Releases)

$\left(\overline{X/Q}\right)$ = 3.58-7 $\frac{sec}{m^3}$ (Reactor Vent Releases)

Also, the Part 1 DOSE limit of Section 3.2.1 Control is:
DR_{TB} = 500 mrem/yr = 1.585E-5 mrem/sec.

Q (stack) was selected by requiring the stack not to yield a DOSE in excess of 300 mrem/yr or 9.51E-6 mrem/sec.

Eq. 4-4b

$$\dot{Q}\ (\text{stack}) = \frac{DR_{TB}\ (\text{stack})}{\left[K_{eff}\ (\text{stack}) \times \left(\overline{X/Q}\right)_{\gamma}\right]}$$

Substituting the preceding values into equation 4-4b, Q(stack) = 3.003E+5 μCi/sec which was rounded to 3.0E+5 μCi/sec. Q(stack) was then substituted into equation 4-4a and solved for Q(vent). Therefore, the following are the cumulative (or gross) noble gas release rate limits:

Elevated Stack Release

Rate Limit	= 3.00E+5 μCi/sec
Vent Release Rate Limit	= 7.515E+4 μCi/sec

As long as the noble gas release rates do not exceed these values (3.00E+5 μCi/sec for elevated stack releases and 7.515E+4 μCi/sec for VENT releases), no additional DOSE RATE calculations are needed to verify compliance with the release rate limits of Part 1, Radiological Effluent Controls, Section 3.2.1 Control.

A. **General Approach** - Whole Body and Skin NUCLIDE Specific Instantaneous Release Rate Calculations

The methods described herein may be used for more refined calculations or used if the actual releases exceed the values of:

Elevated Stack Release = 3.00E+5 μCi/sec

Vent Release = 7.515E+4 μCi/sec

<u>Whole Body DOSE RATE</u>

Vent — Eq. 4-5a

$$DR_{TB} = \sum_{i=1}^{n} K_i \times \left(\overline{X/Q}\right) \times \dot{Q}_i$$

The equation for DR_{TB} is to be summed over all VENT RELEASE SOURCES.

Elevated Stack — Eq. 4-5b

$$DR_{TB} = \sum_{i=1}^{n} K_i \times \left(\overline{X/Q}\right)_{\gamma} \times \dot{Q}_i$$

Where:

DR_{TB} = DOSE RATE to the whole body due to GAMMA emissions from all noble gas NUCLIDES, mrem/sec.

K_i = The whole-body DOSE FACTOR due to GAMMA emissions from noble gas radionuclide (i), in mrem-m^3/μCi-sec (see Appendix B, Table B-1).

$\left(\overline{X/Q}\right)$ = For VENT releases, the highest annual average concentration X/Q, calculated using long-term historic meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/m^3 (Appendix C, Table C-1).

$\left(\overline{X/Q}\right)_{\gamma}$ = For elevated stack releases, the highest annual average finite cloud X/Q, calculated using long-term historic meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/m^3 (Appendix C, Table C-2).

Stack$\left(\overline{X/Q}\right)_{\gamma}$ = 1.16E-7 sec/m^3

Vent $\left(\overline{X/Q}\right)$ = 3.58E-7 sec/m^3

$\dot{Q}_i$ = Release rate of the i^{th} NUCLIDE from the RELEASE SOURCE of interest, in μCi/sec

Skin DOSE RATE

Vent Eq. 4-6a

$$DR_{SKIN} = \sum_{i=1}^{n} [L_i + 1.1\ M_i] \left(\overline{X/Q}\right) x\ \dot{Q}_i$$

The equation for DR_{SKIN} is to be summed over all VENT RELEASE SOURCES.

Elevated Stack Eq. 4-6b

$$DR_{SKIN} = \sum_{i=1}^{n} \left[L_i\left(\overline{X/Q}\right) + 1.1\ M_i\left(\overline{X/Q}\right)_\gamma\right]\ x\ \dot{Q}_i$$

Where:

DR_{SKIN} = DOSE RATE to skin due to BETA and GAMMA radiation from all noble gas NUCLIDES (mrem/ sec).

L_i = The skin DOSE FACTOR due to BETA emissions from noble gas NUCLIDE (i), in mrem m^3/µCi-sec (Appendix B, Table B-1).

M_i = The air DOSE FACTOR due to GAMMA emissions from noble gas NUCLIDE (i), in mrad m^3/µCi-sec (Appendix B, Table B-2).

1.1 = Conversion factor for M_i from mrad to mrem.

$\left(\frac{\overline{X}}{Q}\right)$ = For VENT or elevated stack releases, the highest annual average concentration X/Q, calculated using long-term historic meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/m^3 (Appendix C, Table C-1).

$\left(\frac{\overline{X}}{Q}\right)_\gamma$ = For elevated stack releases, the highest annual average finite cloud X/Q, calculated using long-term meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/m^3 (Appendix C, Table C-2).

$\dot{Q}_i$ = Release rate of the i^{th} NUCLIDE from the RELEASE SOURCE of interest in µCi/sec.

4. Calculating Process

The following outline provides a step-by-step explanation of how the whole body and skin DOSE RATES are calculated on a NUCLIDE-by-NUCLIDE basis to evaluate compliance with Part 1, Radiological Effluent Controls, Section 3.2. This method is used for more refined calculations or if the actual releases exceed the value specified in the Limited Analysis Approach - Instantaneous Noble Gas Release Rate.

A. For a VENT, the X/Q value = __________ sec/m; and ____________ is the most limiting land sector at or beyond the SITE BOUNDARY.

For an elevated stack release, the $\left(\frac{\overline{X}}{Q}\right)$ value = _____ sec/m; and _____ is the most limiting land sector at or beyond the SITE BOUNDARY and the $(X/Q)_\gamma$ value = _____ sec/m; and _____ is the most limiting land sector at or beyond the SITE BOUNDARY.

B. Enter the release rate in ft^3/min of the RELEASE SOURCE and convert it to cc/sec;

$$= \frac{(\quad)ft^3}{min} \times \frac{2.831E+4\ cc}{ft^3} \times \frac{min}{60\ sec}$$

= _______ cc/sec volume release rate

C. Determine for NUCLIDE (i) by obtaining the µCi/cc assay value of the RELEASE SOURCE and multiplying it by the release rate computed in the previous steps.

$$\dot{Q}_i \frac{(\quad)\ \mu Ci}{cc} \times \frac{(\quad)cc}{sec}$$

$\dot{Q}_i$ = ________ µCi/sec for NUCLIDE (i)

D. To evaluate the whole-body DOSE RATE, obtain the K_i value for NUCLIDE (i) from Appendix B, Table B-1.

E. Solve for DR_{TBi}:

Vent

$$DR_{TBi} = K_i \times \left(\overline{X/Q}\right) \times \dot{Q}_i = \frac{mrem - m^3}{\mu Ci - sec} \times \frac{sec}{m^3} \times \frac{\mu Ci}{sec}$$

Elevated Stack

$$DR_{TBi} = K_i \times \left(\overline{X/Q}\right)_\gamma \times \dot{Q}_i = \frac{mrem - m^3}{\mu Ci - sec} \times \frac{sec}{m^3} \times \frac{\mu Ci}{sec}$$

DR_{TBi} = Whole body DOSE RATE from NUCLIDE (i) for the specified RELEASE SOURCE in mrem/sec

F. To evaluate the skin DOSE RATE, obtain the L_i and M_i values from Appendix B Table B-1 and Table B-2 for NUCLIDE (i).

G. Solve for $DR_{SKIN\ i}$:

Vent

$$DR_{SKIN_i} = [L_i + 1.1\ M_i]\ \left(\overline{X/Q}\right) \times \dot{Q}_i$$

Elevated Stack

$$DR_{SKIN_i} = \left[L_i\ \left(\overline{X/Q}\right) + 1.1 M_i\ \left(\overline{X/Q}\right)\right] \times \dot{Q}_i$$

$DR_{SKIN\ i}$ = Skin DOSE RATE from NUCLIDE (i) for the specified RELEASE SOURCE, in mrem/sec

H. Repeat steps A through G above for each noble gas NUCLIDE (i) reported in the assay of the RELEASE SOURCE.

I. The DOSE RATE to the whole body from radioactive noble gas GAMMA radiation from the specified RELEASE SOURCE is:

$$DR_{TB} = \sum_{i=1}^{n} DR_{TB_i}$$

J. The DOSE RATE to the skin due to noble gas radiation from the specified RELEASE SOURCE is:

$$DR_{SKIN} = \sum_{i=1}^{n} DR_{SKIN_i}$$

The DOSE RATE contribution of this RELEASE SOURCE shall be added to all other gaseous RELEASE SOURCES that are in progress at the time of interest.

Part 1, Radiological Effluent Controls, Section 3.2.1 Control requires the following:

DR_{TB} ≤500 mrem/yr (1.585E-5 mrem/sec)

DR_{SKIN} ≤3,000 mrem/yr (9.513E-5 mrem/sec)

Where:

DR_{TB} = The sum of the whole-body DOSE RATE contributions (mrem/sec) from all noble gas NUCLIDES from all concurrent releases.

DR_{SKIN} = The sum of skin DOSE RATE contributions (mrem/sec) from all noble gas NUCLIDES from all concurrent releases.

12.3.2. Setpoint Determination

1. Requirements

To comply with Part 1, Section 3.2.1 Control, the alarm/trip setpoints are established to ensure that the Noble gas releases do not exceed the appropriate cumulative (or gross) Noble gas release rate limit specified in Limited Analysis Approach – Instantaneous Noble Gas Release Rate.

A Change Management Plan as defined in HU-AA-1101 shall be initiated and included in any ODCM revision whenever the methodology for calculating gaseous setpoints or gaseous monitor k-factors are changed and the change to the methodology or k-factors results in a new calculated setpoint.

If the stack setpoint limit is changed in the ODCM, refer to required ACTIONS found in SCR-E1-98-0031 to maintain proper configuration.

2. Methodology

This section describes the methodology for determining alarm/trip setpoints for the stack and VENT gaseous release pathways. To allow for multiple sources of releases from different or common release points, the allowable operating setpoints will be administratively controlled to allocate a percentage of the total allowable release to each of the RELEASE SOURCES. The cumulative Noble gas release rate limit for the stack (elevated) release is 3.0E+5 µCi/sec. The individual release rate limits for the other gaseous release points (assumed to be VENT releases), are based upon an allocated percentage of the cumulative VENT release rate limit (7.515E+4 µCi/sec).

The sum of the four VENT release points cannot exceed 7.515E+4 µCi/sec. The setpoint release rates for the VENTS follow.

Release Point	Setpoint Release Rate (µCi/sec)	K-factor (µCi)/(sec-cpm)	Normal Setpoint Value (cpm)
Turbine Building	46,500	0.62	75,000
Reactor Building	10,800	0.36	30,000*
Refuel Floor	12,000	0.40	30,000
Radwaste Building	5,700	0.19	30,000

* Maximum allowable value by Technical Specification table 3.3.6.2-1 is $\leq$ 24,800 cpm. Nominal setpoint value is the bases for the maximum allowable value.

The K-factors for the VENTS were calculated by multiplying the calculated efficiency for Kr-85, 1.11E-8 µCi/(cc-cpm) derived from the manufacturer's sensitivity equation, by the flow rate for the release point.

Release Point	Flowrate* (cfm)	K-factor (µCi)/(sec-cpm)
Turbine Building	118,000	0.62
Reactor Building	68,000	0.36
Refuel Floor	77,000	0.40
Radwaste Building	36,000	0.19

* Reference 14.18

Stack monitor K-factors are reviewed on a periodic basis. A conservative factor of 1.2 µCi/(sec-cps) was selected considering potential worse case conditions of standby gas treatment in service. The alarm/setpoint value for the stack was calculated by dividing the setpoint release rate by the K-factor. The setpoint limit for the stack follows.

	Setpoint Release Rate (µCi/sec)	K-factor (µCi)/(sec-cps)	Nominal Setpoint Value (cps)
Stack	300,000	1.2	250,000

The whole-body DOSE is more limiting than the calculated skin DOSE. Therefore, the skin DOSE RATE calculations are not required if the simplified DOSE RATE calculation is used (i.e., using K_{eff} to determine release rate limits).

The calculating processes of step 12.3.1.4 are to be used if the actual releases of noble gases exceed the predetermined limits of 3.0E+5 µCi/sec for elevated stack releases or 7.515E+4 µCi/sec for VENT releases.

Under these conditions, a NUCLIDE-by-NUCLIDE evaluation is required to evaluate compliance with the DOSE RATE limits of Part 1, Section 3.2.1 Control.

12.3.3. Determining the Radioiodine, Tritium, and Eight Day Particulate Instantaneous Release Rates

1. Requirements

Part 1, Radiological Effluent Controls, Section 3.2.1 Control, limits the DOSE RATE from I-131, I-133, tritium, and particulate with half-lives greater than eight days released from the plant to <1,500 mrem/yr to any ORGAN, from the inhalation pathway only.

2. Methodology

The following calculating method is provided for determining the DOSE RATE from radioiodines, tritium, and particulate. It is based on NUREG-0133, October 1978, Sections 5.2.1 and 5.2.1.1.

Actual concentrations of Iodine-131, Iodine-133, and radionuclides in particulate form with half-life greater than 8 days released from the plant in gaseous effluents shall be determined using GAMMA isotopic analysis. Tritium and strontium are determined by offsite analysis. Sampling and analysis shall be performed in accordance with frequency specified in Table 3.2-1 of Part 1, Radiological Effluents Controls.

The limiting AGE GROUPS are the child and teen, and the limiting ORGAN is the thyroid, per Appendix B, Table B-6.5. Based on an analysis of DOSES to various ORGANS and AGE GROUPS for the inhalation pathway, the child and teen were verified as being the controlling AGE GROUPS and the thyroid as being the limiting ORGAN. This pathway is the only one that need be considered for instantaneous releases. The long-term sector average concentration (X/Q) values are based on historical meteorological data. DOSE FACTORS for NUCLIDES listed in Appendix B, Table B-3 will be used.

Inhalation Pathway

The equation for $DR_{I\&8DP_T}$ is to be summed over all RELEASE SOURCES.

Eq. 4-9

$$DR_{I\&8DP_T} = \sum_{s=1}^{m} \sum_{i=1}^{n} P_{i_T} \times \left(\frac{\overline{X}}{Q}\right)_s \times \dot{Q}_{is}$$

Where:

T	=	The ORGAN of interest (thyroid) for the AGE GROUP of interest.
$\dot{Q}_{is}$	=	Total release rate of NUCLIDE (i), (µCi/ sec) for each RELEASE SOURCE (s).
$DR_{I\&8DP_T}$	=	Total DOSE RATE to the thyroid of the limiting AGE GROUP from iodines, tritium, and eight-day particulate via the inhalation pathway (mrem/yr) for all release points p.
$\left(\frac{\bar{X}}{Q}\right)_s$	=	The long-term sector average concentration X/Q value based on historical meteorological data in (sec/m3) for RELEASE SOURCES (Appendix C).
P_{i_T}	=	The DOSE FACTOR for the inhalation pathway in (mrem/yr per µCi/m3) for NUCLIDE (i) (Appendix B, Table B-3). The derivation of Pi values is given in Appendix B, Table B-6.1.
m	=	The number of RELEASE SOURCES of interest.

The maximum allowable release rate of all radioiodines, tritium, and particulate, summed together, is determined by the following relationship:

Eq. 4-10

$$\dot{Q}_I = \sum_{S=1}^{m} \left[\frac{(FRAC)_s \;\; DR_{Thyroid}}{\left(\frac{\bar{X}}{Q}\right)_s \;\; P_{i_{(Thyroid)}}} \right] \times 0.8$$

Where:

$DR_{Thyroid}$	=	DOSE RATE to the thyroid from the inhalation pathway set equal to Part 1, Radiological Effluent Controls, Section 3.2.1 Control limit of ≤1,500 mrem/year.
$P_{i_{(Thyroid)}}$	=	The DOSE FACTOR of I-131 for the inhalation pathway (thyroid), 1.62E+7 mrem/yr per µCi/m3 (Appendix B, Table B-3).
$\left(\frac{\bar{X}}{Q}\right)_s$	=	The long-term sector average concentration X/Q value for any land sector value based on historical meteorological data in (sec/m3) for RELEASE SOURCES (Appendix C).
$\dot{Q}_I$	=	Maximum allowable release rate of all radioiodines, tritium, and particulate summed together in µCi/sec.
$(FRAC)_s$	=	Fraction of 1500 mrem/yr limit allocated to RELEASE SOURCES, such that 3(Frac)$_s$ = 1.0.
0.8	=	A conservatism factor.

12.4. DOSE Determination for Radioactive Gaseous Effluents

This section addresses the methodologies for calculating the offsite radiation exposures (to all AGE GROUPS and ORGANS) from radionuclides in the gaseous effluents for the following:

a. Long-term (routine) releases - Annual DOSE assessment for inclusion in the Radioactive Effluent Release Report (Sec. 12.4.1),

b. Long-term (routine) releases - Verification of compliance with 10 CFR 50 Appendix I (Sec. 12.4.2), and

c. Short term releases (Sec. 12.4.3).

As described in NUREG-0133 (Ref. 6.2, Sec. 3.3), gaseous releases are characterized as "long" or "short" term depending on the frequency and duration of the releases. This characterization forms the basis for more accurate offsite DOSE assessments by matching the releases with more appropriate atmospheric dispersion and decay conditions. Long-term gaseous releases refer to releases that are generally continuous and stable, with small fractional variations. Short-term releases, on the other hand, are intermittent or infrequent, with a defined total cumulative duration of 500 hours or less during a calendar year, and no more than 150 hours per quarter; they also include anticipated non-routine operational occurrences.

Offsite radiation DOSES from short-term releases [item (c) above], when they occur, are to be incorporated into both the annual DOSE assessment [item (a)] and the verification of compliance with regulatory guidelines [item (b)]. However, routine releases from JAF are essentially all long-term and are continuously monitored by stack and VENT effluent radiation monitors. Therefore, short-term releases at JAF are considered to be only unmonitored non-routine releases and are not applicable for definition of the alarm/trip setpoints for the stack and VENT effluent monitors. In addition, in line with NUREG-0133, short-term releases are not used in assessing compliance with the Part 1, Section 3.2.1 Control, release limits as discussed in Section 12.3.

12.4.1. Annual DOSE Assessment - Radioactive Effluent Release Report Submittal

1. Requirements

Technical Specification 5.6.3 requires a Radioactive Effluent Release Report be submitted prior to May 1 of each year covering the operation of the plant during the previous year. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the plant. The material provided shall be consistent with the objectives outlined in Part 1, Section 6.2.

2. Methodology

This section provides the methodology to calculate the DOSES to all AGE GROUPS and ORGANS from radionuclides identified in the gaseous effluents.

The method is based on the methodology suggested by NUREG-0133, October 1978, Sections 5.3 and 5.3.1. The determination of viable gaseous DOSE PATHWAYS is described in Appendix B, Table B-6.4. The site related DOSE FACTORS for viable pathways are listed in Appendix B. DOSE FACTORS are compiled by AGE GROUPS, for ORGANS and radionuclides common to a BWR environment. Normally calculated annual long-term historical atmospheric dispersion factors are used to perform the annual DOSE assessment. Actual meteorological data and sector wind frequency distributions for the year of interest may be used in lieu of the annual long-term historical factors. The following equations provide for a DOSE calculation to the whole body or any ORGAN for a given AGE GROUP based on actual releases during a specific time interval for radioactive gaseous RELEASE SOURCES:

A. Annual Air DOSE Due to Noble Gases

Vent — Eq. 4-11a

$$D_{GAMMA\text{-}Air} \sum_{i=1}^{n} M_i \text{ x } \left(\frac{\overline{X}}{Q}\right) \text{ x } Q_i$$

Elevated Stack — Eq. 4-11b

$$D_{GAMMA\text{-}Air} \sum_{i=1}^{n} M_i \text{ x } \left(\frac{\overline{X}}{Q}\right)_{\gamma} \text{ x } Q_i$$

Where:

$D_{GAMMA\text{-}Air}$ = The GAMMA air DOSE from radioactive noble gases, in mrad.

M_i = The GAMMA air DOSE FACTOR for radioactive noble gas NUCLIDE 'i', in mrad-m^3/μCi-sec (Appendix B, Table B-2).

$\left(\frac{\overline{X}}{Q}\right)$ = The long-term historical atmospheric dispersion factors for VENT releases (annual average) for the location of interest. Actual meteorological data and sector wind frequency distributions may be used to determine annual X/Q for the year of interest in sec/m^3.

$\left(\frac{\overline{X}}{Q}\right)_\gamma$ = The long-term historical atmospheric dispersion factor for elevated stack releases (annual average) for the location of interest based on the finite cloud methodology. Actual meteorological data and sector wind frequency distributions may be used to determine annual X/Q for the year of interest in sec/m^3.

Q_i = The number of μCi of NUCLIDE 'i' released during the year of interest from the RELEASE SOURCE of interest.

The equations for $D_{GAMMA\text{-}Air}$ are to be summed over all VENT and elevated stack RELEASE SOURCES.

Eq.4-12

$$D_{BETA\text{-}Air} \sum_{i=1}^{n} N_i \text{ x } \left(\frac{\overline{X}}{Q}\right) \text{ x } Q_i$$

Where:

$D_{BETA\text{-}Air}$ = BETA air DOSE from radioactive noble gases in mrad.

N_i = The BETA air DOSE FACTOR for radioactive noble gas NUCLIDE (i) in mrad-m^3/μCi-sec (see Appendix B, Table B-2).

$\left(\frac{\overline{X}}{Q}\right)$ = The long-term historical atmospheric dispersion factors for VENT or elevated stack releases (annual average) for the location of interest. Actual meteorological data and sector wind frequency distributions may be used to determine annual X/Q for the year of interest in sec/m^3.

Q_i = The number of μCi of NUCLIDE 'i' released during the year of interest from the RELEASE SOURCE of interest.

The equations for $D_{BETA\text{-}Air}$ are to be summed over all VENT and elevated stack RELEASE SOURCES.

B. Annual Whole-Body DOSE Due to Noble Gases

Vent Eq. 4-12a

$$D_{TB} \sum_{i=1}^{n} K_i \times \left(\frac{\overline{X}}{Q}\right) \times Q_i$$

Elevated Stack Eq. 4-12b

$$D_{TB} \sum_{i=1}^{n} M_i \times \left(\frac{\overline{X}}{Q}\right)_{\gamma} \times Q_i$$

Where:

D_{TB} = Whole body DOSE from noble gases in airborne releases, in mrem.

K_i = The whole-body DOSE FACTOR due to GAMMA emissions for each noble gas NUCLIDE (i) reported in the RELEASE SOURCE, in mrem-m^3/µCi-sec (Appendix B, Table B-1).

$\left(\frac{\overline{X}}{Q}\right)$ = The long-term historical atmospheric dispersion factors for VENT or elevated stack releases (annual average) for the location of interest. Actual meteorological data and sector wind frequency distributions may be used to determine annual X/Q for the year of interest in sec/m^3.

$\left(\frac{\overline{X}}{Q}\right)_{\gamma}$ = The long-term historical atmospheric dispersion factor for elevated stack releases (annual average) for the location of interest based on the finite cloud methodology. Actual meteorological data and sector wind frequency distributions may be used to determine annual X/Q for the year of interest in sec/m^3.

Q_i = The number of microcuries for each noble gas NUCLIDE (i) released during the year of interest from the RELEASE SOURCE of interest.

The equations for D_{TB} are to be summed over all VENT and elevated stack RELEASE SOURCES.

C. Annual Total Skin DOSE Due to Noble Gases

Vent — Eq. 4-12c

$$D_{SKIN} \sum_{i=1}^{n} [L_i + 1.1\, M_i] \left(\frac{\overline{X}}{Q}\right) x\ Q_i$$

Elevated Stack — Eq. 4-12d

$$D_{SKIN} \sum_{i=1}^{n} \left[L_i \left(\frac{\overline{X}}{Q}\right) + 1.1 M_i \left(\frac{\overline{X}}{Q}\right)_{\gamma}\right] x\ Q_i$$

Where:

D_{SKIN}= Skin DOSE from noble gases in airborne releases in mrem.

Li = The skin DOSE FACTOR due to BETA emissions for each noble gas NUCLIDE (i) reported in the assay of the RELEASE SOURCE in mrem- m^3/μCi-sec (Appendix B, Table B-1).

Mi = The air DOSE FACTOR due to GAMMA emissions for each noble gas NUCLIDE (i) reported in the assay of the RELEASE SOURCE. The constant 1.1 converts 'mrad' to 'mrem' since the units of M_i are in mrad- m^3/μCi-sec (Appendix B, Table B-2).

$\left(\frac{\overline{X}}{Q}\right)$ = The long-term historical atmospheric dispersion factors for VENT or elevated stack releases (annual average) for the location of interest. Actual meteorological data and sector wind frequency distributions may be used to determine annual X/Q for the year of interest in sec/ m^3.

$\left(\frac{\overline{X}}{Q}\right)_{\gamma}$ = The long-term historical atmospheric dispersion factor for elevated stack releases (annual average) for the location of interest based on the finite cloud methodology. Actual meteorological data and sector wind frequency distributions may be used to determine annual X/Q for the year of interest in sec/ m^3.

Qi = The number of microcuries for each noble gas NUCLIDE (i) released during the year of interest from the RELEASE SOURCE of interest.

The equations for D_{SKIN} are to be summed over all VENT and elevated stack RELEASE SOURCES.

D. Annual DOSE Due to Radioiodines, Tritium, and Eight Day Particulate

Inhalation Pathways Eq. 4-13

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{X}}{Q}\right) \times Q_i$$

GROUND PLANE Deposition Pathway Eq. 4-14

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

Cow's Milk Pathway Eq. 4-15

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

Goat's Milk Pathway Eq. 4-16

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

Meats Eq. 4-17

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

Vegetation Eq. 4-18

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

For tritium, the DOSE is calculated by substituting $\left(\frac{\overline{X}}{Q}\right)$ for $\left(\frac{\overline{D}}{Q}\right)$ and $R_{H\text{-}3_T}$ for R_{i_T} in equations 4-15 to 4-18.

Total Annual DOSE from RELEASE SOURCE of Interest Eq. 4-19a

$$D_{TS} = \sum_{z=1}^{p} (D_{I\&8DP})_{TZ}$$

Total Annual DOSE Eq. 4-19b

$$D_{TS} = \sum_{s=1}^{m} (D)_{TS}$$

Where:

τ	=	The ORGAN of interest for the AGE GROUP of interest.
s	=	The RELEASE SOURCE of interest.
z	=	Pathway of interest.
p	=	The number of pathways of interest.
m	=	Number of RELEASE SOURCES of interest.
$(D_{I\&8DP})_\tau$	=	Annual DOSE to the ORGAN τ for the AGE GROUP of interest from iodines, tritium, and eight-day particulate via the pathway of interest in (mrem).
3.17E-8	=	The inverse of the number of seconds per year in (years/sec).
$D_{\tau s}$	=	Total annual DOSE to ORGAN τ from all applicable pathways for the AGE GROUP of interest and for the RELEASE SOURCE of in (mrem).
D_τ	=	Total annual DOSE to ORGAN τ from all applicable pathways for the AGE GROUP of interest and for all RELEASE SOURCES of interest in (mrem).
Q_i	=	The number of µCi of NUCLIDE 'i' released during the year of interest from the RELEASE SOURCE of interest.
$R_{i\tau}$	=	The DOSE FACTOR for NUCLIDE (i) for ORGAN τ for the pathway specified, units vary with pathway. The derivation of $R_{i\tau}$ values is given in Appendix B, Table B-6.2.
$\left(\frac{\overline{D}}{Q}\right)$	=	The long-term historical annual average relative deposition values for elevated stack or VENT releases for the GROUND PLANE deposition pathway. For the meat, cow, goat, and vegetable pathways, the long-term historical grazing average deposition values for elevated stack and VENT releases are used (Appendix C). A factor with units of m^2 which describes the deposition of particulate matter from a plume at a point downrange from the source. Actual meteorological data and sector wind frequency distribution may be used to determine annual average D/Q for the year of interest. D/Q is not used to calculate DOSES associated with H-3 releases.
$\left(\frac{\overline{X}}{Q}\right)$	=	The long-term historical annual average atmospheric dispersion factors for VENT or elevated stack releases for the location of interest (Appendix C). Actual meteorological data and sector wind frequency distributions may be used to determine annual X/Q for the year of interest in sec/ m^3. The X/Q is used to determine DOSES for H-3 releases.

12.4.2. Monthly DOSE Assessment - Verification of Compliance with 10 CFR 50, Appendix I

1. Determining the GAMMA Air DOSE for Radioactive Noble Gas RELEASE SOURCE(s)

A. Requirement

Part 1, Radiological Effluent Controls, Section 3.3.1Control limits the air DOSE from GAMMA radiation due to noble gases released from the plant in the gaseous effluent ≤10 mrad during any calendar year, and ≤5 mrad in any calendar quarter.

Part 1, Section 3.3.4.3, requires that cumulative air DOSE contributions from noble gases be calculated at least monthly for the current calendar quarter and current calendar year.

B. Methodology

The following calculational method is provided for determining the noble gas GAMMA air DOSE and is based on NUREG-0133 October 1978 Section 5.3.1. The DOSE calculation is independent of AGE GROUP. The equation may be used for Part 1, 3.3.4.3 DOSE calculations, the DOSE calculation for the annual report, or for projecting DOSE, provided that the appropriate value of (X/Q) is used. The equation for GAMMA air DOSE is:

Vent Eq. 4-20a

$$D_{GAMMA\text{-}Air} = \sum_{i=1}^{n} M_i \times \left(\frac{\overline{X}}{Q}\right) \times Q_i$$

Elevated Stack Eq. 4-20b

$$D_{GAMMA\text{-}Air} = \sum_{i=1}^{n} M_i \times \left(\frac{\overline{X}}{Q}\right)_{\gamma} \times Q_i$$

Where:

$D_{GAMMA\text{-}Air}$ = The GAMMA air DOSE from radioactive noble gases in mrad.

Mi = The GAMMA air DOSE FACTOR for radioactive noble gas NUCLIDE 'i', in mrad-m^3/µCi-sec (Appendix B, Table B-2).

$\left(\frac{\overline{X}}{Q}\right)$ = The highest long-term annual average atmospheric dispersion factors for VENT releases for any land sector, in sec/m^3 (Appendix C, Table C-1).

$\left(\frac{\overline{X}}{Q}\right)_\gamma$ = The highest long-term annual average atmospheric dispersion factor for elevated stack releases for any land sector based on the finite cloud methodology, in sec/m^3 (Appendix C, Table C-2).

Q_i = The number of µCi of NUCLIDE 'i' released (or projected to be released) during the DOSE calculation exposure period (e.g., month, quarter, or year) from the RELEASE SOURCE of interest.

The equations for $D_{GAMMA\text{-}Air}$ are to be summed over all VENT and elevated stack RELEASE SOURCES.

1. Limited Analysis Approach

The following limited analysis approach may be used to establish monthly release objectives (µCi/month) that will ensure compliance with 10 CFR 50, Appendix I GAMMA DOSE limits.

From an evaluation of past releases, a single effective GAMMA air DOSE FACTOR (M_{eff}) has been derived, which is representative of the radionuclide abundances and corresponding DOSE contributions typical of past operation. (Appendix E has a detailed explanation and evaluation of M_{eff}). The value of M_{eff} has been derived from the radioactive noble gas effluents for the years 1985 through 1991.

To compensate for any unusual variability in the radionuclide distribution, 3 sigma was added to the average M_{eff} value, and are as follows.

$$M_{eff} = 9.75E\text{-}5 + 3\sigma$$
$$= 9.75E\text{-}5 + (3 \times 4.95E\text{-}5)$$
$$= 2.46E\text{-}4 \text{ (mrad-m}^3\text{)/(}\mu\text{Ci-sec)}$$

(vent release)

$$M_{eff} = 1.57E\text{-}4 + 3\sigma$$
$$= 1.57E\text{-}4 + (3 \times 4.70E\text{-}5)$$
$$= 2.98E\text{-}4 \text{ (mrad-m}^3\text{)/(}\mu\text{Ci-sec)}$$

(stack release)

The effective GAMMA air DOSE FACTOR may be used in conjunction with the total noble gas release to simplify the DOSE evaluation and to verify that the cumulative GAMMA air DOSE is within the equivalence of the limits of Part 1, Radiological Effluent Controls, Section 3.3.1.

Equations 4-20a and 4-20b can be used to establish monthly release objectives. Combining equations 4-20a and 4-20b yields the following:

Eq. 4-21

$$D_{GAMMA\text{-}Air} = \left[M_{eff}\text{ (vent)} \times \left(\frac{\overline{X}}{Q}\right) \times Q\text{ (vent)}\right] + \left[M_{eff}\text{ (stack)} \times \left(\frac{\overline{X}}{Q}\right)_{\gamma} \times Q\text{(stack)}\right]$$

Part 1, Radiological Effluent Controls Section 3.3.4.3 states that the DOSES must be evaluated once per month. The yearly DOSE limit is 10 mrads, which corresponds to a monthly allotment of 0.83 mrads. 0.83 mrads can be substituted into equation 4-21 for $D_{GAMMA\text{-}Air}$. The highest calculated annual average

$\left(\frac{\bar{X}}{Q}\right)_\gamma$, 1.16E-7 sec/m^3, for elevated stack releases and the

highest calculated annual average reactor VENT (X/Q),3.58E-7 sec/m^3, for VENT releases, can be substituted into equation 4-21. Q(stack) and Q(vent) were selected so that the technical specifications limit of 10 mrad/yr or 0.83 mrad/month would not be exceeded. In addition, Q(stack) was selected by requiring the stack not to exceed 60% of 0.83 mrad/month.

Eq. 4-22

$$Q(stack) = \frac{D_{GAMMA\text{-}Air}\ (stack)}{\left[M_{eff}\ (stack) \times \left(\frac{\bar{X}}{Q}\right)_\gamma\right]}$$

Substituting the preceding values into equation 4-22, yields Q(stack) = 1.44E10 µCi/month. Q(stack) was then substituted into equation 4-21 and solved for Q(vent). Therefore, the following are the cumulative noble gas monthly release objectives.

Q(vent release) = 3.77E+9 µCi/month

Q(elevated stack release) = 1.44E+10 µCi/month

As long as these values are not exceeded during any month, compliance with the quarterly and annual noble gas release limits of Part 1, Radiological Effluent Controls, Section 3.3.1 Control is demonstrated. When the limited approach method is used, the calculations of 12.4.2.1.B must be performed monthly at a minimum.

The GAMMA air DOSE limit does not cause the BETA air DOSE limit to be exceeded when the limited analysis approach of this section is used.

2. Determining the BETA Air DOSE for Radioactive Noble Gas RELEASE SOURCES

The BETA air DOSE calculations of this step are required to be performed when the radionuclide specific DOSE analysis of GAMMA Air DOSE is performed. The radionuclide specific DOSE analysis is performed at least monthly in accordance with Part 1, Section 3.3.4.3.

A. Requirement

Part 1, Radiological Effluent Controls, Section 3.3.1 Control limits the air DOSE from BETA radiation, due to noble gases released from the plant in the gaseous effluents, to less than or equal to 20 mrad during any calendar year and less than or equal to 10 mrad in any calendar quarter.

Part 1, Section 3.3.4.3 requires that cumulative air DOSE contributions from noble gases released from the plant be calculated at least monthly for the current calendar quarter and current calendar year.

When the NUCLIDE specific DOSE calculation is used to evaluate compliance with the GAMMA air DOSE limits, the BETA air DOSE shall be evaluated on a NUCLIDE specific basis using the methodology presented below.

B. Methodology

The following calculating method is provided for determining the BETA air DOSE and is based on NUREG-0133, October 1978, Section 5.3.1. The DOSE calculation is independent of any AGE GROUP. The equation may be used for DOSE calculations for Part 1, 3.3.4.3, Radiological Effluent Release Reports, or for projecting DOSE, provided that the appropriate value of (X/Q) is used.

The equation for BETA air DOSE is:

Eq. 4-23

$$D_{BETA\text{-}Air} \sum_{i=1}^{n} N_i \times \left(\frac{\overline{X}}{Q}\right) \times Q_i$$

Where:

$D_{BETA-Air}$ = BETA air DOSE from radioactive noble gases in (mrad).

N_i = The BETA air DOSE FACTOR for radioactive noble gas NUCLIDE 'i' in mrad- m^3/μCi-sec (Appendix B, Table B-2).

$\left(\frac{\bar{X}}{Q}\right)$ = For VENT or elevated stack releases, the highest annual average, X/Q, calculated using long-term historic meteorological data, for any land sector, at or beyond the SITE BOUNDARY, in sec/ m^3 (Appendix C).

Q_i = The number of μCi of NUCLIDE 'i' released (or projected to be released) during the DOSE calculation exposure period from the RELEASE SOURCE of interest.

The equation for $D_{BETA-Air}$ is to be summed over all RELEASE SOURCES.

3. Determining the Radioiodine, Tritium, and Eight Day Particulate DOSE to any ORGAN from Cumulative Releases

A. Requirement

Part 1, Radiological Effluent Controls, Section 3.4.1 Control limits the DOSE to the whole body or any ORGAN resulting from the release of radioiodines, tritium, and particulate with half-lives greater than eight days released from the plant to ≤7.5 mrem/quarter and ≤15 mrem/yr to any ORGAN.

Part 1, Section 3.4.4.3 requires that cumulative DOSE contributions be calculated at least monthly for the current calendar quarter and current calendar year.

B. Methodology

The following calculating method is provided for determining the ORGAN DOSE due to releases of radioiodines (I-131, I-133), tritium, and particulate with half-lives greater than 8 days. It is based on NUREG-0133, October 1978, Section 5.3.1. The equations can be used for any AGE GROUP provided that the appropriate DOSE FACTORS are used, and the total DOSE reflects only those pathways that are applicable to the AGE GROUP and the RECEPTOR location. The deposition factor, (D/Q), represents the rate of fallout from the cloud that affects a square meter of ground at various distances from the site. The total DOSE to an ORGAN can then be determined by summing the pathways that apply to the RECEPTOR in the sector. The equations are:

Inhalation Pathway Eq. 4-24

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{X}}{Q}\right) \times Q_i$$

GROUND PLANE Pathway Eq. 4-25

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

Cow's Milk Pathway Eq. 4-26a

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

Goat's Milk Pathway Eq. 4-26b

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

Meats Eq. 4-26c

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

Vegetation Eq. 4-26d

$$(D_{I\&8DP})_T = (3.17E\text{-}8)\sum_{i=1}^{n} R_{i_T} \times \left(\frac{\overline{D}}{Q}\right) \times Q_i$$

For tritium, the DOSE is calculated by substituting X/Q for (D/Q) and $R_{H\text{-}3_T}$ in R_{i_T} equations 4-26a to 4-26d.

Total DOSE from a RELEASE SOURCE for Applicable Pathways

Eq.4-27a

$$D_{TS} = \sum_{z=1}^{p} (D_{I\&8DP})_{TZ}$$

Total Annual DOSE from All RELEASE SOURCES of Interest

Eq.4-27b

$$D_T = \sum_{s=1}^{m} (D_{TS})$$

Where:

τ	=	The ORGAN of interest in a specified AGE GROUP.
s	=	The RELEASE SOURCE of interest.
z	=	The pathway of interest.
p	=	The number of pathways of interest.
m	=	The number of RELEASE SOURCES of interest.
$D_{I\&8DP_\tau}$	=	DOSE in mrem to the ORGAN τ of a specified AGE GROUP from radioiodines, tritium, and 8 day particulate due to a particular pathway.
$D_{\tau s}$	=	Total DOSE to ORGAN τ from all applicable pathways for a specified AGE GROUP for the RELEASE SOURCE of interest in (mrem).
D_τ	=	Total DOSE to ORGAN τ from all applicable pathways for a specified AGE GROUP and for all RELEASE SOURCES of interest in (mrem).
3.17E-8	=	The inverse of the number of seconds per year in (years/sec).
R_{i_τ}	=	The DOSE FACTOR for NUCLIDE (i) ORGAN τ of the specified AGE GROUP. The units are either mrem-m^3/yr-µCi for pathways using (X/Q), or mrem- m^2-sec/yr-µCi for pathways using (D/Q) (Appendix B, Tables B-4 and B-5).
$\left(\frac{\bar{X}}{Q}\right)$	=	The concentration (X/Q) value for a specific location where the RECEPTOR is located. The units are (sec/m^3) (Appendix C). The X/Q is used to determine DOSES for H-3 releases.
$\left(\frac{\bar{D}}{Q}\right)$	=	The deposition value for a specific location where the RECEPTOR is located. The units are m^2 (Appendix C). D/Q is not used to calculate DOSES associated with H-3 releases.
Q_i	=	The number of µCi of NUCLIDE (i) released (or projected to be released) during the DOSE calculation exposure period from the RELEASE SOURCE of interest.

1. Limited Analysis Approach

Based on an analysis of DOSES to all ORGANS and AGE GROUPS from all monitored atmospheric release pathways, the milk and vegetation pathways have been identified as being the most significant pathways. The infant's thyroid (milk pathway) and child's thyroid (vegetation pathway) have been identified as being the limiting AGE GROUPS and ORGAN. These pathways contribute the majority of the total DOSE received by the infant and child thyroid. The radioiodines and tritium contribute essentially all of the DOSE via the milk and vegetation pathways. Therefore, it is possible to demonstrate compliance with the DOSE limit Part 1, Radiological Effluent Controls, Section 3.4.1 for radioiodines, tritium, and particulate with half-lives greater than 8 days by evaluating only the infant and child thyroid DOSE due to radioiodines and tritium in the milk and vegetation pathways.

The calculating method to be used includes a conservatism factor of 0.5 which assures that the calculated DOSE is always greater than or equal to the actual DOSE despite possible atypical distributions of radionuclides in the gaseous effluent. The following equations are used to calculate the DOSES from the milk and vegetation pathways.

Eq. 4-28a

$$D_{mlk\text{-}inf\ TS} = \frac{3.17E\text{-}8}{0.5}\left[\left(\frac{\overline{D}}{Q}\right)_s \sum_{iodines} R_{mlk\text{-}chd\ iT} \times Q_{is}\right] + \left(\frac{\overline{X}}{Q}\right)_s \times R_{mlk\text{-}chd\ H\text{-}3T} \times Q_{H\text{-}3S}$$

Eq. 4-28b

$$D_{veg\text{-}inf\ TS} = \frac{3.17E\text{-}8}{0.5}\left[\left(\frac{\overline{D}}{Q}\right)_s \sum_{iodines} R_{mlk\text{-}chd\ iT} \times Q_{is}\right] + \left(\frac{\overline{X}}{Q}\right)_s \times R_{veg\text{-}chd\ H\text{-}3T} \times Q_{H\text{-}3S}$$

Eq. 4-28c

$$D_T = \sum_{s=1}^{m} D_{TS}$$

Select the equation (either 4-28a or 4-28b) that yields the highest DOSE. Substitute that equation into 4-28c for D_{TS} and solve for D_T.

Where:

$R_{mlk\text{-}inf\ i\tau}$	=	The DOSE FACTOR for iodine NUCLIDE (i), ORGAN τ (thyroid), of the specified AGE GROUP (infant) for the milk pathway. The units are either mrem-m^3/yr-μCi for pathways using (X/Q), or mrem-m^2-sec/yr-μCi for pathways using (D/Q). (See Appendix B).
$R_{mlk\text{-}inf\ H\text{-}3\tau}$	=	The DOSE FACTOR for iodine NUCLIDE (tritium), ORGAN τ (thyroid), of the specified AGE GROUP (infant) for the milk pathway. The units are either mrem-m^3/yr-μCi for pathways using (X/Q), or mrem-m^2-sec/yr-μCi for pathways using (D/Q). (See Appendix B).
$R_{veg\text{-}chd\ i\tau}$	=	The DOSE FACTOR for iodine NUCLIDE (i), ORGAN τ (thyroid), of the specified AGE GROUP (child) for the vegetation pathway. The units are either mrem-m^3/yr-μCi for pathways using (X/Q), or mrem-m^2-sec/yr-μCi for pathways using (D/Q). (See Appendix B).
$R_{veg\text{-}H\text{-}3\tau}$	=	The DOSE FACTOR for iodine NUCLIDE (tritium), ORGAN τ (thyroid), of the specified AGE GROUP (infant) for the milk pathway. The units are either mrem-m^3/yr-μCi for pathways using (X/Q), or mrem-m^2-sec/yr-μCi for pathways using (D/Q). (See Appendix B).
$D_{mlk\text{-}inf\ \tau s}$	=	DOSE in mrem to the infant's thyroid due to radioiodines and H-3 in the milk pathway for the RELEASE SOURCE of interest.
$D_{veg\text{-}chd\ \tau s}$	=	DOSE in mrem to the child's thyroid due to radioiodines and H-3 in the vegetation pathway for the RELEASE SOURCE of interest.
$D_{\tau s}$	=	DOSE in mrem to the most limiting AGE GROUP'S thyroid, from all pathways.
D_{τ}	=	Total DOSE in mrem to the most limiting AGE GROUP'S thyroid, from all pathways for all RELEASE SOURCES of interest.
s	=	The RELEASE SOURCE of interest.
m	=	The number of RELEASE SOURCES of interest.

Q_{is} = For elevated stack releases, Q_{is} is the total number of microcuries of NUCLIDE i released from the stack during the DOSE calculation exposure period. For VENT releases, Q_{is} is the total number of microcuries of NUCLIDE i released from the four VENTS during the DOSE calculation period.

$Q_{H\text{-}3S}$ = For elevated stack releases, $Q_{H\text{-}3S}$ is the total number of microcuries of NUCLIDE tritium released from the stack during the DOSE calculation exposure period. For VENT releases, $Q_{H\text{-}3S}$ is the total number of microCuries of NUCLIDE tritium released from the four VENTS during the DOSE calculation period.

$\left(\frac{\bar{D}}{Q}\right)_s$ = The deposition value for a specific location where the RECEPTOR is located in (m^{-2}). For elevated stack releases the grazing season D/Q for the stack will be used. For VENT releases, the grazing season D/Q for the reactor VENT will be used.

$\left(\frac{\bar{X}}{Q}\right)_s$ = The concentration (X/Q) value for a specific location where the RECEPTOR is located. The units are sec/m^3. The grazing season X/Q is used to determine DOSES for H-3 releases. For elevated stack releases the grazing season X/Q for the stack will be used. For VENT releases, the grazing season X/Q for the reactor VENT will be used.

2. Approach Selection Criteria

The limited analysis approach may be used for long-term (routine) releases to demonstrate compliance with the DOSE limit of Part 1, Radiological Effluent Controls, Sections 3.4.1.1 and 3.4.1.2 (≤7.5 mrem/qtr and ≤15 mrem/yr) for radioiodines, tritium, and particulate.

However, for the DOSE assessment included in the Radioactive Effluent Release Report, DOSES will be evaluated for designated AGE GROUPS and ORGANS via designated pathways from radioiodines, tritium, and particulates measured in the gaseous effluents according to sampling and analyses required by Part 1, Section 3.4.4.3.

12.4.3. Short Term Releases

As described in the introductory part to Section 12.4 (and in NUREG-0133), short-term releases are intermittent or infrequent, with a defined total cumulative duration of 500 hours or less during a calendar year, and no more than 150 hours per quarter. Radiological impact assessment models for short-term releases may make use of the long-term atmospheric dispersion factors (as described in Sections 12.4.1 and 12.4.2) if it can be demonstrated that past short-term releases were sufficiently random in both time of day and duration to be represented by the annual average dispersion conditions. Otherwise, use should be made of the short-term DOSE equations, as described below.

1. Requirements

Short-term releases, when they occur, are to be incorporated into the Radioactive Effluent Release Report(s) and the annual DOSE assessment report (Section 12.4.1) and the verification of compliance with 10 CFR 50 Appendix I, regulatory guidelines (Section12.4.2). The following are the Technical Specification requirements for short-term releases.

Technical Specification 5.6.3 requires a Radioactive Effluent Release Report covering the operation of the unit during the previous year, be submitted prior to May 1 of each year in accordance with 10 CFR 50.36a. Part 1, Section 6.2 also requires that this report includes an assessment of the radiation DOSES to the public due to the radioactive liquid and gaseous effluents released from the unit during the previous calendar year. Part 1, Section 3.3.1 Control limits the air DOSE from GAMMA radiation due to noble gases released from the plant in the gaseous effluent to ≤10 mrad during any calendar year, and ≤5 mrad in any calendar quarter.

Part 1, Section 3.3.4.3, requires that cumulative air DOSE contributions from noble gases be calculated at least monthly for the current calendar quarter and current calendar year.

2. Methodology

Routine releases via the main stack and VENTS are continuous. The methodology described below for short-term releases is thus for non-routine unmonitored ground-level releases.

The equations for offsite radiation exposures resulting from short-term releases are similar to those provided for VENT releases in Sections 12.4.1 and 12.4.2. They are as follows:

A. Air DOSE Due to Noble Gases

Eq. 4-29

$$D_{\text{Short GAMMA-Air}} \sum_{i=1}^{n} M_i x \ (x/q) \ x \ q_i$$

Eq. 4-30

$$D_{\text{Short BETA-Air}} \sum_{i=1}^{n} N_i x \ (x/q) \ x \ q_i$$

Where:

q_i = The overall total activity (µCi) of radionuclide "i" released (or projected to be released) during the DOSE calculation exposure period (month, quarter, or year, as applicable) from a selected VENT or unmonitored path, as a result of short-term releases.

(x/q) = The short-term atmospheric dispersion factor (sec/m^3) for ground-level releases and the RECEPTOR of interest, defined as (from NUREG-0324):

$$\left(x/q\right) = \left(x/q\right)_{\text{Hourly PC}} \quad (t \le 2 \text{ hr})$$

$$\left(x/q\right) = \left(x/q\right)_{\text{Hourly PC}} \ x \ t^m \quad (2 < t \le 500 \text{ hr})$$

$$\left(x/q\right) = \left(X/Q\right)_{\text{Annual AS}} \quad (t > 500 \text{ hr})$$

Where:

$$m = \frac{\log\left[\left(X/Q\right)_{\text{Annual SA}} \Big/ \left(x/q\right)_{\text{Hourly PC}}\right]}{\log\left(8760\right)}$$

τ = release duration (hrs) (or the total sum of frequent short-term release durations) during the DOSE calculation exposure period

(Note: The limits 2 < τ ≤500 are for annual analysis; for quarterly analysis, they are 2 < τ ≤150)

$\left(X/Q\right)_{\text{Annual SA}}$ = long-term sector average (SA) atmospheric dispersion factor (sec/m^3) for ground level releases and the selected RECEPTOR, for distances out to 45 miles [from Table C-15 for the SITE BOUNDARY, Table C-18 for annual (all-season) meteorology, and Table C-22 for grazing-season meteorology]

$\left({}^{x}/{}_{q}\right)_{Hourly\ PC}$ = short-term 85th percentile hourly plume centerline (PC) atmospheric dispersion factor (sec/m^3) for ground-level releases and the selected RECEPTOR [from Table C-15 for the SITE BOUNDARY, Table C-17 for annual meteorology, and Table C-21 for grazing-season meteorology]

All other parameters have been defined in Section 12.4.1.2.

Short-term GAMMA air DOSES are to be added to the long-term GAMMA air DOSES. Combining equations 4-11a, 4-11b, (or 4-20a, 4-20b for quarterly) and 4-29 results in the following:

Eq. 4-31

$$D_{Total\ GAMMA\text{-}Air} = D_{GAMMA\text{-}Air}\ (\text{Stack}) + D_{GAMMA\text{-}Air}\ (\text{Vents}) + D_{Short\ GAMMA\text{-}Air}\ (\text{Unmonitored Non-routine Releases})$$

Short-term BETA air DOSES are to be added to the long-term BETA air DOSES. Combining equations 4-12 (or 4-23 for quarterly) and 4-30 results in the following:

Eq. 4-32

$$D_{Total\ BETA\text{-}Air} = D_{BETA\text{-}Air} + D_{Short\ BETA\text{-}Air}\ (\text{Unmonitored Non-routine Releases})$$

B. Annual Whole-Body DOSE and Skin DOSE Due to Noble Gases

The equations for whole body DOSE and skin DOSE which follow may be used in the preparation of the Radioactive Effluent Release Report (described above in Section 12.4.1). They are not applicable for the verification of compliance with 10 CFR 50, Appendix I (Section 12.4.2).

Eq. 4-32a

$$D_{short\ TB} = K_i \times \left(\frac{x}{q}\right) \times qi$$

Eq. 4-32b

$$D_{short\ skin} = L_i + 1.1\ M_i \times \left(\frac{x}{q}\right) \times qi$$

All parameters in Equations 4-32a and 4-32b are as previously defined in Sections 12.4.1.2.B and 12.4.1.2.C.

Short-term whole body and skin DOSES are to be added to the corresponding DOSES from long-term releases. Combining Equations 4-12a, 4-12b and 4-32a yields the following equation for the total TB DOSE:

Eq. 4-32c

$$D_{Total\ TB} = D_{TB}\ (Stack) + D_{TB}\ (Vents)$$

$$+ D_{Short\ TB}\ (Unmonitored\ Non\text{-}routine\ Releases)$$

Similarly, combining Equations 4-12c, 4-12d and 4-32b for the skin, yields:

Eq. 4-32d

$$D_{Total\ Skin} = D_{Skin}\ (Stack) + D_{Skin}\ (Vents)$$

$$+ D_{Short\ Skin}\ (Unmonitored\ Non\text{-}routine\ Releases)$$

C. DOSE Due to Radioiodines, Tritium, and Eight Day Particulates Inhalation Pathway

Eq. 4-33

$$(D_{Short\ I\&8DP})_{T} = (3.17E\text{-}8) \sum_{i=1}^{n} R_{i_T} \times \left(\frac{x}{q}\right) \times q_i$$

All parameters have been defined previously. Short-term DOSES from the inhalation pathway are to be added to the corresponding long-term DOSES from the same pathway. Combining equations 4-13 (or 4-24 for quarterly) and 4-33 results in the following:

Eq. 4-34

$$[D_{Total\ I\&8DPT}]_{T} = [D_{\ I\&8DPT}]_{T}$$

$$+ [D_{Short\ I\&8DPT}]_{T}\ (Unmonitored\ Non\text{-}routine\ Releases)$$

GROUND PLANE Deposition Pathway

Eq. 4-35

$$(D_{Short\ I\&8DP})_{T} = (3.17E\text{-}8) \sum_{i=1}^{n} R_{i_T} \times \left(\frac{d}{q}\right) \times q_i$$

Where:

(d/q) = The short-term deposition factor (1/m^2) for ground-level releases and the RECEPTOR of interest, defined as:

$$\left({}^{d}/_{q}\right) = \left({}^{d}/_{q}\right)_{\text{Hourly PC}} \quad (t \le 2\ \text{hr})$$

$$\left({}^{d}/_{q}\right) = \left({}^{d}/_{q}\right)_{\text{Hourly PC}} \times t^{m} \quad (2 < t \le 500\ \text{hr})$$

$$\left({}^{d}/_{q}\right) = \left({}^{D}/_{Q}\right)_{\text{Annual AS}} \quad (t > 500\ \text{hr})$$

Where:

$$m = \frac{\log\left[\left({}^{D}/_{Q}\right)_{\text{Annual SA}} \Big/ \left({}^{d}/_{q}\right)_{\text{Hourly PC}}\right]}{\log(8760)}$$

T = release duration (hrs) (or the total sum of frequent short-term release durations) during the DOSE calculation exposure period (Note: the limits 2 < t ≤500 are for annual analysis; for quarterly analysis, they are 2 < t ≤150)

$\left(\frac{D}{Q}\right)_{\text{Annual SA}}$ = long-term sector average (SA) deposition (1/m^2) for ground level releases and the selected RECEPTOR, for distances out to 45 miles [from Table C-16 for the SITE BOUNDARY, Table C-20 for annual (all-season) meteorology, and Table C-24 for grazing-season meteorology]

$\left(\frac{d}{q}\right)_{\text{Hourly PC}}$ = short-term 85th percentile hourly plume centerline (PC) deposition factor (1/m^2) for ground-level releases and the selected RECEPTOR [from Table C-16 for the SITE BOUNDARY, Table C-19 for annual meteorology, and Table C-23 for grazing-season meteorology]

All other parameters have been defined previously defined in Section 12.4.1.2.D.

Short-term DOSES from the GROUND PLANE pathway are to be added to the corresponding long-term DOSES from the same pathway. Combining equations 4-14 (or 4-25 for quarterly) with 4-35 results in the following:

Eq. 4-36

$$[D_{Total\ I\&8DPT}]_T = [D_{I\&8DPT}]_T$$

$$+ [D_{Short\ I\&8DPT}]_T \text{ (Unmonitored Non-routine Releases)}$$

Cow's Milk Pathway

Eq. 4-37

$$(D_{Short\ I\&8DP})_T = (3.17E\text{-}8) \sum_{i=1}^{n} R_{i_T} \times \left(\frac{d}{q}\right) \times q_i$$

All parameters have been defined previously. Short-term DOSES from the cow's milk pathway are to be added to the corresponding long-term DOSES from the same pathway. Combining equations 4-15 (or 4-26a for quarterly) with 4-37 results in the following:

Eq. 4-38

$$[D_{Total\ I\&8DPT}]_T = [D_{I\&8DPT}]_T$$

$$+ [D_{Total\ I\&8DPT}]_T \text{ (Unmonitored Non-routine Releases)}$$

Goat's Milk Pathway

Eq. 4-39

$$(D_{Short\ I\&8DP})_T = (3.17E\text{-}8) \sum_{i=1}^{n} R_{i_T} \times \left(\frac{d}{q}\right) \times q_i$$

All parameters have been defined previously. Short-term DOSES from the goat's milk pathway are to be added to the corresponding long-term DOSES from the same pathway. Combining equations 4-16 (or 4-26b for quarterly) with 4-39 results in the following:

Eq. 4-40

$$[D_{Total\ I\&8DPT}]_T = [D_{I\&8DPT}]_T$$

$$+ [D_{Short\ I\&8DPT}]_T \text{ (Unmonitored Non-routine Releases)}$$

Eq. 4-41

$$(D_{Short\ I\&8DP})_T = (3.17E\text{-}8) \sum_{i=1}^{n} R_{i_T} \times \left(\frac{d}{q}\right) \times q_i$$

Meats

All parameters have been defined previously. Short-term DOSES from the meat pathway are to be added to the corresponding long-term DOSES from the same pathway. Combining equations 4-17 (or 4-26c for quarterly) with 4-41 results in the following:

Eq. 4-42

$$[D_{Total\ I\&8DPT}]_T = [D_{I\&8DPT}]_T$$
$$+ [D_{Total\ I\&8DPT}]_T \text{ (Unmonitored Non-routine Releases)}$$

Vegetation

Eq. 4-43

$$(D_{Short\ I\&8DPT})_T = (3.17E\text{-}8) \sum_{i=1}^{n} R_{i_T} \times \left(\frac{d}{q}\right) \times q_i$$

All parameters have been defined previously. Short-term DOSES from the vegetation pathway are to be added to the corresponding long-term DOSES from the same pathway. Combining equations 4-18 (or 4-26d for quarterly) with 4-43 results in the following:

Eq. 4-44

$$[D_{Total\ I\&8DPT}]_T = [D_{I\&8DPT}]_T$$
$$+ [D_{Total\ I\&8DPT}]_T \text{ (Unmonitored Non-routine Releases)}$$

For tritium, the DOSE is calculated by substituting x/q for d/q, and $R_{H\text{-}3T}$ for R_{iT} in Equations 4-37, 4-39, 4-41, and 4-43.

Total Annual DOSE from Release Point of Interest

Eq. 4-45

$$(D_{Short})_T = \sum_{z=1}^{p} (D_{Short\ I\&8DP})_{TZ}$$

Short-term DOSES from unmonitored non-routine releases are to be added to the corresponding long-term DOSES from the stack and VENTS. Combining Equations 4-19b (or 4-27b for quarterly) and 4-45, results in the following:

Total Annual DOSE

Eq. 4-46

$$D_{Total_T} = D_T + D_{Short_T}$$

12.5. DOSE Projections - Determination of Need to Operate Offgas Radwaste Treatment System

12.5.1. Requirement

Part 1, Section 3.5.4.3.A requires that DOSES to gaseous releases from the site be projected at least monthly if the charcoal beds are not in service when OFFGAS TREATMENT SYSTEM operation is required.

12.5.2. Methodology

The following calculational methods are provided for determining the projected DOSES.

<u>Method 1</u>

Eq. 4-47

$$PD_{\gamma} = \frac{31}{X} \times D_{\gamma} \times 1.2$$

Eq. 4-48

$$PD_{\beta} = \frac{31}{X} \times D_{\beta} \times 1.2$$

Eq. 4-49

$$PD_{I\&P} = \frac{31}{X} \times D_{I\&P} \times 1.2$$

Where:

PD_{γ} = Projected air DOSE due to noble gas GAMMA radiation during the current month (mrad) from all routine effluent pathways

PD_{β} = Projected air DOSE due to noble gas BETA radiation during the current month (mrad) from all routine effluent pathways

$PD_{I\&P}$ = Projected DOSE to any ORGAN due to Tritium, Iodine-131, Iodine-133 and particulates with half-lives greater than 8 days (mrem)

31 = Time period for projection (days)

X = Number of days to date during sample period used to project the DOSES

D_{γ} = Air DOSE due to noble gas GAMMA radiation corresponding to the time period X (mrad)

D_{β} = Air DOSE due to noble gas BETA radiation corresponding to the time period X (mrad)

$D_{I\&P}$ = ORGAN DOSE due to Iodines, Tritium and Particulates corresponding to the time period X (mrem)

1.2 = Conservatism factor to provide a margin for changes in mixture and operational line up, etc.

A formal DOSE projection would be based on the most appropriate results of the monthly calculations of the GAMMA air DOSE, the BETA air DOSE, and the ORGAN DOSE due to Tritium, Iodines and particulates with half-lives greater than 8 days. The DOSES calculated will be divided by the number of days in the sample period determined to be most appropriate for projecting DOSES. An appropriate period to base projection on should reflect similar radioactive release rates effective at the time of the projection. The per-day DOSES will be multiplied by 31 days, i.e., the time period for projection. The product is the projected DOSE for the coming 31-day period. Its value may be adjusted to account for any changes in operating conditions that could significantly alter the actual releases, such as failed fuel.

<u>Alternate Method</u>

Eq. 4-50

$$D_{proj_{\gamma}} = \frac{t_d D_{\gamma q}}{d}$$

Eq. 4-51

$$D_{proj_{\beta}} = \frac{t_d D_{\beta q}}{d}$$

Eq. 4-52

$$D_{proj_{ORGAN}} = \frac{t_d D_{oq}}{d}$$

Where:

$D_{proj_{\gamma}}$ = Maximum GAMMA air DOSE projection for current 31-day period in mrad

$D_{proj_{\beta}}$ = Maximum BETA air DOSE projection for current 31-day period in mrad

$D_{proj_{ORGAN}}$ = Maximum ORGAN DOSE projection for the current 31-day period in mrem

$D_{\gamma q}$ = GAMMA air DOSE to date for current calendar quarter as obtained by equation 4-31 in mrad

$D_{\beta q}$ = BETA air DOSE to date for current calendar quarter as obtained by equation 4-32 in mrad

D_{oq} = Max ORGAN DOSE to date for current calendar quarter as obtained from equation 4-27a in mrem

d = Number of days in current calendar quarter at the end of the release

t_d = 31, the conservative number of days in a month

The calculated projected DOSES, regardless of method used, will be compared to the following Part 1, Radiological Effluent Controls, Section 3.5.1.2 limits:

0.2 mrad for GAMMA radiation,

0.4 mrad for BETA radiation, or

0.3 mrem to any ORGAN.

If any DOSES exceed the above limits, the offgas charcoal beds will be used whenever the operation of the OFFGAS TREATMENT SYSTEM is required during the projected time period.

1. Limited Analysis Approach and Selection Criteria

   A simpler approach, a linear extrapolation of the most recent three-month DOSE for the coming month, could be used as long as the limits of Part 1, Radiological Effluent Controls, Section 3.5.1.2 are not reached, and that releases of radioactive material have not changed significantly during the time period used for projection.

13. **40 CFR 190 WILL BE DEEMED TO DEMONSTRATE COMPLIANCE WITH THE 100 MREM/YR LIMITS OF 10 CFR 20.1301 (A) (1).**

Part 1, Radiological Effluent Controls, Section 4.1.1 requires that the annual (calendar year) DOSE or DOSE COMMITMENT to any member of the public from uranium fuel cycle sources be limited to ≤25 mrem to the whole body or any ORGAN (except the thyroid which is limited to ≤75 mrem). Compliance with the DOSE limits of 40 CFR 190 will be deemed to demonstrate compliance with the 100 mrem/yr limits of 10 CFR 20.1301 (a) (1).

13.1. Evaluation Bases

DOSE evaluation to demonstrate compliance with the 40 CFR 190 and 10 CFR 72.104(a) DOSE limits need only be performed if the quarterly or annual DOSES calculated in steps 11.4.1, 11.4.2, 12.4.1, 12.4.2, and 12.4.3 exceed twice the DOSE limits of Part 1, Radiological Effluent Controls, Sections 2.3, 3.3, or 3.4 respectively. Quarterly DOSES exceeding 3 mrem to the whole body (liquid releases), 10 mrem to any ORGAN (liquid releases), 10 mrads equivalent GAMMA air DOSE, 20 mrads equivalent BETA air DOSE, or 15 mrem to the thyroid or any ORGAN from radioiodines and particulates (atmospheric releases) and annual DOSES exceeding 6 mrem to the whole body (liquid releases), 20 mrem to any ORGAN (liquid releases), 20 mrads equivalent GAMMA air DOSE, 40 mrads equivalent BETA air DOSE, or 30 mrem to the thyroid or any ORGAN from radioiodines and particulate (atmospheric releases) would require 40 CFR 190 and 10 CFR 72.104(a) evaluation. The DOSE evaluation includes DOSE contributions to a maximally exposed real individual from the calendar quarter in which the quarterly or annual limits were exceeded in addition to plant offsite DOSE contributions during the balance of the current calendar year.

40 CFR 190 and 10 CFR 72.104(a) DOSE assessments, when required, will be made using actual meteorological data and frequency distribution data for the year covered by the evaluation.

For purposes of the evaluation, if required, it may be assumed that the DOSE COMMITMENT to the maximally exposed real individual from other uranium fuel cycle sources is negligible. However, DOSES from JAFNPP will be added to the DOSES to the maximum exposed individual at Nine Mile Point Unit 1 and Unit 2, or to the nuclear fuel cycle facilities within a radius 8 km of the site.

As part of the Radiological Environmental Monitoring Program (REMP), JAF and Nine Mile Point Unit 1 & 2 jointly support a TLD program that monitors the DOSES on and offsite. The environmental TLDs measure the direct GAMMA radiation from the sites; contributions from JAF, Nine Mile Units 1 and 2. The TLD results are presented annually in the JAF/NMP combined Annual Radiological Environmental Operating Report (AREOR).

JAF and Nine Mile Point Unit 1 & 2 issue Radioactive Effluent Release Reports. The DOSE contributions from effluents from the plant can be found in these reports.

JAF also reports annually to the commission, in accordance with 10 CFR 72.4 and 72.44(d)(3), the quantity of each of the principal radionuclides released to the environment in liquid and gaseous effluents during the previous 12 months of operation, and such other information as may be required by the commission to estimate maximum potential radiation DOSE COMMITMENT to the public resulting from effluent releases.

13.2. DOSES from Liquid Releases

For the evaluation of DOSES to real individuals from liquid releases, the same calculating method as employed for Liquid Effluents Annual DOSE Assessment will be used. However, more realistic assumptions and any current field data or updated estimates may be used, if available, concerning the dilution and ingestion of fish and potable water by individuals who live and fish in the area. Also, the results of the Radiological Environmental Monitoring Program will be included in determining more refined estimates of DOSES to real individuals by providing data on actual measured levels of plant-related radionuclides in the environment.

13.3. DOSES from Atmospheric Releases

For the evaluation of DOSES to real individuals from the atmospheric releases, the same calculating methods as employed for Gaseous Effluent Annual DOSE Assessment will be used except that the GAMMA and BETA air DOSES are not calculated. Otherwise the same calculating sequence applies. However, any current field data or updated estimates may be used, if available, concerning the actual location of real individuals, the meteorological conditions, and the consumption of food (e.g., milk, meat and vegetation). Data obtained from the latest land use census Part 1, Section 5.2 should be used to determine locations for evaluating DOSES. Also, the results of the Radiological Environmental Monitoring Program will be included in determining more refined DOSE estimates to real individuals by providing data on actual measured levels of radioactivity and radiation at locations of interest.

13.4. DOSES from Direct Radiation

Because 40 CFR 190 and 10 CFR 72.104(a) requirements include consideration of the offsite DOSE contribution from direct radiation, an estimate must be provided in the evaluation. The direct radiation DOSE contribution from turbine shine (N-16) under hydrogen water chemistry conditions was evaluated to determine the need for additional shielding. SITE BOUNDARY DOSES at the land-based sectors of the site are less than 1 mrem/yr from this source. The Interim Radioactive Waste Storage Facility (IRWSF) was evaluated for DOSES to the SITE BOUNDARY from a fully loaded facility in JAF-CALC-RAD-00030, Rev. 1. The calculation shows the SITE BOUNDARY GAMMA DOSE for the land-based sectors of the site from the contained sources within the Interim Waste Storage Facility to be less than 1 mrem/yr.

The INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) CONTROLLED AREA was evaluated for DOSES to the SITE BOUNDARY from a Phase I and Expanded configuration and cask storage source term. The Phase I INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) CONTROLLED AREA is postulated to be loaded with 22 storage casks in a 11 x 2 array. The Expanded INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) CONTROLLED AREA is postulated to be loaded with 33 storage casks in a 3 x 11 array. Each cask is loaded with 68 spent fuel bundles. Calculations in JAF-CALC-SFS-03346, Rev. 4 demonstrate that the SITE BOUNDARY GAMMA DOSE for the closest land-based sector of the site is significantly less than 25 mrem/yr from a fully loaded Expanded INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) CONTROLLED AREA.

Turbine shine, a fully loaded IRWSF, and the Phase I loaded INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) CONTROLLED AREA are the major contributors to direct radiation exposure at the SITE BOUNDARY. New sources will be analyzed on a case by case basis.

13.5. DOSES to Members of the Public due to On-Site Activities

Members of the public are occasionally granted access to areas within the SITE BOUNDARY. Exposure to these members of the public due to liquid releases while on-site is highly unlikely and is not considered. Therefore, only exposure due to gaseous releases and direct radiation are considered. TLD and periodic area survey information is used to ensure that the DOSE and DOSE RATES to such members of the public are within the limits of 10 CFR 1301 (a)(1).

14. REFERENCES

14.1. Regulatory Guide 1.109, Rev. 1, October 1977

14.2. NUREG-0133, October 1978

14.3. EN-AD-103, Document Control and Records Management Programs, Revision 03, April 29, 2005

14.4. James A. FitzPatrick Technical Specifications

14.5. James A. FitzPatrick Nuclear Power Plant, Docket 50-333, Compliance with 10 CFR 50, Appendix I

14.6. Final Environmental Impact Statement Related to Operation of James A. FitzPatrick Nuclear Power Plant, New York Power Authority; Docket No. 50-333, March 1973

14.7. Environmental Report, Operating License Stage, James A. FitzPatrick Plant, New York Power Authority, May 1971

14.7.1. Supplement Environmental Report, Operating License Stage, November 1971

14.7.2. Supplement #2 Environmental Report, Benefit/Cost Analysis, May 1972

14.7.3. Supplement #3 Environmental Report, Answers to Atomic Energy Commission Questions, August 1982

14.8. Final Safety Analysis Report, James A. FitzPatrick Plant, New York Power Authority, Docket No. 50-333, Operating License No. DPR-59

14.9. New York Power Authority, Internal Memorandum from D. Dunning to G. Re, September 20, 1988

14.10. New York Power Authority, Corporate Radiological Engineering Calculation No. JAF-CALC-RAD-00025, Revision 1, Atmospheric Dispersion and Deposition Parameters for Routine Releases (1995)

14.11. CHAS. T. Main, Inc. X/Q and D/Q Tables for Nine Mile Point Unit 1, Nine Mile Point Unit 2 and James A. FitzPatrick Nuclear Power Plant, November 1985 (Contain 5 years of meteorological data, 1978 through 1982)

14.12. Idaho National Engineering Laboratory Technical Evaluation Report (TER) of the JAF ODCM for the NRC (EGG-PHY-8153, July 1988)

14.13. New York Power Authority Corporate Radiological Engineering Calculation Number JAF-CALC-RAD-00010, Revision 0, Verification Document for Radiological Effluent Controls and Offsite DOSE Calculation Manual (Date Pending)

14.14. New York Power Authority Corporate Radiological Engineering Calculation Number JAF-CALC-RAD-00029, Aquatic Dispersion and DOSE Assessment Methodology for

Non-Routine Releases (1995)

14.15. Entergy Nuclear FitzPatrick, LLC and Entergy Nuclear Operations, Inc., James A. FitzPatrick Independent Spent Fuel Storage Installation JAF-CALC-SFS-03346, Rev. 4, DOSE RATES in the Vicinity of the Hi-Storm Storage Cask and ISFSI

14.16. Entergy Nuclear FitzPatrick, LLC and Entergy Nuclear Operations, Inc., James A. FitzPatrick Independent Spent Fuel Storage Installation, 10 CFR 72.212 Evaluation Report

14.17. Certificate of Compliance No. 1014, Appendix A. Technical Specifications for the Hi-Storm 100 Cask System, Amendments 1 and 2

14.18. JAF-ICD-RBC-04561, Interface Control Document, Offsite Dose Manual Effluent Airflows, 04/23/03, Rev. 0

14.19. EPRI, Estimation of Carbon-14 in Nuclear Power Gaseous Effluents, December 2010

14.20. Entergy Echelon Nuclear Engineering, BWR Input Parameters for Determining Carbon-14 in Gaseous Effluent, NEAD-NS-11/006, Rev. 0

14.21. SCR-E1-98-0031

14.22. Chemistry Technical Information Document, CTID-13-006, Rev. 0, Inhalation DOSE FACTORS for Se-75, 3/21/13.

14.23. JAF-CALC-PRM-02047, Revision 2A, Turbine Building Exhaust Ventilation Radiation Loop Uncertainty Calculation (09/2019)

14.24. JAF-CALC-PRM-02081, Revision 1A, Radwaste Building Exhaust Ventilation Radiation Loop Uncertainty Calculation (09/2019)

7/20 14.25. JAF-91-095, Revision 1A, Radiation Monitor Calibration Tolerance Evaluation (09/2019)

14.26 EC 629332, Setpoint Calculation Update to Support Surveillance Interval Extension of ISP-25A, B and ISP-26A, B

14.27 EC 631913, Engineering Evaluation to Support Surveillance Interval Extension for ISP-25A, B and ISP-26A, B

APPENDIX A

LIQUID DOSE CALCULATION DATA

APPENDIX A

LIQUID DOSE CALCULATION DATA

TABLE A-1
EFFLUENT CONCENTRATION LIMITS FOR WATER IN UNRESTRICTED AREAS

NUCLIDE[1]	ECL (μCi/ml)	NUCLIDE[1]	ECL(μCi/ml)
H-3	1.000E-02	Ru-103	3.000E-04
Be-7	6.000E-03	Ru-105	7.000E-04
Na-24	5.000E-04	Ru-106	3.000E-05
P-32	9.000E-05	Cd-109	6.000E-05
K-40	4.000E-05	Ag-110m	6.000E-05
Cr-51	5.000E-03	Sn-113	3.000E-04
Mn-54	3.000E-04	In-113m	7.000E-03
Mn-56	7.000E-04	Sb-122	1.000E-04
Fe-55	1.000E-03	Sb-124	7.000E-05
Fe-59	1.000E-04	Sb-125	3.000E-04
Co-57	6.000E-04	Te-123M	9.000E-05
Co-58	2.000E-04	Te-125m	2.000E-04
Co-60	3.000E-05	Te-127	1.000E-03
Ni-63	1.000E-03	Te-127m	9.000E-05
Ni-65	1.000E-03	Te-129m	7.000E-05
Cu-64	2.000E-03	Te-129	4.000E-03
Zn-65	5.000E-05	Te-131m	8.000E-05
Zn-69	8.000E-03	Te-131	8.000E-04
Zn-69m	6.000E-04	Te-132	9.000E-05
As-76	1.000E-04	Te-134	3.000E-03
Br-82	4.000E-04	I-130	2.000E-04
Br-83	9.000E-03	I-131	1.000E-05
Br-84	4.000E-03	I-132	1.000E-03
Br-85	1.000E-05	I-133	7.000E-05
Rb-86	7.000E-05	I-134	4.000E-03
Rb-88	4.000E-03	I-135	3.000E-04
Rb-89	9.000E-03	Cs-134	9.000E-06
Sr-85	4.000E-04	Cs-136	6.000E-05
Sr-89	8.000E-05	Cs-137	1.000E-05
Sr-90	5.000E-06	Cs-138	4.000E-03
Sr-91	2.000E-04	Ba-133	2.000E-04
Sr-92	4.000E-04	Ba-139	2.000E-03
Y-88	1.000E-04	Ba-140	8.000E-05
Y-90	7.000E-05	Ba-141	3.000E-03
Y-91m	2.000E-02	Ba-142	7.000E-03
Y-91	8.000E-05	La-140	9.000E-05
Y-92	4.000E-04	La-142	1.000E-03
Y-93	2.000E-04	Ce-139	7.000E-04
Zr-95	2.000E-04	Ce-141	3.000E-04
Zr-97	9.000E-05	Ce-143	2.000E-04
Nb-94	1.000E-04	Ce-144	3.000E-05
Nb-95	3.000E-04	Pr-143	2.000E-04
Nb-95m	3.000E-04	Pr-144	6.000E-03
Nb-97	3.000E-03	Nd-147	2.000E-04
Mo-99	2.000E-04	W-187	3.000E-04
Tc-99m	1.000E-02	Np-239	2.000E-04
Tc-101	2.000E-02		

(1) All ECL values are taken from 10 times 10CFR20 EC values.

TABLE A-2 DOSE

CONVERSION FACTORS FOR LIQUID DISCHARGES

TABLE A-2
A_{itf} VALUES - FRESHWATER FISH – ADULT
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	1.89E-02	1.89E-02	1.89E-02	1.89E-02	1.89E-02	0.00E+00	1.89E-02
Na-24	3.40E+01	3.40E+01	3.40E+01	3.40E+01	3.40E+01	3.40E+01	0.00E+00	3.40E+01
Cr-51	0.00E+00	0.00E+00	6.35E-02	2.34E-02	1.41E-01	2.67E+01	0.00E+00	1.06E-01
Mn-54	0.00E+00	3.65E+02	0.00E+00	1.09E+02	0.00E+00	1.12E+03	0.00E+00	6.97E+01
Fe-55	5.49E+01	3.80E+01	0.00E+00	0.00E+00	2.12E+01	2.18E+01	0.00E+00	8.85E+00
Fe-59	8.67E+01	2.04E+02	0.00E+00	0.00E+00	5.69E+01	6.79E+02	0.00E+00	7.81E+01
Co-57	0.00E+00	1.75E+00	0.00E+00	0.00E+00	0.00E+00	4.43E+01	0.00E+00	2.91E+00
Co-58	0.00E+00	7.44E+00	0.00E+00	0.00E+00	0.00E+00	1.51E+02	0.00E+00	1.67E+01
Co-60	0.00E+00	2.14E+01	0.00E+00	0.00E+00	0.00E+00	4.02E+02	0.00E+00	4.71E+01
Cu-64	0.00E+00	8.32E-01	0.00E+00	2.10E+00	0.00E+00	7.09E+01	0.00E+00	3.91E-01
Zn-65	1.93E+03	6.15E+03	0.00E+00	4.12E+03	0.00E+00	3.88E+03	0.00E+00	2.78E+03
Sr-89	1.85E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.96E+02	0.00E+00	5.30E+01
Sr-90	4.54E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E+03	0.00E+00	1.11E+04
Nb-95	3.73E+01	2.07E+01	0.00E+00	2.05E+01	0.00E+00	1.26E+05	0.00E+00	1.11E+01
Zr-95	2.00E-02	6.43E-03	0.00E+00	1.01E-02	0.00E+00	2.04E+01	0.00E+00	4.35E-03
As-76	0.00E+00	9.45E-01	0.00E+00	1.78E+00	0.00E+00	2.29E+03	0.00E+00	9.02E-01
Nb-95m	3.73E+01	2.08E+01	0.00E+00	2.04E+01	0.00E+00	1.26E+05	0.00E+00	1.11E+01
Zr-97	1.11E-03	2.23E-04	0.00E+00	3.38E-04	0.00E+00	6.92E+01	0.00E+00	1.02E-04
Mo-99	0.00E+00	8.61E+00	0.00E+00	1.95E+01	0.00E+00	2.00E+01	0.00E+00	1.64E+00
Tc-99m	7.40E-04	2.09E-03	0.00E+00	3.18E-02	1.02E-03	1.24E+00	0.00E+00	2.66E-02
Ag-110m	7.35E-02	6.80E-02	0.00E+00	1.34E-01	0.00E+00	2.78E+01	0.00E+00	4.04E-02
Sb-124	5.59E-01	1.06E-02	1.36E-03	0.00E+00	4.36E-01	1.59E+01	0.00E+00	2.22E-01
I-131	1.25E+01	1.78E+01	5.84E+03	3.06E+01	0.00E+00	4.70E+00	0.00E+00	1.02E+01
I-133	4.26E+00	7.40E+00	1.09E+03	1.29E+01	0.00E+00	6.65E+00	0.00E+00	2.26E+00
I-135	1.33E+00	3.48E+00	2.29E+02	5.57E+00	0.00E+00	3.93E+00	0.00E+00	1.28E+00
Cs-134	2.49E+04	5.91E+04	0.00E+00	1.91E+04	6.35E+03	1.03E+03	0.00E+00	4.83E+04
Cs-137	3.18E+04	4.36E+04	0.00E+00	1.48E+04	4.91E+03	8.43E+02	0.00E+00	2.85E+04
Ba-140	1.62E+01	2.04E-02	0.00E+00	6.93E-03	1.17E-02	3.34E+01	0.00E+00	1.06E+00
La-140	1.25E-02	6.29E-03	0.00E+00	0.00E+00	0.00E+00	4.62E+02	0.00E+00	1.66E-03
Ce-141	1.87E-03	1.26E-03	0.00E+00	5.87E-04	0.00E+00	4.83E+00	0.00E+00	1.43E-04
Ce-144	9.75E-02	4.08E-02	0.00E+00	2.42E-02	0.00E+00	3.30E+01	0.00E+00	5.23E-03
W-187	2.47E+01	2.06E+01	0.00E+00	0.00E+00	0.00E+00	6.76E+03	0.00E+00	7.22E+00
Np-239	2.38E-03	2.34E-04	0.00E+00	7.29E-04	0.00E+00	4.79E+01	0.00E+00	1.29E-04

TABLE A-2

A_{itf} VALUES - POTABLE WATER - ADULT
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	5.30E-02	5.30E-02	5.30E-02	5.30E-02	5.30E-02	0.00E+00	5.30E-02
Cr-51	0.00E+00	0.00E+00	8.03E-04	2.96E-04	1.78E-03	3.38E-01	0.00E+00	1.34E-03
Mn-54	0.00E+00	2.31E+00	0.00E+00	6.87E-01	0.00E+00	7.07E+00	0.00E+00	4.40E-01
Fe-55	1.39E+00	9.60E-01	0.00E+00	0.00E+00	5.35E-01	5.51E-01	0.00E+00	2.24E-01
Fe-59	2.19E+00	5.15E+00	0.00E+00	0.00E+00	1.44E+00	1.72E+01	0.00E+00	1.97E+00
Co-57	0.00E+00	8.84E-02	0.00E+00	0.00E+00	0.00E+00	2.24E+00	0.00E+00	1.47E-01
Co-58	0.00E+00	3.76E-01	0.00E+00	0.00E+00	0.00E+00	7.63E+00	0.00E+00	8.43E-01
Co-60	0.00E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00	2.03E+01	0.00E+00	2.38E+00
Zn-65	2.44E+00	7.78E+00	0.00E+00	5.20E+00	0.00E+00	4.90E+00	0.00E+00	3.52E+00
Sr-89	1.56E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E+01	0.00E+00	4.46E+00
Sr-90	3.83E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+02	0.00E+00	9.39E+02
Zr-95	1.54E-02	4.92E-03	0.00E+00	7.73E-03	0.00E+00	1.56E+01	0.00E+00	3.33E-03
Zr-97	8.48E-04	1.71E-04	0.00E+00	2.59E-04	0.00E+00	5.30E+01	0.00E+00	7.83E-05
Nb-95	3.14E-03	1.75E-03	0.00E+00	1.73E-03	0.00E+00	1.06E+01	0.00E+00	9.39E-04
Mo-99	0.00E+00	2.18E+00	0.00E+00	4.93E+00	0.00E+00	5.05E+00	0.00E+00	4.14E-01
Ag-110m	8.08E-02	7.47E-02	0.00E+00	1.47E-01	0.00E+00	3.05E+01	0.00E+00	4.44E-02
Sb-124	1.41E+00	2.67E-02	3.43E-03	0.00E+00	1.10E+00	4.02E+01	0.00E+00	5.61E-01
I-131	2.10E+00	3.01E+00	9.85E+02	5.15E+00	0.00E+00	7.93E-01	0.00E+00	1.72E+00
I-133	7.17E-01	1.25E+00	1.83E+02	2.18E+00	0.00E+00	1.12E+00	0.00E+00	3.80E-01
I-135	2.24E-01	5.86E-01	3.86E+01	9.39E-01	0.00E+00	6.62E-01	0.00E+00	2.16E-01
Cs-134	3.14E+01	7.47E+01	0.00E+00	2.42E+01	8.03E+00	1.31E+00	0.00E+00	6.11E+01
Cs-137	4.03E+01	5.51E+01	0.00E+00	1.87E+01	6.21E+00	1.07E+00	0.00E+00	3.61E+01
Ba-140	1.03E+01	1.29E-02	0.00E+00	4.38E-03	7.37E-03	2.11E+01	0.00E+00	6.72E-01
La-140	1.26E-03	6.36E-04	0.00E+00	0.00E+00	0.00E+00	4.67E+01	0.00E+00	1.68E-04
Ce-141	4.73E-03	3.20E-03	0.00E+00	1.48E-03	0.00E+00	1.22E+01	0.00E+00	3.63E-04
Ce-144	2.46E-01	1.03E-01	0.00E+00	6.11E-02	0.00E+00	8.33E+01	0.00E+00	1.32E-02
Na-24	8.59E-01	8.59E-01	8.59E-01	8.59E-01	8.59E-01	8.59E-01	0.00E+00	8.59E-01
Cu-64	0.00E+00	4.21E-02	0.00E+00	1.06E-01	0.00E+00	3.59E+00	0.00E+00	1.97E-02
W-187	5.20E-02	4.35E-02	0.00E+00	0.00E+00	0.00E+00	1.42E+01	0.00E+00	1.52E-02
Np-239	6.01E-04	5.91E-05	0.00E+00	1.84E-04	0.00E+00	1.21E+01	0.00E+00	3.26E-05
Tc-99m	1.25E-04	3.53E-04	0.00E+00	5.35E-03	1.73E-04	2.09E-01	0.00E+00	4.49E-03
As-76	0.00E+00	2.39E-02	0.00E+00	4.50E-02	0.00E+00	5.80E+01	0.00E+00	2.28E-02
Nb-95m	3.14E-03	1.75E-03	0.00E+00	1.72E-03	0.00E+00	1.06E+01	0.00E+00	9.38E-04

TABLE A-2
A_{itw} VALUES - FRESHWATER FISH - TEENAGER
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	1.45E-02	1.45E-02	1.45E-02	1.45E-02	1.45E-02	0.00E+00	1.45E-02
Na-24	3.50E+01	3.50E+01	3.50E+01	3.50E+01	3.50E+01	3.50E+01	0.00E+00	3.50E+01
Cr-51	0.00E+00	0.00E+00	6.09E-02	2.40E-02	1.56E-01	1.84E+01	0.00E+00	1.10E-01
Mn-54	0.00E+00	3.59E+02	0.00E+00	1.07E+02	0.00E+00	7.37E+02	0.00E+00	7.12E+01
Fe-55	5.75E+01	4.08E+01	0.00E+00	0.00E+00	2.59E+01	1.77E+01	0.00E+00	9.51E+00
Fe-59	8.93E+01	2.09E+02	0.00E+00	0.00E+00	6.58E+01	4.93E+02	0.00E+00	8.05E+01
Co-57	0.00E+00	1.81E+00	0.00E+00	0.00E+00	0.00E+00	3.38E+01	0.00E+00	3.04E+00
Co-58	0.00E+00	7.40E+00	0.00E+00	0.00E+00	0.00E+00	1.02E+02	0.00E+00	1.70E+01
Co-60	0.00E+00	2.14E+01	0.00E+00	0.00E+00	0.00E+00	2.79E+02	0.00E+00	4.82E+01
Cu-64	0.00E+00	8.75E-01	0.00E+00	2.21E+00	0.00E+00	6.79E+01	0.00E+00	4.12E-01
Zn-65	1.75E+03	6.09E+03	0.00E+00	3.90E+03	0.00E+00	2.58E+03	0.00E+00	2.84E+03
Sr-89	2.01E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.39E+02	0.00E+00	5.75E+01
Sr-90	3.79E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E+03	0.00E+00	9.36E+03
Nb-95	3.75E+01	2.08E+01	0.00E+00	2.02E+01	0.00E+00	8.90E+04	0.00E+00	1.15E+01
Zr-95	2.07E-02	6.53E-03	0.00E+00	9.59E-03	0.00E+00	1.51E+01	0.00E+00	4.49E-03
As-76	0.00E+00	1.02E+00	0.00E+00	1.93E+00	0.00E+00	1.96E+03	0.00E+00	9.84E-01
Nb-95m	3.75E+01	2.08E+01	0.00E+00	2.02E+01	0.00E+00	8.89E+04	0.00E+00	1.14E+01
Zr-97	1.19E-03	2.36E-04	0.00E+00	3.57E-04	0.00E+00	6.38E+01	0.00E+00	1.08E-04
Mo-99	0.00E+00	9.18E+00	0.00E+00	2.10E+01	0.00E+00	1.64E+01	0.00E+00	1.75E+00
Tc-99m	7.58E-04	2.11E-03	0.00E+00	3.15E-02	1.17E-03	1.39E+00	0.00E+00	2.74E-02
Ag-110m	7.18E-02	6.79E-02	0.00E+00	1.30E-01	0.00E+00	1.91E+01	0.00E+00	4.13E-02
Sb-124	5.89E-01	1.09E-02	1.34E-03	0.00E+00	5.14E-01	1.19E+01	0.00E+00	2.30E-01
I-131	1.34E+01	1.87E+01	5.46E+03	3.22E+01	0.00E+00	3.70E+00	0.00E+00	1.00E+01
I-133	4.59E+00	7.79E+00	1.09E+03	1.37E+01	0.00E+00	5.89E+00	0.00E+00	2.37E+00
I-135	1.39E+00	3.58E+00	2.31E+02	5.66E+00	0.00E+00	3.97E+00	0.00E+00	1.33E+00
Cs-134	2.55E+04	6.00E+04	0.00E+00	1.91E+04	7.28E+03	7.46E+02	0.00E+00	2.78E+04
Cs-137	3.41E+04	4.54E+04	0.00E+00	1.54E+04	6.00E+03	6.45E+02	0.00E+00	1.58E+04
Ba-140	1.73E+01	2.12E-02	0.00E+00	7.18E-03	1.42E-02	2.67E+01	0.00E+00	1.11E+00
La-140	1.32E-02	6.51E-03	0.00E+00	0.00E+00	0.00E+00	3.74E+02	0.00E+00	1.73E-03
Ce-141	2.02E-03	1.35E-03	0.00E+00	6.36E-04	0.00E+00	3.87E+00	0.00E+00	1.55E-04
Ce-144	1.06E-01	4.38E-02	0.00E+00	2.62E-02	0.00E+00	2.66E+01	0.00E+00	5.69E-03
W-187	2.67E+01	2.17E+01	0.00E+00	0.00E+00	0.00E+00	5.88E+03	0.00E+00	7.62E+00
Np-239	2.68E-03	2.53E-04	0.00E+00	7.93E-04	0.00E+00	4.06E+01	0.00E+00	1.40E-04

TABLE A-2
A_{itw} VALUES - POTABLE WATER - TEENAGER
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	3.74E-02	3.74E-02	3.74E-02	3.74E-02	3.74E-02	0.00E+00	3.74E-02
Cr-51	0.00E+00	0.00E+00	7.06E-04	2.78E-04	1.81E-03	2.13E-01	0.00E+00	1.27E-03
Mn-54	0.00E+00	2.08E+00	0.00E+00	6.21E-01	0.00E+00	4.27E+00	0.00E+00	4.13E-01
Fe-55	1.33E+00	9.46E-01	0.00E+00	0.00E+00	6.00E-01	4.09E-01	0.00E+00	2.21E-01
Fe-59	2.07E+00	4.83E+00	0.00E+00	0.00E+00	1.52E+00	1.14E+01	0.00E+00	1.87E+00
Co-57	0.00E+00	8.40E-02	0.00E+00	0.00E+00	0.00E+00	1.57E+00	0.00E+00	1.41E-01
Co-58	0.00E+00	3.43E-01	0.00E+00	0.00E+00	0.00E+00	4.73E+00	0.00E+00	7.90E-01
Co-60	0.00E+00	9.91E-01	0.00E+00	0.00E+00	0.00E+00	1.29E+01	0.00E+00	2.23E+00
Zn-65	2.03E+00	7.06E+00	0.00E+00	4.52E+00	0.00E+00	2.99E+00	0.00E+00	3.29E+00
Sr-89	1.55E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E+01	0.00E+00	4.45E+00
Sr-90	2.93E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.22E+01	0.00E+00	7.23E+02
Zr-95	1.45E-02	4.59E-03	0.00E+00	6.74E-03	0.00E+00	1.06E+01	0.00E+00	3.15E-03
Zr-97	8.36E-04	1.65E-04	0.00E+00	2.51E-04	0.00E+00	4.48E+01	0.00E+00	7.62E-05
Nb-95	2.90E-03	1.61E-03	0.00E+00	1.56E-03	0.00E+00	6.88E+00	0.00E+00	8.86E-04
Mo-99	0.00E+00	2.13E+00	0.00E+00	4.87E+00	0.00E+00	3.81E+00	0.00E+00	4.06E-01
Ag-110m	7.23E-02	6.85E-02	0.00E+00	1.31E-01	0.00E+00	1.92E+01	0.00E+00	4.16E-02
Sb-124	1.37E+00	2.52E-02	3.10E-03	0.00E+00	1.19E+00	2.75E+01	0.00E+00	5.33E-01
I-131	2.06E+00	2.89E+00	8.43E+02	4.98E+00	0.00E+00	5.72E-01	0.00E+00	1.55E+00
I-133	7.09E-01	1.20E+00	1.68E+02	2.11E+00	0.00E+00	9.10E-01	0.00E+00	3.67E-01
I-135	2.15E-01	5.54E-01	3.56E+01	8.75E-01	0.00E+00	6.14E-01	0.00E+00	2.05E-01
Cs-134	2.95E+01	6.95E+01	0.00E+00	2.21E+01	8.43E+00	8.64E-01	0.00E+00	3.22E+01
Cs-137	3.95E+01	5.26E+01	0.00E+00	1.79E+01	6.95E+00	7.48E-01	0.00E+00	1.83E+01
Ba-140	1.00E+01	1.23E-02	0.00E+00	4.16E-03	8.26E-03	1.55E+01	0.00E+00	6.46E-01
La-140	1.23E-03	6.03E-04	0.00E+00	0.00E+00	0.00E+00	3.46E+01	0.00E+00	1.61E-04
Ce-141	4.69E-03	3.13E-03	0.00E+00	1.47E-03	0.00E+00	8.96E+00	0.00E+00	3.60E-04
Ce-144	2.46E-01	1.02E-01	0.00E+00	6.07E-02	0.00E+00	6.17E+01	0.00E+00	1.32E-02
Na-24	8.12E-01	8.12E-01	8.12E-01	8.12E-01	8.12E-01	8.12E-01	0.00E+00	8.12E-01
Cu-64	0.00E+00	4.06E-02	0.00E+00	1.03E-01	0.00E+00	3.15E+00	0.00E+00	1.91E-02
W-187	5.15E-02	4.20E-02	0.00E+00	0.00E+00	0.00E+00	1.14E+01	0.00E+00	1.47E-02
Np-239	6.21E-04	5.86E-05	0.00E+00	1.84E-04	0.00E+00	9.42E+00	0.00E+00	3.25E-05
Tc-99m	1.17E-04	3.27E-04	0.00E+00	4.87E-03	1.81E-04	2.15E-01	0.00E+00	4.23E-03
As-76	0.00E+00	2.36E-02	0.00E+00	4.48E-02	0.00E+00	4.55E+01	0.00E+00	2.28E-02
Nb-95m	2.90E-03	1.61E-03	0.00E+00	1.56E-03	0.00E+00	6.87E+00	0.00E+00	8.84E-04

TABLE A-3

DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES

TABLE A-3
A_{itsh} VALUES - LAKE SHORELINE DEPOSITS - ADULT
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	3.57E-02	3.57E-02	3.57E-02	3.57E-02	3.57E-02	3.57E-02	4.14E-02	3.57E-02
Cr-51	1.39E-02	1.39E-02	1.39E-02	1.39E-02	1.39E-02	1.39E-02	1.64E-02	1.39E-02
Mn-54	4.14E+00	4.14E+00	4.14E+00	4.14E+00	4.14E+00	4.14E+00	4.85E+00	4.14E+00
Fe-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	8.15E-01	8.15E-01	8.15E-01	8.15E-01	8.15E-01	8.15E-01	9.58E-01	8.15E-01
Co-57	5.63E-01	5.63E-01	5.63E-01	5.63E-01	5.63E-01	5.63E-01	6.18E-01	5.63E-01
Co-58	1.13E+00	1.13E+00	1.13E+00	1.13E+00	1.13E+00	1.13E+00	1.33E+00	1.13E+00
Co-60	6.43E+01	6.43E+01	6.43E+01	6.43E+01	6.43E+01	6.43E+01	7.57E+01	6.43E+01
Cu-64	1.81E-03	1.81E-03	1.81E-03	1.81E-03	1.81E-03	1.81E-03	2.05E-03	1.81E-03
Zn-65	2.23E+00	2.23E+00	2.23E+00	2.23E+00	2.23E+00	2.23E+00	2.57E+00	2.23E+00
Sr-89	6.46E-05	6.46E-05	6.46E-05	6.46E-05	6.46E-05	6.46E-05	7.50E-05	6.46E-05
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-95	4.08E-01	4.08E-01	4.08E-01	4.08E-01	4.08E-01	4.08E-01	4.80E-01	4.08E-01
Zr-95	7.31E-01	7.31E-01	7.31E-01	7.31E-01	7.31E-01	7.31E-01	8.48E-01	7.31E-01
As-76	1.14E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02	1.14E-02	3.96E-01	1.14E-02
Nb-95m	5.85E-03	5.85E-03	5.85E-03	5.85E-03	5.85E-03	5.85E-03	3.67E-02	5.85E-03
Zr-97	8.84E-03	8.84E-03	8.84E-03	8.84E-03	8.84E-03	8.84E-03	1.03E-02	8.84E-03
Mo-99	1.19E-02	1.19E-02	1.19E-02	1.19E-02	1.19E-02	1.19E-02	1.38E-02	1.19E-02
Tc-99m	5.50E-04	5.50E-04	5.50E-04	5.50E-04	5.50E-04	5.50E-04	6.30E-04	5.50E-04
Ag-110m	1.03E+01	1.03E+01	1.03E+01	1.03E+01	1.03E+01	1.03E+01	1.20E+01	1.03E+01
Sb-124	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	2.06E+00	1.79E+00
I-131	5.14E-02	5.14E-02	5.14E-02	5.14E-02	5.14E-02	5.14E-02	6.24E-02	5.14E-02
I-133	7.32E-03	7.32E-03	7.32E-03	7.32E-03	7.32E-03	7.32E-03	8.90E-03	7.32E-03
I-135	7.55E-03	7.55E-03	7.55E-03	7.55E-03	7.55E-03	7.55E-03	8.80E-03	7.55E-03
Cs-134	2.05E+01	2.05E+01	2.05E+01	2.05E+01	2.05E+01	2.05E+01	2.39E+01	2.05E+01
Cs-137	3.08E+01	3.08E+01	3.08E+01	3.08E+01	3.08E+01	3.08E+01	3.59E+01	3.08E+01
Ba-140	6.13E-02	6.13E-02	6.13E-02	6.13E-02	6.13E-02	6.13E-02	7.01E-02	6.13E-02
La-140	5.74E-02	5.74E-02	5.74E-02	5.74E-02	5.74E-02	5.74E-02	6.50E-02	5.74E-02
Ce-141	4.08E-02	4.08E-02	4.08E-02	4.08E-02	4.08E-02	4.08E-02	4.60E-02	4.08E-02
Ce-144	2.08E-01	2.08E-01	2.08E-01	2.08E-01	2.08E-01	2.08E-01	2.40E-01	2.08E-01
W-187	7.03E-03	7.03E-03	7.03E-03	7.03E-03	7.03E-03	7.03E-03	8.16E-03	7.03E-03
Np-239	5.11E-03	5.11E-03	5.11E-03	5.11E-03	5.11E-03	5.11E-03	5.91E-03	5.11E-03

TABLE A-3 (Continued)
A_{itsh} VALUES - LAKE SHORELINE DEPOSITS - TEENAGER
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	1.99E-01	1.99E-01	1.99E-01	1.99E-01	1.99E-01	1.99E-01	2.31E-01	1.99E-01
Cr-51	7.77E-02	7.77E-02	7.77E-02	7.77E-02	7.77E-02	7.77E-02	9.18E-02	7.77E-02
Mn-54	2.31E+01	2.31E+01	2.31E+01	2.31E+01	2.31E+01	2.31E+01	2.71E+01	2.31E+01
Fe-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	4.55E+00	4.55E+00	4.55E+00	4.55E+00	4.55E+00	4.55E+00	5.35E+00	4.55E+00
Co-57	3.14E+00	3.14E+00	3.14E+00	3.14E+00	3.14E+00	3.14E+00	3.45E+00	3.14E+00
Co-58	6.32E+00	6.32E+00	6.32E+00	6.32E+00	6.32E+00	6.32E+00	7.40E+00	6.32E+00
Co-60	3.59E+02	3.59E+02	3.59E+02	3.59E+02	3.59E+02	3.59E+02	4.23E+02	3.59E+02
Cu-64	1.01E-02	1.01E-02	1.01E-02	1.01E-02	1.01E-02	1.01E-02	1.15E-02	1.01E-02
Zn-65	1.25E+01	1.25E+01	1.25E+01	1.25E+01	1.25E+01	1.25E+01	1.43E+01	1.25E+01
Sr-89	3.61E-04	3.61E-04	3.61E-04	3.61E-04	3.61E-04	3.61E-04	4.19E-04	3.61E-04
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-95	2.28E+00	2.28E+00	2.28E+00	2.28E+00	2.28E+00	2.28E+00	2.68E+00	2.28E+00
Zr-95	4.08E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00	4.73E+00	4.08E+00
As-76	6.36E-02	6.36E-02	6.36E-02	6.36E-02	6.36E-02	6.36E-02	2.21E+00	6.36E-02
Nb-95m	3.27E-02	3.27E-02	3.27E-02	3.27E-02	3.27E-02	3.27E-02	2.05E-01	3.27E-02
Zr-97	4.94E-02	4.94E-02	4.94E-02	4.94E-02	4.94E-02	4.94E-02	5.74E-02	4.94E-02
Mo-99	6.66E-02	6.66E-02	6.66E-02	6.66E-02	6.66E-02	6.66E-02	7.71E-02	6.66E-02
Tc-99m	3.07E-03	3.07E-03	3.07E-03	3.07E-03	3.07E-03	3.07E-03	3.52E-03	3.07E-03
Ag-110m	5.73E+01	5.73E+01	5.73E+01	5.73E+01	5.73E+01	5.73E+01	6.69E+01	5.73E+01
Sb-124	9.98E+00	9.98E+00	9.98E+00	9.98E+00	9.98E+00	9.98E+00	1.15E+01	9.98E+00
I-131	2.87E-01	2.87E-01	2.87E-01	2.87E-01	2.87E-01	2.87E-01	3.48E-01	2.87E-01
I-133	4.09E-02	4.09E-02	4.09E-02	4.09E-02	4.09E-02	4.09E-02	4.97E-02	4.09E-02
I-135	4.21E-02	4.21E-02	4.21E-02	4.21E-02	4.21E-02	4.21E-02	4.92E-02	4.21E-02
Cs-134	1.14E+02	1.14E+02	1.14E+02	1.14E+02	1.14E+02	1.14E+02	1.34E+02	1.14E+02
Cs-137	1.72E+02	1.72E+02	1.72E+02	1.72E+02	1.72E+02	1.72E+02	2.01E+02	1.72E+02
Ba-140	3.42E-01	3.42E-01	3.42E-01	3.42E-01	3.42E-01	3.42E-01	3.91E-01	3.42E-01
La-140	3.20E-01	3.20E-01	3.20E-01	3.20E-01	3.20E-01	3.20E-01	3.63E-01	3.20E-01
Ce-141	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.28E-01	2.57E-01	2.28E-01
Ce-144	1.16E+00	1.16E+00	1.16E+00	1.16E+00	1.16E+00	1.16E+00	1.34E+00	1.16E+00
W-187	3.92E-02	3.92E-02	3.92E-02	3.92E-02	3.92E-02	3.92E-02	4.56E-02	3.92E-02
Np-239	2.85E-02	2.85E-02	2.85E-02	2.85E-02	2.85E-02	2.85E-02	3.30E-02	2.85E-02

TABLE A-3 (Continued)
A_{itw} VALUES - POTABLE WATER - CHILD
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	7.16E-02	7.16E-02	7.16E-02	7.16E-02	7.16E-02	0.00E+00	7.16E-02
Cr-51	0.00E+00	0.00E+00	1.74E-03	4.76E-04	3.18E-03	1.67E-01	0.00E+00	3.14E-03
Mn-54	0.00E+00	3.78E+00	0.00E+00	1.06E+00	0.00E+00	3.17E+00	0.00E+00	1.01E+00
Fe-55	4.06E+00	2.15E+00	0.00E+00	0.00E+00	1.22E+00	3.99E-01	0.00E+00	6.67E-01
Fe-59	5.82E+00	9.42E+00	0.00E+00	0.00E+00	2.73E+00	9.81E+00	0.00E+00	4.69E+00
Co-57	0.00E+00	1.74E-01	0.00E+00	0.00E+00	0.00E+00	1.43E+00	0.00E+00	3.52E-01
Co-58	0.00E+00	6.35E-01	0.00E+00	0.00E+00	0.00E+00	3.70E+00	0.00E+00	1.94E+00
Co-60	0.00E+00	1.87E+00	0.00E+00	0.00E+00	0.00E+00	1.03E+01	0.00E+00	5.50E+00
Zn-65	4.83E+00	1.29E+01	0.00E+00	8.12E+00	0.00E+00	2.26E+00	0.00E+00	8.01E+00
Sr-89	4.66E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.80E+01	0.00E+00	1.33E+01
Sr-90	6.00E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.08E+01	0.00E+00	1.52E+03
Zr-95	4.09E-02	9.00E-03	0.00E+00	1.29E-02	0.00E+00	9.39E+00	0.00E+00	8.01E-03
Zr-97	2.47E-03	3.56E-04	0.00E+00	5.12E-04	0.00E+00	5.40E+01	0.00E+00	2.10E-04
Nb-95	7.94E-03	3.09E-03	0.00E+00	2.90E-03	0.00E+00	5.72E+00	0.00E+00	2.21E-03
Mo-99	0.00E+00	4.69E+00	0.00E+00	1.00E+01	0.00E+00	3.88E+00	0.00E+00	1.16E+00
Ag-110m	1.90E-01	1.28E-01	0.00E+00	2.39E-01	0.00E+00	1.53E+01	0.00E+00	1.03E-01
Sb-124	3.92E+00	5.08E-02	8.64E-03	0.00E+00	2.17E+00	2.45E+01	0.00E+00	1.37E+00
I-131	6.07E+00	6.10E+00	2.02E+03	1.00E+01	0.00E+00	5.43E-01	0.00E+00	3.47E+00
I-133	2.09E+00	2.58E+00	4.80E+02	4.30E+00	0.00E+00	1.04E+00	0.00E+00	9.77E-01
I-135	6.17E-01	1.11E+00	9.84E+01	1.70E+00	0.00E+00	8.47E-01	0.00E+00	5.26E-01
Cs-134	8.26E+01	1.35E+02	0.00E+00	4.20E+01	1.51E+01	7.30E-01	0.00E+00	2.86E+01
Cs-137	1.15E+02	1.10E+02	0.00E+00	3.60E+01	1.29E+01	6.92E-01	0.00E+00	1.63E+01
Ba-140	2.93E+01	2.57E-02	0.00E+00	8.36E-03	1.53E-02	1.49E+01	0.00E+00	1.71E+00
La-140	3.56E-03	1.25E-03	0.00E+00	0.00E+00	0.00E+00	3.47E+01	0.00E+00	4.20E-04
Ce-141	1.40E-02	6.99E-03	0.00E+00	3.06E-03	0.00E+00	8.72E+00	0.00E+00	1.04E-03
Ce-144	7.34E-01	2.30E-01	0.00E+00	1.27E-01	0.00E+00	6.00E+01	0.00E+00	3.92E-02
Na-24	2.05E+00	2.05E+00	2.05E+00	2.05E+00	2.05E+00	2.05E+00	0.00E+00	2.05E+00
Cu-64	0.00E+00	8.64E-02	0.00E+00	2.09E-01	0.00E+00	4.06E+00	0.00E+00	5.22E-02
W-187	1.51E-01	8.96E-02	0.00E+00	0.00E+00	0.00E+00	1.26E+01	0.00E+00	4.02E-02
Np-239	1.85E-03	1.33E-04	0.00E+00	3.85E-04	0.00E+00	9.84E+00	0.00E+00	9.35E-05
Tc-99m	3.26E-04	6.39E-04	0.00E+00	9.28E-03	3.24E-04	3.63E-01	0.00E+00	1.06E-02
As-76	0.00E+00	5.36E-02	0.00E+00	9.44E-02	0.00E+00	5.43E+01	0.00E+00	6.80E-02
Nb-95m	7.93E-03	3.09E-03	0.00E+00	2.90E-03	0.00E+00	5.71E+00	0.00E+00	2.21E-03

TABLE A-3 (Continued)
A_{itw} VALUES - FRESHWATER FISH - CHILD
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	1.20E-02	1.20E-02	1.20E-02	1.20E-02	1.20E-02	0.00E+00	1.20E-02
Na-24	3.81E+01	3.81E+01	3.81E+01	3.81E+01	3.81E+01	3.81E+01	0.00E+00	3.81E+01
Cr-51	0.00E+00	0.00E+00	6.49E-02	1.77E-02	1.18E-01	6.20E+00	0.00E+00	1.17E-01
Mn-54	0.00E+00	2.81E+02	0.00E+00	7.88E+01	0.00E+00	2.36E+02	0.00E+00	7.48E+01
Fe-55	7.55E+01	4.00E+01	0.00E+00	0.00E+00	2.26E+01	7.42E+00	0.00E+00	1.24E+01
Fe-59	1.08E+02	1.75E+02	0.00E+00	0.00E+00	5.08E+01	1.82E+02	0.00E+00	8.73E+01
Co-57	0.00E+00	1.62E+00	0.00E+00	0.00E+00	0.00E+00	1.33E+01	0.00E+00	3.28E+00
Co-58	0.00E+00	5.91E+00	0.00E+00	0.00E+00	0.00E+00	3.45E+01	0.00E+00	1.81E+01
Co-60	0.00E+00	1.74E+01	0.00E+00	0.00E+00	0.00E+00	9.62E+01	0.00E+00	5.12E+01
Cu-64	0.00E+00	8.04E-01	0.00E+00	1.94E+00	0.00E+00	3.77E+01	0.00E+00	4.86E-01
Zn-65	1.80E+03	4.79E+03	0.00E+00	3.02E+03	0.00E+00	8.41E+02	0.00E+00	2.98E+03
Sr-89	2.60E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E+02	0.00E+00	7.42E+01
Sr-90	3.35E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.51E+02	0.00E+00	8.49E+03
Nb-95	4.43E+01	1.73E+01	0.00E+00	1.62E+01	0.00E+00	3.19E+04	0.00E+00	1.23E+01
Zr-95	2.51E-02	5.52E-03	0.00E+00	7.91E-03	0.00E+00	5.76E+00	0.00E+00	4.92E-03
As-76	0.00E+00	9.97E-01	0.00E+00	1.76E+00	0.00E+00	1.01E+03	0.00E+00	1.27E+00
Nb-95m	4.43E+01	1.72E+01	0.00E+00	1.62E+01	0.00E+00	3.19E+04	0.00E+00	1.23E+01
Zr-97	1.51E-03	2.19E-04	0.00E+00	3.14E-04	0.00E+00	3.31E+01	0.00E+00	1.29E-04
Mo-99	0.00E+00	8.73E+00	0.00E+00	1.86E+01	0.00E+00	7.22E+00	0.00E+00	2.16E+00
Tc-99m	9.09E-04	1.78E-03	0.00E+00	2.59E-02	9.05E-04	1.01E+00	0.00E+00	2.95E-02
Ag-110m	8.14E-02	5.50E-02	0.00E+00	1.02E-01	0.00E+00	6.54E+00	0.00E+00	4.39E-02
Sb-124	7.29E-01	9.45E-03	1.61E-03	0.00E+00	4.04E-01	4.56E+00	0.00E+00	2.55E-01
I-131	1.69E+01	1.70E+01	5.63E+03	2.80E+01	0.00E+00	1.52E+00	0.00E+00	9.68E+00
I-133	5.83E+00	7.21E+00	1.34E+03	1.20E+01	0.00E+00	2.90E+00	0.00E+00	2.73E+00
I-135	1.72E+00	3.10E+00	2.75E+02	4.76E+00	0.00E+00	2.36E+00	0.00E+00	1.47E+00
Cs-134	3.07E+04	5.04E+04	0.00E+00	1.56E+04	5.61E+03	2.72E+02	0.00E+00	1.06E+04
Cs-137	4.29E+04	4.11E+04	0.00E+00	1.34E+04	4.82E+03	2.57E+02	0.00E+00	6.07E+03
Ba-140	2.18E+01	1.91E-02	0.00E+00	6.22E-03	1.14E-02	1.11E+01	0.00E+00	1.27E+00
La-140	1.66E-02	5.79E-03	0.00E+00	0.00E+00	0.00E+00	1.61E+02	0.00E+00	1.95E-03
Ce-141	2.61E-03	1.30E-03	0.00E+00	5.70E-04	0.00E+00	1.62E+00	0.00E+00	1.93E-04
Ce-144	1.37E-01	4.28E-02	0.00E+00	2.37E-02	0.00E+00	1.12E+01	0.00E+00	7.29E-03
W-187	3.38E+01	2.00E+01	0.00E+00	0.00E+00	0.00E+00	2.81E+03	0.00E+00	8.98E+00
Np-239	3.45E-03	2.47E-04	0.00E+00	7.15E-04	0.00E+00	1.83E+01	0.00E+00	1.74E-04

TABLE A-3 (Continued)
A_{itsh} VALUES - LAKE SHORELINE DEPOSITS - CHILD
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na-24	4.16E-02	4.16E-02	4.16E-02	4.16E-02	4.16E-02	4.16E-02	4.83E-02	4.16E-02
Cr-51	1.62E-02	1.62E-02	1.62E-02	1.62E-02	1.62E-02	1.62E-02	1.92E-02	1.62E-02
Mn-54	4.83E+00	4.83E+00	4.83E+00	4.83E+00	4.83E+00	4.83E+00	5.66E+00	4.83E+00
Fe-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	9.51E-01	9.51E-01	9.51E-01	9.51E-01	9.51E-01	9.51E-01	1.12E+00	9.51E-01
Co-57	6.57E-01	6.57E-01	6.57E-01	6.57E-01	6.57E-01	6.57E-01	7.22E-01	6.57E-01
Co-58	1.32E+00	1.32E+00	1.32E+00	1.32E+00	1.32E+00	1.32E+00	1.55E+00	1.32E+00
Co-60	7.51E+01	7.51E+01	7.51E+01	7.51E+01	7.51E+01	7.51E+01	8.83E+01	7.51E+01
Cu-64	2.11E-03	2.11E-03	2.11E-03	2.11E-03	2.11E-03	2.11E-03	2.40E-03	2.11E-03
Zn-65	2.60E+00	2.60E+00	2.60E+00	2.60E+00	2.60E+00	2.60E+00	2.99E+00	2.60E+00
Sr-89	7.54E-05	7.54E-05	7.54E-05	7.54E-05	7.54E-05	7.54E-05	8.75E-05	7.54E-05
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-95	4.76E-01	4.76E-01	4.76E-01	4.76E-01	4.76E-01	4.76E-01	5.60E-01	4.76E-01
Zr-95	8.53E-01	8.53E-01	8.53E-01	8.53E-01	8.53E-01	8.53E-01	9.89E-01	8.53E-01
As-76	1.33E-02	1.33E-02	1.33E-02	1.33E-02	1.33E-02	1.33E-02	4.62E-01	1.33E-02
Nb-95m	6.82E-03	6.82E-03	6.82E-03	6.82E-03	6.82E-03	6.82E-03	4.28E-02	6.82E-03
Zr-97	1.03E-02	1.03E-02	1.03E-02	1.03E-02	1.03E-02	1.03E-02	1.20E-02	1.03E-02
Mo-99	1.39E-02	1.39E-02	1.39E-02	1.39E-02	1.39E-02	1.39E-02	1.61E-02	1.39E-02
Tc-99m	6.41E-04	6.41E-04	6.41E-04	6.41E-04	6.41E-04	6.41E-04	7.35E-04	6.41E-04
Ag-110m	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.20E+01	1.40E+01	1.20E+01
Sb-124	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.41E+00	2.08E+00
I-131	6.00E-02	6.00E-02	6.00E-02	6.00E-02	6.00E-02	6.00E-02	7.28E-02	6.00E-02
I-133	8.54E-03	8.54E-03	8.54E-03	8.54E-03	8.54E-03	8.54E-03	1.04E-02	8.54E-03
I-135	8.80E-03	8.80E-03	8.80E-03	8.80E-03	8.80E-03	8.80E-03	1.03E-02	8.80E-03
Cs-134	2.39E+01	2.39E+01	2.39E+01	2.39E+01	2.39E+01	2.39E+01	2.79E+01	2.39E+01
Cs-137	3.59E+01	3.59E+01	3.59E+01	3.59E+01	3.59E+01	3.59E+01	4.19E+01	3.59E+01
Ba-140	7.15E-02	7.15E-02	7.15E-02	7.15E-02	7.15E-02	7.15E-02	8.18E-02	7.15E-02
La-140	6.70E-02	6.70E-02	6.70E-02	6.70E-02	6.70E-02	6.70E-02	7.59E-02	6.70E-02
Ce-141	4.76E-02	4.76E-02	4.76E-02	4.76E-02	4.76E-02	4.76E-02	5.37E-02	4.76E-02
Ce-144	2.42E-01	2.42E-01	2.42E-01	2.42E-01	2.42E-01	2.42E-01	2.80E-01	2.42E-01
W-187	8.20E-03	8.20E-03	8.20E-03	8.20E-03	8.20E-03	8.20E-03	9.52E-03	8.20E-03
Np-239	5.96E-03	5.96E-03	5.96E-03	5.96E-03	5.96E-03	5.96E-03	6.90E-03	5.96E-03

TABLE A-3 (Continued)
A_{itw} VALUES - POTABLE WATER - INFANT
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	7.03E-02	7.03E-02	7.03E-02	7.03E-02	7.03E-02	0.00E+00	7.03E-02
Cr-51	0.00E+00	0.00E+00	2.10E-03	4.59E-04	4.09E-03	9.38E-02	0.00E+00	3.22E-03
Mn-54	0.00E+00	4.54E+00	0.00E+00	1.01E+00	0.00E+00	1.67E+00	0.00E+00	1.03E+00
Fe-55	3.17E+00	2.05E+00	0.00E+00	0.00E+00	1.00E+00	2.60E-01	0.00E+00	5.48E-01
Fe-59	7.03E+00	1.23E+01	0.00E+00	0.00E+00	3.63E+00	5.87E+00	0.00E+00	4.84E+00
Co-57	0.00E+00	2.63E-01	0.00E+00	0.00E+00	0.00E+00	8.95E-01	0.00E+00	4.27E-01
Co-58	0.00E+00	8.22E-01	0.00E+00	0.00E+00	0.00E+00	2.05E+00	0.00E+00	2.05E+00
Co-60	0.00E+00	2.47E+00	0.00E+00	0.00E+00	0.00E+00	5.87E+00	0.00E+00	5.82E+00
Zn-65	4.20E+00	1.44E+01	0.00E+00	6.99E+00	0.00E+00	1.22E+01	0.00E+00	6.64E+00
Sr-89	5.73E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E+01	0.00E+00	1.64E+01
Sr-90	4.22E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.27E+01	0.00E+00	1.08E+03
Zr-95	4.70E-02	1.15E-02	0.00E+00	1.24E-02	0.00E+00	5.71E+00	0.00E+00	8.13E-03
Zr-97	3.38E-03	5.80E-04	0.00E+00	5.84E-04	0.00E+00	3.70E+01	0.00E+00	2.65E-04
Nb-95	9.59E-03	3.95E-03	0.00E+00	2.83E-03	0.00E+00	3.33E+00	0.00E+00	2.28E-03
Mo-99	0.00E+00	7.76E+00	0.00E+00	1.16E+01	0.00E+00	2.56E+00	0.00E+00	1.51E+00
Ag-110m	2.27E-01	1.66E-01	0.00E+00	2.37E-01	0.00E+00	8.61E+00	0.00E+00	1.10E-01
Sb-124	4.89E+00	7.19E-02	1.30E-02	0.00E+00	3.06E+00	1.51E+01	0.00E+00	1.51E+00
I-131	8.20E+00	9.66E+00	3.17E+03	1.13E+01	0.00E+00	3.45E-01	0.00E+00	4.25E+00
I-133	2.85E+00	4.16E+00	7.56E+02	4.89E+00	0.00E+00	7.03E-01	0.00E+00	1.22E+00
I-135	8.31E-01	1.65E+00	1.48E+02	1.84E+00	0.00E+00	5.98E-01	0.00E+00	6.03E-01
Cs-134	8.61E+01	1.61E+02	0.00E+00	4.13E+01	1.69E+01	4.36E-01	0.00E+00	1.62E+01
Cs-137	1.19E+02	1.39E+02	0.00E+00	3.74E+01	1.52E+01	4.36E-01	0.00E+00	9.89E+00
Ba-140	3.90E+01	3.90E-02	0.00E+00	9.27E-03	2.40E-02	9.59E+00	0.00E+00	2.01E+00
La-140	4.82E-03	1.90E-03	0.00E+00	0.00E+00	0.00E+00	2.23E+01	0.00E+00	4.89E-04
Ce-141	1.80E-02	1.10E-02	0.00E+00	3.38E-03	0.00E+00	5.66E+00	0.00E+00	1.29E-03
Ce-144	6.80E-01	2.79E-01	0.00E+00	1.13E-01	0.00E+00	3.90E+01	0.00E+00	3.81E-02
Na-24	2.31E+00	2.31E+00	2.31E+00	2.31E+00	2.31E+00	2.31E+00	0.00E+00	2.31E+00
Cu-64	0.00E+00	1.39E-01	0.00E+00	2.35E-01	0.00E+00	2.85E+00	0.00E+00	6.44E-02
W-187	2.06E-01	1.43E-01	0.00E+00	0.00E+00	0.00E+00	8.42E+00	0.00E+00	4.95E-02
Np-239	2.53E-03	2.27E-04	0.00E+00	4.52E-04	0.00E+00	6.55E+00	0.00E+00	1.28E-04
Tc-99m	4.38E-04	9.04E-04	0.00E+00	9.73E-03	4.73E-04	2.63E-01	0.00E+00	1.16E-02
As-76	0.00E+00	9.14E-02	0.00E+00	1.11E-01	0.00E+00	3.65E+01	0.00E+00	9.33E-02
Nb-95m	9.58E-03	3.94E-03	0.00E+00	2.83E-03	0.00E+00	3.33E+00	0.00E+00	2.28E-03

TABLE A-4

DERIVATION OF LIQUID DOSE FACTORS

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TABLE A-4.1

LIQUID DOSE FACTOR (A_{it}) DERIVATION

For purposes of calculating the dose contribution to organs of various receptor age groups, a composite dose factor, A_{it}, may be used for each radionuclide i. The composite dose factor, A_{it}, is the sum of the freshwater fish, A_{itf}, potable water, A_{itw}, and shoreline deposits pathway, A_{itsh}, dose factors. A_{it} embodies pathway transfer parameters (e.g., bioaccumulation factors), pathway usage factors, organ dose conversion factors, and dilution factors between the release point and assumed point of exposure pathway. The composite dose factor may be expressed as:

$$A_{it} = (K_o (U_w \; / D_w) + \; K_o U_f \, BF_i \; / D_f \,) DF_i \; + (\; KSUBo \, Z \, W \, T_i \, U_{sh} / D_{sh} \,) \; (1 - e^{-\lambda_i T_b} \;) DE$$

(A-4.1)

Where:

A_{it} = is the composite dose parameter for the total body or organ of an age group for radionuclide, i, for all appropriate pathways, mrem/hr per µCi/ml.

K_o = is a unit conversion factor, 1.14E5 yr-pCi-ml per µCi-hr-l (NUREG-0133).

U_w = water consumption rate for age group of interest (Table A-4.2).

U_f = freshwater fish consumption rate for age group of interest (Table A-4.2).

U_{sh} = duration of time an individual is located on the beach (Table A-4.2).

D_w = dilution factor which reflects the dilution from the point of release to the nearest potable water intake (Table A-4.2).

D_f = dilution factor which reflects the dilution from the point of release to the nearest point assumed for the freshwater fish catch (Table A-4.2).

D_{sh} = dilution factor which reflects the dilution from the point of release to the nearest point assumed for shoreline deposit (Table A-4.2).

BF_i = bioaccumulation factor for radionuclide i, in freshwater fish, pCi/kg per pCi/l, from Table A-1 of Regulatory Guide 1.109.

Ti = is the radiological half-life of radionuclide, i, in days.

λi = is the radiological decay constant for radionuclide, i, in sec-1. W = is the shoreline width factor (Table A-4.2).

Tb = the period of time for which sediment or soil is exposed to he contaminated water (Table A-4.2).

K_c = assumed transfer constant from water to sediment, in liters/kg per hr as defined in Z.

Ms = mass of sediment, in kg/m2 of surface as defined in Z. Z = Kc x Ms x (24/.693), in l per m2-day (Table A-4.2).

DFi = dose conversion factor for radionuclide, i, for organ and age group of interest. Used to calculate the radiation dose from an intake of a radionuclide, mrem/pCi (Regulatory Guide 1.109, Tables E-11 to E-14).

Dei = dose conversion factor for radionuclide, i, for organ and age group of interest. Used to calculate the radiation dose from an external exposure of a radionuclide, mrem/hr per pCi/m2 (Regulatory Guide 1.109, Table E-6).

Example Calculation:

I. Potable Water

The potable water pathway dose factor, A_{itw}, is calculated from Equation A-4.1 by setting the usage factors for freshwater fish and shoreline deposits equal to zero. Equation A-4.1 reduces to the following:

$$A_{itw} = K_o \left(U_w / D_w \right) DF_i$$

For Co-60, the total body dose factor for an adult due to the ingestion of potable water is:

DF_i = 4.72E-06 mrem/pCi

U_w = 730 liters/yr

D_w = 165

K_o = 1.14E5 yr-pCi-ml per µCi-hr-l

These values yield an A_{itw} factor of 2.38 mrem/hr per µCi/ml as listed in Table A-2 of this appendix.

II. Freshwater Fish

The freshwater fish pathway dose factor, A_{itf}, is calculated from Equation A-4.1 by setting the usage factors for potable water and shoreline deposits equal to zero.

$$A_{itf} = K_o \,(U_f \; BF_i \,/\, D_f \,) DF_i$$

Equation A-4.1 reduces to the following:

For Co-60, the total body dose factor for an adult due to the ingestion of freshwater fish is:

DF_i = 4.72E-06 mrem/pCi

U_f = 21 kg/yr

D_f = 12

BF_i = 50 pCi/kg per pCi/l

K_o = 1.14E5 yr-pCi-ml per μCi-hr-l

These values yield an A_{itf} factor of 47.1 mrem/hr per μCi/ml as listed in Table

A-2 of this appendix.

III. Lake Shoreline Deposits

The shoreline deposits pathway dose factor, A_{itsh}, is calculated from Equation A-4.1 by setting the usage factors for potable water and freshwater fish equal to zero. Equation

$$A_{itsh} = (K_o \; Z \; W \; T_i \; U_{sh} \,/\, D_{sh}) \, (1 - e^{-iT_b} \;) \; DE_i$$

A-4.1 reduces to the following:

For Co-60, the total body dose factor for an adult from shoreline deposits is:

U_{sh} = 12 hrs/yr

D_{sh} = 18

W = 0.30

T_i = 1.92E3 days

T_b = 15 years or 4.73E8 sec

K_o = 1.14E5 yr-pCi-ml per μCi-hr-l

Z = 100 l per m^2-day

λi = 4.2E-9 sec^{-1}

DE_i = 1.70E-8 mrem/hr per pCi/m^2 (Regulatory Guide 1.109, Table E-6)

These values will yield and A_{itsh} factor of 64.2 mrem/hr per μCi/ml as listed in Table A-3 of this appendix.

TABLE A-4.2

PARAMETER FOR THE LIQUID EFFLUENT PATHWAY

PARAMETER		VALUE	REFERENCE	TABLE
U_w	(liters/yr)-Potable Water/			
	- infant	330	R.G. 1.109	E-5
	- child	510	R.G. 1.109	E-5
	- teen	510	R.G. 1.109	E-5
	- adult	730	R.G. 1.109	E-5
U_f	(kg/yr)-Freshwater Fish/			
	- infant	0	R.G. 1.109	E-5
	- child	6.9	R.G. 1.109	E-5
	- teen	16	R.G. 1.109	E-5
	- adult	21	R.G. 1.109	E-5
U_{sh}	(hr/yr)-Lake Shoreline Deposits/			
	- infant	0	R.G. 1.109	E-5
	- child	14	R.G. 1.109	E-5
	- teen	67	R.G. 1.109	E-5
	- adult	12	R.G. 1.109	E-5
BF_i	(pCi/kg per pCi/l)-Freshwater Fish	Each Radionuclide	R.G. 1.109	A-1
D_w	(dimensionless)-Potable Water	165	Site Specific (JAF FSAR Fig. 16.1-19)	
D_f	(dimensionless)-Freshwater Fish	12	Site Specific (JAF FSAR Fig. 16.1-19)	
D_{sh}	(dimensionless)-Lake Shoreline Deposits	18	Site Specific (JAF FSAR Fig. 16.1-19)	

TABLE A-4.2 (Continued)
PARAMETER FOR THE LIQUID EFFLUENT PATHWAY

PARAMETER		VALUE	REFERENCE	TABLE
DF_i	Potable Water/Freshwater Fish (mrem/pCi)	Each Radionuclide	R.G. 1.109	E-11 to E-14
DE_i	Lake Shoreline Deposits (mrem/hr per pCi/m^2)	Each Radionuclide	R.G. 1.109	E-6
Z	(l per m^2-day)-Lake Shoreline Deposits	100	R.G. 1.109	pg-14
W	(dimensionless)-Lake Shoreline Deposits	0.3	R.G. 1.109	A-2
T_b	(sec)-Lake Shoreline Deposits	4.73E8	R.G. 1.109	E-15
*	Transit Time (hours)-Potable Water	31	Site Specific (Based on a current speed of 0.4 ft./sec JAF FSAR Fig. 16.1-19)	
*	Transit Time (hours)-Freshwater Fish Consumption	0	Site Specific (JAF FSAR Fig. 16.1-19)	
*	Transit Time (hours)-Lake Shoreline Deposits	2.9	Site Specific (JAF FSAR Fig. 16.1-19)	

* Location of maximally exposed individual for potable water is Oswego, 8.5 miles west of JAF discharge. Location of maximally exposed individual for freshwater fish consumption is the JAF discharge vicinity. Location of maximally exposed individual for lake shoreline deposits is Sunset Bay, 0.8 miles east of JAF discharge.

TABLE A-4.3
JUSTIFICATION FOR LIQUID PATHWAYS USED TO ASSESS DOSE TO MAN

PATHWAY		JUSTIFICATION FOR OMISSION OR INCLUSION
1.	POTABLE WATER	This pathway is considered for all required analysis.
2.	FRESHWATER FISH	This pathway is considered for all required analysis.
3.	FRESHWATER SHELL	This pathway was not considered for the annual dose calculations and the 40CFR190 dose analysis. Reference 6.9 states that direct ingestion of aquatic invertebrates from Lake Ontario is not a common practice.
4.	FRESHWATER PLANTS	No known pathway exists for the J.A. FitzPatrick plant and none is included in the dose analysis of References 6.5 through 6.8. Regulatory Guide 1.109, Appendix E, Section 2, page 1.109-36, states "Ingestion of aquatic plant material is not normally assumed."
5.	SALTWATER FISH	Not applicable to a freshwater site.
6.	SALTWATER SHELL FISH	Not applicable to a freshwater site.
7.	SALTWATER PLANTS	Not applicable to a freshwater site.
8.	DISCHARGE CANAL SHORELINE	This pathway is not applicable since the J.A. FitzPatrick Plant discharges through a tunnel to a diffuser offshore.
9.	RIVER SHORELINE DEPOSITS	Not applicable to a Great Lake site.
10.	LAKE SHORELINE DEPOSITS	This pathway is not necessary to demonstrate compliance with 10CFR20 and 10CFR50 as specified in Sections 4.2, and 4.3.1 of NUREG-0133. This pathway is considered for the annual dose calculations, the 40CFR190 dose analysis, and Section 3.4.2.b (1).
11.	OCEAN SHORELINE DEPOSITS	Not applicable to a Great Lake Site.

TABLE A-4.3 (continued)
JUSTIFICATION FOR LIQUID PATHWAYS USED TO ASSESS DOSE TO MAN

PATHWAY		JUSTIFICATION FOR OMISSION OR INCLUSION
12.	TIDAL BASIN DEPOSITS	Not applicable to a Great Lake site.
13.	SWIMMING	This pathway is not necessary to demonstrate compliance with 10CFR20 and 10CFR50 as specified in Sections 4.2, and 4.3.1 of NUREG-0133. This pathway is not used in the ODCM since its dose contribution is very small (Appendix D, Table D-8).
14.	BOATING	This pathway is not necessary to demonstrate compliance with 10CFR20 and 10CFR50 as specified in Sections 4.2, and 4.3.1 of NUREG-0133. This pathway is not used in the ODCM since its dose contribution is very small (See Appendix D, Table D-8).
15.	STORED FRUITS AND VEGETABLES	There are two possible methods of establishing this pathway; by using water from the lake for irrigation or using well water for irrigation, which may have become contaminated through discharges to the lake. References 6.6 and 6.7 document that a limited irrigation pathway exists; however, Reference 6.5 states that recent surveys indicate that the irrigation pathways discussed in the other documents no longer use lake water for irrigation. Since Reference 6.5 is the most recent document it is concluded that the irrigation pathway does not exist and need not be considered in any dose analysis. References 6.5 through 6.8 state that the possibility of groundwater contamination is extremely remote and no impact on groundwater is expected.
16.	FRESH FRUITS AND VEGETABLES	This pathway need not be considered. See justification for pathway 15.
17.	MEAT (CONTAMI-NATED FORAGE)	This pathway need not be considered. See justification for pathway 15.

TABLE A-4.3 (continued)
JUSTIFICATION FOR LIQUID PATHWAYS USED TO ASSESS DOSE TO MAN

PATHWAY		JUSTIFICATION FOR OMISSION OR INCLUSION
18.	MEAT (CONTAMI-NATED FEED)	This pathway need not be considered. See Justification for pathway 15.
19.	MEAT (CONTAMI-NATED WATER)	This pathway is not necessary to demonstrate compliance with 10CFR20 and 10CFR50 as specified in Section 4.2 and 4.3.1 of NUREG-0133. The dose calculations shown in References 6.5 through 6.8 do not consider this pathway as a part of the analysis; hence, it is concluded that this pathway is insignificant and need not be considered for annual and 40CFR190 dose calculations.
20.	COWS MILK (CONTAMINATED FORAGE)	This pathway need not be considered. See justification for pathway 15.
21.	COWS MILK (CONTAMINATED FEED)	This pathway need not be considered. See justification for pathway 15.
22.	COWS MILK (CONTAMINATED WATER)	This pathway need not be considered. See justification for pathway 19.
23.	GOATS MILK (CONTAMINATED FORAGE)	This pathway need not be considered. See justification for pathway 15.
24.	GOATS MILK (CONTAMINATED FEED)	This pathway need not be considered. See justification for pathway 15.
25.	GOATS MILK (CONTAMINATED WATER)	This pathway need not be considered. See justification for pathway 19.

APPENDIX B

GASEOUS DOSE CALCULATION DATA

APPENDIX B

GASEOUS DOSE CALCULATION DATA

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TABLE B-1

TRANSFER FACTORS FOR MAXIMUM DOSE TO A PERSON OFFSITE DUE TO RADIOACTIVE NOBLE GASES

Dose Transfer Factors

RADIONUCLIDE	GAMMA K_i mrem / μCi sec/m³	BETA L_i mrem / μCi sec/m³	GAMMA + BETA (L + 1.1 M) i mrem / μCi sec/m³
Kr-83m	2.4E-9	--	6.7E-7
Kr-85m	3.7E-5	4.6E-5	8.9E-5
Kr-85	5.1E-7	4.2E-5	4.3E-5
Kr-87	1.9E-4	3.1E-4	5.3E-4
Kr-88	4.7E-4	7.5E-5	6.0E-4
Kr-89	5.3E-4	3.2E-4	9.3E-4
Kr-90	4.9E-4	2.3E-4	8.0E-4
Xe-131m	2.9E-6	1.5E-5	2.0E-5
Xe-133m	8.0E-6	3.1E-5	4.2E-5
Xe-133	9.3E-6	9.7E-6	2.2E-5
Xe-135m	9.9E-5	2.3E-5	1.4E-4
Xe-135	5.7E-5	5.9E-5	1.3E-4
Xe-137	4.5E-5	3.9E-4	4.4E-4
Xe-138	2.8E-4	1.3E-4	4.5E-4
Ar-41	2.8E-4	8.5E-5	4.0E-4

Ref: Regulatory Guide 1.109, Revision 1, Table B-1.

TABLE B-2

TRANSFER FACTORS FOR MAXIMUM OFFSITE AIR DOSE

Air Dose Transfer Factors

RADIONUCLIDE	GAMMA M_i mrad / μCi sec/m³	BETA N_i mrad / μCi sec/m³
Kr-83m	6.1E-7	9.1E-6
Kr-85m	3.9E-5	6.2E-5
Kr-85	5.4E-7	6.2E-5
Kr-87	2.0E-4	3.3E-4
Kr-88	4.8E-4	9.3E-5
Kr-89	5.5E-4	3.4E-4
Kr-90	5.2E-4	2.5E-4
Xe-131m	4.9E-6	3.5E-5
Xe-133m	1.0E-5	4.7E-5
Xe-133	1.1E-5	3.3E-5
Xe-135m	1.1E-4	2.3E-5
Xe-135	6.1E-5	7.8E-5
Xe-137	4.8E-5	4.0E-4
Xe-138	2.9E-4	1.5E-4
Ar-41	2.9E-4	1.0E-4

Ref: Regulatory Guide 1.109, Revision 1, Table B-1.

TABLE B-3
P_i VALUES - INHALATION - CHILD
$\frac{mrem/yr}{\mu Ci/m^3}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0	1.12E 03	1.12E 03	1.12E 03	1.12E 03	1.12E 03	0	1.12E 03
Cr-51	0	0	8.55E 01	2.43E 01	1.70E 04	1.08E 03	0	1.54E 02
Mn-54	0	4.29E 04	0	1.00E 04	1.58E 06	2.29E 04	0	9.51E 03
Fe-55	4.74E 04	2.52E 04	0	0	1.11E 05	2.87E 03	0	7.77E 03
Fe-59	2.07E 04	3.34E 04	0	0	1.27E 06	7.07E 04	0	1.67E 04
Co-57	0	9.03E 02	0	0	5.07E 05	1.32E 04	0	1.07E 03
Co-58	0	1.77E 03	0	0	1.11E 06	3.44E 04	0	3.16E 03
Co-60	0	1.31E 04	0	0	7.07E 06	9.62E 04	0	2.26E 04
Zn-65	4.26E 04	1.13E 05	0	7.14E 04	9.95E 05	1.63E 04	0	7.03E 04
Se-75	0	0	0	0	0	0		0
Sr-89	5.99E 05	0	0	0	2.16E 06	1.67E 05	0	1.72E 04
Sr-90	1.01E 08	0	0	0	1.48E 07	3.43E 05	0	6.44E 06
Zr-95	1.90E 05	4.18E 04	0	5.96E 04	2.23E 06	6.11E 04	0	3.70E 04
Nb-95	2.35E 04	9.18E 03	0	8.62E 03	6.14E 05	3.70E 04	0	6.55E 03
Mo-99	0	1.72E 02	0	3.92E 02	1.35E 05	1.27E 05	0	4.25E 01
Ag-110m	1.69E 04	1.14E 04	0	2.12E 04	5.48E 06	1.00E 05	0	9.14E 03
Sb-124	5.74E 04	7.40E 02	1.26E 02	0	3.24E 06	1.64E 05	0	2.00E 04
I-131	4.81E 04	4.81E 04	1.62E 07	7.88E 04	0	2.84E 03	0	2.73E 04
I-133	1.66E 04	2.03E 04	3.85E 06	3.38E 04	0	5.48E 03	0	7.70E 03
I-135	4.92E 03	8.73E 03	7.92E 05	1.34E 04	0	4.44E 03	0	4.14E 03
Cs-134	6.51E 05	1.01E 06	0	3.30E 05	1.21E 05	3.85E 03	0	2.25E 05
Cs-136	6.51E 04	1.71E 05	0	9.55E 04	1.45E 04	4.18E 03	0	1.16E 05
Cs-137	9.07E 05	8.25E 05	0	2.82E 05	1.04E 05	3.62E 03	0	1.28E 05
Ba-140	7.40E 04	6.48E 01	0	2.11E 01	1.74E 06	1.02E 05	0	4.33E 03
La-140	6.44E 02	2.25E 02	0	0	1.83E 05	2.26E 05	0	7.55E 01
Ce-141	3.92E 04	1.95E 04	0	8.55E 03	5.44E 05	5.66E 04	0	2.90E 03
Ce-144	6.77E 06	2.12E 06	0	1.17E 06	1.20E 07	3.89E 05	0	3.61E 05

TABLE B-4
R_i VALUES - COW MILK - INFANT
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	2.38E+03	2.38E+03	2.38E+03	2.38E+03	2.38E+03	0.00E+00	2.38E+03
Cr-51	0.00E+00	0.00E+00	5.45E+04	1.19E+04	1.06E+05	2.44E+06	0.00E+00	8.36E+04
Mn-54	0.00E+00	2.51E+07	0.00E+00	5.56E+06	0.00E+00	9.22E+06	0.00E+00	5.69E+06
Fe-55	8.98E+07	5.80E+07	0.00E+00	0.00E+00	2.83E+07	7.36E+06	0.00E+00	1.55E+07
Fe-59	1.22E+08	2.13E+08	0.00E+00	0.00E+00	6.29E+07	1.02E+08	0.00E+00	8.39E+07
Co-57	0.00E+00	5.72E+06	0.00E+00	0.00E+00	0.00E+00	1.95E+07	0.00E+00	9.30E+06
Co-58	0.00E+00	1.39E+07	0.00E+00	0.00E+00	0.00E+00	3.46E+07	0.00E+00	3.46E+07
Co-60	0.00E+00	5.90E+07	0.00E+00	0.00E+00	0.00E+00	1.40E+08	0.00E+00	1.39E+08
Zn-65	3.53E+09	1.21E+10	0.00E+00	5.87E+09	0.00E+00	1.02E+10	0.00E+00	5.58E+09
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	6.93E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.43E+08	0.00E+00	1.99E+08
Sr-90	8.19E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E+09	0.00E+00	2.09E+10
Zr-95	3.85E+03	9.39E+02	0.00E+00	1.01E+03	0.00E+00	4.67E+05	0.00E+00	6.66E+02
Nb-95	3.14E+05	1.29E+05	0.00E+00	9.28E+04	0.00E+00	1.09E+08	0.00E+00	7.48E+04
Mo-99	0.00E+00	1.04E+08	0.00E+00	1.55E+08	0.00E+00	3.43E+07	0.00E+00	2.03E+07
Ag-110m	2.46E+08	1.79E+08	0.00E+00	2.56E+08	0.00E+00	9.29E+09	0.00E+00	1.19E+08
Sb-124	1.18E+08	1.73E+06	3.12E+05	0.00E+00	7.37E+07	3.63E+08	0.00E+00	3.65E+07
I-131	1.36E+09	1.60E+09	5.27E+11	1.87E+09	0.00E+00	5.72E+07	0.00E+00	7.05E+08
I-133	1.81E+07	2.64E+07	4.80E+09	3.10E+07	0.00E+00	4.47E+06	0.00E+00	7.73E+06
I-135	5.61E+04	1.12E+05	1.00E+07	1.24E+05	0.00E+00	4.04E+04	0.00E+00	4.07E+04
Cs-134	2.41E+10	4.50E+10	0.00E+00	1.16E+10	4.75E+09	1.22E+08	0.00E+00	4.54E+09
Cs-136	9.91E+08	2.91E+09	0.00E+00	1.16E+09	2.37E+08	4.43E+07	0.00E+00	1.09E+09
Cs-137	3.47E+10	4.06E+10	0.00E+00	1.09E+10	4.41E+09	1.27E+08	0.00E+00	2.88E+09
Ba-140	1.21E+08	1.21E+05	0.00E+00	2.87E+04	7.42E+04	2.97E+07	0.00E+00	6.23E+06
La-140	2.03E+01	7.99E+00	0.00E+00	0.00E+00	0.00E+00	9.38E+04	0.00E+00	2.06E+00
Ce-141	2.28E+04	1.39E+04	0.00E+00	4.29E+03	0.00E+00	7.18E+06	0.00E+00	1.64E+03
Ce-144	1.49E+06	6.10E+05	0.00E+00	2.46E+05	0.00E+00	8.55E+07	0.00E+00	8.35E+04

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-4 (Continued)
R_i VALUES - GOAT MILK - INFANT
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	4.86E+03	4.86E+03	4.86E+03	4.86E+03	4.86E+03	0.00E+00	4.86E+03
Cr-51	0.00E+00	0.00E+00	6.54E+03	1.43E+03	1.27E+04	2.92E+05	0.00E+00	1.00E+04
Mn-54	0.00E+00	3.01E+06	0.00E+00	6.67E+05	0.00E+00	1.11E+06	0.00E+00	6.82E+05
Fe-55	1.17E+06	7.54E+05	0.00E+00	0.00E+00	3.69E+05	9.57E+04	0.00E+00	2.01E+05
Fe-59	1.58E+06	2.77E+06	0.00E+00	0.00E+00	8.18E+05	1.32E+06	0.00E+00	1.09E+06
Co-57	0.00E+00	6.86E+05	0.00E+00	0.00E+00	0.00E+00	2.34E+06	0.00E+00	1.12E+06
Co-58	0.00E+00	1.67E+06	0.00E+00	0.00E+00	0.00E+00	4.15E+06	0.00E+00	4.16E+06
Co-60	0.00E+00	7.08E+06	0.00E+00	0.00E+00	0.00E+00	1.69E+07	0.00E+00	1.67E+07
Zn-65	4.23E+08	1.45E+09	0.00E+00	7.04E+08	0.00E+00	1.23E+09	0.00E+00	6.70E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.46E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.99E+08	0.00E+00	4.18E+08
Sr-90	1.72E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E+09	0.00E+00	4.38E+10
Zr-95	4.62E+02	1.13E+02	0.00E+00	1.21E+02	0.00E+00	5.61E+04	0.00E+00	7.99E+01
Nb-95	3.77E+04	1.55E+04	0.00E+00	1.11E+04	0.00E+00	1.31E+07	0.00E+00	8.98E+03
Mo-99	0.00E+00	1.25E+07	0.00E+00	1.86E+07	0.00E+00	4.11E+06	0.00E+00	2.43E+06
Ag-110m	2.95E+07	2.15E+07	0.00E+00	3.08E+07	0.00E+00	1.12E+09	0.00E+00	1.42E+07
Sb-124	1.41E+07	2.08E+05	3.75E+04	0.00E+00	8.84E+06	4.36E+07	0.00E+00	4.38E+06
I-131	1.63E+09	1.92E+09	6.32E+11	2.25E+09	0.00E+00	6.86E+07	0.00E+00	8.46E+08
I-133	2.18E+07	3.17E+07	5.76E+09	3.72E+07	0.00E+00	5.36E+06	0.00E+00	9.28E+06
I-135	6.74E+04	1.34E+05	1.20E+07	1.49E+05	0.00E+00	4.85E+04	0.00E+00	4.89E+04
Cs-134	7.23E+10	1.35E+11	0.00E+00	3.47E+10	1.42E+10	3.66E+08	0.00E+00	1.36E+10
Cs-136	2.97E+09	8.74E+09	0.00E+00	3.48E+09	7.12E+08	1.33E+08	0.00E+00	3.26E+09
Cs-137	1.04E+11	1.22E+11	0.00E+00	3.27E+10	1.32E+10	3.81E+08	0.00E+00	8.63E+09
Ba-140	1.45E+07	1.45E+04	0.00E+00	3.44E+03	8.90E+03	3.56E+06	0.00E+00	7.47E+05
La-140	2.43E+00	9.59E-01	0.00E+00	0.00E+00	0.00E+00	1.13E+04	0.00E+00	2.47E-01
Ce-141	2.74E+03	1.67E+03	0.00E+00	5.14E+02	0.00E+00	8.62E+05	0.00E+00	1.96E+02
Ce-144	1.79E+05	7.32E+04	0.00E+00	2.96E+04	0.00E+00	1.03E+07	0.00E+00	1.00E+04

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-4 (Continued)
R_i VALUES - VEGETATION - CHILD
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	4.01E+03	4.01E+03	4.01E+03	4.01E+03	4.01E+03	0.00E+00	4.01E+03
Cr-51	0.00E+00	0.00E+00	6.50E+04	1.78E+04	1.19E+05	6.21E+06	0.00E+00	1.17E+05
Mn-54	0.00E+00	6.65E+08	0.00E+00	1.86E+08	0.00E+00	5.58E+08	0.00E+00	1.77E+08
Fe-55	8.01E+08	4.25E+08	0.00E+00	0.00E+00	2.40E+08	7.87E+07	0.00E+00	1.32E+08
Fe-59	3.98E+08	6.43E+08	0.00E+00	0.00E+00	1.86E+08	6.70E+08	0.00E+00	3.20E+08
Co-57	0.00E+00	2.99E+07	0.00E+00	0.00E+00	0.00E+00	2.45E+08	0.00E+00	6.04E+07
Co-58	0.00E+00	6.44E+07	0.00E+00	0.00E+00	0.00E+00	3.76E+08	0.00E+00	1.97E+08
Co-60	0.00E+00	3.78E+08	0.00E+00	0.00E+00	0.00E+00	2.10E+09	0.00E+00	1.12E+09
Zn-65	8.13E+08	2.16E+09	0.00E+00	1.36E+09	0.00E+00	3.80E+08	0.00E+00	1.35E+09
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.60E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E+09	0.00E+00	1.03E+09
Sr-90	1.24E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E+10	0.00E+00	3.15E+11
Zr-95	3.86E+06	8.48E+05	0.00E+00	1.21E+06	0.00E+00	8.85E+08	0.00E+00	7.55E+05
Nb-95	4.10E+05	1.60E+05	0.00E+00	1.50E+05	0.00E+00	2.96E+08	0.00E+00	1.14E+05
Mo-99	0.00E+00	7.70E+06	0.00E+00	1.64E+07	0.00E+00	6.37E+06	0.00E+00	1.91E+06
Ag-110m	3.21E+07	2.17E+07	0.00E+00	4.04E+07	0.00E+00	2.58E+09	0.00E+00	1.73E+07
Sb-124	3.52E+08	4.56E+06	7.77E+05	0.00E+00	1.95E+08	2.20E+09	0.00E+00	1.23E+08
I-131	1.43E+08	1.44E+08	4.75E+10	2.36E+08	0.00E+00	1.28E+07	0.00E+00	8.17E+07
I-133	3.52E+06	4.35E+06	8.08E+08	7.25E+06	0.00E+00	1.75E+06	0.00E+00	1.65E+06
I-135	6.18E+04	1.11E+05	9.86E+06	1.71E+05	0.00E+00	8.48E+04	0.00E+00	5.26E+04
Cs-134	1.60E+10	2.63E+10	0.00E+00	8.15E+09	2.93E+09	1.42E+08	0.00E+00	5.55E+09
Cs-136	8.24E+07	2.27E+08	0.00E+00	1.21E+08	1.80E+07	7.96E+06	0.00E+00	1.47E+08
Cs-137	2.39E+10	2.29E+10	0.00E+00	7.46E+09	2.68E+09	1.43E+08	0.00E+00	3.38E+09
Ba-140	2.77E+08	2.42E+05	0.00E+00	7.89E+04	1.44E+05	1.40E+08	0.00E+00	1.61E+07
La-140	3.24E+03	1.13E+03	0.00E+00	0.00E+00	0.00E+00	3.16E+07	0.00E+00	3.82E+02
Ce-141	6.56E+05	3.27E+05	0.00E+00	1.43E+05	0.00E+00	4.08E+08	0.00E+00	4.86E+04
Ce-144	1.27E+08	3.98E+07	0.00E+00	2.21E+07	0.00E+00	1.04E+10	0.00E+00	6.78E+06

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5
R_i VALUES - INHALATION - ADULT
$\frac{mrem/yr}{\mu Ci/m^3}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	0.00E+00	1.26E+03
Cr-51	0.00E+00	0.00E+00	5.95E+01	2.28E+01	1.44E+04	3.32E+03	0.00E+00	1.00E+02
Mn-54	0.00E+00	3.96E+04	0.00E+00	9.84E+03	1.40E+06	7.74E+04	0.00E+00	6.30E+03
Fe-55	2.46E+04	1.70E+04	0.00E+00	0.00E+00	7.21E+04	6.03E+03	0.00E+00	3.94E+03
Fe-59	1.18E+04	2.78E+04	0.00E+00	0.00E+00	1.02E+06	1.88E+05	0.00E+00	1.06E+04
Co-57	0.00E+00	6.92E+02	0.00E+00	0.00E+00	3.70E+05	3.14E+04	0.00E+00	6.71E+02
Co-58	0.00E+00	1.58E+03	0.00E+00	0.00E+00	9.28E+05	1.06E+05	0.00E+00	2.07E+03
Co-60	0.00E+00	1.15E+04	0.00E+00	0.00E+00	5.97E+06	2.85E+05	0.00E+00	1.48E+04
Zn-65	3.24E+04	1.03E+05	0.00E+00	6.90E+04	8.64E+05	5.34E+04	0.00E+00	4.66E+04
Se-75	0.00E+00	4.96E+04	0.00E+00	1.20E+05	6.88E+05	7.04E+04	0.00E+00	1.28E+03
Sr-89	3.04E+05	0.00E+00	0.00E+00	0.00E+00	1.40E+06	3.50E+05	0.00E+00	8.72E+03
Sr-90	9.92E+07	0.00E+00	0.00E+00	0.00E+00	9.60E+06	7.22E+05	0.00E+00	6.10E+06
Zr-95	1.07E+05	3.44E+04	0.00E+00	5.42E+04	1.77E+06	1.50E+05	0.00E+00	2.33E+04
Nb-95	1.41E+04	7.82E+03	0.00E+00	7.74E+03	5.05E+05	1.04E+05	0.00E+00	4.21E+03
Mo-99	0.00E+00	1.21E+02	0.00E+00	2.91E+02	9.12E+04	2.48E+05	0.00E+00	2.30E+01
Ag-110m	1.08E+04	1.00E+04	0.00E+00	1.97E+04	4.63E+06	3.02E+05	0.00E+00	5.94E+03
Sb-124	3.12E+04	5.89E+02	7.55E+01	0.00E+00	2.48E+06	4.06E+05	0.00E+00	1.24E+04
I-131	2.52E+04	3.58E+04	1.19E+07	6.13E+04	0.00E+00	6.28E+03	0.00E+00	2.05E+04
I-133	8.64E+03	1.48E+04	2.15E+06	2.58E+04	0.00E+00	8.88E+03	0.00E+00	4.52E+03
I-135	2.68E+03	6.98E+03	4.48E+05	1.11E+04	0.00E+00	5.25E+03	0.00E+00	2.57E+03
Cs-134	3.73E+05	8.48E+05	0.00E+00	2.87E+05	9.76E+04	1.04E+04	0.00E+00	7.28E+05
Cs-136	3.90E+04	1.46E+05	0.00E+00	8.56E+04	1.20E+04	1.17E+04	0.00E+00	1.10E+05
Cs-137	4.78E+05	6.21E+05	0.00E+00	2.22E+05	7.52E+04	8.40E+03	0.00E+00	4.28E+05
Ba-140	3.90E+04	4.90E+01	0.00E+00	1.67E+01	1.27E+06	2.18E+05	0.00E+00	2.57E+03
La-140	3.44E+02	1.74E+02	0.00E+00	0.00E+00	1.36E+05	4.58E+05	0.00E+00	4.58E+01
Ce-141	1.99E+04	1.35E+04	0.00E+00	6.26E+03	3.62E+05	1.20E+05	0.00E+00	1.53E+03
Ce-144	3.43E+06	1.43E+06	0.00E+00	8.48E+05	7.78E+06	8.16E+05	0.00E+00	1.84E+05

TABLE B-5 (Continued)
R_i VALUES - VEGETATION - ADULT
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	2.26E+03	2.26E+03	2.26E+03	2.26E+03	2.26E+03	0.00E+00	2.26E+03
Cr-51	0.00E+00	0.00E+00	2.78E+04	1.02E+04	6.16E+04	1.17E+07	0.00E+00	4.64E+04
Mn-54	0.00E+00	3.13E+08	0.00E+00	9.31E+07	0.00E+00	9.59E+08	0.00E+00	5.97E+07
Fe-55	2.10E+08	1.45E+08	0.00E+00	0.00E+00	8.08E+07	8.31E+07	0.00E+00	3.38E+07
Fe-59	1.26E+08	2.96E+08	0.00E+00	0.00E+00	8.28E+07	9.88E+08	0.00E+00	1.14E+08
Co-57	0.00E+00	1.17E+07	0.00E+00	0.00E+00	0.00E+00	2.97E+08	0.00E+00	1.95E+07
Co-58	0.00E+00	3.07E+07	0.00E+00	0.00E+00	0.00E+00	6.23E+08	0.00E+00	6.89E+07
Co-60	0.00E+00	1.67E+08	0.00E+00	0.00E+00	0.00E+00	3.14E+09	0.00E+00	3.69E+08
Zn-65	3.17E+08	1.01E+09	0.00E+00	6.75E+08	0.00E+00	6.36E+08	0.00E+00	4.56E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	9.97E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.60E+09	0.00E+00	2.86E+08
Sr-90	6.05E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E+10	0.00E+00	1.48E+11
Zr-95	1.17E+06	3.77E+05	0.00E+00	5.91E+05	0.00E+00	1.19E+09	0.00E+00	2.55E+05
Nb-95	1.42E+05	7.92E+04	0.00E+00	7.83E+04	0.00E+00	4.81E+08	0.00E+00	4.26E+04
Mo-99	0.00E+00	6.14E+06	0.00E+00	1.39E+07	0.00E+00	1.42E+07	0.00E+00	1.17E+06
Ag-110m	1.05E+07	9.75E+06	0.00E+00	1.92E+07	0.00E+00	3.98E+09	0.00E+00	5.79E+06
Sb-124	1.04E+08	1.96E+06	2.51E+05	0.00E+00	8.07E+07	2.94E+09	0.00E+00	4.11E+07
I-131	8.07E+07	1.15E+08	3.78E+10	1.98E+08	0.00E+00	3.05E+07	0.00E+00	6.62E+07
I-133	2.08E+06	3.61E+06	5.31E+08	6.31E+06	0.00E+00	3.25E+06	0.00E+00	1.10E+06
I-135	3.85E+04	1.01E+05	6.65E+06	1.62E+05	0.00E+00	1.14E+05	0.00E+00	3.72E+04
Cs-134	4.67E+09	1.11E+10	0.00E+00	3.59E+09	1.19E+09	1.94E+08	0.00E+00	9.08E+09
Cs-136	4.27E+07	1.68E+08	0.00E+00	9.37E+07	1.28E+07	1.91E+07	0.00E+00	1.21E+08
Cs-137	6.36E+09	8.70E+09	0.00E+00	2.95E+09	9.81E+08	1.68E+08	0.00E+00	5.70E+09
Ba-140	1.28E+08	1.61E+05	0.00E+00	5.49E+04	9.24E+04	2.65E+08	0.00E+00	8.42E+06
La-140	1.97E+03	9.95E+02	0.00E+00	0.00E+00	0.00E+00	7.30E+07	0.00E+00	2.63E+02
Ce-141	1.97E+05	1.33E+05	0.00E+00	6.19E+04	0.00E+00	5.10E+08	0.00E+00	1.51E+04
Ce-144	3.29E+07	1.38E+07	0.00E+00	8.16E+06	0.00E+00	1.11E+10	0.00E+00	1.77E+06

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - COW MEAT - ADULT
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	3.25E+02	3.25E+02	3.25E+02	3.25E+02	3.25E+02	0.00E+00	3.25E+02
Cr-51	0.00E+00	0.00E+00	2.18E+03	8.05E+02	4.85E+03	9.19E+05	0.00E+00	3.65E+03
Mn-54	0.00E+00	5.91E+06	0.00E+00	1.76E+06	0.00E+00	1.81E+07	0.00E+00	1.13E+06
Fe-55	1.95E+08	1.35E+08	0.00E+00	0.00E+00	7.51E+07	7.72E+07	0.00E+00	3.14E+07
Fe-59	1.44E+08	3.39E+08	0.00E+00	0.00E+00	9.47E+07	1.13E+09	0.00E+00	1.30E+08
Co-57	0.00E+00	3.60E+06	0.00E+00	0.00E+00	0.00E+00	9.14E+07	0.00E+00	5.99E+06
Co-58	0.00E+00	1.04E+07	0.00E+00	0.00E+00	0.00E+00	2.12E+08	0.00E+00	2.34E+07
Co-60	0.00E+00	5.03E+07	0.00E+00	0.00E+00	0.00E+00	9.46E+08	0.00E+00	1.11E+08
Zn-65	2.26E+08	7.20E+08	0.00E+00	4.81E+08	0.00E+00	4.53E+08	0.00E+00	3.25E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.66E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.66E+07	0.00E+00	4.77E+06
Sr-90	8.38E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.42E+08	0.00E+00	2.06E+09
Zr-95	1.06E+06	3.40E+05	0.00E+00	5.33E+05	0.00E+00	1.08E+09	0.00E+00	2.30E+05
Nb-95	1.22E+06	6.77E+05	0.00E+00	6.69E+05	0.00E+00	4.11E+09	0.00E+00	3.64E+05
Mo-99	0.00E+00	5.00E+04	0.00E+00	1.13E+05	0.00E+00	1.16E+05	0.00E+00	9.51E+03
Ag-110m	4.25E+06	3.93E+06	0.00E+00	7.73E+06	0.00E+00	1.61E+09	0.00E+00	2.34E+06
Sb-124	1.11E+07	2.10E+05	2.70E+04	0.00E+00	8.66E+06	3.16E+08	0.00E+00	4.41E+06
I-131	5.37E+06	7.68E+06	2.52E+09	1.32E+07	0.00E+00	2.03E+06	0.00E+00	4.40E+06
I-133	1.83E-01	3.18E-01	4.67E+01	5.54E-01	0.00E+00	2.85E-01	0.00E+00	9.68E-02
I-135	2.21E-17	5.79E-17	3.82E-15	9.29E-17	0.00E+00	6.54E-17	0.00E+00	2.14E-17
Cs-134	4.35E+08	1.03E+09	0.00E+00	3.35E+08	1.11E+08	1.81E+07	0.00E+00	8.46E+08
Cs-136	6.04E+06	2.39E+07	0.00E+00	1.33E+07	1.82E+06	2.71E+06	0.00E+00	1.72E+07
Cs-137	5.88E+08	8.04E+08	0.00E+00	2.73E+08	9.07E+07	1.56E+07	0.00E+00	5.27E+08
Ba-140	1.44E+07	1.81E+04	0.00E+00	6.15E+03	1.04E+04	2.97E+07	0.00E+00	9.44E+05
La-140	1.85E-02	9.35E-03	0.00E+00	0.00E+00	0.00E+00	6.86E+02	0.00E+00	2.47E-03
Ce-141	7.38E+03	4.99E+03	0.00E+00	2.32E+03	0.00E+00	1.91E+07	0.00E+00	5.66E+02
Ce-144	9.34E+05	3.90E+05	0.00E+00	2.31E+05	0.00E+00	3.16E+08	0.00E+00	5.01E+04

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - COW MILK - ADULT
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	7.63E+02	7.63E+02	7.63E+02	7.63E+02	7.63E+02	0.00E+00	7.63E+02
Cr-51	0.00E+00	0.00E+00	8.85E+03	3.26E+03	1.97E+04	3.73E+06	0.00E+00	1.48E+04
Mn-54	0.00E+00	5.41E+06	0.00E+00	1.61E+06	0.00E+00	1.66E+07	0.00E+00	1.03E+06
Fe-55	1.67E+07	1.15E+07	0.00E+00	0.00E+00	6.43E+06	6.61E+06	0.00E+00	2.69E+06
Fe-59	1.61E+07	3.79E+07	0.00E+00	0.00E+00	1.06E+07	1.26E+08	0.00E+00	1.45E+07
Co-57	0.00E+00	8.18E+05	0.00E+00	0.00E+00	0.00E+00	2.07E+07	0.00E+00	1.36E+06
Co-58	0.00E+00	2.70E+06	0.00E+00	0.00E+00	0.00E+00	5.47E+07	0.00E+00	6.05E+06
Co-60	0.00E+00	1.10E+07	0.00E+00	0.00E+00	0.00E+00	2.06E+08	0.00E+00	2.42E+07
Zn-65	8.72E+08	2.77E+09	0.00E+00	1.86E+09	0.00E+00	1.75E+09	0.00E+00	1.25E+09
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	7.99E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.28E+08	0.00E+00	2.29E+07
Sr-90	3.15E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.11E+08	0.00E+00	7.74E+09
Zr-95	5.34E+02	1.71E+02	0.00E+00	2.69E+02	0.00E+00	5.43E+05	0.00E+00	1.16E+02
Nb-95	4.37E+04	2.43E+04	0.00E+00	2.40E+04	0.00E+00	1.48E+08	0.00E+00	1.31E+04
Mo-99	0.00E+00	1.24E+07	0.00E+00	2.80E+07	0.00E+00	2.87E+07	0.00E+00	2.36E+06
Ag-110m	3.70E+07	3.43E+07	0.00E+00	6.74E+07	0.00E+00	1.40E+10	0.00E+00	2.04E+07
Sb-124	1.45E+07	2.73E+05	3.51E+04	0.00E+00	1.13E+07	4.11E+08	0.00E+00	5.73E+06
I-131	1.48E+08	2.12E+08	6.94E+10	3.63E+08	0.00E+00	5.59E+07	0.00E+00	1.21E+08
I-133	1.93E+06	3.37E+06	4.95E+08	5.87E+06	0.00E+00	3.02E+06	0.00E+00	1.03E+06
I-135	6.42E+03	1.68E+04	1.11E+06	2.70E+04	0.00E+00	1.90E+04	0.00E+00	6.20E+03
Cs-134	3.74E+09	8.89E+09	0.00E+00	2.88E+09	9.55E+08	1.56E+08	0.00E+00	7.27E+09
Cs-136	1.32E+08	5.21E+08	0.00E+00	2.90E+08	3.98E+07	5.92E+07	0.00E+00	3.75E+08
Cs-137	4.98E+09	6.80E+09	0.00E+00	2.31E+09	7.68E+08	1.32E+08	0.00E+00	4.46E+09
Ba-140	1.35E+07	1.69E+04	0.00E+00	5.75E+03	9.69E+03	2.77E+07	0.00E+00	8.83E+05
La-140	2.26E+00	1.14E+00	0.00E+00	0.00E+00	0.00E+00	8.35E+04	0.00E+00	3.00E-01
Ce-141	2.55E+03	1.72E+03	0.00E+00	8.00E+02	0.00E+00	6.58E+06	0.00E+00	1.95E+02
Ce-144	2.29E+05	9.58E+04	0.00E+00	5.68E+04	0.00E+00	7.75E+07	0.00E+00	1.23E+04

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - GOAT MILK - ADULT

$$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03	0.00E+00	1.56E+03
Cr-51	0.00E+00	0.00E+00	1.06E+03	3.92E+02	2.36E+03	4.47E+05	0.00E+00	1.78E+03
Mn-54	0.00E+00	6.50E+05	0.00E+00	1.93E+05	0.00E+00	1.99E+06	0.00E+00	1.24E+05
Fe-55	2.17E+05	1.50E+05	0.00E+00	0.00E+00	8.36E+04	8.60E+04	0.00E+00	3.49E+04
Fe-59	2.10E+05	4.93E+05	0.00E+00	0.00E+00	1.38E+05	1.64E+06	0.00E+00	1.89E+05
Co-57	0.00E+00	9.81E+04	0.00E+00	0.00E+00	0.00E+00	2.49E+06	0.00E+00	1.63E+05
Co-58	0.00E+00	3.24E+05	0.00E+00	0.00E+00	0.00E+00	6.56E+06	0.00E+00	7.26E+05
Co-60	0.00E+00	1.32E+06	0.00E+00	0.00E+00	0.00E+00	2.48E+07	0.00E+00	2.91E+06
Zn-65	1.05E+08	3.33E+08	0.00E+00	2.23E+08	0.00E+00	2.10E+08	0.00E+00	1.50E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.68E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E+08	0.00E+00	4.82E+07
Sr-90	6.62E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.91E+09	0.00E+00	1.63E+10
Zr-95	6.41E+01	2.05E+01	0.00E+00	3.22E+01	0.00E+00	6.51E+04	0.00E+00	1.39E+01
Nb-95	5.25E+03	2.92E+03	0.00E+00	2.88E+03	0.00E+00	1.77E+07	0.00E+00	1.57E+03
Mo-99	0.00E+00	1.49E+06	0.00E+00	3.37E+06	0.00E+00	3.44E+06	0.00E+00	2.83E+05
Ag-110m	4.45E+06	4.11E+06	0.00E+00	8.09E+06	0.00E+00	1.68E+09	0.00E+00	2.44E+06
Sb-124	1.74E+06	3.28E+04	4.21E+03	0.00E+00	1.35E+06	4.93E+07	0.00E+00	6.88E+05
I-131	1.78E+08	2.54E+08	8.33E+10	4.36E+08	0.00E+00	6.71E+07	0.00E+00	1.46E+08
I-133	2.32E+06	4.04E+06	5.93E+08	7.05E+06	0.00E+00	3.63E+06	0.00E+00	1.23E+06
I-135	7.70E+03	2.02E+04	1.33E+06	3.23E+04	0.00E+00	2.28E+04	0.00E+00	7.44E+03
Cs-134	1.12E+10	2.67E+10	0.00E+00	8.63E+09	2.87E+09	4.67E+08	0.00E+00	2.18E+10
Cs-136	3.96E+08	1.56E+09	0.00E+00	8.70E+08	1.19E+08	1.78E+08	0.00E+00	1.13E+09
Cs-137	1.49E+10	2.04E+10	0.00E+00	6.93E+09	2.30E+09	3.95E+08	0.00E+00	1.34E+10
Ba-140	1.62E+06	2.03E+03	0.00E+00	6.91E+02	1.16E+03	3.33E+06	0.00E+00	1.06E+05
La-140	2.71E-01	1.36E-01	0.00E+00	0.00E+00	0.00E+00	1.00E+04	0.00E+00	3.61E-02
Ce-141	3.06E+02	2.07E+02	0.00E+00	9.60E+01	0.00E+00	7.90E+05	0.00E+00	2.34E+01
Ce-144	2.75E+04	1.15E+04	0.00E+00	6.82E+03	0.00E+00	9.30E+06	0.00E+00	1.48E+03

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - INHALATION - TEEN
$\frac{mrem/yr}{\mu Ci/m^3}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	1.27E+03	1.27E+03	1.27E+03	1.27E+03	1.27E+03	0.00E+00	1.27E+03
Cr-51	0.00E+00	0.00E+00	7.50E+01	3.07E+01	2.10E+04	3.00E+03	0.00E+00	1.35E+02
Mn-54	0.00E+00	5.11E+04	0.00E+00	1.27E+04	1.98E+06	6.68E+04	0.00E+00	8.40E+03
Fe-55	3.34E+04	2.38E+04	0.00E+00	0.00E+00	1.24E+05	6.39E+03	0.00E+00	5.54E+03
Fe-59	1.59E+04	3.70E+04	0.00E+00	0.00E+00	1.53E+06	1.78E+05	0.00E+00	1.43E+04
Co-57	0.00E+00	9.44E+02	0.00E+00	0.00E+00	5.86E+05	3.14E+04	0.00E+00	9.20E+02
Co-58	0.00E+00	2.07E+03	0.00E+00	0.00E+00	1.34E+06	9.52E+04	0.00E+00	2.78E+03
Co-60	0.00E+00	1.51E+04	0.00E+00	0.00E+00	8.72E+06	2.59E+05	0.00E+00	1.98E+04
Zn-65	3.86E+04	1.34E+05	0.00E+00	8.64E+04	1.24E+06	4.66E+04	0.00E+00	6.24E+04
Se-75	0.00E+00	8.00E+04	0.00E+00	1.76E+05	1.04E+06	6.32E+04	0.00E+00	2.08E+03
Sr-89	4.34E+05	0.00E+00	0.00E+00	0.00E+00	2.42E+06	3.71E+05	0.00E+00	1.25E+04
Sr-90	1.08E+08	0.00E+00	0.00E+00	0.00E+00	1.65E+07	7.65E+05	0.00E+00	6.68E+06
Zr-95	1.46E+05	4.58E+04	0.00E+00	6.74E+04	2.69E+06	1.49E+05	0.00E+00	3.15E+04
Nb-95	1.86E+04	1.03E+04	0.00E+00	1.00E+04	7.51E+05	9.68E+04	0.00E+00	5.66E+03
Mo-99	0.00E+00	1.69E+02	0.00E+00	4.11E+02	1.54E+05	2.69E+05	0.00E+00	3.22E+01
Ag-110m	1.38E+04	1.31E+04	0.00E+00	2.50E+04	6.75E+06	2.73E+05	0.00E+00	7.99E+03
Sb-124	4.30E+04	7.94E+02	9.76E+01	0.00E+00	3.85E+06	3.98E+05	0.00E+00	1.68E+04
I-131	3.54E+04	4.91E+04	1.46E+07	8.40E+04	0.00E+00	6.49E+03	0.00E+00	2.64E+04
I-133	1.22E+04	2.05E+04	2.92E+06	3.59E+04	0.00E+00	1.03E+04	0.00E+00	6.22E+03
I-135	3.70E+03	9.44E+03	6.21E+05	1.49E+04	0.00E+00	6.95E+03	0.00E+00	3.49E+03
Cs-134	5.02E+05	1.13E+06	0.00E+00	3.75E+05	1.46E+05	9.76E+03	0.00E+00	5.49E+05
Cs-136	5.15E+04	1.94E+05	0.00E+00	1.10E+05	1.78E+04	1.09E+04	0.00E+00	1.37E+05
Cs-137	6.70E+05	8.48E+05	0.00E+00	3.04E+05	1.21E+05	8.48E+03	0.00E+00	3.11E+05
Ba-140	5.47E+04	6.70E+01	0.00E+00	2.28E+01	2.03E+06	2.29E+05	0.00E+00	3.52E+03
La-140	4.79E+02	2.36E+02	0.00E+00	0.00E+00	2.14E+05	4.87E+05	0.00E+00	6.26E+01
Ce-141	2.84E+04	1.90E+04	0.00E+00	8.88E+03	6.14E+05	1.26E+05	0.00E+00	2.17E+03
Ce-144	4.89E+06	2.02E+06	0.00E+00	1.21E+06	1.34E+07	8.64E+05	0.00E+00	2.62E+05

TABLE B-5 (Continued)
R_i VALUES - VEGETATION - TEEN
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	0.00E+00	2.59E+03
Cr-51	0.00E+00	0.00E+00	3.43E+04	1.35E+04	8.81E+04	1.04E+07	0.00E+00	6.17E+04
Mn-54	0.00E+00	4.54E+08	0.00E+00	1.36E+08	0.00E+00	9.32E+08	0.00E+00	9.01E+07
Fe-55	3.26E+08	2.31E+08	0.00E+00	0.00E+00	1.47E+08	1.00E+08	0.00E+00	5.39E+07
Fe-59	1.79E+08	4.19E+08	0.00E+00	0.00E+00	1.32E+08	9.90E+08	0.00E+00	1.62E+08
Co-57	0.00E+00	1.79E+07	0.00E+00	0.00E+00	0.00E+00	3.33E+08	0.00E+00	3.00E+07
Co-58	0.00E+00	4.36E+07	0.00E+00	0.00E+00	0.00E+00	6.01E+08	0.00E+00	1.00E+08
Co-60	0.00E+00	2.49E+08	0.00E+00	0.00E+00	0.00E+00	3.24E+09	0.00E+00	5.60E+08
Zn-65	4.24E+08	1.47E+09	0.00E+00	9.42E+08	0.00E+00	6.23E+08	0.00E+00	6.87E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.51E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.80E+09	0.00E+00	4.34E+08
Sr-90	7.51E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.11E+10	0.00E+00	1.85E+11
Zr-95	1.72E+06	5.43E+05	0.00E+00	7.98E+05	0.00E+00	1.25E+09	0.00E+00	3.73E+05
Nb-95	1.92E+05	1.07E+05	0.00E+00	1.03E+05	0.00E+00	4.56E+08	0.00E+00	5.87E+04
Mo-99	0.00E+00	5.64E+06	0.00E+00	1.29E+07	0.00E+00	1.01E+07	0.00E+00	1.08E+06
Ag-110m	1.52E+07	1.43E+07	0.00E+00	2.74E+07	0.00E+00	4.03E+09	0.00E+00	8.72E+06
Sb-124	1.54E+08	2.84E+06	3.50E+05	0.00E+00	1.35E+08	3.11E+09	0.00E+00	6.02E+07
I-131	7.68E+07	1.08E+08	3.14E+10	1.85E+08	0.00E+00	2.13E+07	0.00E+00	5.78E+07
I-133	1.93E+06	3.27E+06	4.57E+08	5.74E+06	0.00E+00	2.48E+06	0.00E+00	9.99E+05
I-135	3.48E+04	8.96E+04	5.76E+06	1.42E+05	0.00E+00	9.93E+04	0.00E+00	3.32E+04
Cs-134	7.10E+09	1.67E+10	0.00E+00	5.31E+09	2.03E+09	2.08E+08	0.00E+00	7.75E+09
Cs-136	4.37E+07	1.72E+08	0.00E+00	9.37E+07	1.48E+07	1.38E+07	0.00E+00	1.16E+08
Cs-137	1.01E+10	1.35E+10	0.00E+00	4.59E+09	1.78E+09	1.92E+08	0.00E+00	4.69E+09
Ba-140	1.38E+08	1.69E+05	0.00E+00	5.74E+04	1.14E+05	2.13E+08	0.00E+00	8.90E+06
La-140	1.80E+03	8.86E+02	0.00E+00	0.00E+00	0.00E+00	5.09E+07	0.00E+00	2.36E+02
Ce-141	2.83E+05	1.89E+05	0.00E+00	8.89E+04	0.00E+00	5.40E+08	0.00E+00	2.17E+04
Ce-144	5.27E+07	2.18E+07	0.00E+00	1.30E+07	0.00E+00	1.33E+10	0.00E+00	2.83E+06

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - COW MEAT - TEEN
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	1.94E+02	1.94E+02	1.94E+02	1.94E+02	1.94E+02	0.00E+00	1.94E+02
Cr-51	0.00E+00	0.00E+00	1.62E+03	6.40E+02	4.17E+03	4.91E+05	0.00E+00	2.92E+03
Mn-54	0.00E+00	4.51E+06	0.00E+00	1.34E+06	0.00E+00	9.24E+06	0.00E+00	8.93E+05
Fe-55	1.58E+08	1.12E+08	0.00E+00	0.00E+00	7.12E+07	4.86E+07	0.00E+00	2.62E+07
Fe-59	1.15E+08	2.69E+08	0.00E+00	0.00E+00	8.48E+07	6.36E+08	0.00E+00	1.04E+08
Co-57	0.00E+00	2.89E+06	0.00E+00	0.00E+00	0.00E+00	5.40E+07	0.00E+00	4.85E+06
Co-58	0.00E+00	8.04E+06	0.00E+00	0.00E+00	0.00E+00	1.11E+08	0.00E+00	1.85E+07
Co-60	0.00E+00	3.91E+07	0.00E+00	0.00E+00	0.00E+00	5.09E+08	0.00E+00	8.80E+07
Zn-65	1.59E+08	5.52E+08	0.00E+00	3.53E+08	0.00E+00	2.34E+08	0.00E+00	2.58E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.40E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E+07	0.00E+00	4.02E+06
Sr-90	5.42E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E+08	0.00E+00	1.34E+09
Zr-95	8.49E+05	2.68E+05	0.00E+00	3.94E+05	0.00E+00	6.18E+08	0.00E+00	1.84E+05
Nb-95	9.50E+05	5.27E+05	0.00E+00	5.11E+05	0.00E+00	2.25E+09	0.00E+00	2.90E+05
Mo-99	0.00E+00	4.13E+04	0.00E+00	9.46E+04	0.00E+00	7.40E+04	0.00E+00	7.88E+03
Ag-110m	3.22E+06	3.05E+06	0.00E+00	5.81E+06	0.00E+00	8.56E+08	0.00E+00	1.85E+06
Sb-124	9.08E+06	1.67E+05	2.06E+04	0.00E+00	7.93E+06	1.83E+08	0.00E+00	3.54E+06
I-131	4.46E+06	6.25E+06	1.82E+09	1.08E+07	0.00E+00	1.24E+06	0.00E+00	3.36E+06
I-133	1.53E-01	2.59E-01	3.62E+01	4.54E-01	0.00E+00	1.96E-01	0.00E+00	7.90E-02
I-135	1.80E-17	4.63E-17	2.98E-15	7.32E-17	0.00E+00	5.14E-17	0.00E+00	1.72E-17
Cs-134	3.46E+08	8.14E+08	0.00E+00	2.59E+08	9.87E+07	1.01E+07	0.00E+00	3.78E+08
Cs-136	4.71E+06	1.85E+07	0.00E+00	1.01E+07	1.59E+06	1.49E+06	0.00E+00	1.25E+07
Cs-137	4.88E+08	6.49E+08	0.00E+00	2.21E+08	8.59E+07	9.24E+06	0.00E+00	2.26E+08
Ba-140	1.19E+07	1.46E+04	0.00E+00	4.95E+03	9.81E+03	1.84E+07	0.00E+00	7.67E+05
La-140	1.53E-02	7.50E-03	0.00E+00	0.00E+00	0.00E+00	4.31E+02	0.00E+00	1.99E-03
Ce-141	6.20E+03	4.14E+03	0.00E+00	1.95E+03	0.00E+00	1.18E+07	0.00E+00	4.75E+02
Ce-144	7.87E+05	3.26E+05	0.00E+00	1.94E+05	0.00E+00	1.98E+08	0.00E+00	4.23E+04

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - COW MILK - TEEN
$$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	9.94E+02	9.94E+02	9.94E+02	9.94E+02	9.94E+02	0.00E+00	9.94E+02
Cr-51	0.00E+00	0.00E+00	1.44E+04	5.67E+03	3.69E+04	4.35E+06	0.00E+00	2.59E+04
Mn-54	0.00E+00	9.02E+06	0.00E+00	2.69E+06	0.00E+00	1.85E+07	0.00E+00	1.79E+06
Fe-55	2.96E+07	2.10E+07	0.00E+00	0.00E+00	1.33E+07	9.08E+06	0.00E+00	4.89E+06
Fe-59	2.82E+07	6.57E+07	0.00E+00	0.00E+00	2.07E+07	1.55E+08	0.00E+00	2.54E+07
Co-57	0.00E+00	1.43E+06	0.00E+00	0.00E+00	0.00E+00	2.68E+07	0.00E+00	2.41E+06
Co-58	0.00E+00	4.54E+06	0.00E+00	0.00E+00	0.00E+00	6.26E+07	0.00E+00	1.05E+07
Co-60	0.00E+00	1.86E+07	0.00E+00	0.00E+00	0.00E+00	2.42E+08	0.00E+00	4.19E+07
Zn-65	1.34E+09	4.65E+09	0.00E+00	2.98E+09	0.00E+00	1.97E+09	0.00E+00	2.17E+09
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	1.47E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E+08	0.00E+00	4.22E+07
Sr-90	4.46E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E+09	0.00E+00	1.10E+10
Zr-95	9.34E+02	2.95E+02	0.00E+00	4.33E+02	0.00E+00	6.80E+05	0.00E+00	2.03E+02
Nb-95	7.45E+04	4.13E+04	0.00E+00	4.01E+04	0.00E+00	1.77E+08	0.00E+00	2.28E+04
Mo-99	0.00E+00	2.24E+07	0.00E+00	5.12E+07	0.00E+00	4.00E+07	0.00E+00	4.26E+06
Ag-110m	6.13E+07	5.80E+07	0.00E+00	1.11E+08	0.00E+00	1.63E+10	0.00E+00	3.53E+07
Sb-124	2.58E+07	4.75E+05	5.85E+04	0.00E+00	2.25E+07	5.20E+08	0.00E+00	1.01E+07
I-131	2.69E+08	3.76E+08	1.10E+11	6.47E+08	0.00E+00	7.44E+07	0.00E+00	2.02E+08
I-133	3.53E+06	5.99E+06	8.37E+08	1.05E+07	0.00E+00	4.54E+06	0.00E+00	1.83E+06
I-135	1.14E+04	2.94E+04	1.89E+06	4.64E+04	0.00E+00	3.25E+04	0.00E+00	1.09E+04
Cs-134	6.49E+09	1.53E+10	0.00E+00	4.85E+09	1.85E+09	1.90E+08	0.00E+00	7.09E+09
Cs-136	2.25E+08	8.85E+08	0.00E+00	4.82E+08	7.59E+07	7.12E+07	0.00E+00	5.94E+08
Cs-137	9.02E+09	1.20E+10	0.00E+00	4.08E+09	1.59E+09	1.71E+08	0.00E+00	4.18E+09
Ba-140	2.43E+07	2.98E+04	0.00E+00	1.01E+04	2.00E+04	3.75E+07	0.00E+00	1.57E+06
La-140	4.05E+00	1.99E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+05	0.00E+00	5.30E-01
Ce-141	4.67E+03	3.12E+03	0.00E+00	1.47E+03	0.00E+00	8.92E+06	0.00E+00	3.58E+02
Ce-144	4.22E+05	1.74E+05	0.00E+00	1.04E+05	0.00E+00	1.06E+08	0.00E+00	2.27E+04

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - GOAT MILK - TEEN
$\frac{m^2\text{-mrem/yr}}{\mu\text{Ci/sec}}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03	0.00E+00	2.03E+03
Cr-51	0.00E+00	0.00E+00	1.72E+03	6.80E+02	4.43E+03	5.22E+05	0.00E+00	3.10E+03
Mn-54	0.00E+00	1.08E+06	0.00E+00	3.23E+05	0.00E+00	2.22E+06	0.00E+00	2.15E+05
Fe-55	3.85E+05	2.73E+05	0.00E+00	0.00E+00	1.73E+05	1.18E+05	0.00E+00	6.36E+04
Fe-59	3.66E+05	8.54E+05	0.00E+00	0.00E+00	2.69E+05	2.02E+06	0.00E+00	3.30E+05
Co-57	0.00E+00	1.72E+05	0.00E+00	0.00E+00	0.00E+00	3.21E+06	0.00E+00	2.89E+05
Co-58	0.00E+00	5.45E+05	0.00E+00	0.00E+00	0.00E+00	7.52E+06	0.00E+00	1.26E+06
Co-60	0.00E+00	2.23E+06	0.00E+00	0.00E+00	0.00E+00	2.91E+07	0.00E+00	5.03E+06
Zn-65	1.61E+08	5.58E+08	0.00E+00	3.57E+08	0.00E+00	2.36E+08	0.00E+00	2.60E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.09E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E+08	0.00E+00	8.86E+07
Sr-90	9.36E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.63E+09	0.00E+00	2.31E+10
Zr-95	1.12E+02	3.54E+01	0.00E+00	5.19E+01	0.00E+00	8.16E+04	0.00E+00	2.43E+01
Nb-95	8.94E+03	4.96E+03	0.00E+00	4.81E+03	0.00E+00	2.12E+07	0.00E+00	2.73E+03
Mo-99	0.00E+00	2.68E+06	0.00E+00	6.14E+06	0.00E+00	4.81E+06	0.00E+00	5.12E+05
Ag-110m	7.35E+06	6.96E+06	0.00E+00	1.33E+07	0.00E+00	1.95E+09	0.00E+00	4.23E+06
Sb-124	3.10E+06	5.70E+04	7.02E+03	0.00E+00	2.70E+06	6.24E+07	0.00E+00	1.21E+06
I-131	3.22E+08	4.51E+08	1.32E+11	7.77E+08	0.00E+00	8.93E+07	0.00E+00	2.42E+08
I-133	4.24E+06	7.19E+06	1.00E+09	1.26E+07	0.00E+00	5.44E+06	0.00E+00	2.19E+06
I-135	1.37E+04	3.52E+04	2.27E+06	5.56E+04	0.00E+00	3.90E+04	0.00E+00	1.31E+04
Cs-134	1.95E+10	4.58E+10	0.00E+00	1.46E+10	5.56E+09	5.70E+08	0.00E+00	2.13E+10
Cs-136	6.74E+08	2.65E+09	0.00E+00	1.44E+09	2.28E+08	2.14E+08	0.00E+00	1.78E+09
Cs-137	2.71E+10	3.60E+10	0.00E+00	1.23E+10	4.76E+09	5.12E+08	0.00E+00	1.25E+10
Ba-140	2.92E+06	3.58E+03	0.00E+00	1.21E+03	2.41E+03	4.50E+06	0.00E+00	1.88E+05
La-140	4.86E-01	2.39E-01	0.00E+00	0.00E+00	0.00E+00	1.37E+04	0.00E+00	6.36E-02
Ce-141	5.60E+02	3.74E+02	0.00E+00	1.76E+02	0.00E+00	1.07E+06	0.00E+00	4.30E+01
Ce-144	5.06E+04	2.09E+04	0.00E+00	1.25E+04	0.00E+00	1.27E+07	0.00E+00	2.72E+03

* $\frac{\text{mrem/yr}}{\mu\text{Ci/m}^3}$

TABLE B-5 (Continued)
R_i VALUES - GROUND PLANE – All Ages
$\frac{m^2\text{-mrem/yr}}{\mu\text{Ci/sec}}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cr-51	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06	4.66E+06	5.51E+06	4.66E+06
Mn-54	1.39E+09	1.39E+09	1.39E+09	1.39E+09	1.39E+09	1.39E+09	1.63E+09	1.39E+09
Fe-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	2.73E+08	3.21E+08	2.73E+08
Co-57	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.88E+08	2.07E+08	1.88E+08
Co-58	3.79E+08	3.79E+08	3.79E+08	3.79E+08	3.79E+08	3.79E+08	4.44E+08	3.79E+08
Co-60	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.15E+10	2.53E+10	2.15E+10
Zn-65	7.47E+08	7.47E+08	7.47E+08	7.47E+08	7.47E+08	7.47E+08	8.59E+08	7.47E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.16E+04	2.51E+04	2.16E+04
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr-95	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.45E+08	2.84E+08	2.45E+08
Nb-95	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.37E+08	1.61E+08	1.37E+08
Mo-99	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	3.99E+06	4.63E+06	3.99E+06
Ag-110m	3.44E+09	3.44E+09	3.44E+09	3.44E+09	3.44E+09	3.44E+09	4.01E+09	3.44E+09
Sb-124	5.98E+08	5.98E+08	5.98E+08	5.98E+08	5.98E+08	5.98E+08	6.90E+08	5.98E+08
I-131	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	1.72E+07	2.09E+07	1.72E+07
I-133	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.45E+06	2.98E+06	2.45E+06
I-135	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.53E+06	2.95E+06	2.53E+06
Cs-134	6.86E+09	6.86E+09	6.86E+09	6.86E+09	6.86E+09	6.86E+09	8.01E+09	6.86E+09
Cs-136	1.51E+08	1.51E+08	1.51E+08	1.51E+08	1.51E+08	1.51E+08	1.71E+08	1.51E+08
Cs-137	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.03E+10	1.20E+10	1.03E+10
Ba-140	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.05E+07	2.35E+07	2.05E+07
La-140	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	1.92E+07	2.18E+07	1.92E+07
Ce-141	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.37E+07	1.54E+07	1.37E+07
Ce-144	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	6.95E+07	8.04E+07	6.95E+07

TABLE B-5 (Continued)
R_i VALUES - INHALATION - CHILD
$\frac{mrem/yr}{\mu Ci/m^3}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	0.00E+00	1.12E+03
Cr-51	0.00E+00	0.00E+00	8.55E+01	2.43E+01	1.70E+04	1.08E+03	0.00E+00	1.54E+02
Mn-54	0.00E+00	4.29E+04	0.00E+00	1.00E+04	1.58E+06	2.29E+04	0.00E+00	9.51E+03
Fe-55	4.74E+04	2.52E+04	0.00E+00	0.00E+00	1.11E+05	2.87E+03	0.00E+00	7.77E+03
Fe-59	2.07E+04	3.34E+04	0.00E+00	0.00E+00	1.27E+06	7.07E+04	0.00E+00	1.67E+04
Co-57	0.00E+00	9.03E+02	0.00E+00	0.00E+00	5.07E+05	1.32E+04	0.00E+00	1.07E+03
Co-58	0.00E+00	1.77E+03	0.00E+00	0.00E+00	1.11E+06	3.44E+04	0.00E+00	3.16E+03
Co-60	0.00E+00	1.31E+04	0.00E+00	0.00E+00	7.07E+06	9.62E+04	0.00E+00	2.26E+04
Zn-65	4.26E+04	1.13E+05	0.00E+00	7.14E+04	9.95E+05	1.63E+04	0.00E+00	7.03E+04
Se-75	0.00E+00	6.29E+04	0.00E+00	1.30E+05	8.88E+05	2.33E+04	0.00E+00	2.11E+03
Sr-89	5.99E+05	0.00E+00	0.00E+00	0.00E+00	2.16E+06	1.67E+05	0.00E+00	1.72E+04
Sr-90	1.01E+08	0.00E+00	0.00E+00	0.00E+00	1.48E+07	3.43E+05	0.00E+00	6.44E+06
Zr-95	1.90E+05	4.18E+04	0.00E+00	5.96E+04	2.23E+06	6.11E+04	0.00E+00	3.70E+04
Nb-95	2.35E+04	9.18E+03	0.00E+00	8.62E+03	6.14E+05	3.70E+04	0.00E+00	6.55E+03
Mo-99	0.00E+00	1.72E+02	0.00E+00	3.92E+02	1.35E+05	1.27E+05	0.00E+00	4.26E+01
Ag-110m	1.69E+04	1.14E+04	0.00E+00	2.12E+04	5.48E+06	1.00E+05	0.00E+00	9.14E+03
Sb-124	5.74E+04	7.40E+02	1.26E+02	0.00E+00	3.24E+06	1.64E+05	0.00E+00	2.00E+04
I-131	4.81E+04	4.81E+04	1.62E+07	7.88E+04	0.00E+00	2.84E+03	0.00E+00	2.73E+04
I-133	1.66E+04	2.03E+04	3.85E+06	3.38E+04	0.00E+00	5.48E+03	0.00E+00	7.70E+03
I-135	4.92E+03	8.73E+03	7.92E+05	1.34E+04	0.00E+00	4.44E+03	0.00E+00	4.14E+03
Cs-134	6.51E+05	1.01E+06	0.00E+00	3.30E+05	1.21E+05	3.85E+03	0.00E+00	2.25E+05
Cs-136	6.51E+04	1.71E+05	0.00E+00	9.55E+04	1.45E+04	4.18E+03	0.00E+00	1.16E+05
Cs-137	9.07E+05	8.25E+05	0.00E+00	2.82E+05	1.04E+05	3.62E+03	0.00E+00	1.28E+05
Ba-140	7.40E+04	6.48E+01	0.00E+00	2.11E+01	1.74E+06	1.02E+05	0.00E+00	4.33E+03
La-140	6.44E+02	2.25E+02	0.00E+00	0.00E+00	1.83E+05	2.26E+05	0.00E+00	7.55E+01
Ce-141	3.92E+04	1.95E+04	0.00E+00	8.55E+03	5.44E+05	5.66E+04	0.00E+00	2.90E+03
Ce-144	6.77E+06	2.12E+06	0.00E+00	1.17E+06	1.20E+07	3.89E+05	0.00E+00	3.61E+05

TABLE B-5 (Continued)
R_i VALUES - COW MEAT - CHILD
$$\frac{m^2\text{-mrem/yr}}{\mu\text{Ci/sec}}$$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	2.34E+02	2.34E+02	2.34E+02	2.34E+02	2.34E+02	0.00E+00	2.34E+02
Cr-51	0.00E+00	0.00E+00	2.53E+03	6.91E+02	4.62E+03	2.42E+05	0.00E+00	4.56E+03
Mn-54	0.00E+00	5.15E+06	0.00E+00	1.45E+06	0.00E+00	4.33E+06	0.00E+00	1.37E+06
Fe-55	3.04E+08	1.61E+08	0.00E+00	0.00E+00	9.11E+07	2.98E+07	0.00E+00	4.99E+07
Fe-59	2.04E+08	3.31E+08	0.00E+00	0.00E+00	9.59E+07	3.44E+08	0.00E+00	1.65E+08
Co-57	0.00E+00	3.78E+06	0.00E+00	0.00E+00	0.00E+00	3.10E+07	0.00E+00	7.66E+06
Co-58	0.00E+00	9.40E+06	0.00E+00	0.00E+00	0.00E+00	5.48E+07	0.00E+00	2.88E+07
Co-60	0.00E+00	4.64E+07	0.00E+00	0.00E+00	0.00E+00	2.57E+08	0.00E+00	1.37E+08
Zn-65	2.39E+08	6.36E+08	0.00E+00	4.01E+08	0.00E+00	1.12E+08	0.00E+00	3.95E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	2.65E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E+07	0.00E+00	7.58E+06
Sr-90	7.01E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.44E+07	0.00E+00	1.78E+09
Zr-95	1.51E+06	3.31E+05	0.00E+00	4.74E+05	0.00E+00	3.46E+08	0.00E+00	2.95E+05
Nb-95	1.64E+06	6.39E+05	0.00E+00	6.00E+05	0.00E+00	1.18E+09	0.00E+00	4.56E+05
Mo-99	0.00E+00	5.75E+04	0.00E+00	1.23E+05	0.00E+00	4.76E+04	0.00E+00	1.42E+04
Ag-110m	5.34E+06	3.61E+06	0.00E+00	6.72E+06	0.00E+00	4.29E+08	0.00E+00	2.88E+06
Sb-124	1.64E+07	2.13E+05	3.63E+04	0.00E+00	9.12E+06	1.03E+08	0.00E+00	5.76E+06
I-131	8.28E+06	8.32E+06	2.75E+09	1.37E+07	0.00E+00	7.41E+05	0.00E+00	4.73E+06
I-133	2.84E-01	3.51E-01	6.52E+01	5.85E-01	0.00E+00	1.41E-01	0.00E+00	1.33E-01
I-135	3.26E-17	5.87E-17	5.19E-15	8.99E-17	0.00E+00	4.47E-17	0.00E+00	2.77E-17
Cs-134	6.10E+08	1.00E+09	0.00E+00	3.10E+08	1.11E+08	5.39E+06	0.00E+00	2.11E+08
Cs-136	8.13E+06	2.24E+07	0.00E+00	1.19E+07	1.78E+06	7.86E+05	0.00E+00	1.45E+07
Cs-137	8.99E+08	8.60E+08	0.00E+00	2.80E+08	1.01E+08	5.39E+06	0.00E+00	1.27E+08
Ba-140	2.20E+07	1.93E+04	0.00E+00	6.27E+03	1.15E+04	1.11E+07	0.00E+00	1.28E+06
La-140	2.79E-02	9.76E-03	0.00E+00	0.00E+00	0.00E+00	2.72E+02	0.00E+00	3.29E-03
Ce-141	1.17E+04	5.82E+03	0.00E+00	2.55E+03	0.00E+00	7.26E+06	0.00E+00	8.64E+02
Ce-144	1.48E+06	4.65E+05	0.00E+00	2.57E+05	0.00E+00	1.21E+08	0.00E+00	7.92E+04

* $\frac{\text{mrem/yr}}{\mu\text{Ci/m}^3}$

TABLE B-5 (Continued)
R_i VALUES - COW MILK - CHILD
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	0.00E+00	1.57E+03
Cr-51	0.00E+00	0.00E+00	2.93E+04	8.00E+03	5.35E+04	2.80E+06	0.00E+00	5.28E+04
Mn-54	0.00E+00	1.35E+07	0.00E+00	3.78E+06	0.00E+00	1.13E+07	0.00E+00	3.59E+06
Fe-55	7.43E+07	3.94E+07	0.00E+00	0.00E+00	2.23E+07	7.30E+06	0.00E+00	1.22E+07
Fe-59	6.53E+07	1.06E+08	0.00E+00	0.00E+00	3.06E+07	1.10E+08	0.00E+00	5.26E+07
Co-57	0.00E+00	2.45E+06	0.00E+00	0.00E+00	0.00E+00	2.01E+07	0.00E+00	4.96E+06
Co-58	0.00E+00	6.94E+06	0.00E+00	0.00E+00	0.00E+00	4.05E+07	0.00E+00	2.12E+07
Co-60	0.00E+00	2.89E+07	0.00E+00	0.00E+00	0.00E+00	1.60E+08	0.00E+00	8.52E+07
Zn-65	2.63E+09	7.00E+09	0.00E+00	4.41E+09	0.00E+00	1.23E+09	0.00E+00	4.35E+09
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	3.65E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E+08	0.00E+00	1.04E+08
Sr-90	7.53E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E+09	0.00E+00	1.91E+10
Zr-95	2.17E+03	4.77E+02	0.00E+00	6.82E+02	0.00E+00	4.97E+05	0.00E+00	4.24E+02
Nb-95	1.68E+05	6.55E+04	0.00E+00	6.16E+04	0.00E+00	1.21E+08	0.00E+00	4.68E+04
Mo-99	0.00E+00	4.07E+07	0.00E+00	8.69E+07	0.00E+00	3.36E+07	0.00E+00	1.01E+07
Ag-110m	1.33E+08	8.97E+07	0.00E+00	1.67E+08	0.00E+00	1.07E+10	0.00E+00	7.17E+07
Sb-124	6.10E+07	7.92E+05	1.35E+05	0.00E+00	3.39E+07	3.82E+08	0.00E+00	2.14E+07
I-131	6.52E+08	6.55E+08	2.17E+11	1.08E+09	0.00E+00	5.83E+07	0.00E+00	3.72E+08
I-133	8.59E+06	1.06E+07	1.97E+09	1.77E+07	0.00E+00	4.28E+06	0.00E+00	4.02E+06
I-135	2.70E+04	4.86E+04	4.30E+06	7.45E+04	0.00E+00	3.70E+04	0.00E+00	2.30E+04
Cs-134	1.50E+10	2.46E+10	0.00E+00	7.61E+09	2.73E+09	1.32E+08	0.00E+00	5.18E+09
Cs-136	5.07E+08	1.39E+09	0.00E+00	7.43E+08	1.11E+08	4.90E+07	0.00E+00	9.02E+08
Cs-137	2.17E+10	2.08E+10	0.00E+00	6.78E+09	2.44E+09	1.30E+08	0.00E+00	3.07E+09
Ba-140	5.87E+07	5.14E+04	0.00E+00	1.67E+04	3.07E+04	2.97E+07	0.00E+00	3.43E+06
La-140	9.70E+00	3.39E+00	0.00E+00	0.00E+00	0.00E+00	9.45E+04	0.00E+00	1.14E+00
Ce-141	1.15E+04	5.73E+03	0.00E+00	2.51E+03	0.00E+00	7.15E+06	0.00E+00	8.51E+02
Ce-144	1.04E+06	3.26E+05	0.00E+00	1.80E+05	0.00E+00	8.50E+07	0.00E+00	5.55E+04

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - GOAT MILK - CHILD
$\frac{m^2\text{-mrem/yr}}{\mu Ci/sec}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3*	0.00E+00	3.20E+03	3.20E+03	3.20E+03	3.20E+03	3.20E+03	0.00E+00	3.20E+03
Cr-51	0.00E+00	0.00E+00	3.51E+03	9.60E+02	6.42E+03	3.36E+05	0.00E+00	6.33E+03
Mn-54	0.00E+00	1.62E+06	0.00E+00	4.54E+05	0.00E+00	1.36E+06	0.00E+00	4.31E+05
Fe-55	9.65E+05	5.12E+05	0.00E+00	0.00E+00	2.90E+05	9.49E+04	0.00E+00	1.59E+05
Fe-59	8.49E+05	1.37E+06	0.00E+00	0.00E+00	3.98E+05	1.43E+06	0.00E+00	6.84E+05
Co-57	0.00E+00	2.94E+05	0.00E+00	0.00E+00	0.00E+00	2.41E+06	0.00E+00	5.96E+05
Co-58	0.00E+00	8.33E+05	0.00E+00	0.00E+00	0.00E+00	4.86E+06	0.00E+00	2.55E+06
Co-60	0.00E+00	3.47E+06	0.00E+00	0.00E+00	0.00E+00	1.92E+07	0.00E+00	1.02E+07
Zn-65	3.15E+08	8.40E+08	0.00E+00	5.29E+08	0.00E+00	1.48E+08	0.00E+00	5.22E+08
Se-75	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	7.66E+09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.96E+08	0.00E+00	2.19E+08
Sr-90	1.58E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+09	0.00E+00	4.01E+10
Zr-95	2.60E+02	5.72E+01	0.00E+00	8.19E+01	0.00E+00	5.97E+04	0.00E+00	5.09E+01
Nb-95	2.02E+04	7.86E+03	0.00E+00	7.39E+03	0.00E+00	1.45E+07	0.00E+00	5.62E+03
Mo-99	0.00E+00	4.88E+06	0.00E+00	1.04E+07	0.00E+00	4.04E+06	0.00E+00	1.21E+06
Ag-110m	1.59E+07	1.08E+07	0.00E+00	2.01E+07	0.00E+00	1.28E+09	0.00E+00	8.61E+06
Sb-124	7.33E+06	9.50E+04	1.62E+04	0.00E+00	4.07E+06	4.58E+07	0.00E+00	2.57E+06
I-131	7.82E+08	7.87E+08	2.60E+11	1.29E+09	0.00E+00	7.00E+07	0.00E+00	4.47E+08
I-133	1.03E+07	1.27E+07	2.37E+09	2.12E+07	0.00E+00	5.13E+06	0.00E+00	4.82E+06
I-135	3.24E+04	5.83E+04	5.16E+06	8.94E+04	0.00E+00	4.44E+04	0.00E+00	2.76E+04
Cs-134	4.49E+10	7.37E+10	0.00E+00	2.28E+10	8.19E+09	3.97E+08	0.00E+00	1.55E+10
Cs-136	1.52E+09	4.18E+09	0.00E+00	2.23E+09	3.32E+08	1.47E+08	0.00E+00	2.71E+09
Cs-137	6.52E+10	6.24E+10	0.00E+00	2.03E+10	7.32E+09	3.91E+08	0.00E+00	9.21E+09
Ba-140	7.05E+06	6.17E+03	0.00E+00	2.01E+03	3.68E+03	3.57E+06	0.00E+00	4.11E+05
La-140	1.16E+00	4.07E-01	0.00E+00	0.00E+00	0.00E+00	1.13E+04	0.00E+00	1.37E-01
Ce-141	1.38E+03	6.88E+02	0.00E+00	3.02E+02	0.00E+00	8.58E+05	0.00E+00	1.02E+02
Ce-144	1.25E+05	3.91E+04	0.00E+00	2.17E+04	0.00E+00	1.02E+07	0.00E+00	6.66E+03

* $\frac{\text{mrem/yr}}{\mu Ci/m^3}$

TABLE B-5 (Continued)
R_i VALUES - INHALATION - INFANT
$\frac{mrem/yr}{\mu Ci/m^3}$

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	Skin	T. Body
H-3	0.00E+00	6.47E+02	6.47E+02	6.47E+02	6.47E+02	6.47E+02	0.00E+00	6.47E+02
Cr-51	0.00E+00	0.00E+00	5.75E+01	1.32E+01	1.28E+04	3.57E+02	0.00E+00	8.95E+01
Mn-54	0.00E+00	2.53E+04	0.00E+00	4.98E+03	1.00E+06	7.06E+03	0.00E+00	4.98E+03
Fe-55	1.97E+04	1.17E+04	0.00E+00	0.00E+00	8.69E+04	1.09E+03	0.00E+00	3.33E+03
Fe-59	1.36E+04	2.35E+04	0.00E+00	0.00E+00	1.02E+06	2.48E+04	0.00E+00	9.48E+03
Co-57	0.00E+00	6.51E+02	0.00E+00	0.00E+00	3.79E+05	4.86E+03	0.00E+00	6.41E+02
Co-58	0.00E+00	1.22E+03	0.00E+00	0.00E+00	7.77E+05	1.11E+04	0.00E+00	1.82E+03
Co-60	0.00E+00	8.02E+03	0.00E+00	0.00E+00	4.51E+06	3.19E+04	0.00E+00	1.18E+04
Zn-65	1.93E+04	6.26E+04	0.00E+00	3.25E+04	6.47E+05	5.14E+04	0.00E+00	3.11E+04
Se-75	0.00E+00	4.06E+04	0.00E+00	6.72E+04	6.86E+05	7.70E+03	0.00E+00	1.16E+03
Sr-89	3.98E+05	0.00E+00	0.00E+00	0.00E+00	2.03E+06	6.40E+04	0.00E+00	1.14E+04
Sr-90	4.09E+07	0.00E+00	0.00E+00	0.00E+00	1.12E+07	1.31E+05	0.00E+00	2.59E+06
Zr-95	1.15E+05	2.79E+04	0.00E+00	3.11E+04	1.75E+06	2.17E+04	0.00E+00	2.03E+04
Nb-95	1.57E+04	6.43E+03	0.00E+00	4.72E+03	4.79E+05	1.27E+04	0.00E+00	3.78E+03
Mo-99	0.00E+00	1.65E+02	0.00E+00	2.65E+02	1.35E+05	4.87E+04	0.00E+00	3.23E+01
Ag-110m	9.98E+03	7.22E+03	0.00E+00	1.09E+04	3.67E+06	3.30E+04	0.00E+00	5.00E+03
Sb-124	3.79E+04	5.56E+02	1.01E+02	0.00E+00	2.65E+06	5.91E+04	0.00E+00	1.20E+04
I-131	3.79E+04	4.44E+04	1.48E+07	5.18E+04	0.00E+00	1.06E+03	0.00E+00	1.96E+04
I-133	1.32E+04	1.92E+04	3.56E+06	2.24E+04	0.00E+00	2.16E+03	0.00E+00	5.60E+03
I-135	3.86E+03	7.60E+03	6.96E+05	8.47E+03	0.00E+00	1.83E+03	0.00E+00	2.77E+03
Cs-134	3.96E+05	7.03E+05	0.00E+00	1.90E+05	7.97E+04	1.33E+03	0.00E+00	7.45E+04
Cs-136	4.83E+04	1.35E+05	0.00E+00	5.64E+04	1.18E+04	1.43E+03	0.00E+00	5.29E+04
Cs-137	5.49E+05	6.12E+05	0.00E+00	1.72E+05	7.13E+04	1.33E+03	0.00E+00	4.55E+04
Ba-140	5.60E+04	5.60E+01	0.00E+00	1.34E+01	1.60E+06	3.84E+04	0.00E+00	2.90E+03
La-140	5.05E+02	2.00E+02	0.00E+00	0.00E+00	1.68E+05	8.48E+04	0.00E+00	5.15E+01
Ce-141	2.77E+04	1.67E+04	0.00E+00	5.25E+03	5.17E+05	2.16E+04	0.00E+00	1.99E+03
Ce-144	3.19E+06	1.21E+06	0.00E+00	5.38E+05	9.84E+06	1.48E+05	0.00E+00	1.76E+05

TABLE B-6

DERIVATION OF GASEOUS DOSE FACTORS

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TABLE B-6.1

DERIVATION OF (P_i) VALUES

The pathway dose factor, P_i, for radioiodines, tritium, and 8-day particulates includes transport parameters of the ith nuclide, the receptor usage rate of the pathway media, and the appropriate dose conversion factor. For the inhalation pathway, the value of P_i is calculated as follows:

$$P_i = K'(BR)\,DFA_i \ (mrem/yr\ per\ \mu Ci/m^3)$$

Where:

K' = a constant of unit conversion, 10^6 pCi/μCi.

(BR) = the breathing rate of the age group, in m^3/yr (Table E-5 of Regulatory Guide 1.109).

DFA_i = the maximum organ inhalation dose factor for the appropriate age group for the ith radionuclide, in mrem/pCi (Tables E-7 to E-10 of Regulatory Guide 1.109).

Example Calculation:

For the I-131 child thyroid dose factor for exposure from inhalation:

DFA_i = 4.39E-03 mrem/pCi

BR = 3700 m^3/yr

These values will yield a P_i factor of 1.62E7 mrem/yr per μCi/m^3 as listed in Table B-3 of this appendix.

TABLE B-6.2

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

The pathway dose factor R_i for radioiodines, tritium, and 8-day particulates include transport parameters of the ith nuclide, the receptor usage rate of the pathway media, and the appropriate dose conversion factor. In developing the R_i values, separate expressions are written for each of the potential pathways.

I. INHALATION

For the inhalation pathway, the value of R_i is calculated as follows:

$$R_i = K'(BR)_a\ (DFA_i)_a \quad (\text{mrem/yr per } \mu\text{Ci/m}^3)$$

Where:

K'	=	a constant of unit conversion, 10^6 pCi/µCi.
$(BR)_a$	=	the breathing rate of the receptor of age group (a) in m^3/yr (Table B-6.3).
$(DFA_i)_a$	=	the organ inhalation dose factor for the receptor of age group (a) for the ith radionuclide, in mrem/pCi (Tables E-7 to E-10 of Regulatory Guide 1.109).

Example Calculation:

For the Co-60 child whole body dose factor from exposure due to inhalation:

$(DFA_i)_a$ = 6.12E-6 mrem/pCi

$(BR)_a$ = 3700 m^3/yr

These values yield a R_i factor of 2.26E4 mrem/yr per µCi/m^3 as listed in Table B-5 of this appendix.

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

II. GROUND PLANE

For the ground plane pathway, the value of R_i is calculated as follows:

$$R_i = K' K'' (SF) DFG_i \left[(1 - e^{-\lambda_i t}) / \lambda_i \right]$$

$$(m^2 - mrem / yr \text{ per } \mu Ci / \sec)$$

Where:

K'	=	a constant of unit conversion, 10^6 pCi/μCi.
K"	=	a constant of unit conversion, 8760 hr/yr.
λ_i	=	the decay constant for the ith radionuclide, sec^{-1}.
t	=	the exposure time, 4.73E8 sec (Table B-6.3).
DFG_i	=	the ground plane dose conversion factor for the ith radionuclide, mrem/hr per pCi/m^2. (See Table E-6 of Regulatory Guide 1.109).
SF	=	the shielding factor, 0.7, dimensionless (Table B-6.3).

Example Calculation:

For the Co-60 child whole body dose factor from exposure due to the ground plane:

λ_i	=	4.20E-9 sec^{-1}
DFG_i	=	1.70E-8 mrem/hr per pCi/m^2

These values yield a R_i factor of 2.15E10 m^2-mrem/yr per μCi/sec as listed in Table B-5 of this appendix.

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

III. VEGETATION

A. Radioiodines And Eight Day Particulates

For the vegetation pathway, R_i, is calculated as follows:

$$R_i = K' \frac{(r)}{Y_v(\lambda_i + \lambda_w)} (DFL_i)_a \left[U_a^L f_L e^{-\lambda_i t_L} + U_a^s f_g e^{-\lambda_i t_h} \right]$$

$$(m^2 \text{-} mrem / yr \; per \; \mu Ci / \sec)$$

Where:

K'	=	a Constant of unit conversion, 10^6 pCi/μCi.
U_a^L	=	the consumption rate of fresh leafy vegetation by the receptor in age group (a), in kg/yr (Table B-6.3).
U_a^s	=	the consumption rate of stored vegetation by the receptor in age group (a), in kg/yr (Table B-6.3).
f_L	=	the fraction of the annual intake of fresh leafy vegetation grown locally (Table B-6.3).
f_g	=	the fraction of the annual intake of stored vegetation grown locally (Table B-6.3).
t_L	=	the average time between harvest of leafy vegetation and its consumption, in seconds (Table B-6.3).
t_h	=	the average time between harvest of stored vegetation and its consumption, in seconds (Table B-6.3).
Y_v	=	the vegetation areal density, in kg/m^2 (Table B-6.3).
r	=	fraction of deposited activity retained on vegetation (Table B-6.3).
λ_i	=	the decay constant for the ith radionuclide, in sec^{-1}.

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

λw = the decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73E-7 sec^{-1} (corresponding to a 14-day half-life).

$(DFL_i)_a$ = the maximum organ ingestion dose factor for the ith radionuclide for the receptor in age group (a), in mrem/pCi (Tables E-11 to E-14 of Regulatory Guide 1.109).

Example Calculation:

For the Co-60 child whole body dose factor from exposure due to ingestion of vegetation:

U_a^L = 26 kg/yr

U_a^s = 520 kg/yr

f_L = 1

f_g = 0.76

t_L = 8.6E4 sec

t_h = 5.18E6 sec

Y_v = 2 kg/m^2

r = 0.2

λ_i = 4.2E-9 sec^{-1}

λw = 5.73E-7 sec^{-1}

$(DFL_i)_a$ = 1.56E-5 mrem/pCi

These values yield an R_i factor of 1.12E9 m^2-mrem/yr per μCi/sec as listed in Table B-4 of this appendix.

TABLE B-6.2 (Continued)

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

B. Tritium

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. R_i is calculated as follows:

$$R_i = K' K''' (U_a^L \ f_L + U_a^s \ f_g) \ (DFL_i)_a \ [0.75 (0.5 / H)]$$

$$(mrem / yr \ per \ \mu Ci / m^3)$$

Where:

K'	=	unit conversion constant, 10^6 pCi/µCi.
K'''	=	unit conversion constant, 10^3 gm/kg.
0.75	=	the fraction of vegetation which is water (NUREG-0133).
0.50	=	the ratio of the specific activity of the vegetation that is water to the atmospheric water (NUREG-0133).
H	=	absolute atmospheric humidity, in gm/m^3 (Table B-6.3).

All other parameters are as previously defined above.

TABLE B-6.2 (Continued)

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

Example Calculation

For the H-3 child whole body dose factor from exposure due to ingestion of vegetation:

U_a^L = 26 kg/yr

U_a^s = 520 kg/yr

f_L = I

f_g = 0.76

$(DFL_i)_a$ = 2.03E-7 mrem/pCi

H = 8 gm/m^3 (NUREG-0133)

These values yield a R_i factor of 4.01E3 mrem/yr per μCi/m^3 as listed in Table B-4 of this appendix.

IV. <u>MEAT</u>

A. <u>Radioiodines And Eight Day Particulates</u>

$$R_i = K' \frac{Q_F (U_{ap})}{(\lambda_i + \lambda_w)} F_f (r) (DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

$$(m^2 - mrem / yr \ per \ \mu Ci / \sec)$$

Where:

U_{ap} = the receptor's meat consumption rate for age (a), in kg/yr (Table B-6.3).

F_f = the stable element transfer coefficients, in days/kg (Table E-1 of Regulatory Guide 1.109).

t_f = the transport time from pasture to receptor, in sec (Table B-6.3).

t_h = the transport time from crop field to receptor, in sec (Table B-6.3).

f_p = fraction of the year that the cow is on pasture (Table B-6.3).

f_s = fraction of the cow feed that is pasture grass while the cow is on pasture (Table B-6.3).

Q_f = the cow's consumption rate, in kg/day (wet weight). See Table B-6.3.

All other parameters were defined previously.

<u>Example Calculation</u>:

For the Co-60 child whole body dose factor from exposure due to ingestion of meat:

U_{ap} = 41 kg/yr

F_f = 1.3E-2 days/kg

t_h = 7.78E6 sec

TABLE B-6.2 (Continued)

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

t_f = 1.73E6 sec

f_p = 6/12 = 0.5

f_s = 1

$(DFL_i)_a$ = 1.56E-5 mrem/pCi

Y_p = 0.7 kg/m^2

Y_s = 2.0 kg/m^2

Q_F = 50 kg/day

These values yield a Ri factor of 1.37E8 m^2-mrem/yr per μCi/sec as listed in Table B-5 of this appendix.

TABLE B-6.2 (Continued)

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

B. Tritium

The concentration of tritium in meat is based on the airborne concentration rather than the deposition. R_i is calculated as follows:

$$R_i = K' K''' F_f Q_F U_{ap} (DFL_i)_a [0.75(0.5/H)]$$

$$(mrem / yr \ per \ \mu Ci / m^3)$$

Example Calculation:

All parameters have been defined in the previous sections for the H-3 child whole body dose factor from exposure due to ingestion of meat. Substituting values into the preceding equation, results in a R_i factor of 2.33E2 mrem/yr per µCi/m^3 as listed in Table B-5 of this appendix.

V. COW'S MILK

A. Radioiodines and Eight Day Particulates

For the cow's milk pathway, R_i is calculated as follows:

$$R_i = K' \frac{Q_F (U_{ap})}{(\lambda_i + \lambda_w)} F_m(r) (DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

$$(m^2 - mrem / yr \ per \ \mu Ci / \sec)$$

Where:

U_{ap} = the receptor's milk consumption rate for age (a), in liters/yr (Table B-6.3).

t_f = the transport time from pasture to cow, to milk, to receptor in sec (Table B-6.3).

F_m = the stable element transfer coefficients, in days/liter (from Regulatory Guide 1.109, Table E-1).

All other parameters were defined previously.

Example Calculation:

For the Co-60 child whole body dose factor from exposure due to ingestion of cow's milk:

t_f = 1.73E5 sec

U_{ap} = 330 l/yr

F_m = 1.0E-3 days/l

These values yield a R_i factor of 8.52E7 m^2-mrem/yr per µCi/sec as listed in Table B-5 of this appendix.

B. Tritium

The concentration of tritium in cow's milk is based on the airborne concentration rather than the deposition. R_i is calculated as follows:

$$R_i = K' K''' F_m Q_F U_{ap} (DFL_i)_a [0.75 (0.5/H)]$$

$$(mrem / year \ per \ \mu Ci / m^3)$$

TABLE B-6.2 (Continued)

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

Example Calculation:

All parameters have been defined in the previous sections for the H-3 child whole body dose factor from exposure due to ingestion of cow's milk. Substituting values into the preceding equation, results in a R_i factor of 1.57E3 mrem/yr per $\mu Ci/m^3$ as listed in Table B-5 of this appendix.

VI. GOAT'S MILK

A. Radioiodines and Eight Day Particulates

For the goat's milk pathway, R_i is calculated as follows:

$$R_i = K' \frac{Q_F (U_{ap})}{(\lambda_i + \lambda_w)} F_m (r) (DFL_i)_a \left[\frac{f_p f_s}{Y_p} + \frac{(1 - f_p f_s) e^{-\lambda_i t_h}}{Y_s} \right] e^{-\lambda_i t_f}$$

$$(m^2 - mrem / yr \ per \ \mu Ci / \sec)$$

Where:

t_f = the transport time from pasture to goat, to milk, to receptor in sec (Table B-6.3).

F_m = the stable element transfer coefficients. For the radionuclide in question, use Table E-2 of Regulatory Guide 1.109. If the radionuclide is not listed in Table E-2, use Table E-1 (i.e., the same value used for the cow's milk pathway).

All other parameters were defined previously.

TABLE B-6.2 (Continued)

DERIVATION OF GASEOUS DOSE FACTORS (R_i)

Example Calculation:

For the Co-60 child whole body dose factor from exposure due to ingestion of goat's milk:

Q_F = 6 kg/day (wet weight)

F_m = 1.0E-3 days/l

t_f = 1.73E5 sec

These values yield a R_i factor of 1.02E7 m^2-mrem/yr per μCi/sec as listed in Table B-5 of this appendix.

B. Tritium

The concentration of tritium in goat's milk is based on the airborne concentration rather than the deposition. R_i is calculated as follows:

$$R_i = K' K''' F_m Q_F U_{ap} (DFL_i)_a \; [0.75(0.5/H)]$$

$$(mrem/yr \text{ per } \mu Ci/m^3)$$

Example Calculation:

All parameters have been defined in the previous sections for the H-3 child whole body dose factor from exposure due to ingestion of goat's milk. Substituting values into the preceding equation, result in a R_i factor of 3.20E3 mrem/yr per μCi/m^3 as listed in Table B-5 of this appendix.

TABLE B-6.3

PARAMETER FOR THE GASEOUS EFFLUENT PATHWAY

PARAMETERS	VALUE	REFERENCE	TABLE
Uap (liters/yr)-cow's milk/			
-infant	330	R.G.1.109	E-5
-child	330	R.G.1.109	E-5
-teen	400	R.G.1.109	E-5
-adult	310	R.G.1.109	E-5
Uap (liters/yr)-goat's milk/			
-infant	330	R.G.1.109	E-5
-child	330	R.G.1.109	E-5
-teen	400	R.G.1.109	E-5
-adult	310	R.G.1.109	E-5
U_a^L (kg/yr)-vegetation/			
-infant	0	R.G.1.109	E-5
-child	26	R.G.1.109	E-5
-teen	42	R.G.1.109	E-5
-adult	64	R.G.1.109	E-5
U_a^s (kg/yr)-vegetation/			
-infant	0	R.G.1.109	E-5
-child	520	R.G.1.109	E-5
-teen	630	R.G.1.109	E-5
-adult	520	R.G.1.109	E-5
Uap (kg/yr)-meat/			
-infant	0	R.G.1.109	E-5
-child	41	R.G.1.109	E-5
-teen	65	R.G.1.109	E-5
-adult	110	R.G.1.109	E-5
(BR)a (m3/yr)-inhalation/			
-infant	1400	R.G.1.109	E-5
-child	3700	R.G.1.109	E-5
-teen	8000	R.G.1.109	E-5
-adult	8000	R.G.1.109	E-5

TABLE B-6.3 (Continued)

PARAMETER FOR THE GASEOUS EFFLUENT PATHWAY

PARAMETERS	VALUE	REFERENCE	TABLE
r (dimensionless)	1.0 for Radioiodine	R.G. 1.109	E-15
	0.2 for Particulates	R.G. 1.109	E-15
fl (dimensionless)	1.0	R.G. 1.109	E-15
fg (dimensionless)	0.76	R.G. 1.109	E-15
tL (sec)-vegetation	8.6E4	R.G. 1.109	E-15
th (sec)-vegetation	5.18E6	R.G. 1.109	E-15
(DFAi)a (mrem/pCi)- inhalation	Each Radionuclide	R.G. 1.109	E-7 to E-10
DFGi (mrem/hr per pCi/m2) ground plane	Each Radionuclide	R.G. 1.109	E-6
SF (dimensionless)	0.7	R.G. 1.109	E-15
t (sec)-ground plane	4.73E8	R.G. 1.109	E-15
QF (kg/day)-cow milk	50	R.G. 1.109	E-3
QF (kg/day)-goat milk	6	R.G. 1.109	E-3
Yp (kg/m2)	0.7	R.G. 1.109	E-15
Ys (kg/m2)	2.0	R.G. 1.109	E-15
(DFLi)a (mrem/pCi)- meat/milk/vegetation	Each Radionuclide	R.G. 1.109	E-11 to E-14
λw (sec-1)	5.73E-7	R.G. 1.109	E-15
tf (sec)-cow milk/ goat milk	1.73E5	R.G. 1.109	E-15
th (sec)-cow milk/ goat milk	7.78E6	R.G. 1.109	E-15
Yv (kg/m2)	2.0	R.G. 1.109	E-15

TABLE B-6.3 (Continued)

PARAMETER FOR THE GASEOUS EFFLUENT PATHWAY

PARAMETERS	VALUE	REFERENCE	TABLE
fp (dimensionless)	0.5	site specific	
fs (dimensionless)	1.0	NUREG-0133	page 33
Fm (days/liter)	Each Radionuclide	R. G. 1.109	E-1
Ff (days/kg)	Each Stable Element	R.G. 1.109	E-1
tf (sec)-meat	1.73E6	R.G. 1.109	E-15
th (sec)-meat	7.78E6	R.G. 1.109	E-15
H (gm/m3)	8.0	NUREG-0133	page 34

TABLE B-6.4

JUSTIFICATION FOR GASEOUS PATHWAYS USED TO ASSESS DOSE AT THE J. A. FITZPATRICK NUCLEAR POWER PLANT

PATHWAY	JUSTIFICATION FOR USAGE
1. NOBLE GAS EXPOSURE (GAMMA)	
a. Whole body	This pathway is used in the ODCM to calculate dose rates only. This pathway is required by Part 1 (REC) and NUREG-0133.
b. Gamma Air	This pathway is used in the ODCM. This pathway is required by Part 1 (REC) and NUREG-0133.
2. NOBLE GAS EXPOSURE (BETA)	
a. Skin	This pathway is used in the ODCM to calculate dose rates only. This pathway is required by Part 1 (REC) and NUREG-0133.
b. Beta Air	This pathway is used in the ODCM. This pathway is required by Part 1 (REC) and NUREG-0133.
3. GROUND PLANE DEPOSITION	This pathway is used in the ODCM to calculate dose only. It is not used to calculate dose rates. This pathway is required for use in dose calculation by Part 1 (REC). Part 1 (REC) does not require it to be used for dose rate calculations.
4. INHALATION	This pathway is used in the ODCM to calculate dose and dose rates. This pathway is required for use in dose and dose rate calculations by the Part 1 (REC) and NUREG-0133.
5. VEGETATION	This pathway is used in the ODCM to calculate dose only. It is not used to calculate dose rates. This pathway is required for use in dose calculations by NUREG-0133. Part 1 (REC) and NUREG-0133 do not require it to be used for dose rate calculations. The calculation of dose factors for stored fruit and vegetables and fresh is combined in one equation in both the ODCM and NUREG-0133.

TABLE B-6.4 (Continued)

JUSTIFICATION FOR GASEOUS PATHWAYS USED TO ASSESS

DOSE AT THE J. A. FITZPATRICK NUCLEAR POWER PLANT

PATHWAY	JUSTIFICATION FOR USAGE
6. MEAT	This pathway is used in the ODCM to calculate dose only. It is not used to calculate dose rates. This pathway is required for use in dose calculations by NUREG-0133. Part 1 (REC) does not require it to be used for dose rate calculations. The calculation of dose factors for Meat Contaminated Feed and Meat Contaminated Forage is combined in one equation in both the ODCM and NUREG-0133.
7. COW'S MILK	This pathway is used in the ODCM to calculate dose only. It is not used to calculate dose rates. This pathway is required for use in dose calculations by NUREG-0133. Part 1 (REC) does not require it to be used for dose rate calculations. The calculation of dose factors for Milk Contaminated Feed and Milk Contaminated Forage is combined in one equation in both the ODCM and NUREG-0133.
8. GOAT'S MILK	This pathway is used in the ODCM to calculate dose only. It is not used to calculate dose rates. This pathway is required for use in dose calculations by NUREG-0133. Part 1 (REC) and NUREG-0133 do not require it to be used for dose rate calculations. The calculation of dose factors for Milk Contaminated Feed and Milk Contaminated Forage is combined in one equation in both the ODCM and NUREG-0133.

TABLE B-6.5
ORGAN DOSES FOR GASEOUS RELEASES (INHALATION PATHWAYS)*

ADULT							
YEAR	BONE (mrem)	LIVER (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LLI (mrem)	T. BODY (mrem)
1997	1.89E-07	7.25E-04	7.34E-04	7.25E-04	7.27E-04	7.25E-04	7.25E-04
1996	5.06E-07	1.88E-04	2.84E-04	1.89E-04	1.91E-04	1.88E-04	1.88E-04
1995	7.91E-07	5.34E-05	1.51E-04	5.37E-05	5.65E-05	5.34E-05	5.28E-05
1994	7.63E-07	6.17E-05	2.53E-04	6.23E-05	7.46E-05	6.19E-05	6.10E-05
1993	1.05E-06	6.07E-05	1.32E-04	6.07E-05	8.13E-05	6.11E-05	6.00E-05
TEEN							
YEAR	BONE (mrem)	LIVER (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LLI (mrem)	T. BODY (mrem)
1997	2.68E-07	7.31E-04	7.42E-04	7.31E-04	7.34E-04	7.31E-04	7.31E-04
1996	7.11E-07	1.91E-04	3.15E-04	1.91E-04	1.95E-04	1.90E-04	1.90E-04
1995	7.04E-07	5.40E-05	1.84E-04	5.46E-05	5.91E-05	5.40E-05	5.33E-05
1994	1.07E-06	6.26E-05	3.09E-04	6.35E-05	8.17E-05	6.24E-05	6.16E-05
1993	6.56E-07	6.16E-05	1.55E-04	6.16E-05	9.21E-05	6.15E-05	6.06E-05
CHILD							
YEAR	BONE (mrem)	LIVER (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LLI (mrem)	T. BODY (mrem)
1997	3.67E-07	6.44E-04	6.59E-04	6.44E-04	6.47E-04	6.44E-04	6.44E-04
1996	9.69E-07	1.68E-04	3.20E-04	1.68E-04	1.71E-04	1.67E-04	1.67E-04
1995	1.53E-06	4.78E-05	2.08E-04	4.82E-05	5.19E-05	4.72E-05	4.71E-05
1994	1.44E-06	5.53E-05	3.52E-04	5.61E-05	7.07E-05	5.44E-05	5.45E-05
1993	1.96E-06	5.44E-05	1.72E-04	5.43E-05	7.92E-05	5.36E-05	5.36E-05
INFANT							
YEAR	BONE (mrem)	LIVER (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LLI (mrem)	T. BODY (mrem)
1997	2.50E-07	3.72E-04	3.85E-04	3.72E-04	3.74E-04	3.72E-04	3.72E-04
1996	7.13E-07	9.71E-05	2.37E-04	9.72E-05	9.96E-05	9.66E-05	9.68E-05
1995	9.91E-07	2.79E-05	1.74E-04	2.79E-05	3.09E-05	2.72E-05	2.72E-05
1994	1.09E-06	3.25E-05	3.04E-04	3.26E-05	4.22E-05	3.13E-05	3.15E-05
1993	1.12E-06	3.16E-05	1.39E-04	3.14E-05	4.80E-05	3.10E-05	3.09E-05

* The critical organ is the thyroid for the years 1993 to 1997.
The critical age group is the teen for 1997 and the child for 1993 to 1996

TABLE B-7

QUANTIFICATION AND REPORTING OF C-14 IN JAF RELEASES

QUANTIFICATION AND REPORTING OF C-14 IN JAF RELEASES

In 2009, the NRC informed the nuclear power industry that it would require the industry to report releases of radioactive Carbon-14 in gaseous effluents beginning with the Annual Radioactive Effluent Release Report for calendar year 2010. In order to support this industry-wide effort, EPRI began to establish a standard methodology for estimating Carbon-14 (^{14}C) production in power plants, in addition to equations to estimate gaseous releases and chemical forms. EPRI published these standard methodologies in EPRI Technical Report 1021106, "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents". This report was used as the basis for estimating C-14 production rates and release activity for the James A. FitzPatrick NPP for 2010.

Carbon-14 Production Rate

The ^{14}C production rate from the $^{17}O(n,\alpha)^{14}C$ reaction is calculated using the equation in Section 3.2.2.1 from EPRI Report 1021106, modified for the two energy group flux distribution as follows:

$$\text{Production Rate } (\mu Ci/sec - kg) = \frac{N * [\, \sigma th * \varphi th + \sigma if * \varphi if \,] * 1E\text{-}24 * \lambda}{3.7E4}$$

where:

N	= 1.27E22 atoms ^{17}O/kg H_2O
σth	= "effective" thermal cross-section, b
φth	= thermal neutron flux, n/cm^2-sec
σif	= "effective" intermediate+fast cross-section, b
φif	= intermediate+fast neutron flux, n/cm^2-sec
1.0E-24	= conversion factor, 1.0E-24 cm2/b
λ	= ^{14}C decay constant, 3.833E-12/sec
3.7E4	= conversion factor, 3.7E4 d/sec-μCi

Combining common constants in the equation, the formula is simplified as follows:

$$(1.27E{+}22 * 1E{-}24 * 3.833E{-}12) \div 3.7E4 = 1.316E{-}18$$

Production Rate (µCi/sec - kg) = 1.316E-18 * [σth * φth + σif * φif]

In accordance with EPRI Report 1021106, the production of ^{14}C from the $^{14}N(n,p)^{14}C$ contributes less than 0.1% to the total production, and is considered to be insignificant and negligible.

Neutron flux data for the James A. FitzPatrick (JAF) Station's reactor were derived in calculation NEAD-NS-11/006 performed by Entergy Echelon Nuclear Engineering. Flux data for the beginning-of-cycle, mid-cycle, and end-of-cycle periods in the moderator and bypass regions are presented in Table 2-1 of the Calculation Package. The JAF-specific neutron flux data in units of n/cm^2-sec are as follows:

Period of Cycle	Moderator Region		Bypass Region	
	Thermal	Intermed+Fast	Thermal	Intermed+Fast
BOC	2.964E+13	1.962E+14	5.825E+13	1.810E+14
MOC	3.125E+13	2.028E+14	6.142E+13	1.871E+14
EOC	3.423E+13	2.062E+14	6.728E+13	1.901E+14

Effective neutron cross-section data for the $^{17}O(n,\alpha)^{14}C$ reaction in the two energy groups and regions of the reactor in a BWR are provided in Table 3-5 in EPRI Report 1021106. Data for the two neutron energy groups used in the JAF model are as follows:

Neutron Group	Effective Cross-Section - barns	
	Moderator	Bypass
Thermal	1.325E-01	1.386E-01
Intermediate+Fast	4.58E-02	4.32E-02

Combining the JAF-specific data in accordance with Section 3.3.2.1 of EPRI Report 1021106 yields the following ^{14}C production rates in units of uCi/sec-kg:

BOC,Thermal, Moderator: 1.316E-18 * 2.964E+13 * 0.1325 = 5.168E-6

BOC, I+F, Moderator: 1.316E-18 * 1.962E+14 * 0.0458 = 1.183E-5

BOC Moderator Subtotal: (5.168E-6 + 1.183E-5) = 1.699E-5 uCi/sec-kg

MOC,Thermal, Moderator: 1.316E-18 * 3.125E+13 * 0.1325 = 5.449E-6

MOC, I+F, Moderator: 1.316E-18 * 2.028E+14 * 0.0458 = 1.222E-5

MOC Moderator Subtotal: (5.449E-6 + 1.222E-5) = 1.767E-5 uCi/sec-kg

EOC,Thermal, Moderator: 1.316E-18 * 3.423E+13 * 0.1325 = 5.969E-6

EOC, I+F, Moderator: 1.316E-18 * 2.062E+14 * 0.0458 = 1.243E-5

EOC Moderator Subtotal: (5.969E-6 + 1.243E-5) = 1.840E-5 uCi/sec-kg

Moderator Average: (1.699E-5 + 1.767E-5 + 1.840E-5) ÷ 3 = 1.769E-5 uCi/sec-kg

BOC,Thermal, Bypass: 1.316E-18 * 5.825E+13 * 0.1386 = 1.062E-5

BOC, I+F, Bypass: 1.316E-18 * 1.810E+14 * 0.0432 = 1.029E-05

BOC Bypass Subtotal: (1.062E-5 + 1.029E-05) = 2.091E-5 uCi/sec-kg

MOC,Thermal, Bypass: 1.316E-18 * 6.142E+13 * 0.1386 = 1.120E-5

MOC, I+F, Bypass: 1.316E-18 * 1.871E+14 * 0.0432 = 1.064E-5

MOC Bypass Subtotal: (1.120E-5 + 1.064E-5) = 2.184E-5 uCi/sec-kg

EOC,Thermal, Bypass: 1.316E-18 * 6.728E+13 * 0.1386 = 1.227E-5

EOC, I+F, Bypass: 1.316E-18 * 1.901E+14 * 0.0432 = 1.081E-5

EOC Bypass Subtotal: (1.227E-5 + 1.081E-05) = 2.308E-5 uCi/sec-kg

Bypass Average: (2.091E-5 + 2.184E-5 + 2.308E-5) ÷ 3 = 2.194E-5 uCi/sec-kg

The final set of parameters required to calculate the carbon-14 production is the mass of coolant in each region of the reactor. These data are provided in Table 2-2 of calculation NEAD-NS-11/006 and are as follows:

Moderator Region: 11005.9 kg

Bypass Region: 6931.6 kg

Multiplying the JAF-specific ^{14}C production rates by the coolant masses in accordance with Sections 3.3.3 and 3.3.4 from EPRI Report 1021106 yields the following:

Moderator: 1.769E-5 uCi/sec-kg * 11005.9 kg = 1.947E-1 uCi/sec

Bypass: 2.194E-5 uCi/sec-kg * 6931.6 kg = 1.521E-1 uCi/sec

Combined: (1.947E-1 + 1.521E-1) = 3.468E-1 uCi/sec

JAF- Curies of C-14 Released per Effective Full-Power Year:

Curies Produced per Full-Power Year (FPY):

3.468E-1 uCi/sec * 3600 sec/hr * 24 hr/d * 365.25 d/yr * 1E-6 Ci/uCi = 10.9 Ci/FPY

Applying a correction factor for effective full power days (EFPD, Obtained from Corporate Reactor Engineering) provides actual curies for each year. For example, JAF's EFPD for 2010 was 316, the factor would be 316/365 or 0.87.

Information presented in EPRI Report 1021106 indicates that approximately 95% to 99% of all Carbon-14 produced in a BWR reactor vessel is released as a gaseous effluent. For conservative purposes, 99% of all C-14 produced in the reactor is assumed to be released as gaseous effluents.

For 2010, this would result in a release rate of:

10.9 Ci/FPY * 0.87 * 0.99 release fraction = 9.4 Ci of C-14/EFPY

<u>Carbon-14 Dose Pathways Resulting from Gaseous Effluents</u>

The following assumptions and equations can be used for estimating C-14 doses from gaseous effluents. Examples are presented for calculating doses to the child from the inhalation and vegetation (ingestion) pathways. Regulatory Guide 1.109 methodology is used.

1. Assumptions
   a. Q_{C14} = gaseous effluent C-14 release rate, Ci/yr.
      (10.9 Ci/FPY * $EFPD_{Fraction}$ * 0.99 release fraction)
   b. Q = C-14 gaseous release rate that is carbon dioxide, Ci/yr.
      (10.9 Ci/FPY * $EFPD_{Fraction}$ * 0.99 release fraction * 0.95 {95% as CO_2})
   c. p = ratio of C-14 releases to total release time = 1 (very conservative)
   d. X/Q @ Primary Receptor
   e. Fraction of total plant mass that is natural carbon = 0.11 (RG 1.109, C-8)
   f. Concentration (g/m^3) of natural carbon = 0.16 (RG 1.109, C-8)
   g. Child dose at the Primary Receptor is most limiting
   h. Dose Factors used from Reg Guide 1.109

      Note: Values for c, e, and f are conservative and offered by RG 1.109. Better (site specific) data is being evaluated at JAF and throughout the industry for application in the future.

2. Vegetative Pathway Calculation from Reg Guide (see RG 1.109, equation C-8)

   C^V_{14} pCi/kg = 3.17E7 {(pCi-g-yr)/(Ci-kg-sec)}* p * Q * X/Q * (0.11/0.16)

3. Child Ingestion (uses 95% of total C-14 released, or just the CO_2 portion)

   $Dose_{C-14}$ = DF * [$u^{v*}f_g + u^L$] * C^V_{14} pCi/kg

   Where: DF = 1.21E-5 mrem/pCi Bone Child [RG 1.109, E-13]

   2.42E-6 mrem/pCi TB Child [RG 1.109, E-13]

   u^v = 520 kg/yr {child; u^L = 26 kg/yr [usage factors, RG 1.109, E-5]}

   f_g = 0.76 [fraction of produce ingested in garden of interest, E-15]

4. Child Inhalation (uses all released C-14, not just CO_2)

   $Dose_{C-14}$ = BR * C^a_{14} pCi/m^3 * DFI

   Where: C^a_{14} pCi/m^3 = 3.17E+4 (pCi-yr)/(Ci-sec) * (Q_{C14}) * (X/Q)

   BR_{child} = 3700 m^3/yr;

   DFI = 9.70E-6 mrem/$pCi_{Child\ Bone}$

   DFI = 1.82E-6 mrem/$pCi_{Child\ TB}$

APPENDIX C

METEOROLOGICAL INDEX

APPENDIX C

METEOROLOGICAL INDEX

The atmospheric dispersion and deposition tables presented in this Appendix were prepared using 8 years' worth of hourly meteorological data (at 10 m and 61 m above grade) collected on site by Niagara Mohawk during the period 1985 through 1992. The tables include the following:

(a) Long-term annual average concentration (X/Q)s, finite-cloud gamma (X/Q)s, and (D/Q)s for the main stack, the four building vents, and unmonitored ground-level releases (site boundary and offsite receptors) [Tables C-1 through C-8, C-18, and C-20],

(b) Long-term grazing season concentration (X/Q)s and (D/Q)s for the main stack, the four building vents, and unmonitored ground-level releases (offsite receptors excluding the site boundary) [Tables C-9 through C-13, C-22 and C-24],

(c) Short-term 85th percentile hourly plume centerline concentration (X/Q)s and (D/Q)s for unmonitored ground-level releases, based on year-round meteorological data (site boundary and offsite receptors) [Tables C-15, C-16, C-17 and C-19],

(d) Short-term 85th percentile hourly plume centerline concentration (X/Q)s and (D/Q)s for unmonitored ground-level releases, based on meteorological data for the grazing season (offsite receptors excluding the site boundary [Tables C-21 and C-23],

(e) Critical receptor long-term dispersion and deposition parameters for vent and elevated releases, year-round and grazing season averages [Table C-14].

The receptors of interest include the site boundary (SB) and various offsite locations in each sector at distances out to 45 miles. Note the following:

(1) The long-term annual average concentration (X/Q)s and finite-cloud gamma (X/Q)s which were based on the sector-average model, are for use in assessing the air doses (gamma and beta), total body and skin dose, and doses due to inhalation from the various release points. The long-term annual average (D/Q)s are for assessing the radiation exposures due to ground plane deposition of radioactivity.

(2) The long-term grazing season concentration (X/Q)s and (D/Q)s are for use in assessing the radiation exposures for the ingestion pathway. Based on census data, the grazing season was taken to be six months (May through October).

(3) The 85th percentile hourly concentration (X/Q)s and (D/Q)s were based on the plume-centerline model and are for use in conjunction with short-term releases, as described in Section 4.4.3 of the ODCM. The selected percentile (85%) is applicable for the assessment of intermittent releases; it implies that the probability of exceeding the calculated hourly dispersion and deposition values is only 15%.

(4) The dispersion and deposition parameters for the stack were based on the "elevated plume" model (with plume rise effects, and terrain features, but without building wake effects), and the meteorological data collected on the 61-m elevation of the meteorological tower. The dispersion and deposition parameters for the building vents (reactor building, refuel floor, turbine building, and radwaste building) were based on the "mixed-mode" release (with plume rise and building wake effects), and the data collected on the

10-m elevation of the tower. Unmonitored ground-level releases made use for the "ground release" model (with building wake effects, but without plume rise) and the meteorological data collected on the 10-m elevation of the tower.

(5) For vent releases and unmonitored ground-level releases, the equations for gamma air dose, total body dose, and the gamma portion of skin dose make use of the concentration (X/Q) (i.e., the semi-infinite cloud model). For stack releases, on the other hand, the equations for the said exposures make use of the finite-cloud gamma (X/Q). By definition, the gamma (X/Q) is the equivalent relative concentration of radioactivity in a semi-infinite cloud that would yield the same radiation exposure as a finite cloud aloft; it accounts for the actual plume dimensions, elevation above the receptor, and gamma radiation spectra.

Complete details on the definition of the dispersion and deposition values presented in this appendix may be found in Reference 6.10.

APPENDIX C

METEOROLOGICAL DATA

APPENDIX C

METEOROLOGICAL DATA (CONTINUED)

APPENDIX C

METEOROLOGICAL DATA (CONTINUED)

TABLE C-1
CONCENTRATION X/Q VALUES FOR SITE BOUNDARY DETERMINED FROM ANNUAL AVERAGE METEROLOGICAL DATA (1985 To 1992)

Sector Average Concentration X/Q

(sec/m^3)

Direction		Distance (m)	Stack	Turbine Building Vent	Refuel Floor Vent	Radwaste Building Vent	Reactor Building Vent	Unmonitored Ground Level Release
N	w	225	1.05E-10	3.81E-06	4.65E-06	5.75E-06	4.65E-06	3.50E-05
NNE	w	225	3.58E-11	1.68E-06	2.05E-06	2.60E-06	2.05E-06	1.78E-05
NE	w	354	7.52E-10	6.53E-07	8.02E-07	1.12E-06	8.02E-07	5.34E-06
ENE	w	563	1.51E-08	7.82E-07	9.21E-07	1.35E-06	9.21E-07	3.43E-06
E	l	950	1.64E-08	3.19E-07	3.58E-07	5.39E-07	3.58E-07	1.05E-06
ESE	l	1030	1.78E-08	1.78E-07	1.97E-07	3.02E-07	1.97E-07	5.86E-07
SE	l	1110	1.94E-08	1.22E-07	1.33E-07	2.28E-07	1.33E-07	4.17E-07
SSE	l	1754	1.57E-08	4.74E-08	4.94E-08	9.17E-08	4.94E-08	1.73E-07
S	l	2205	1.79E-08	4.71E-08	4.80E-08	8.30E-08	4.80E-08	1.36E-07
SSW	l	2269	2.19E-08	6.11E-08	6.25E-08	1.14E-07	6.25E-08	2.00E-07
SW	l	2382	1.64E-08	7.97E-08	8.17E-08	1.60E-07	8.17E-08	3.14E-07
WSW	w	1867	3.55E-09	4.08E-08	4.52E-08	1.23E-07	4.52E-08	4.14E-07
W	w	644	1.33E-09	9.17E-08	1.43E-07	2.48E-07	1.43E-07	2.68E-06
WNW	w	370	1.87E-09	6.82E-07	9.99E-07	1.37E-06	9.99E-07	1.39E-05
NW	w	306	2.50E-09	1.77E-06	2.37E-06	3.09E-06	2.37E-06	2.60E-05
NNW	w	241	3.96E-10	2.98E-06	3.85E-06	4.81E-06	3.85E-06	3.68E-05

l = land

w = water

TABLE C-2
FINITE CLOUD GAMMA X/Q VALUES FOR SITE BOUNDARY DETERMINED FROM ANNUAL AVERAGE METEROLOGICAL DATA (1985 To 1992)

Finite Cloud Gamma X/Q

(sec/m^3)

Direction		Distance (m)	Stack
N	w	225	1.32E-07
NNE	w	225	1.06E-07
NE	w	354	1.12E-07
ENE	w	563	1.82E-07
E	l	950	1.16E-07
ESE	l	1030	7.71E-08
SE	l	1110	6.23E-08
SSE	l	1754	3.34E-08
S	l	2205	3.02E-08
SSW	l	2269	3.89E-08
SW	l	2382	3.45E-08
WSW	w	1867	2.20E-08
W	w	644	5.43E-08
WNW	w	370	8.40E-08
NW	w	306	1.38E-07
NNW	w	241	1.38E-07

l = land

w = water

TABLE C-3
DEPOSITION D/Q VALUES FOR SITE BOUNDARY DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)

(D/Q) Sector Average Deposition (1/m^2)

SEGMENT BOUNDARIES IN MILES

Direction		Distance (m)	Stack	Turbine Building Vent	Refuel Floor Vent	Radwaste Building Vent	Reactor Building Vent	Unmonitored Ground Level Release
N	w	225	2.95E-10	2.27E-08	2.65E-08	3.63E-08	2.65E-08	1.33E-07
NNE	w	225	9.26E-11	1.02E-08	1.18E-08	1.65E-08	1.18E-08	7.09E-08
NE	w	354	9.30E-11	6.21E-09	7.30E-09	1.05E-08	7.30E-09	3.00E-08
ENE	w	563	1.65E-09	1.40E-08	1.55E-08	2.00E-08	1.55E-08	3.23E-08
E	l	950	1.73E-09	9.03E-09	9.49E-09	1.11E-08	9.49E-09	1.35E-08
ESE	l	1030	1.70E-09	6.22E-09	6.49E-09	7.43E-09	6.49E-09	8.76E-09
SE	l	1110	1.61E-09	4.37E-09	4.54E-09	5.42E-09	4.54E-09	6.46E-09
SSE	l	1754	7.57E-10	1.16E-09	1.19E-09	1.39E-09	1.19E-09	1.85E-09
S	l	2205	5.52E-10	9.15E-10	9.31E-10	1.06E-09	9.31E-10	1.41E-09
SSW	l	2269	6.50E-10	7.66E-10	7.76E-10	9.33E-10	7.76E-10	1.37E-09
SW	l	2382	3.23E-10	7.01E-10	7.09E-10	9.00E-10	7.09E-10	1.51E-09
WSW	w	1867	9.10E-11	2.97E-10	3.08E-10	4.68E-10	3.08E-10	1.25E-09
W	w	644	7.43E-11	7.58E-10	9.15E-10	1.59E-09	9.15E-10	7.79E-09
WNW	w	370	1.89E-10	4.56E-09	5.56E-09	8.40E-09	5.56E-09	4.10E-08
NW	w	306	4.28E-10	1.22E-08	1.45E-08	2.08E-08	1.45E-08	8.55E-08
NNW	w	241	3.63E-10	1.71E-08	2.03E-08	2.80E-08	2.03E-08	1.14E-07

l = land

w = water

TABLE C-4
SECTOR AVERAGE DISPERSION VALUES FOR REACTOR VENT DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	5.667E-07	3.319E-07	2.409E-07	1.596E-07	9.380E-08	6.472E-08
NNE	2.600E-07	1.591E-07	1.198E-07	8.235E-08	4.960E-08	3.446E-08
NE	2.296E-07	1.410E-07	1.048E-07	7.034E-08	4.129E-08	2.830E-08
ENE	5.479E-07	3.185E-07	2.260E-07	1.452E-07	7.962E-08	5.287E-08
E	4.528E-07	2.601E-07	1.808E-07	1.132E-07	5.918E-08	3.843E-08
ESE	2.804E-07	1.631E-07	1.142E-07	6.935E-08	3.941E-08	2.559E-08
SE	1.991E-07	1.204E-07	8.715E-08	5.609E-08	3.276E-08	2.602E-08
SSE	1.071E-07	6.936E-08	5.348E-08	3.911E-08	2.835E-08	2.013E-08
S	1.150E-07	7.388E-08	5.963E-08	4.379E-08	3.218E-08	2.223E-08
SSW	1.388E-07	9.086E-08	7.603E-08	5.888E-08	3.860E-08	2.786E-08
SW	1.688E-07	1.129E-07	1.094E-07	8.073E-08	5.290E-08	3.576E-08
WSW	8.263E-08	5.551E-08	4.795E-08	4.949E-08	3.369E-08	2.430E-08
W	1.040E-07	6.463E-08	5.213E-08	4.115E-08	2.881E-08	2.151E-08
WNW	2.926E-07	1.754E-07	1.326E-07	9.420E-08	5.955E-08	4.260E-08
NW	5.036E-07	3.005E-07	2.226E-07	1.520E-07	9.183E-08	6.416E-08
NNW	5.247E-07	3.041E-07	2.202E-07	1.468E-07	8.737E-08	6.082E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	4.865E-08	2.687E-08	1.186E-08	6.640E-09	4.458E-09	3.915E-09
NNE	2.595E-08	1.428E-08	6.212E-09	4.945E-09	3.183E-09	2.299E-09
NE	2.110E-08	1.138E-08	5.166E-09	3.338E-09	2.130E-09	1.530E-09
ENE	3.870E-08	2.034E-08	1.024E-08	5.223E-09	3.362E-09	2.430E-09
E	2.779E-08	1.440E-08	7.309E-09	3.751E-09	2.434E-09	1.772E-09
ESE	1.849E-08	1.133E-08	4.571E-09	2.357E-09	1.535E-09	1.121E-09
SE	1.833E-08	9.165E-09	3.693E-09	1.922E-09	1.261E-09	9.270E-10
SSE	1.438E-08	7.159E-09	2.869E-09	1.492E-09	9.784E-10	7.185E-10
S	1.595E-08	7.922E-09	3.182E-09	1.659E-09	1.091E-09	8.025E-10
SSW	2.231E-08	1.089E-08	4.278E-09	2.156E-09	1.385E-09	1.002E-09
SW	2.896E-08	1.667E-08	6.450E-09	3.357E-09	2.135E-09	1.532E-09
WSW	1.856E-08	1.029E-08	4.799E-09	2.500E-09	1.783E-09	1.393E-09
W	1.690E-08	9.922E-09	4.586E-09	2.552E-09	1.729E-09	1.294E-09
WNW	3.276E-08	1.885E-08	8.746E-09	4.942E-09	3.391E-09	2.562E-09
NW	4.862E-08	2.733E-08	1.241E-08	6.932E-09	4.729E-09	3.560E-09
NNW	4.607E-08	2.596E-08	1.186E-08	6.657E-09	4.554E-09	3.433E-09

TABLE C-4 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR REACTOR VENT DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
(D/Q) Sector Average Deposition (1/m^2)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	4.951E-09	2.856E-09	1.927E-09	1.065E-09	4.777E-10	2.756E-10
NNE	2.348E-09	1.421E-09	9.951E-10	5.692E-10	2.619E-10	1.528E-10
NE	2.456E-09	1.458E-09	1.004E-09	5.654E-10	2.556E-10	1.477E-10
ENE	9.540E-09	5.276E-09	3.429E-09	1.835E-09	8.030E-10	4.595E-10
E	1.212E-08	6.587E-09	4.219E-09	2.224E-09	9.594E-10	5.450E-10
ESE	9.330E-09	5.097E-09	3.260E-09	1.707E-09	7.428E-10	4.219E-10
SE	7.165E-09	3.997E-09	2.587E-09	1.378E-09	6.078E-10	3.473E-10
SSE	3.529E-09	2.047E-09	1.348E-09	7.357E-10	3.353E-10	1.926E-10
S	3.791E-09	2.219E-09	1.477E-09	8.098E-10	3.723E-10	2.142E-10
SSW	2.906E-09	1.760E-09	1.231E-09	7.082E-10	3.322E-10	1.950E-10
SW	2.421E-09	1.564E-09	1.185E-09	6.960E-10	3.340E-10	1.972E-10
WSW	6.780E-10	4.656E-10	3.626E-10	2.368E-10	1.188E-10	7.206E-11
W	7.119E-10	4.615E-10	3.455E-10	2.100E-10	1.041E-10	6.282E-11
WNW	2.129E-09	1.329E-09	9.567E-10	5.617E-10	2.648E-10	1.561E-10
NW	4.192E-09	2.500E-09	1.735E-09	9.847E-10	4.514E-10	2.629E-10
NNW	4.251E-09	2.462E-09	1.669E-09	9.270E-10	4.186E-10	2.423E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.805E-10	7.499E-11	2.350E-11	1.000E-11	5.731E-12	5.309E-11
NNE	1.006E-10	4.197E-11	1.303E-11	1.958E-11	9.064E-12	5.188E-12
NE	9.681E-11	4.014E-11	1.237E-11	9.909E-12	5.316E-12	3.291E-12
ENE	2.998E-10	1.245E-10	9.570E-11	2.256E-11	1.210E-11	7.496E-12
E	3.539E-10	1.462E-10	6.692E-11	2.192E-11	1.176E-11	7.287E-12
ESE	2.738E-10	1.133E-10	4.636E-11	1.651E-11	8.777E-12	5.439E-12
SE	2.252E-10	9.507E-11	3.796E-11	1.493E-11	7.928E-12	4.765E-12
SSE	1.266E-10	5.635E-11	2.578E-11	1.172E-11	4.605E-12	2.811E-12
S	1.434E-10	6.420E-11	2.776E-11	1.370E-11	5.149E-12	3.137E-12
SSW	1.279E-10	5.527E-11	3.074E-11	1.119E-11	5.882E-12	3.129E-12
SW	1.318E-10	5.575E-11	3.290E-11	1.541E-11	7.800E-12	4.596E-12
WSW	4.828E-11	2.055E-11	6.450E-12	2.997E-12	2.323E-11	2.807E-12
W	4.194E-11	1.780E-11	5.615E-12	2.418E-12	1.384E-12	9.038E-13
WNW	1.032E-10	4.323E-11	1.338E-11	5.670E-12	3.207E-12	2.082E-12
NW	1.730E-10	7.212E-11	2.246E-11	9.534E-12	5.405E-12	3.520E-12
NNW	1.590E-10	6.621E-11	2.081E-11	8.887E-12	5.062E-12	3.309E-12

TABLE C-5
SECTOR AVERAGE DISPERSION VALUES FOR REFUEL FLOOR VENT
DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA
(1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	5.667E-07	3.319E-07	2.409E-07	1.596E-07	9.380E-08	6.472E-08
NNE	2.600E-07	1.591E-07	1.198E-07	8.235E-08	4.960E-08	3.446E-08
NE	2.296E-07	1.410E-07	1.048E-07	7.034E-08	4.129E-08	2.830E-08
ENE	5.479E-07	3.185E-07	2.260E-07	1.452E-07	7.962E-08	5.287E-08
E	4.528E-07	2.601E-07	1.808E-07	1.132E-07	5.918E-08	3.843E-08
ESE	2.804E-07	1.631E-07	1.142E-07	6.935E-08	3.941E-08	2.559E-08
SE	1.991E-07	1.204E-07	8.715E-08	5.609E-08	3.276E-08	2.602E-08
SSE	1.071E-07	6.936E-08	5.348E-08	3.911E-08	2.835E-08	2.013E-08
S	1.150E-07	7.388E-08	5.963E-08	4.379E-08	3.218E-08	2.223E-08
SSW	1.388E-07	9.086E-08	7.603E-08	5.888E-08	3.860E-08	2.786E-08
SW	1.688E-07	1.129E-07	1.094E-07	8.073E-08	5.290E-08	3.576E-08
WSW	8.263E-08	5.551E-08	4.795E-08	4.949E-08	3.369E-08	2.430E-08
W	1.040E-07	6.463E-08	5.213E-08	4.115E-08	2.881E-08	2.151E-08
WNW	2.926E-07	1.754E-07	1.326E-07	9.420E-08	5.955E-08	4.260E-08
NW	5.036E-07	3.005E-07	2.226E-07	1.520E-07	9.183E-08	6.416E-08
NNW	5.247E-07	3.041E-07	2.202E-07	1.468E-07	8.737E-08	6.082E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	4.865E-08	2.687E-08	1.186E-08	6.640E-09	4.458E-09	3.915E-09
NNE	2.595E-08	1.428E-08	6.212E-09	4.945E-09	3.183E-09	2.299E-09
NE	2.110E-08	1.138E-08	5.166E-09	3.338E-09	2.130E-09	1.530E-09
ENE	3.870E-08	2.034E-08	1.024E-08	5.223E-09	3.362E-09	2.430E-09
E	2.779E-08	1.440E-08	7.309E-09	3.751E-09	2.434E-09	1.772E-09
ESE	1.849E-08	1.133E-08	4.571E-09	2.357E-09	1.535E-09	1.121E-09
SE	1.833E-08	9.165E-09	3.693E-09	1.922E-09	1.261E-09	9.270E-10
SSE	1.438E-08	7.159E-09	2.869E-09	1.492E-09	9.784E-10	7.185E-10
S	1.595E-08	7.922E-09	3.182E-09	1.659E-09	1.091E-09	8.025E-10
SSW	2.231E-08	1.089E-08	4.278E-09	2.156E-09	1.385E-09	1.002E-09
SW	2.896E-08	1.667E-08	6.450E-09	3.357E-09	2.135E-09	1.532E-09
WSW	1.856E-08	1.029E-08	4.799E-09	2.500E-09	1.783E-09	1.393E-09
W	1.690E-08	9.922E-09	4.586E-09	2.552E-09	1.729E-09	1.294E-09
WNW	3.276E-08	1.885E-08	8.746E-09	4.942E-09	3.391E-09	2.562E-09
NW	4.862E-08	2.733E-08	1.241E-08	6.932E-09	4.729E-09	3.560E-09
NNW	4.607E-08	2.596E-08	1.186E-08	6.657E-09	4.554E-09	3.433E-09

TABLE C-5 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR REFUEL FLOOR VENT DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
(D/Q) Sector Average Deposition ($1/m^2$)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	4.951E-09	2.856E-09	1.927E-09	1.065E-09	4.777E-10	2.756E-10
NNE	2.348E-09	1.421E-09	9.951E-10	5.692E-10	2.619E-10	1.528E-10
NE	2.456E-09	1.458E-09	1.004E-09	5.654E-10	2.556E-10	1.477E-10
ENE	9.540E-09	5.276E-09	3.429E-09	1.835E-09	8.030E-10	4.595E-10
E	1.212E-08	6.587E-09	4.219E-09	2.224E-09	9.594E-10	5.450E-10
ESE	9.330E-09	5.097E-09	3.260E-09	1.707E-09	7.428E-10	4.219E-10
SE	7.165E-09	3.997E-09	2.587E-09	1.378E-09	6.078E-10	3.473E-10
SSE	3.529E-09	2.047E-09	1.348E-09	7.357E-10	3.353E-10	1.926E-10
S	3.791E-09	2.219E-09	1.477E-09	8.098E-10	3.723E-10	2.142E-10
SSW	2.906E-09	1.760E-09	1.231E-09	7.082E-10	3.322E-10	1.950E-10
SW	2.421E-09	1.564E-09	1.185E-09	6.960E-10	3.340E-10	1.972E-10
WSW	6.780E-10	4.656E-10	3.626E-10	2.368E-10	1.188E-10	7.206E-11
W	7.119E-10	4.615E-10	3.455E-10	2.100E-10	1.041E-10	6.282E-11
WNW	2.129E-09	1.329E-09	9.567E-10	5.617E-10	2.648E-10	1.561E-10
NW	4.192E-09	2.500E-09	1.735E-09	9.847E-10	4.514E-10	2.629E-10
NNW	4.251E-09	2.462E-09	1.669E-09	9.270E-10	4.186E-10	2.423E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.805E-10	7.499E-11	2.350E-11	1.000E-11	5.731E-12	5.309E-11
NNE	1.006E-10	4.197E-11	1.303E-11	1.958E-11	9.064E-12	5.188E-12
NE	9.681E-11	4.014E-11	1.237E-11	9.909E-12	5.316E-12	3.291E-12
ENE	2.998E-10	1.245E-10	9.570E-11	2.256E-11	1.210E-11	7.496E-12
E	3.539E-10	1.462E-10	6.692E-11	2.192E-11	1.176E-11	7.287E-12
ESE	2.738E-10	1.133E-10	4.636E-11	1.651E-11	8.777E-12	5.439E-12
SE	2.252E-10	9.507E-11	3.796E-11	1.493E-11	7.928E-12	4.765E-12
SSE	1.266E-10	5.635E-11	2.578E-11	1.172E-11	4.605E-12	2.811E-12
S	1.434E-10	6.420E-11	2.776E-11	1.370E-11	5.149E-12	3.137E-12
SSW	1.279E-10	5.527E-11	3.074E-11	1.119E-11	5.882E-12	3.129E-12
SW	1.318E-10	5.575E-11	3.290E-11	1.541E-11	7.800E-12	4.596E-12
WSW	4.828E-11	2.055E-11	6.450E-12	2.997E-12	2.323E-11	2.807E-12
W	4.194E-11	1.780E-11	5.615E-12	2.418E-12	1.384E-12	9.038E-13
WNW	1.032E-10	4.323E-11	1.338E-11	5.670E-12	3.207E-12	2.082E-12
NW	1.730E-10	7.212E-11	2.246E-11	9.534E-12	5.405E-12	3.520E-12
NNW	1.590E-10	6.621E-11	2.081E-11	8.887E-12	5.062E-12	3.309E-12

TABLE C-6
SECTOR AVERAGE DISPERSION VALUES FOR TURBINE VENT DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	4.745E-07	2.863E-07	2.135E-07	1.455E-07	8.729E-08	6.072E-08
NNE	2.185E-07	1.391E-07	1.080E-07	7.646E-08	4.692E-08	3.283E-08
NE	1.908E-07	1.216E-07	9.320E-08	6.460E-08	3.878E-08	2.680E-08
ENE	4.685E-07	2.784E-07	2.016E-07	1.333E-07	7.437E-08	4.972E-08
E	4.004E-07	2.349E-07	1.660E-07	1.065E-07	5.619E-08	3.664E-08
ESE	2.495E-07	1.493E-07	1.063E-07	6.567E-08	3.806E-08	2.477E-08
SE	1.786E-07	1.116E-07	8.218E-08	5.383E-08	3.190E-08	2.554E-08
SSE	9.585E-08	6.492E-08	5.110E-08	3.820E-08	2.809E-08	1.988E-08
S	1.034E-07	6.930E-08	5.745E-08	4.300E-08	3.197E-08	2.199E-08
SSW	1.215E-07	8.350E-08	7.256E-08	5.767E-08	3.815E-08	2.758E-08
SW	1.416E-07	1.007E-07	1.047E-07	7.883E-08	5.215E-08	3.523E-08
WSW	5.908E-08	4.428E-08	4.183E-08	4.757E-08	3.288E-08	2.378E-08
W	6.826E-08	4.692E-08	4.159E-08	3.599E-08	2.653E-08	2.013E-08
WNW	2.087E-07	1.345E-07	1.079E-07	8.132E-08	5.342E-08	3.877E-08
NW	3.914E-07	2.458E-07	1.897E-07	1.349E-07	8.370E-08	5.909E-08
NNW	4.173E-07	2.514E-07	1.883E-07	1.300E-07	7.933E-08	5.580E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	4.584E-08	2.550E-08	1.134E-08	6.384E-09	4.294E-09	3.815E-09
NNE	2.481E-08	1.372E-08	5.996E-09	4.845E-09	3.117E-09	2.252E-09
NE	2.007E-08	1.089E-08	4.994E-09	3.250E-09	2.074E-09	1.489E-09
ENE	3.653E-08	1.930E-08	9.903E-09	5.042E-09	3.245E-09	2.346E-09
E	2.656E-08	1.381E-08	7.100E-09	3.641E-09	2.362E-09	1.720E-09
ESE	1.792E-08	1.108E-08	4.459E-09	2.297E-09	1.496E-09	1.093E-09
SE	1.797E-08	8.964E-09	3.605E-09	1.875E-09	1.230E-09	9.044E-10
SSE	1.416E-08	7.035E-09	2.816E-09	1.463E-09	9.598E-10	7.048E-10
S	1.571E-08	7.792E-09	3.126E-09	1.629E-09	1.071E-09	7.880E-10
SSW	2.205E-08	1.074E-08	4.204E-09	2.118E-09	1.360E-09	9.842E-10
SW	2.862E-08	1.648E-08	6.362E-09	3.300E-09	2.098E-09	1.506E-09
WSW	1.817E-08	1.008E-08	4.723E-09	2.459E-09	1.757E-09	1.368E-09
W	1.593E-08	9.451E-09	4.406E-09	2.462E-09	1.672E-09	1.253E-09
WNW	3.006E-08	1.752E-08	8.236E-09	4.686E-09	3.228E-09	2.445E-09
NW	4.505E-08	2.558E-08	1.174E-08	6.598E-09	4.516E-09	3.407E-09
NNW	4.254E-08	2.422E-08	1.119E-08	6.323E-09	4.340E-09	3.279E-09

TABLE C-6 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR TURBINE VENT DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
(D/Q) Sector Average Deposition ($1/m^2$)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	4.471E-09	2.622E-09	1.788E-09	9.981E-10	4.499E-10	2.601E-10
NNE	2.162E-09	1.335E-09	9.453E-10	5.462E-10	2.521E-10	1.472E-10
NE	2.186E-09	1.329E-09	9.286E-10	5.298E-10	2.409E-10	1.395E-10
ENE	8.763E-09	4.896E-09	3.204E-09	1.729E-09	7.605E-10	4.363E-10
E	1.148E-08	6.289E-09	4.047E-09	2.149E-09	9.307E-10	5.299E-10
ESE	8.909E-09	4.906E-09	3.151E-09	1.660E-09	7.258E-10	4.130E-10
SE	6.876E-09	3.858E-09	2.503E-09	1.341E-09	5.937E-10	3.397E-10
SSE	3.429E-09	1.995E-09	1.315E-09	7.210E-10	3.289E-10	1.890E-10
S	3.698E-09	2.171E-09	1.447E-09	7.965E-10	3.662E-10	2.108E-10
SSW	2.822E-09	1.722E-09	1.209E-09	6.997E-10	3.281E-10	1.923E-10
SW	2.314E-09	1.520E-09	1.164E-09	6.882E-10	3.299E-10	1.945E-10
WSW	6.070E-10	4.358E-10	3.469E-10	2.310E-10	1.159E-10	7.021E-11
W	6.082E-10	4.138E-10	3.183E-10	1.977E-10	9.874E-11	5.972E-11
WNW	1.870E-09	1.209E-09	8.870E-10	5.293E-10	2.511E-10	1.483E-10
NW	3.749E-09	2.290E-09	1.611E-09	9.262E-10	4.269E-10	2.492E-10
NNW	3.807E-09	2.246E-09	1.540E-09	8.652E-10	3.928E-10	2.280E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.706E-10	7.094E-11	2.218E-11	9.588E-12	5.736E-12	8.525E-11
NNE	9.706E-11	4.050E-11	1.253E-11	1.916E-11	8.919E-12	5.122E-12
NE	9.157E-11	3.799E-11	1.175E-11	9.911E-12	5.318E-12	3.292E-12
ENE	2.851E-10	1.186E-10	9.504E-11	2.256E-11	1.211E-11	7.499E-12
E	3.447E-10	1.427E-10	6.735E-11	2.192E-11	1.177E-11	7.290E-12
ESE	2.684E-10	1.124E-10	4.674E-11	1.645E-11	8.781E-12	5.440E-12
SE	2.212E-10	9.493E-11	3.784E-11	1.485E-11	7.867E-12	4.731E-12
SSE	1.257E-10	5.742E-11	2.530E-11	1.104E-11	4.586E-12	2.812E-12
S	1.444E-10	6.569E-11	2.721E-11	1.289E-11	5.120E-12	3.138E-12
SSW	1.262E-10	5.539E-11	2.941E-11	1.103E-11	5.812E-12	3.129E-12
SW	1.299E-10	5.523E-11	3.711E-11	1.548E-11	7.792E-12	4.577E-12
WSW	4.707E-11	2.001E-11	6.249E-12	3.103E-12	3.395E-11	2.790E-12
W	3.996E-11	1.697E-11	5.314E-12	2.295E-12	1.321E-12	8.690E-13
WNW	9.827E-11	4.117E-11	1.267E-11	5.391E-12	3.075E-12	2.019E-12
NW	1.642E-10	6.851E-11	2.125E-11	9.075E-12	5.220E-12	3.464E-12
NNW	1.498E-10	6.246E-11	1.958E-11	8.426E-12	4.885E-12	3.267E-12

TABLE C-7
SECTOR AVERAGE DISPERSION VALUES FOR RADWASTE VENT DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	9.289E-07	6.007E-07	4.440E-07	2.832E-07	1.567E-07	1.052E-07
NNE	4.668E-07	3.155E-07	2.371E-07	1.529E-07	8.435E-08	5.617E-08
NE	4.087E-07	2.683E-07	1.978E-07	1.247E-07	6.698E-08	4.381E-08
ENE	8.420E-07	5.096E-07	3.592E-07	2.227E-07	1.142E-07	7.324E-08
E	6.787E-07	3.900E-07	2.660E-07	1.626E-07	8.118E-08	5.158E-08
ESE	4.270E-07	2.525E-07	1.727E-07	1.002E-07	5.512E-08	3.467E-08
SE	3.397E-07	2.050E-07	1.413E-07	8.476E-08	4.607E-08	3.077E-08
SSE	1.996E-07	1.413E-07	1.017E-07	6.620E-08	3.908E-08	2.419E-08
S	2.112E-07	1.498E-07	1.138E-07	7.360E-08	4.310E-08	2.660E-08
SSW	2.970E-07	2.024E-07	1.587E-07	1.052E-07	5.857E-08	3.831E-08
SW	3.696E-07	2.716E-07	2.542E-07	1.569E-07	8.631E-08	5.441E-08
WSW	1.939E-07	1.634E-07	1.376E-07	1.185E-07	6.500E-08	4.262E-08
W	2.088E-07	1.643E-07	1.369E-07	9.847E-08	5.958E-08	4.143E-08
WNW	5.250E-07	3.657E-07	2.845E-07	1.925E-07	1.135E-07	7.900E-08
NW	8.757E-07	5.846E-07	4.402E-07	2.869E-07	1.634E-07	1.120E-07
NNW	8.560E-07	5.557E-07	4.144E-07	2.685E-07	1.531E-07	1.051E-07

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	7.785E-08	4.199E-08	1.805E-08	9.939E-09	6.584E-09	5.508E-09
NNE	4.127E-08	2.189E-08	9.195E-09	5.947E-09	3.828E-09	2.766E-09
NE	3.177E-08	1.642E-08	7.167E-09	3.976E-09	2.538E-09	1.823E-09
ENE	5.250E-08	2.670E-08	1.191E-08	6.030E-09	3.879E-09	2.803E-09
E	3.681E-08	1.868E-08	8.370E-09	4.283E-09	2.778E-09	2.022E-09
ESE	2.458E-08	1.326E-08	5.225E-09	2.684E-09	1.747E-09	1.276E-09
SE	2.154E-08	1.063E-08	4.246E-09	2.205E-09	1.446E-09	1.062E-09
SSE	1.695E-08	8.373E-09	3.340E-09	1.733E-09	1.136E-09	8.335E-10
S	1.865E-08	9.222E-09	3.690E-09	1.920E-09	1.261E-09	9.272E-10
SSW	2.696E-08	1.300E-08	4.993E-09	2.515E-09	1.615E-09	1.168E-09
SW	4.155E-08	2.103E-08	7.964E-09	3.960E-09	2.520E-09	1.809E-09
WSW	3.087E-08	1.587E-08	6.862E-09	3.473E-09	2.331E-09	1.681E-09
W	3.125E-08	1.729E-08	7.572E-09	4.088E-09	2.722E-09	2.012E-09
WNW	5.992E-08	3.374E-08	1.518E-08	8.361E-09	5.637E-09	4.201E-09
NW	8.418E-08	4.678E-08	2.083E-08	1.141E-08	7.675E-09	5.711E-09
NNW	7.914E-08	4.414E-08	1.974E-08	1.085E-08	7.307E-09	5.443E-09

TABLE C-7 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR RADWASTE VENT DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
(D/Q) Sector Average Deposition ($1/m^2$)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	7.139E-09	3.957E-09	2.509E-09	1.308E-09	5.489E-10	3.053E-10
NNE	3.697E-09	2.120E-09	1.363E-09	7.217E-10	3.046E-10	1.697E-10
NE	3.738E-09	2.100E-09	1.337E-09	6.993E-10	2.930E-10	1.625E-10
ENE	1.197E-08	6.395E-09	3.998E-09	2.058E-09	8.649E-10	4.834E-10
E	1.429E-08	7.542E-09	4.691E-09	2.400E-09	1.006E-09	5.616E-10
ESE	1.088E-08	5.771E-09	3.590E-09	1.833E-09	7.733E-10	4.331E-10
SE	8.853E-09	4.728E-09	2.941E-09	1.510E-09	6.410E-10	4.709E-10
SSE	4.668E-09	2.551E-09	1.593E-09	8.277E-10	3.887E-10	3.189E-10
S	5.074E-09	2.781E-09	1.752E-09	9.121E-10	4.447E-10	3.448E-10
SSW	4.395E-09	2.459E-09	1.585E-09	8.439E-10	3.627E-10	2.380E-10
SW	4.104E-09	2.423E-09	1.653E-09	8.807E-10	3.772E-10	2.107E-10
WSW	1.314E-09	8.355E-10	5.716E-10	3.315E-10	1.429E-10	8.030E-11
W	1.257E-09	7.732E-10	5.198E-10	2.877E-10	1.248E-10	7.047E-11
WNW	3.526E-09	2.077E-09	1.355E-09	7.280E-10	3.094E-10	1.727E-10
NW	6.440E-09	3.665E-09	2.353E-09	1.242E-09	5.239E-10	2.917E-10
NNW	6.161E-09	3.436E-09	2.187E-09	1.144E-09	4.817E-10	2.683E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.960E-10	8.595E-11	1.329E-10	3.272E-10	3.824E-10	2.186E-11
NNE	1.089E-10	4.740E-11	6.689E-11	1.218E-11	6.526E-12	4.037E-12
NE	1.040E-10	4.433E-11	5.931E-11	9.899E-12	5.306E-12	3.283E-12
ENE	3.114E-10	1.326E-10	8.260E-11	2.254E-11	1.209E-11	7.484E-12
E	3.613E-10	1.508E-10	6.296E-11	2.190E-11	1.175E-11	7.278E-12
ESE	2.795E-10	1.565E-10	4.490E-11	1.635E-11	8.770E-12	5.432E-12
SE	3.152E-10	1.283E-10	3.658E-11	1.382E-11	7.413E-12	4.590E-12
SSE	2.167E-10	8.427E-11	2.362E-11	8.810E-12	4.534E-12	2.805E-12
S	2.195E-10	8.754E-11	2.582E-11	9.909E-12	5.060E-12	3.130E-12
SSW	2.885E-10	1.221E-10	2.685E-11	9.418E-12	5.047E-12	3.122E-12
SW	1.536E-10	1.603E-10	4.503E-11	1.117E-11	5.944E-12	3.669E-12
WSW	5.191E-11	2.346E-11	3.839E-11	4.126E-11	4.659E-12	1.963E-12
W	4.561E-11	1.917E-11	2.377E-11	8.037E-11	1.204E-10	1.255E-10
WNW	1.110E-10	4.715E-11	6.492E-11	1.955E-10	2.750E-10	2.777E-10
NW	1.873E-10	8.094E-11	1.173E-10	3.145E-10	4.176E-10	4.099E-10
NNW	1.725E-10	7.523E-11	1.182E-10	3.151E-10	4.133E-10	4.025E-10

TABLE C-8
SECTOR AVERAGE DISPERSION VALUES FOR THE STACK DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	6.304E-09	7.537E-09	9.600E-09	1.382E-08	1.504E-08	1.366E-08
NNE	2.263E-09	3.378E-09	5.419E-09	9.466E-09	1.092E-08	1.011E-08
NE	1.092E-09	2.089E-09	4.269E-09	8.509E-09	1.005E-08	9.366E-09
ENE	1.260E-08	1.222E-08	1.454E-08	2.100E-08	2.117E-08	1.845E-08
E	1.547E-08	1.816E-08	2.136E-08	2.978E-08	2.655E-08	2.150E-08
ESE	1.888E-08	1.914E-08	2.056E-08	2.174E-08	2.283E-08	1.737E-08
SE	2.187E-08	1.933E-08	1.993E-08	2.243E-08	2.028E-08	2.229E-08
SSE	1.833E-08	1.560E-08	1.566E-08	1.731E-08	2.077E-08	1.817E-08
S	1.747E-08	1.440E-08	1.540E-08	1.730E-08	2.211E-08	1.900E-08
SSW	1.689E-08	1.479E-08	1.724E-08	2.180E-08	2.270E-08	1.996E-08
SW	6.866E-09	6.874E-09	1.247E-08	1.675E-08	1.789E-08	1.442E-08
WSW	1.163E-09	1.723E-09	2.811E-09	6.821E-09	7.244E-09	6.414E-09
W	1.151E-09	1.393E-09	2.274E-09	4.102E-09	4.796E-09	4.483E-09
WNW	2.266E-09	3.077E-09	4.890E-09	8.276E-09	9.171E-09	8.262E-09
NW	5.561E-09	6.833E-09	9.696E-09	1.511E-08	1.648E-08	1.481E-08
NNW	6.602E-09	7.476E-09	9.456E-09	1.365E-08	1.498E-08	1.370E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.190E-08	7.990E-09	4.005E-09	2.317E-09	1.572E-09	1.348E-09
NNE	8.882E-09	6.046E-09	3.081E-09	4.716E-09	3.041E-09	2.200E-09
NE	8.270E-09	5.697E-09	3.376E-09	5.591E-09	3.622E-09	2.629E-09
ENE	1.569E-08	1.021E-08	8.735E-09	6.410E-09	4.121E-09	2.977E-09
E	1.748E-08	1.059E-08	7.444E-09	4.667E-09	2.974E-09	2.137E-09
ESE	1.362E-08	1.066E-08	4.756E-09	3.000E-09	1.917E-09	1.381E-09
SE	1.624E-08	8.678E-09	3.802E-09	2.282E-09	1.464E-09	1.059E-09
SSE	1.421E-08	7.626E-09	3.217E-09	1.770E-09	1.263E-09	9.154E-10
S	1.632E-08	8.545E-09	3.558E-09	1.953E-09	1.440E-09	1.045E-09
SSW	1.910E-08	1.011E-08	4.845E-09	2.835E-09	1.813E-09	1.306E-09
SW	1.354E-08	9.554E-09	4.078E-09	2.987E-09	1.946E-09	1.454E-09
WSW	5.511E-09	3.659E-09	2.100E-09	1.197E-09	9.790E-10	1.201E-09
W	3.977E-09	2.773E-09	1.472E-09	8.742E-10	6.133E-10	4.701E-10
WNW	7.135E-09	4.716E-09	2.335E-09	1.322E-09	9.004E-10	6.765E-10
NW	1.277E-08	8.409E-09	4.115E-09	2.298E-09	1.548E-09	1.152E-09
NNW	1.198E-08	8.121E-09	4.120E-09	2.355E-09	1.608E-09	1.207E-09

TABLE C-8 (CONTINUED)
SECTOR AVERAGE DISPERSION VALUES FOR THE STACK DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
Sector Average Finite Cloud Gamma X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

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Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	1.056E-07	7.326E-08	5.707E-08	4.048E-08	2.615E-08	1.930E-08
NNE	8.423E-08	5.830E-08	4.543E-08	3.233E-08	2.100E-08	1.554E-08
NE	8.669E-08	5.979E-08	4.651E-08	3.304E-08	2.144E-08	1.588E-08
ENE	1.359E-07	9.388E-08	7.314E-08	5.381E-08	3.443E-08	2.522E-08
E	1.345E-07	9.409E-08	7.352E-08	5.582E-08	3.486E-08	2.500E-08
ESE	9.666E-08	6.962E-08	5.419E-08	3.785E-08	2.627E-08	1.849E-08
SE	8.156E-08	5.786E-08	4.497E-08	3.227E-08	2.186E-08	1.919E-08
SSE	6.370E-08	4.642E-08	3.607E-08	2.673E-08	2.041E-08	1.573E-08
S	6.367E-08	4.638E-08	3.736E-08	2.774E-08	2.192E-08	1.668E-08
SSW	8.747E-08	6.029E-08	4.886E-08	3.679E-08	2.549E-08	1.958E-08
SW	7.805E-08	5.421E-08	4.798E-08	3.412E-08	2.313E-08	1.662E-08
WSW	4.633E-08	3.206E-08	2.498E-08	2.009E-08	1.289E-08	9.455E-09
W	4.390E-08	3.020E-08	2.344E-08	1.660E-08	1.074E-08	7.954E-09
WNW	6.518E-08	4.519E-08	3.531E-08	2.520E-08	1.636E-08	1.207E-08
NW	1.075E-07	7.471E-08	5.846E-08	4.177E-08	2.713E-08	2.002E-08
NNW	1.090E-07	7.544E-08	5.873E-08	4.163E-08	2.689E-08	1.987E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.520E-08	9.085E-09	4.282E-09	2.428E-09	1.640E-09	1.343E-09
NNE	1.228E-08	7.377E-09	3.510E-09	3.242E-09	2.140E-09	1.574E-09
NE	1.255E-08	7.577E-09	3.990E-09	3.674E-09	2.441E-09	1.803E-09
ENE	1.975E-08	1.168E-08	7.533E-09	4.588E-09	3.017E-09	2.213E-09
E	1.925E-08	1.103E-08	6.332E-09	3.583E-09	2.329E-09	1.695E-09
ESE	1.405E-08	9.511E-09	4.144E-09	2.339E-09	1.522E-09	1.110E-09
SE	1.411E-08	7.582E-09	3.268E-09	1.809E-09	1.181E-09	8.637E-10
SSE	1.197E-08	6.451E-09	2.751E-09	1.485E-09	1.011E-09	7.413E-10
S	1.317E-08	7.027E-09	2.988E-09	1.616E-09	1.116E-09	8.202E-10
SSW	1.669E-08	8.946E-09	4.025E-09	2.212E-09	1.441E-09	1.051E-09
SW	1.405E-08	8.902E-09	3.815E-09	2.323E-09	1.522E-09	1.125E-09
WSW	7.417E-09	4.409E-09	2.259E-09	1.259E-09	9.433E-10	8.792E-10
W	6.295E-09	3.815E-09	1.849E-09	1.061E-09	7.318E-10	5.545E-10
WNW	9.503E-09	5.659E-09	2.658E-09	1.485E-09	1.006E-09	7.536E-10
NW	1.574E-08	9.343E-09	4.349E-09	2.405E-09	1.617E-09	1.203E-09
NNW	1.567E-08	9.395E-09	4.454E-09	2.499E-09	1.696E-09	1.269E-09

TABLE C-8 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR THE STACK DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985 To 1992)
(D/Q) Sector Average Deposition (1/m^2)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	5.867E-10	5.512E-10	5.298E-10	3.807E-10	2.303E-10	1.496E-10
NNE	2.220E-10	2.564E-10	2.787E-10	2.173E-10	1.374E-10	9.029E-11
NE	1.569E-10	2.254E-10	2.692E-10	2.210E-10	1.434E-10	9.484E-11
ENE	1.440E-09	1.219E-09	1.078E-09	7.247E-10	4.209E-10	2.708E-10
E	1.868E-09	1.566E-09	1.378E-09	9.226E-10	5.343E-10	3.433E-10
ESE	1.970E-09	1.546E-09	1.277E-09	8.070E-10	4.493E-10	2.857E-10
SE	2.009E-09	1.513E-09	1.195E-09	7.215E-10	3.920E-10	2.675E-10
SSE	1.472E-09	1.088E-09	8.401E-10	4.952E-10	2.782E-10	1.783E-10
S	1.432E-09	1.062E-09	8.226E-10	4.864E-10	2.765E-10	1.758E-10
SSW	1.448E-09	1.145E-09	9.499E-10	6.029E-10	3.398E-10	2.227E-10
SW	4.816E-10	4.577E-10	4.424E-10	3.191E-10	1.934E-10	1.258E-10
WSW	7.953E-11	9.105E-11	9.852E-11	7.657E-11	4.834E-11	3.175E-11
W	7.596E-11	8.732E-11	9.453E-11	7.349E-11	4.641E-11	3.049E-11
WNW	2.259E-10	2.548E-10	2.733E-10	2.114E-10	1.331E-10	8.739E-11
NW	5.672E-10	5.729E-10	5.770E-10	4.285E-10	2.640E-10	1.724E-10
NNW	6.313E-10	5.755E-10	5.408E-10	3.820E-10	2.288E-10	1.483E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.024E-10	4.512E-11	1.499E-11	6.634E-12	3.864E-12	2.538E-12
NNE	6.187E-11	2.717E-11	8.936E-12	1.079E-11	1.877E-11	2.331E-11
NE	6.504E-11	2.852E-11	9.333E-12	1.922E-11	7.686E-12	4.762E-12
ENE	1.851E-10	8.191E-11	2.723E-11	2.589E-11	1.390E-11	8.613E-12
E	2.345E-10	1.038E-10	3.439E-11	2.443E-11	1.312E-11	8.128E-12
ESE	1.949E-10	9.097E-11	2.905E-11	1.009E-10	9.057E-12	5.613E-12
SE	1.804E-10	7.805E-11	2.518E-11	1.564E-11	3.646E-11	5.691E-11
SSE	1.212E-10	5.228E-11	1.700E-11	7.764E-12	1.078E-11	3.148E-12
S	1.203E-10	5.162E-11	1.675E-11	7.661E-12	2.389E-11	3.375E-12
SSW	1.581E-10	6.827E-11	2.174E-11	2.120E-11	3.021E-11	5.082E-12
SW	8.713E-11	3.976E-11	1.252E-11	5.266E-12	3.020E-12	2.782E-12
WSW	2.175E-11	9.548E-12	3.137E-12	1.362E-12	7.678E-13	5.268E-13
W	2.089E-11	9.176E-12	3.018E-12	1.312E-12	7.520E-13	4.906E-13
WNW	5.988E-11	2.631E-11	8.665E-12	3.775E-12	2.168E-12	1.417E-12
NW	1.181E-10	5.197E-11	1.720E-11	7.561E-12	4.378E-12	2.873E-12
NNW	1.014E-10	4.475E-11	1.490E-11	6.628E-12	3.876E-12	2.556E-12

TABLE C-9
SECTOR AVERAGE DISPERSION VALUES FOR REACTOR VENT DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	6.872E-07	3.876E-07	2.760E-07	1.809E-07	1.070E-07	7.473E-08
NNE	2.784E-07	1.618E-07	1.187E-07	8.049E-08	4.922E-08	3.490E-08
NE	2.146E-07	1.293E-07	9.637E-08	6.593E-08	4.010E-08	2.814E-08
ENE	5.379E-07	3.161E-07	2.287E-07	1.517E-07	8.544E-08	5.754E-08
E	4.349E-07	2.511E-07	1.781E-07	1.161E-07	6.271E-08	4.151E-08
ESE	2.237E-07	1.316E-07	9.517E-08	6.077E-08	3.752E-08	2.507E-08
SE	1.404E-07	8.555E-08	6.434E-08	4.391E-08	2.761E-08	2.379E-08
SSE	8.466E-08	5.343E-08	4.251E-08	3.290E-08	2.625E-08	1.947E-08
S	1.138E-07	7.142E-08	5.844E-08	4.397E-08	3.334E-08	2.340E-08
SSW	1.195E-07	7.622E-08	6.418E-08	5.096E-08	3.474E-08	2.567E-08
SW	1.568E-07	1.021E-07	9.798E-08	7.350E-08	4.952E-08	3.388E-08
WSW	8.303E-08	5.439E-08	4.638E-08	4.813E-08	3.323E-08	2.418E-08
W	1.023E-07	6.109E-08	4.808E-08	3.752E-08	2.675E-08	2.039E-08
WNW	2.768E-07	1.563E-07	1.144E-07	8.024E-08	5.180E-08	3.796E-08
NW	4.819E-07	2.733E-07	1.974E-07	1.336E-07	8.207E-08	5.850E-08
NNW	5.836E-07	3.255E-07	2.311E-07	1.525E-07	9.119E-08	6.415E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	5.682E-08	3.229E-08	1.487E-08	8.630E-09	5.900E-09	5.432E-09
NNE	2.674E-08	1.527E-08	6.981E-09	6.259E-09	4.065E-09	2.955E-09
NE	2.133E-08	1.186E-08	5.653E-09	3.842E-09	2.467E-09	1.778E-09
ENE	4.249E-08	2.266E-08	1.191E-08	6.123E-09	3.960E-09	2.874E-09
E	3.039E-08	1.610E-08	8.670E-09	4.499E-09	2.939E-09	2.151E-09
ESE	1.846E-08	1.219E-08	5.018E-09	2.620E-09	1.719E-09	1.262E-09
SE	1.691E-08	8.600E-09	3.531E-09	1.859E-09	1.229E-09	9.077E-10
SSE	1.408E-08	7.122E-09	2.909E-09	1.533E-09	1.014E-09	7.489E-10
S	1.694E-08	8.538E-09	3.497E-09	1.849E-09	1.227E-09	9.083E-10
SSW	2.096E-08	1.036E-08	4.152E-09	2.119E-09	1.372E-09	9.979E-10
SW	2.774E-08	1.607E-08	6.287E-09	3.285E-09	2.100E-09	1.512E-09
WSW	1.858E-08	1.043E-08	5.006E-09	2.642E-09	1.930E-09	1.538E-09
W	1.628E-08	9.896E-09	4.778E-09	2.735E-09	1.885E-09	1.426E-09
WNW	2.983E-08	1.804E-08	8.977E-09	5.317E-09	3.751E-09	2.887E-09
NW	4.517E-08	2.656E-08	1.290E-08	7.554E-09	5.303E-09	4.069E-09
NNW	4.913E-08	2.849E-08	1.363E-08	7.907E-09	5.519E-09	4.218E-09

TABLE C-9 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR REACTOR VENT DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
(D/Q) Sector Average Deposition (1/m^2)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	5.293E-09	3.001E-09	1.993E-09	1.084E-09	4.833E-10	2.788E-10
NNE	2.213E-09	1.282E-09	8.672E-10	4.796E-10	2.178E-10	1.268E-10
NE	1.943E-09	1.129E-09	7.661E-10	4.253E-10	1.923E-10	1.114E-10
ENE	9.567E-09	5.374E-09	3.526E-09	1.908E-09	8.486E-10	4.910E-10
E	1.195E-08	6.594E-09	4.262E-09	2.273E-09	9.946E-10	5.705E-10
ESE	7.360E-09	4.098E-09	2.647E-09	1.400E-09	6.200E-10	3.559E-10
SE	4.567E-09	2.616E-09	1.713E-09	9.208E-10	4.141E-10	2.395E-10
SSE	2.349E-09	1.404E-09	9.335E-10	5.095E-10	2.374E-10	1.385E-10
S	3.680E-09	2.178E-09	1.449E-09	7.904E-10	3.660E-10	2.123E-10
SSW	2.552E-09	1.539E-09	1.065E-09	6.032E-10	2.835E-10	1.674E-10
SW	2.250E-09	1.407E-09	1.024E-09	5.859E-10	2.795E-10	1.655E-10
WSW	7.002E-10	4.587E-10	3.426E-10	2.133E-10	1.060E-10	6.420E-11
W	6.960E-10	4.315E-10	3.101E-10	1.811E-10	8.844E-11	5.324E-11
WNW	1.630E-09	9.674E-10	6.706E-10	3.802E-10	1.774E-10	1.045E-10
NW	3.128E-09	1.814E-09	1.232E-09	6.840E-10	3.116E-10	1.814E-10
NNW	4.161E-09	2.381E-09	1.595E-09	8.757E-10	3.947E-10	2.289E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.827E-10	7.623E-11	2.436E-11	1.057E-11	6.134E-12	5.692E-11
NNE	8.343E-11	3.499E-11	1.119E-11	2.150E-11	9.789E-12	5.547E-12
NE	7.311E-11	3.048E-11	9.592E-12	9.504E-12	5.097E-12	3.154E-12
ENE	3.225E-10	1.353E-10	1.156E-10	2.576E-11	1.382E-11	8.557E-12
E	3.727E-10	1.553E-10	7.770E-11	2.423E-11	1.300E-11	8.052E-12
ESE	2.326E-10	9.743E-11	4.546E-11	1.508E-11	7.942E-12	4.919E-12
SE	1.566E-10	6.774E-11	3.081E-11	1.184E-11	6.303E-12	3.709E-12
SSE	9.207E-11	4.261E-11	2.281E-11	1.017E-11	3.707E-12	2.214E-12
S	1.426E-10	6.463E-11	2.960E-11	1.496E-11	5.349E-12	3.211E-12
SSW	1.104E-10	4.819E-11	2.963E-11	1.059E-11	5.586E-12	2.816E-12
SW	1.109E-10	4.744E-11	3.118E-11	1.551E-11	7.818E-12	4.584E-12
WSW	4.303E-11	1.843E-11	5.936E-12	2.825E-12	2.461E-11	2.913E-12
W	3.556E-11	1.520E-11	4.937E-12	2.188E-12	1.280E-12	8.473E-13
WNW	6.913E-11	2.912E-11	9.300E-12	4.046E-12	2.335E-12	1.535E-12
NW	1.193E-10	4.998E-11	1.589E-11	6.865E-12	3.941E-12	2.584E-12
NNW	1.504E-10	6.293E-11	2.015E-11	8.774E-12	5.073E-12	3.346E-12

TABLE C-10
SECTOR AVERAGE DISPERSION VALUES FOR REFUEL FLOOR VENT DETERMINED FROM GRAZING METEOROLOGICAL DATA
(May-Oct, 1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	6.872E-07	3.876E-07	2.760E-07	1.809E-07	1.070E-07	7.473E-08
NNE	2.784E-07	1.618E-07	1.187E-07	8.049E-08	4.922E-08	3.490E-08
NE	2.146E-07	1.293E-07	9.637E-08	6.593E-08	4.010E-08	2.814E-08
ENE	5.379E-07	3.161E-07	2.287E-07	1.517E-07	8.544E-08	5.754E-08
E	4.349E-07	2.511E-07	1.781E-07	1.161E-07	6.271E-08	4.151E-08
ESE	2.237E-07	1.316E-07	9.517E-08	6.077E-08	3.752E-08	2.507E-08
SE	1.404E-07	8.555E-08	6.434E-08	4.391E-08	2.761E-08	2.379E-08
SSE	8.466E-08	5.343E-08	4.251E-08	3.290E-08	2.625E-08	1.947E-08
S	1.138E-07	7.142E-08	5.844E-08	4.397E-08	3.334E-08	2.340E-08
SSW	1.195E-07	7.622E-08	6.418E-08	5.096E-08	3.474E-08	2.567E-08
SW	1.568E-07	1.021E-07	9.798E-08	7.350E-08	4.952E-08	3.388E-08
WSW	8.303E-08	5.439E-08	4.638E-08	4.813E-08	3.323E-08	2.418E-08
W	1.023E-07	6.109E-08	4.808E-08	3.752E-08	2.675E-08	2.039E-08
WNW	2.768E-07	1.563E-07	1.144E-07	8.024E-08	5.180E-08	3.796E-08
NW	4.819E-07	2.733E-07	1.974E-07	1.336E-07	8.207E-08	5.850E-08
NNW	5.836E-07	3.255E-07	2.311E-07	1.525E-07	9.119E-08	6.415E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	5.682E-08	3.229E-08	1.487E-08	8.630E-09	5.900E-09	5.432E-09
NNE	2.674E-08	1.527E-08	6.981E-09	6.259E-09	4.065E-09	2.955E-09
NE	2.133E-08	1.186E-08	5.653E-09	3.842E-09	2.467E-09	1.778E-09
ENE	4.249E-08	2.266E-08	1.191E-08	6.123E-09	3.960E-09	2.874E-09
E	3.039E-08	1.610E-08	8.670E-09	4.499E-09	2.939E-09	2.151E-09
ESE	1.846E-08	1.219E-08	5.018E-09	2.620E-09	1.719E-09	1.262E-09
SE	1.691E-08	8.600E-09	3.531E-09	1.859E-09	1.229E-09	9.077E-10
SSE	1.408E-08	7.122E-09	2.909E-09	1.533E-09	1.014E-09	7.489E-10
S	1.694E-08	8.538E-09	3.497E-09	1.849E-09	1.227E-09	9.083E-10
SSW	2.096E-08	1.036E-08	4.152E-09	2.119E-09	1.372E-09	9.979E-10
SW	2.774E-08	1.607E-08	6.287E-09	3.285E-09	2.100E-09	1.512E-09
WSW	1.858E-08	1.043E-08	5.006E-09	2.642E-09	1.930E-09	1.538E-09
W	1.628E-08	9.896E-09	4.778E-09	2.735E-09	1.885E-09	1.426E-09
WNW	2.983E-08	1.804E-08	8.977E-09	5.317E-09	3.751E-09	2.887E-09
NW	4.517E-08	2.656E-08	1.290E-08	7.554E-09	5.303E-09	4.069E-09
NNW	4.913E-08	2.849E-08	1.363E-08	7.907E-09	5.519E-09	4.218E-09

TABLE C-10 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR REFUEL FLOOR VENT DETERMINED FROM GRAZING METEOROLOGICAL DATA
(May-Oct, 1985 To 1992)
(D/Q) Sector Average Deposition (1/m^2)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	5.293E-09	3.001E-09	1.993E-09	1.084E-09	4.833E-10	2.788E-10
NNE	2.213E-09	1.282E-09	8.672E-10	4.796E-10	2.178E-10	1.268E-10
NE	1.943E-09	1.129E-09	7.661E-10	4.253E-10	1.923E-10	1.114E-10
ENE	9.567E-09	5.374E-09	3.526E-09	1.908E-09	8.486E-10	4.910E-10
E	1.195E-08	6.594E-09	4.262E-09	2.273E-09	9.946E-10	5.705E-10
ESE	7.360E-09	4.098E-09	2.647E-09	1.400E-09	6.200E-10	3.559E-10
SE	4.567E-09	2.616E-09	1.713E-09	9.208E-10	4.141E-10	2.395E-10
SSE	2.349E-09	1.404E-09	9.335E-10	5.095E-10	2.374E-10	1.385E-10
S	3.680E-09	2.178E-09	1.449E-09	7.904E-10	3.660E-10	2.123E-10
SSW	2.552E-09	1.539E-09	1.065E-09	6.032E-10	2.835E-10	1.674E-10
SW	2.250E-09	1.407E-09	1.024E-09	5.859E-10	2.795E-10	1.655E-10
WSW	7.002E-10	4.587E-10	3.426E-10	2.133E-10	1.060E-10	6.420E-11
W	6.960E-10	4.315E-10	3.101E-10	1.811E-10	8.844E-11	5.324E-11
WNW	1.630E-09	9.674E-10	6.706E-10	3.802E-10	1.774E-10	1.045E-10
NW	3.128E-09	1.814E-09	1.232E-09	6.840E-10	3.116E-10	1.814E-10
NNW	4.161E-09	2.381E-09	1.595E-09	8.757E-10	3.947E-10	2.289E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.827E-10	7.623E-11	2.436E-11	1.057E-11	6.134E-12	5.692E-11
NNE	8.343E-11	3.499E-11	1.119E-11	2.150E-11	9.789E-12	5.547E-12
NE	7.311E-11	3.048E-11	9.592E-12	9.504E-12	5.097E-12	3.154E-12
ENE	3.225E-10	1.353E-10	1.156E-10	2.576E-11	1.382E-11	8.557E-12
E	3.727E-10	1.553E-10	7.770E-11	2.423E-11	1.300E-11	8.052E-12
ESE	2.326E-10	9.743E-11	4.546E-11	1.508E-11	7.942E-12	4.919E-12
SE	1.566E-10	6.774E-11	3.081E-11	1.184E-11	6.303E-12	3.709E-12
SSE	9.207E-11	4.261E-11	2.281E-11	1.017E-11	3.707E-12	2.214E-12
S	1.426E-10	6.463E-11	2.960E-11	1.496E-11	5.349E-12	3.211E-12
SSW	1.104E-10	4.819E-11	2.963E-11	1.059E-11	5.586E-12	2.816E-12
SW	1.109E-10	4.744E-11	3.118E-11	1.551E-11	7.818E-12	4.584E-12
WSW	4.303E-11	1.843E-11	5.936E-12	2.825E-12	2.461E-11	2.913E-12
W	3.556E-11	1.520E-11	4.937E-12	2.188E-12	1.280E-12	8.473E-13
WNW	6.913E-11	2.912E-11	9.300E-12	4.046E-12	2.335E-12	1.535E-12
NW	1.193E-10	4.998E-11	1.589E-11	6.865E-12	3.941E-12	2.584E-12
NNW	1.504E-10	6.293E-11	2.015E-11	8.774E-12	5.073E-12	3.346E-12

TABLE C-11
SECTOR AVERAGE DISPERSION VALUES FOR TURBINE VENT DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	5.709E-07	3.305E-07	2.412E-07	1.625E-07	9.818E-08	6.921E-08
NNE	2.285E-07	1.372E-07	1.037E-07	7.275E-08	4.562E-08	3.268E-08
NE	1.764E-07	1.102E-07	8.477E-08	6.015E-08	3.755E-08	2.661E-08
ENE	4.616E-07	2.776E-07	2.055E-07	1.405E-07	8.050E-08	5.457E-08
E	3.792E-07	2.246E-07	1.625E-07	1.091E-07	5.960E-08	3.964E-08
ESE	1.965E-07	1.194E-07	8.826E-08	5.753E-08	3.635E-08	2.434E-08
SE	1.272E-07	7.992E-08	6.120E-08	4.254E-08	2.712E-08	2.351E-08
SSE	7.646E-08	5.020E-08	4.085E-08	3.235E-08	2.618E-08	1.933E-08
S	1.036E-07	6.737E-08	5.658E-08	4.335E-08	3.322E-08	2.320E-08
SSW	1.046E-07	6.974E-08	6.111E-08	4.995E-08	3.438E-08	2.545E-08
SW	1.314E-07	9.022E-08	9.323E-08	7.163E-08	4.882E-08	3.339E-08
WSW	5.958E-08	4.293E-08	4.003E-08	4.609E-08	3.238E-08	2.363E-08
W	6.396E-08	4.183E-08	3.639E-08	3.164E-08	2.412E-08	1.880E-08
WNW	1.777E-07	1.075E-07	8.434E-08	6.407E-08	4.390E-08	3.301E-08
NW	3.558E-07	2.118E-07	1.598E-07	1.134E-07	7.213E-08	5.224E-08
NNW	4.537E-07	2.623E-07	1.924E-07	1.315E-07	8.085E-08	5.761E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	5.294E-08	3.037E-08	1.413E-08	8.267E-09	5.666E-09	5.296E-09
NNE	2.518E-08	1.451E-08	6.687E-09	6.127E-09	3.978E-09	2.891E-09
NE	2.028E-08	1.135E-08	5.477E-09	3.750E-09	2.407E-09	1.735E-09
ENE	4.044E-08	2.168E-08	1.158E-08	5.945E-09	3.845E-09	2.790E-09
E	2.910E-08	1.547E-08	8.448E-09	4.380E-09	2.862E-09	2.094E-09
ESE	1.794E-08	1.196E-08	4.909E-09	2.560E-09	1.680E-09	1.233E-09
SE	1.669E-08	8.467E-09	3.468E-09	1.826E-09	1.207E-09	8.915E-10
SSE	1.392E-08	7.028E-09	2.868E-09	1.511E-09	9.997E-10	7.383E-10
S	1.673E-08	8.418E-09	3.445E-09	1.821E-09	1.208E-09	8.947E-10
SSW	2.075E-08	1.023E-08	4.085E-09	2.083E-09	1.349E-09	9.812E-10
SW	2.742E-08	1.588E-08	6.199E-09	3.229E-09	2.064E-09	1.486E-09
WSW	1.818E-08	1.022E-08	4.932E-09	2.603E-09	1.905E-09	1.512E-09
W	1.518E-08	9.366E-09	4.578E-09	2.636E-09	1.821E-09	1.381E-09
WNW	2.633E-08	1.632E-08	8.318E-09	4.988E-09	3.541E-09	2.735E-09
NW	4.074E-08	2.438E-08	1.207E-08	7.141E-09	5.039E-09	3.879E-09
NNW	4.450E-08	2.620E-08	1.274E-08	7.463E-09	5.234E-09	4.013E-09

TABLE C-11 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR TURBINE VENT DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
(D/Q) Sector Average Deposition ($1/m^2$)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	4.847E-09	2.779E-09	1.860E-09	1.020E-09	4.566E-10	2.639E-10
NNE	2.032E-09	1.194E-09	8.146E-10	4.548E-10	2.075E-10	1.210E-10
NE	1.740E-09	1.030E-09	7.073E-10	3.972E-10	1.806E-10	1.049E-10
ENE	8.906E-09	5.042E-09	3.325E-09	1.812E-09	8.095E-10	4.694E-10
E	1.133E-08	6.299E-09	4.090E-09	2.199E-09	9.662E-10	5.554E-10
ESE	7.061E-09	3.955E-09	2.563E-09	1.364E-09	6.063E-10	3.486E-10
SE	4.447E-09	2.551E-09	1.671E-09	9.025E-10	4.067E-10	2.352E-10
SSE	2.328E-09	1.388E-09	9.215E-10	5.051E-10	2.350E-10	1.369E-10
S	3.634E-09	2.148E-09	1.428E-09	7.821E-10	3.617E-10	2.097E-10
SSW	2.496E-09	1.510E-09	1.047E-09	5.968E-10	2.803E-10	1.653E-10
SW	2.157E-09	1.362E-09	1.001E-09	5.766E-10	2.750E-10	1.628E-10
WSW	6.331E-10	4.276E-10	3.252E-10	2.063E-10	1.026E-10	6.218E-11
W	5.976E-10	3.834E-10	2.817E-10	1.680E-10	8.284E-11	5.007E-11
WNW	1.388E-09	8.480E-10	5.993E-10	3.462E-10	1.632E-10	9.657E-11
NW	2.777E-09	1.641E-09	1.128E-09	6.346E-10	2.909E-10	1.699E-10
NNW	3.765E-09	2.185E-09	1.477E-09	8.192E-10	3.712E-10	2.158E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.732E-10	7.236E-11	2.311E-11	1.013E-11	6.026E-12	8.848E-11
NNE	7.973E-11	3.347E-11	1.068E-11	2.103E-11	9.625E-12	5.470E-12
NE	6.896E-11	2.878E-11	9.085E-12	9.506E-12	5.098E-12	3.156E-12
ENE	3.089E-10	1.298E-10	1.140E-10	2.577E-11	1.382E-11	8.559E-12
E	3.636E-10	1.518E-10	7.743E-11	2.424E-11	1.300E-11	8.054E-12
ESE	2.282E-10	9.672E-11	4.575E-11	1.498E-11	7.946E-12	4.920E-12
SE	1.544E-10	6.793E-11	3.047E-11	1.174E-11	6.217E-12	3.655E-12
SSE	9.165E-11	4.352E-11	2.187E-11	9.446E-12	3.670E-12	2.215E-12
S	1.435E-10	6.606E-11	2.883E-11	1.384E-11	5.297E-12	3.212E-12
SSW	1.090E-10	4.835E-11	2.801E-11	1.041E-11	5.507E-12	2.816E-12
SW	1.090E-10	4.691E-11	3.601E-11	1.557E-11	7.813E-12	4.562E-12
WSW	4.171E-11	1.784E-11	5.729E-12	2.935E-12	3.639E-11	2.915E-12
W	3.353E-11	1.435E-11	4.643E-12	2.068E-12	1.217E-12	8.100E-13
WNW	6.407E-11	2.705E-11	8.612E-12	3.772E-12	2.196E-12	1.457E-12
NW	1.120E-10	4.697E-11	1.490E-11	6.476E-12	3.751E-12	2.485E-12
NNW	1.420E-10	5.952E-11	1.904E-11	8.344E-12	4.874E-12	3.254E-12

TABLE C-12
SECTOR AVERAGE DISPERSION VALUES FOR RADWASTE VENT DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	1.033E-06	6.607E-07	4.934E-07	3.221E-07	1.851E-07	1.275E-07
NNE	4.455E-07	2.987E-07	2.285E-07	1.525E-07	8.827E-08	6.054E-08
NE	3.625E-07	2.468E-07	1.879E-07	1.232E-07	6.884E-08	4.598E-08
ENE	8.475E-07	5.272E-07	3.794E-07	2.416E-07	1.263E-07	8.178E-08
E	6.881E-07	4.030E-07	2.806E-07	1.778E-07	9.089E-08	5.854E-08
ESE	3.637E-07	2.260E-07	1.604E-07	9.717E-08	5.730E-08	3.661E-08
SE	2.507E-07	1.591E-07	1.137E-07	7.166E-08	4.147E-08	2.871E-08
SSE	1.528E-07	1.153E-07	8.631E-08	5.956E-08	3.778E-08	2.365E-08
S	2.033E-07	1.462E-07	1.136E-07	7.515E-08	4.517E-08	2.814E-08
SSW	2.465E-07	1.710E-07	1.378E-07	9.433E-08	5.423E-08	3.604E-08
SW	3.232E-07	2.419E-07	2.349E-07	1.473E-07	8.225E-08	5.213E-08
WSW	1.847E-07	1.571E-07	1.341E-07	1.183E-07	6.589E-08	4.363E-08
W	1.925E-07	1.496E-07	1.266E-07	9.400E-08	5.935E-08	4.234E-08
WNW	4.533E-07	3.100E-07	2.455E-07	1.732E-07	1.090E-07	7.925E-08
NW	7.620E-07	5.042E-07	3.862E-07	2.611E-07	1.583E-07	1.133E-07
NNW	8.836E-07	5.647E-07	4.242E-07	2.807E-07	1.666E-07	1.178E-07

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	9.616E-08	5.366E-08	2.398E-08	1.359E-08	9.122E-09	7.874E-09
NNE	4.539E-08	2.496E-08	1.093E-08	7.546E-09	4.900E-09	3.562E-09
NE	3.379E-08	1.787E-08	8.096E-09	4.598E-09	2.952E-09	2.128E-09
ENE	5.900E-08	3.037E-08	1.395E-08	7.112E-09	4.597E-09	3.334E-09
E	4.216E-08	2.175E-08	1.009E-08	5.213E-09	3.404E-09	2.490E-09
ESE	2.622E-08	1.462E-08	5.848E-09	3.039E-09	1.992E-09	1.462E-09
SE	2.025E-08	1.013E-08	4.110E-09	2.159E-09	1.426E-09	1.053E-09
SSE	1.670E-08	8.369E-09	3.400E-09	1.788E-09	1.181E-09	8.713E-10
S	1.986E-08	9.951E-09	4.056E-09	2.139E-09	1.417E-09	1.048E-09
SSW	2.557E-08	1.246E-08	4.861E-09	2.477E-09	1.603E-09	1.166E-09
SW	3.986E-08	2.025E-08	7.746E-09	3.881E-09	2.481E-09	1.786E-09
WSW	3.183E-08	1.658E-08	7.380E-09	3.775E-09	2.571E-09	1.863E-09
W	3.249E-08	1.853E-08	8.383E-09	4.616E-09	3.108E-09	2.313E-09
WNW	6.191E-08	3.671E-08	1.744E-08	9.907E-09	6.795E-09	5.122E-09
NW	8.779E-08	5.149E-08	2.428E-08	1.376E-08	9.425E-09	7.099E-09
NNW	9.054E-08	5.244E-08	2.444E-08	1.376E-08	9.398E-09	7.065E-09

TABLE C-12 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR RADWASTE VENT DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
(D/Q) Sector Average Deposition (1/m^2)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	7.161E-09	3.910E-09	2.468E-09	1.281E-09	5.399E-10	3.016E-10
NNE	3.098E-09	1.725E-09	1.100E-09	5.785E-10	2.454E-10	1.375E-10
NE	2.767E-09	1.546E-09	9.859E-10	5.168E-10	2.179E-10	1.215E-10
ENE	1.236E-08	6.620E-09	4.148E-09	2.151E-09	9.130E-10	5.142E-10
E	1.471E-08	7.775E-09	4.841E-09	2.489E-09	1.051E-09	5.901E-10
ESE	8.980E-09	4.777E-09	2.975E-09	1.527E-09	6.496E-10	3.661E-10
SE	5.951E-09	3.176E-09	1.973E-09	1.018E-09	4.362E-10	3.758E-10
SSE	3.184E-09	1.734E-09	1.082E-09	5.670E-10	2.795E-10	2.748E-10
S	4.939E-09	2.682E-09	1.686E-09	8.791E-10	4.358E-10	3.566E-10
SSW	3.731E-09	2.062E-09	1.325E-09	7.054E-10	3.056E-10	2.065E-10
SW	3.491E-09	2.008E-09	1.354E-09	7.203E-10	3.108E-10	1.753E-10
WSW	1.216E-09	7.473E-10	5.065E-10	2.908E-10	1.262E-10	7.139E-11
W	1.108E-09	6.552E-10	4.355E-10	2.391E-10	1.045E-10	5.944E-11
WNW	2.417E-09	1.382E-09	8.957E-10	4.786E-10	2.049E-10	1.152E-10
NW	4.435E-09	2.485E-09	1.590E-09	8.377E-10	3.551E-10	1.988E-10
NNW	5.741E-09	3.164E-09	2.007E-09	1.049E-09	4.437E-10	2.484E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.944E-10	8.685E-11	1.650E-10	4.423E-10	5.252E-10	2.758E-11
NNE	8.880E-11	3.942E-11	7.098E-11	1.219E-11	6.530E-12	4.038E-12
NE	7.813E-11	3.424E-11	6.883E-11	9.492E-12	5.086E-12	3.146E-12
ENE	3.330E-10	1.437E-10	9.824E-11	2.573E-11	1.380E-11	8.541E-12
E	3.813E-10	1.608E-10	7.197E-11	2.421E-11	1.298E-11	8.039E-12
ESE	2.378E-10	1.543E-10	4.294E-11	1.480E-11	7.934E-12	4.911E-12
SE	2.575E-10	1.053E-10	2.854E-11	1.033E-11	5.540E-12	3.428E-12
SSE	1.909E-10	7.321E-11	1.969E-11	7.139E-12	3.573E-12	2.208E-12
S	2.295E-10	9.154E-11	2.687E-11	1.032E-11	5.181E-12	3.203E-12
SSW	2.750E-10	1.176E-10	2.497E-11	8.477E-12	4.541E-12	2.807E-12
SW	1.329E-10	1.642E-10	4.605E-11	1.041E-11	5.525E-12	3.393E-12
WSW	4.643E-11	2.156E-11	4.157E-11	4.604E-11	4.839E-12	1.971E-12
W	3.868E-11	1.646E-11	2.393E-11	8.590E-11	1.303E-10	1.365E-10
WNW	7.449E-11	3.222E-11	6.113E-11	2.097E-10	3.048E-10	3.120E-10
NW	1.282E-10	5.677E-11	1.156E-10	3.505E-10	4.802E-10	4.775E-10
NNW	1.602E-10	7.077E-11	1.317E-10	3.775E-10	5.051E-10	4.961E-10

TABLE C-13
SECTOR AVERAGE DISPERSION VALUES FOR THE STACK DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	1.027E-08	1.097E-08	1.194E-08	1.411E-08	1.486E-08	1.339E-08
NNE	3.203E-09	4.104E-09	5.361E-09	7.740E-09	9.169E-09	8.589E-09
NE	1.541E-09	2.147E-09	3.601E-09	6.414E-09	8.365E-09	8.095E-09
ENE	2.136E-08	1.920E-08	2.080E-08	2.654E-08	2.643E-08	2.296E-08
E	2.418E-08	2.669E-08	2.929E-08	3.752E-08	3.256E-08	2.619E-08
ESE	2.565E-08	2.362E-08	2.317E-08	2.243E-08	2.257E-08	1.729E-08
SE	2.484E-08	1.862E-08	1.761E-08	1.750E-08	1.669E-08	1.992E-08
SSE	2.207E-08	1.569E-08	1.476E-08	1.572E-08	1.921E-08	1.773E-08
S	2.327E-08	1.668E-08	1.630E-08	1.732E-08	2.215E-08	1.961E-08
SSW	1.929E-08	1.592E-08	1.765E-08	2.163E-08	2.276E-08	2.047E-08
SW	7.525E-09	6.805E-09	1.138E-08	1.499E-08	1.706E-08	1.411E-08
WSW	1.477E-09	1.939E-09	2.783E-09	6.039E-09	6.782E-09	6.122E-09
W	1.621E-09	1.537E-09	2.124E-09	3.344E-09	4.143E-09	3.951E-09
WNW	3.121E-09	3.456E-09	4.222E-09	5.656E-09	6.317E-09	5.765E-09
NW	7.262E-09	7.526E-09	8.766E-09	1.127E-08	1.242E-08	1.130E-08
NNW	9.840E-09	1.035E-08	1.126E-08	1.325E-08	1.394E-08	1.259E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.166E-08	7.912E-09	4.057E-09	2.400E-09	1.651E-09	1.473E-09
NNE	7.654E-09	5.395E-09	2.899E-09	5.959E-09	3.873E-09	2.818E-09
NE	7.362E-09	5.385E-09	3.568E-09	7.949E-09	5.187E-09	3.784E-09
ENE	1.956E-08	1.284E-08	1.211E-08	9.552E-09	6.177E-09	4.480E-09
E	2.126E-08	1.291E-08	9.490E-09	6.183E-09	3.959E-09	2.853E-09
ESE	1.367E-08	1.137E-08	5.359E-09	3.641E-09	2.348E-09	1.702E-09
SE	1.483E-08	8.319E-09	3.902E-09	2.516E-09	1.633E-09	1.189E-09
SSE	1.426E-08	7.927E-09	3.472E-09	1.969E-09	1.445E-09	1.052E-09
S	1.720E-08	9.169E-09	3.894E-09	2.170E-09	1.617E-09	1.178E-09
SSW	2.008E-08	1.080E-08	5.377E-09	3.251E-09	2.089E-09	1.510E-09
SW	1.368E-08	1.015E-08	4.452E-09	3.488E-09	2.294E-09	1.730E-09
WSW	5.337E-09	3.643E-09	2.196E-09	1.283E-09	1.101E-09	1.497E-09
W	3.568E-09	2.588E-09	1.451E-09	8.966E-10	6.449E-10	5.031E-10
WNW	5.053E-09	3.461E-09	1.805E-09	1.063E-09	7.440E-10	5.702E-10
NW	9.881E-09	6.705E-09	3.423E-09	1.972E-09	1.356E-09	1.024E-09
NNW	1.100E-08	7.528E-09	3.920E-09	2.292E-09	1.590E-09	1.208E-09

TABLE C-13 (CONTINUED)
SECTOR AVERAGE DISPERSION VALUES FOR THE STACK DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
Sector Average Finite Cloud Gamma X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	1.158E-07	8.009E-08	6.198E-08	4.338E-08	2.763E-08	2.031E-08
NNE	8.837E-08	6.084E-08	4.707E-08	3.305E-08	2.119E-08	1.565E-08
NE	1.004E-07	6.872E-08	5.300E-08	3.714E-08	2.383E-08	1.764E-08
ENE	1.844E-07	1.268E-07	9.832E-08	7.168E-08	4.551E-08	3.328E-08
E	1.719E-07	1.199E-07	9.332E-08	7.016E-08	4.346E-08	3.109E-08
ESE	1.054E-07	7.510E-08	5.799E-08	3.997E-08	2.748E-08	1.939E-08
SE	7.518E-08	5.213E-08	4.029E-08	2.868E-08	1.954E-08	1.780E-08
SSE	6.310E-08	4.479E-08	3.474E-08	2.569E-08	1.995E-08	1.574E-08
S	6.769E-08	4.821E-08	3.859E-08	2.845E-08	2.262E-08	1.744E-08
SSW	9.202E-08	6.303E-08	5.095E-08	3.824E-08	2.660E-08	2.061E-08
SW	8.132E-08	5.613E-08	4.944E-08	3.503E-08	2.387E-08	1.725E-08
WSW	5.017E-08	3.457E-08	2.681E-08	2.139E-08	1.367E-08	1.004E-08
W	4.869E-08	3.326E-08	2.566E-08	1.797E-08	1.151E-08	8.521E-09
WNW	5.779E-08	3.977E-08	3.077E-08	2.159E-08	1.379E-08	1.015E-08
NW	9.748E-08	6.725E-08	5.218E-08	3.674E-08	2.357E-08	1.737E-08
NNW	1.133E-07	7.823E-08	6.053E-08	4.235E-08	2.696E-08	1.982E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	1.599E-08	9.594E-09	4.587E-09	2.642E-09	1.803E-09	1.510E-09
NNE	1.238E-08	7.517E-09	3.669E-09	3.858E-09	2.576E-09	1.909E-09
NE	1.400E-08	8.577E-09	4.739E-09	4.937E-09	3.317E-09	2.468E-09
ENE	2.608E-08	1.550E-08	1.048E-08	6.589E-09	4.365E-09	3.218E-09
E	2.393E-08	1.373E-08	8.069E-09	4.645E-09	3.035E-09	2.217E-09
ESE	1.480E-08	1.035E-08	4.652E-09	2.723E-09	1.792E-09	1.316E-09
SE	1.326E-08	7.323E-09	3.289E-09	1.896E-09	1.256E-09	9.271E-10
SSE	1.216E-08	6.698E-09	2.936E-09	1.621E-09	1.123E-09	8.295E-10
S	1.392E-08	7.524E-09	3.256E-09	1.785E-09	1.244E-09	9.190E-10
SSW	1.778E-08	9.626E-09	4.425E-09	2.476E-09	1.623E-09	1.189E-09
SW	1.478E-08	9.614E-09	4.201E-09	2.647E-09	1.750E-09	1.302E-09
WSW	7.897E-09	4.740E-09	2.495E-09	1.413E-09	1.085E-09	1.056E-09
W	6.758E-09	4.136E-09	2.051E-09	1.200E-09	8.395E-10	6.423E-10
WNW	8.007E-09	4.832E-09	2.340E-09	1.344E-09	9.281E-10	7.043E-10
NW	1.369E-08	8.224E-09	3.930E-09	2.224E-09	1.520E-09	1.143E-09
NNW	1.561E-08	9.393E-09	4.520E-09	2.573E-09	1.765E-09	1.331E-09

TABLE C-13 (CONTINUED)
SECTOR AVERAGE DEPOSITION VALUES FOR THE STACK DETERMINED FROM GRAZING METEOROLOGICAL DATA (May-Oct, 1985 To 1992)
(D/Q) Sector Average Deposition (1/m^2)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	8.120E-10	6.726E-10	5.859E-10	3.891E-10	2.241E-10	1.437E-10
NNE	2.594E-10	2.425E-10	2.324E-10	1.666E-10	1.006E-10	6.537E-11
NE	1.367E-10	1.617E-10	1.778E-10	1.396E-10	8.856E-11	5.825E-11
ENE	2.061E-09	1.641E-09	1.373E-09	8.782E-10	4.932E-10	3.145E-10
E	2.344E-09	1.893E-09	1.611E-09	1.048E-09	5.954E-10	3.804E-10
ESE	1.916E-09	1.446E-09	1.148E-09	6.978E-10	3.772E-10	2.378E-10
SE	1.509E-09	1.111E-09	8.536E-10	5.001E-10	2.647E-10	1.788E-10
SSE	1.381E-09	9.953E-10	7.444E-10	4.225E-10	2.282E-10	1.451E-10
S	1.637E-09	1.173E-09	8.706E-10	4.899E-10	2.644E-10	1.664E-10
SSW	1.380E-09	1.068E-09	8.670E-10	5.385E-10	2.985E-10	1.946E-10
SW	4.653E-10	4.167E-10	3.854E-10	2.688E-10	1.598E-10	1.034E-10
WSW	8.735E-11	8.698E-11	8.685E-11	6.410E-11	3.936E-11	2.568E-11
W	8.824E-11	8.612E-11	8.467E-11	6.182E-11	3.773E-11	2.459E-11
WNW	2.513E-10	2.214E-10	2.025E-10	1.401E-10	8.281E-11	5.351E-11
NW	5.753E-10	4.944E-10	4.434E-10	3.018E-10	1.766E-10	1.138E-10
NNW	8.411E-10	6.830E-10	5.837E-10	3.811E-10	2.170E-10	1.388E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	9.813E-11	4.342E-11	1.458E-11	6.584E-12	3.899E-12	2.583E-12
NNE	4.471E-11	1.970E-11	6.541E-12	1.089E-11	2.064E-11	2.610E-11
NE	3.992E-11	1.753E-11	5.759E-12	2.237E-11	8.393E-12	5.198E-12
ENE	2.147E-10	9.530E-11	3.198E-11	3.184E-11	1.709E-11	1.059E-11
E	2.596E-10	1.151E-10	3.834E-11	2.707E-11	1.453E-11	9.002E-12
ESE	1.620E-10	7.545E-11	2.442E-11	1.053E-10	7.907E-12	4.897E-12
SE	1.206E-10	5.231E-11	1.711E-11	1.248E-11	3.737E-11	6.706E-11
SSE	9.856E-11	4.268E-11	1.416E-11	6.581E-12	1.193E-11	2.789E-12
S	1.136E-10	4.896E-11	1.630E-11	7.617E-12	2.812E-11	3.396E-12
SSW	1.379E-10	5.967E-11	1.916E-11	2.198E-11	3.347E-11	4.991E-12
SW	7.147E-11	3.262E-11	1.036E-11	4.400E-12	2.543E-12	2.759E-12
WSW	1.757E-11	7.730E-12	2.554E-12	1.121E-12	6.388E-13	4.550E-13
W	1.684E-11	7.414E-12	2.457E-12	1.084E-12	6.291E-13	4.130E-13
WNW	3.659E-11	1.616E-11	5.394E-12	2.412E-12	1.417E-12	9.362E-13
NW	7.779E-11	3.438E-11	1.151E-11	5.170E-12	3.048E-12	2.018E-12
NNW	9.472E-11	4.197E-11	1.413E-11	6.421E-12	3.821E-12	2.541E-12

TABLE C-14
CRITICAL RECEPTOR DISPERSION AND DEPOSITION PARAMETERS FOR VENT AND ELEVATED RELEASES

DISPERSION PARAMETER DESCRIPTION	RECEPTOR
Annual Average X/Q - Total Body; Stack	Site Boundary
Annual Average X/Q - Skin; Stack	Site Boundary*
Annual Average X/Q - Gamma Air; Stack	Site Boundary
Annual Average X/Q - Beta Air; Stack	Site Boundary*
Annual Average X/Q - Dep. Inhal.; Stack	Resident
Annual Average D/Q - GPD; Stack	Resident
Grazing D/Q - SFV & FFV; Stack	Garden
Grazing D/Q - Cow; Stack	Milk Animal
Grazing D/Q - Goat; Stack	Milk Animal
Grazing D/Q - Meat; Stack	Meat Animal
Annual Average X/Q - Total Body; Vent	Site Boundary
Annual Average X/Q - Skin; Vent	Site Boundary
Annual Average X/Q - Gamma Air; Vent	Site Boundary
Annual Average X/Q - Beta Air; Vent	Site Boundary
Annual Average X/Q - Dep. Inhal.; Vent	Resident
Annual Average D/Q - GPD; Vent	Resident
Grazing D/Q - SFV & FFV; Vent	Garden
Grazing D/Q - Cow; Vent	Milk Animal
Grazing D/Q - Goat; Vent	Milk Animal
Grazing D/Q - Meat; Vent	Meat Animal

* The highest X/Q is located beyond the site boundary.

TABLE C-15
85TH PERCENTILE HOURLY PLUME CENTERLINE DISPERSION VALUES AND ANNUAL SECTOR AVERAGE DISPERSION VALUES FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985-1992) (FOR USE WITH SHORT TERM RELEASES)

Concentration X/Q (sec/m^3)

Direction		Site Boundary Distance (m)	Hourly Plume Cent. Conc. (X/Q) (sec/m^3)	Annual Sector Ave. Conc. (X/Q) (sec/m^3)	Slope m
N	w	225	1.284E-03	3.496E-05	-0.3970
NNE	w	225	1.061E-03	1.775E-05	-0.4506
NE	w	354	4.704E-04	5.342E-06	-0.4933
ENE	w	563	1.650E-04	3.429E-06	-0.4267
E	l	950	4.960E-05	1.054E-06	-0.4243
ESE	l	1030	3.611E-05	5.862E-07	-0.4539
SE	l	1110	3.204E-05	4.168E-07	-0.4783
SSE	l	1754	2.213E-05	1.732E-07	-0.5343
S	l	2205	1.640E-05	1.363E-07	-0.5277
SSW	l	2269	2.610E-05	2.003E-07	-0.5365
SW	l	2382	3.489E-05	3.141E-07	-0.5189
WSW	w	1867	7.570E-05	4.141E-07	-0.5737
W	w	644	3.338E-04	2.683E-06	-0.5314
WNW	w	370	8.355E-04	1.389E-05	-0.4513
NW	w	306	9.082E-04	2.596E-05	-0.3916
NNW	w	241	1.395E-03	3.684E-05	-0.4003

(Refer to Section 12.4.3)

TABLE C-16
85TH PERCENTILE HOURLY PLUME CENTERLINE DEPOSITION VALUES AND ANNUAL SECTOR AVERAGE DEPOSITION VALUES FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985-1992) (FOR USE WITH SHORT TERM RELEASES)

Deposition (D/Q) (1/m²)

Direction		Site Boundary Distance (m)	Hourly Plume Cent. (D/Q) (1/m²)	Annual Sector Ave. (D/Q) (1/m²)	Slope m
N	w	225	3.819E-06	1.331E-07	-0.3698
NNE	w	225	3.549E-06	7.094E-08	-0.4310
NE	w	354	1.840E-06	3.000E-08	-0.4534
ENE	w	563	1.166E-06	3.235E-08	-0.3949
E	l	950	4.777E-07	1.352E-08	-0.3927
ESE	l	1030	3.797E-07	8.757E-09	-0.4152
SE	l	1110	3.096E-07	6.456E-09	-0.4263
SSE	l	1754	1.560E-07	1.852E-09	-0.4884
S	l	2205	1.083E-07	1.409E-09	-0.4783
SSW	l	2269	1.300E-07	1.371E-09	-0.5014
SW	l	2382	1.366E-07	1.507E-09	-0.4965
WSW	w	1867	2.155E-07	1.247E-09	-0.5676
W	w	644	1.008E-06	7.794E-09	-0.5356
WNW	w	370	2.080E-06	4.097E-08	-0.4326
NW	w	306	2.588E-06	8.546E-08	-0.3757
NNW	w	241	3.727E-06	1.139E-07	-0.3842

(Refer to Section 12.4.3)

TABLE C-17
85TH PERCENTILE HOURLY PLUME CENTERLINE DISPERSION VALUES FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985-1992) (FOR USE WITH SHORT TERM RELEASES)
Plume Centerline Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	1.699E-04	1.076E-04	7.986E-05	4.929E-05	3.382E-05	2.338E-05
NNE	1.607E-04	1.046E-04	7.674E-05	4.790E-05	2.941E-05	2.237E-05
NE	1.443E-04	8.910E-05	6.364E-05	3.787E-05	2.353E-05	1.628E-05
ENE	9.691E-05	6.042E-05	4.300E-05	2.458E-05	1.431E-05	9.546E-06
E	6.170E-05	3.762E-05	2.673E-05	1.457E-05	8.488E-06	5.543E-06
ESE	4.999E-05	2.937E-05	2.013E-05	1.079E-05	5.958E-06	3.790E-06
SE	4.934E-05	2.856E-05	1.944E-05	1.003E-05	5.698E-06	3.529E-06
SSE	6.206E-05	3.660E-05	2.469E-05	1.349E-05	7.622E-06	4.850E-06
S	6.415E-05	3.732E-05	2.483E-05	1.356E-05	7.681E-06	4.949E-06
SSW	1.018E-04	5.889E-05	4.124E-05	2.228E-05	1.334E-05	9.017E-06
SW	1.254E-04	7.730E-05	5.343E-05	3.173E-05	1.959E-05	1.331E-05
WSW	1.937E-04	1.217E-04	9.179E-05	5.636E-05	3.565E-05	2.610E-05
W	2.334E-04	1.519E-04	1.131E-04	7.255E-05	4.837E-05	3.588E-05
WNW	2.266E-04	1.507E-04	1.154E-04	7.694E-05	4.867E-05	3.613E-05
NW	2.002E-04	1.305E-04	9.910E-05	6.428E-05	4.403E-05	3.137E-05
NNW	1.950E-04	1.251E-04	9.565E-05	6.064E-05	4.107E-05	3.028E-05

Miles	4.5	7.5	15.0	25.0	35.0	45.0
N	1.787E-05	1.084E-05	5.123E-06	3.189E-06	2.506E-06	2.232E-06
NNE	1.640E-05	9.724E-06	4.242E-06	2.665E-06	2.197E-06	1.946E-06
NE	1.202E-05	6.775E-06	3.149E-06	2.240E-06	1.763E-06	1.658E-06
ENE	7.055E-06	3.816E-06	1.880E-06	1.244E-06	1.024E-06	9.608E-07
E	3.976E-06	2.256E-06	1.239E-06	8.773E-07	7.968E-07	7.410E-07
ESE	2.708E-06	1.508E-06	8.402E-07	6.951E-07	6.563E-07	6.136E-07
SE	2.529E-06	1.446E-06	9.104E-07	7.173E-07	6.712E-07	6.380E-07
SSE	3.487E-06	1.855E-06	1.336E-06	1.005E-06	9.152E-07	8.714E-07
S	3.617E-06	1.977E-06	1.347E-06	9.941E-07	8.840E-07	8.540E-07
SSW	6.567E-06	3.377E-06	1.965E-06	1.491E-06	1.158E-06	1.102E-06
SW	9.555E-06	5.304E-06	2.844E-06	2.096E-06	1.490E-06	1.505E-06
WSW	2.015E-05	1.144E-05	6.078E-06	3.816E-06	2.824E-06	2.563E-06
W	2.801E-05	1.656E-05	8.601E-06	5.208E-06	4.080E-06	3.717E-06
WNW	2.841E-05	1.784E-05	8.792E-06	5.268E-06	4.015E-06	3.663E-06
NW	2.484E-05	1.399E-05	7.019E-06	4.387E-06	3.446E-06	3.205E-06
NNW	2.416E-05	1.525E-05	7.180E-06	4.311E-06	3.235E-06	3.083E-06

TABLE C-18
SECTOR AVERAGE DISPERSION VALUES
FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED
FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985-1992)
(FOR USE WITH LONG TERM RELEASES)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	3.948E-06	2.078E-06	1.348E-06	7.608E-07	3.800E-07	2.415E-07
NNE	2.048E-06	1.091E-06	7.116E-07	3.995E-07	1.969E-07	1.241E-07
NE	1.427E-06	7.723E-07	5.060E-07	2.825E-07	1.373E-07	8.575E-08
ENE	1.985E-06	1.070E-06	6.992E-07	3.889E-07	1.884E-07	1.176E-07
E	1.375E-06	7.249E-07	4.692E-07	2.593E-07	1.254E-07	7.838E-08
ESE	8.717E-07	4.596E-07	2.977E-07	1.639E-07	7.877E-08	4.911E-08
SE	6.983E-07	3.671E-07	2.384E-07	1.315E-07	6.333E-08	3.958E-08
SSE	5.697E-07	3.018E-07	1.968E-07	1.089E-07	5.258E-08	3.289E-08
S	6.334E-07	3.339E-07	2.169E-07	1.195E-07	5.752E-08	3.595E-08
SSW	9.625E-07	5.148E-07	3.338E-07	1.828E-07	8.685E-08	5.362E-08
SW	1.601E-06	8.640E-07	5.612E-07	3.081E-07	1.465E-07	9.029E-08
WSW	1.457E-06	7.891E-07	5.157E-07	2.866E-07	1.385E-07	8.613E-08
W	1.881E-06	9.925E-07	6.461E-07	3.645E-07	1.815E-07	1.150E-07
WNW	3.757E-06	1.944E-06	1.254E-06	7.106E-07	3.593E-07	2.300E-07
NW	5.025E-06	2.605E-06	1.678E-06	9.490E-07	4.789E-07	3.063E-07
NNW	4.607E-06	2.382E-06	1.534E-06	8.699E-07	4.408E-07	2.826E-07
	4.5	7.5	15.0	25.0	35.0	45.0
N	1.726E-07	8.781E-08	3.565E-08	1.855E-08	1.212E-08	8.843E-09
NNE	8.811E-08	4.427E-08	1.769E-08	9.098E-09	5.901E-09	4.285E-09
NE	6.049E-08	2.998E-08	1.176E-08	5.962E-09	3.832E-09	2.764E-09
ENE	8.299E-08	4.122E-08	1.627E-08	8.305E-09	5.365E-09	3.887E-09
E	5.540E-08	2.769E-08	1.109E-08	5.734E-09	3.740E-09	2.731E-09
ESE	3.465E-08	1.728E-08	6.916E-09	3.581E-09	2.339E-09	1.711E-09
SE	2.799E-08	1.402E-08	5.659E-09	2.952E-09	1.939E-09	1.425E-09
SSE	2.326E-08	1.164E-08	4.686E-09	2.438E-09	1.598E-09	1.172E-09
S	2.541E-08	1.272E-08	5.133E-09	2.678E-09	1.759E-09	1.293E-09
SSW	3.755E-08	1.840E-08	7.166E-09	3.633E-09	2.341E-09	1.696E-09
SW	6.312E-08	3.078E-08	1.186E-08	5.954E-09	3.807E-09	2.741E-09
WSW	6.060E-08	2.988E-08	1.165E-08	5.884E-09	3.773E-09	2.718E-09
W	8.207E-08	4.159E-08	1.680E-08	8.704E-09	5.673E-09	4.133E-09
WNW	1.653E-07	8.495E-08	3.494E-08	1.834E-08	1.206E-08	8.836E-09
NW	2.199E-07	1.130E-07	4.643E-08	2.436E-08	1.601E-08	1.173E-08
NNW	2.033E-07	1.048E-07	4.324E-08	2.275E-08	1.498E-08	1.099E-08

TABLE C-19
85TH PERCENTILE HOURLY PLUME CENTERLINE DEPOSITION VALUES FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985-1992)
(FOR USE WITH SHORT TERM RELEASES)
(D/Q) Plume Centerline Deposition ($1/m^2$)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	8.196E-07	4.879E-07	3.235E-07	1.745E-07	7.680E-08	4.389E-08
NNE	7.499E-07	4.421E-07	2.918E-07	1.568E-07	6.889E-08	3.933E-08
NE	7.015E-07	4.084E-07	2.680E-07	1.434E-07	6.279E-08	3.582E-08
ENE	7.513E-07	4.265E-07	2.758E-07	1.458E-07	6.348E-08	3.618E-08
E	6.000E-07	3.392E-07	2.198E-07	1.164E-07	5.095E-08	2.906E-08
ESE	5.379E-07	2.994E-07	1.925E-07	1.013E-07	4.402E-08	2.510E-08
SE	4.920E-07	2.729E-07	1.756E-07	9.248E-08	4.022E-08	2.294E-08
SSE	4.987E-07	2.787E-07	1.793E-07	9.390E-08	4.076E-08	2.322E-08
S	5.035E-07	2.780E-07	1.784E-07	9.367E-08	4.064E-08	2.315E-08
SSW	6.150E-07	3.456E-07	2.231E-07	1.178E-07	5.125E-08	2.924E-08
SW	6.826E-07	3.885E-07	2.522E-07	1.337E-07	5.831E-08	3.312E-08
WSW	7.002E-07	4.101E-07	2.698E-07	1.446E-07	6.339E-08	3.617E-08
W	7.821E-07	4.647E-07	3.077E-07	1.658E-07	7.294E-08	4.168E-08
WNW	8.673E-07	5.222E-07	3.480E-07	1.886E-07	8.325E-08	4.764E-08
NW	8.526E-07	5.116E-07	3.403E-07	1.841E-07	8.119E-08	4.643E-08
NNW	8.945E-07	5.382E-07	3.586E-07	1.943E-07	8.572E-08	4.903E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	2.868E-08	1.216E-08	4.258E-09	1.853E-09	1.097E-09	8.646E-10
NNE	2.569E-08	1.087E-08	3.874E-09	1.831E-09	1.092E-09	8.632E-10
NE	2.339E-08	9.896E-09	3.653E-09	1.815E-09	1.091E-09	8.661E-10
ENE	2.344E-08	9.104E-09	3.470E-09	1.779E-09	1.102E-09	8.689E-10
E	1.884E-08	8.362E-09	3.407E-09	1.768E-09	1.099E-09	8.723E-10
ESE	1.644E-08	7.454E-09	3.210E-09	1.772E-09	1.094E-09	8.726E-10
SE	1.522E-08	7.432E-09	3.238E-09	1.752E-09	1.098E-09	8.714E-10
SSE	1.524E-08	7.294E-09	3.216E-09	1.725E-09	1.093E-09	8.703E-10
S	1.518E-08	7.268E-09	3.248E-09	1.760E-09	1.092E-09	8.686E-10
SSW	1.909E-08	7.815E-09	3.324E-09	1.801E-09	1.089E-09	8.654E-10
SW	2.164E-08	8.873E-09	3.386E-09	1.767E-09	1.086E-09	8.625E-10
WSW	2.362E-08	1.002E-08	3.516E-09	1.747E-09	1.081E-09	8.607E-10
W	2.724E-08	1.156E-08	3.953E-09	1.818E-09	1.082E-09	8.582E-10
WNW	3.117E-08	1.325E-08	4.389E-09	1.856E-09	1.088E-09	8.598E-10
NW	3.035E-08	1.288E-08	4.349E-09	1.863E-09	1.091E-09	8.632E-10
NNW	3.206E-08	1.348E-08	4.593E-09	1.895E-09	1.094E-09	8.638E-10

TABLE C-20
SECTOR AVERAGE DEPOSITION VALUES
FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED
FROM ANNUAL AVERAGE METEOROLOGICAL DATA (1985-1992)
(FOR USE WITH LONG TERM RELEASES)
(D/Q) Sector Average Deposition ($1/m^2$)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	1.937E-08	9.969E-09	6.130E-09	3.059E-09	1.257E-09	6.930E-10
NNE	1.032E-08	5.308E-09	3.264E-09	1.629E-09	6.689E-10	3.688E-10
NE	8.393E-09	4.317E-09	2.654E-09	1.324E-09	5.436E-10	2.996E-10
ENE	1.845E-08	9.552E-09	5.899E-09	2.962E-09	1.227E-09	6.800E-10
E	1.764E-08	9.161E-09	5.670E-09	2.856E-09	1.187E-09	6.598E-10
ESE	1.294E-08	6.744E-09	4.184E-09	2.114E-09	8.826E-10	4.920E-10
SE	1.076E-08	5.627E-09	3.499E-09	1.774E-09	7.439E-10	4.158E-10
SSE	6.557E-09	3.433E-09	2.137E-09	1.085E-09	4.555E-10	2.548E-10
S	7.306E-09	3.827E-09	2.383E-09	1.210E-09	5.084E-10	2.845E-10
SSW	7.625E-09	3.959E-09	2.450E-09	1.234E-09	5.125E-10	2.848E-10
SW	9.231E-09	4.768E-09	2.940E-09	1.473E-09	6.079E-10	3.363E-10
WSW	5.073E-09	2.611E-09	1.606E-09	8.018E-10	3.294E-10	1.816E-10
W	5.456E-09	2.807E-09	1.725E-09	8.608E-10	3.534E-10	1.947E-10
WNW	1.224E-08	6.296E-09	3.870E-09	1.930E-09	7.922E-10	4.365E-10
NW	1.930E-08	9.928E-09	6.103E-09	3.044E-09	1.250E-09	6.888E-10
NNW	1.827E-08	9.403E-09	5.782E-09	2.886E-09	1.185E-09	6.535E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	4.420E-10	1.789E-10	5.648E-11	2.279E-11	1.219E-11	7.527E-12
NNE	2.352E-10	9.517E-11	3.004E-11	1.212E-11	6.481E-12	4.001E-12
NE	1.911E-10	7.733E-11	2.442E-11	9.857E-12	5.274E-12	3.258E-12
ENE	4.346E-10	1.760E-10	5.563E-11	2.248E-11	1.204E-11	7.449E-12
E	4.221E-10	1.709E-10	5.406E-11	2.186E-11	1.172E-11	7.255E-12
ESE	3.150E-10	1.276E-10	4.035E-11	1.632E-11	8.750E-12	5.416E-12
SE	2.665E-10	1.079E-10	3.412E-11	1.379E-11	7.393E-12	4.574E-12
SSE	1.634E-10	6.612E-11	2.089E-11	8.433E-12	4.514E-12	2.789E-12
S	1.824E-10	7.383E-11	2.332E-11	9.413E-12	5.038E-12	3.112E-12
SSW	1.821E-10	7.369E-11	2.327E-11	9.385E-12	5.020E-12	3.099E-12
SW	2.147E-10	8.686E-11	2.740E-11	1.104E-11	5.900E-12	3.639E-12
WSW	1.158E-10	4.682E-11	1.474E-11	5.924E-12	3.156E-12	1.941E-12
W	1.241E-10	5.017E-11	1.579E-11	6.346E-12	3.381E-12	2.079E-12
WNW	2.783E-10	1.126E-10	3.548E-11	1.428E-11	7.624E-12	4.697E-12
NW	4.392E-10	1.777E-10	5.606E-11	2.259E-11	1.207E-11	7.446E-12
NNW	4.168E-10	1.686E-10	5.321E-11	2.145E-11	1.147E-11	7.074E-12

TABLE C-21
85TH PERCENTILE HOURLY PLUME CENTERLINE DISPERSION VALUES FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED FROM GRAZING METEOROLOGICAL DATA (1985-1992) (FOR USE WITH SHORT TERM RELEASES)
Plume Centerline Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	2.035E-04	1.319E-04	9.688E-05	6.511E-05	4.473E-05	3.234E-05
NNE	1.879E-04	1.270E-04	9.123E-05	5.931E-05	3.831E-05	2.740E-05
NE	1.632E-04	1.030E-04	7.465E-05	4.782E-05	2.895E-05	1.998E-05
ENE	1.029E-04	6.414E-05	4.529E-05	2.778E-05	1.533E-05	1.037E-05
E	6.347E-05	3.871E-05	2.645E-05	1.643E-05	8.680E-06	5.704E-06
ESE	5.529E-05	3.284E-05	2.249E-05	1.344E-05	7.231E-06	4.554E-06
SE	5.878E-05	3.449E-05	2.322E-05	1.327E-05	7.155E-06	4.530E-06
SSE	7.662E-05	4.653E-05	3.199E-05	1.929E-05	1.017E-05	6.744E-06
S	6.387E-05	3.657E-05	2.530E-05	1.454E-05	7.813E-06	5.065E-06
SSW	1.002E-04	6.046E-05	4.342E-05	2.548E-05	1.416E-05	9.655E-06
SW	1.271E-04	7.949E-05	5.718E-05	3.660E-05	2.001E-05	1.420E-05
WSW	2.173E-04	1.416E-04	1.017E-04	7.040E-05	4.171E-05	3.095E-05
W	2.657E-04	1.695E-04	1.282E-04	8.955E-05	5.926E-05	4.564E-05
WNW	2.947E-04	1.962E-04	1.530E-04	1.115E-04	7.065E-05	5.353E-05
NW	2.589E-04	1.711E-04	1.294E-04	9.394E-05	5.940E-05	4.747E-05
NNW	2.240E-04	1.457E-04	1.122E-04	7.873E-05	5.217E-05	4.167E-05

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	2.466E-05	1.477E-05	7.229E-06	4.548E-06	3.258E-06	2.939E-06
NNE	2.146E-05	1.237E-05	5.954E-06	3.551E-06	2.874E-06	2.555E-06
NE	1.480E-05	8.449E-06	4.107E-06	2.760E-06	2.172E-06	1.943E-06
ENE	7.723E-06	4.094E-06	2.113E-06	1.431E-06	1.194E-06	1.080E-06
E	4.203E-06	2.450E-06	1.520E-06	1.093E-06	9.532E-07	9.103E-07
ESE	3.277E-06	2.083E-06	1.212E-06	8.868E-07	9.226E-07	9.234E-07
SE	3.284E-06	2.108E-06	1.223E-06	9.083E-07	9.658E-07	9.015E-07
SSE	4.949E-06	3.255E-06	1.759E-06	1.451E-06	1.200E-06	1.125E-06
S	3.595E-06	2.290E-06	1.634E-06	1.226E-06	1.051E-06	9.739E-07
SSW	7.015E-06	3.692E-06	2.072E-06	1.640E-06	1.361E-06	1.212E-06
SW	1.059E-05	5.604E-06	2.972E-06	2.285E-06	1.926E-06	1.784E-06
WSW	2.380E-05	1.346E-05	6.594E-06	4.291E-06	3.372E-06	3.081E-06
W	3.488E-05	2.109E-05	1.008E-05	6.435E-06	5.014E-06	4.515E-06
WNW	4.291E-05	2.492E-05	1.284E-05	8.174E-06	5.922E-06	5.432E-06
NW	3.796E-05	2.309E-05	1.200E-05	7.419E-06	4.994E-06	4.573E-06
NNW	3.380E-05	2.018E-05	9.838E-06	5.947E-06	4.413E-06	4.003E-06

TABLE C-22
SECTOR AVERAGE DISPERSION VALUES
FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED
FROM GRAZING METEOROLOGICAL DATA (1985-1992)
(FOR USE WITH LONG TERM RELEASES)
Sector Average Concentration X/Q (sec/m^3)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	5.300E-06	2.743E-06	1.774E-06	1.010E-06	5.125E-07	3.291E-07
NNE	2.423E-06	1.273E-06	8.309E-07	4.714E-07	2.365E-07	1.507E-07
NE	1.607E-06	8.669E-07	5.697E-07	3.202E-07	1.572E-07	9.874E-08
ENE	2.342E-06	1.257E-06	8.224E-07	4.586E-07	2.232E-07	1.398E-07
E	1.650E-06	8.651E-07	5.604E-07	3.111E-07	1.517E-07	9.540E-08
ESE	9.686E-07	5.088E-07	3.309E-07	1.837E-07	8.941E-08	5.619E-08
SE	6.517E-07	3.422E-07	2.237E-07	1.250E-07	6.131E-08	3.878E-08
SSE	5.531E-07	2.919E-07	1.915E-07	1.072E-07	5.265E-08	3.332E-08
S	6.636E-07	3.486E-07	2.274E-07	1.262E-07	6.142E-08	3.870E-08
SSW	8.999E-07	4.813E-07	3.136E-07	1.731E-07	8.310E-08	5.169E-08
SW	1.540E-06	8.357E-07	5.447E-07	2.999E-07	1.430E-07	8.841E-08
WSW	1.549E-06	8.355E-07	5.452E-07	3.039E-07	1.479E-07	9.243E-08
W	2.100E-06	1.097E-06	7.138E-07	4.055E-07	2.043E-07	1.305E-07
WNW	4.454E-06	2.263E-06	1.452E-06	8.306E-07	4.280E-07	2.7awE-07
NW	6.109E-06	3.102E-06	1.987E-06	1.135E-06	5.847E-07	3.787E-07
NNW	5.849E-06	2.971E-06	1.903E-06	1.087E-06	5.593E-07	3.621E-07

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	2.369E-07	1.223E-07	5.055E-08	2.663E-08	1.753E-08	1.286E-08
NNE	1.079E-07	5.507E-08	2.245E-08	1.171E-08	7.663E-09	5.598E-09
NE	6.998E-08	3.501E-08	1.389E-08	7.107E-09	4.592E-09	3.324E-09
ENE	9.892E-08	4.941E-08	1.967E-08	1.011E-08	6.559E-09	4.768E-09
E	6.774E-08	3.416E-08	1.385E-08	7.224E-09	4.739E-09	3.475E-09
ESE	3.988E-08	2.010E-08	8.165E-09	4.270E-09	2.807E-09	2.062E-09
SE	2.764E-08	1.405E-08	5.767E-09	3.044E-09	2.013E-09	1.486E-09
SSE	2.376E-08	1.207E-08	4.950E-09	2.609E-09	1.724E-09	1.272E-09
S	2.753E-08	1.395E-08	5.723E-09	3.022E-09	2.002E-09	1.480E-09
SSW	3.639E-08	1.802E-08	7.121E-09	3.649E-09	2.367E-09	1.723E-09
SW	6.194E-08	3.035E-08	1.178E-08	5.946E-09	3.814E-09	2.750E-09
WSW	6.527E-08	3.245E-08	1.279E-08	6.514E-09	4.200E-09	3.037E-09
W	9.357E-08	4.793E-08	1.962E-08	1.026E-08	6.727E-09	4.920E-09
WNW	2.008E-07	1.049E-07	4.398E-08	2.339E-08	1.550E-08	1.142E-08
NW	2.744E-07	1.433E-07	6.013E-08	3.200E-08	2.120E-08	1.563E-08
NNW	2.622E-07	1.369E-07	5.743E-08	3.056E-08	2.025E-08	1.493E-08

TABLE C-23
85TH PERCENTILE HOURLY PLUME CENTERLINE DEPOSITION VALUES FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED FROM GRAZING METEOROLOGICAL DATA (1985-1992)
(FOR USE WITH SHORT TERM RELEASES)
(D/Q) Sector Average Deposition ($1/m^2$)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	9.063E-07	5.471E-07	3.636E-07	1.966E-07	8.666E-08	4.952E-08
NNE	8.251E-07	4.868E-07	3.215E-07	1.728E-07	7.592E-08	4.334E-08
NE	7.357E-07	4.285E-07	2.771E-07	1.482E-07	6.503E-08	3.718E-08
ENE	7.139E-07	4.059E-07	2.633E-07	1.390E-07	6.056E-08	3.455E-08
E	5.942E-07	3.352E-07	2.174E-07	1.145E-07	4.986E-08	2.843E-08
ESE	5.161E-07	2.898E-07	1.872E-07	9.833E-08	4.282E-08	2.443E-08
SE	5.089E-07	2.831E-07	1.820E-07	9.577E-08	4.161E-08	2.372E-08
SSE	5.281E-07	2.921E-07	1.855E-07	9.735E-08	4.223E-08	2.406E-08
S	4.971E-07	2.780E-07	1.795E-07	9.481E-08	4.129E-08	2.356E-08
SSW	6.017E-07	3.342E-07	2.150E-07	1.132E-07	4.916E-08	2.802E-08
SW	6.735E-07	3.808E-07	2.459E-07	1.297E-07	5.629E-08	3.210E-08
WSW	7.454E-07	4.299E-07	2.812E-07	1.501E-07	6.569E-08	3.750E-08
W	8.255E-07	4.942E-07	3.284E-07	1.775E-07	7.813E-08	4.461E-08
WNW	9.768E-07	5.984E-07	4.019E-07	2.191E-07	9.694E-08	5.542E-08
NW	9.981E-07	6.144E-07	4.117E-07	2.241E-07	9.911E-08	5.667E-08
NNW	9.449E-07	5.713E-07	3.826E-07	2.082E-07	9.205E-08	5.265E-08

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	3.236E-08	1.356E-08	4.621E-09	1.897E-09	1.098E-09	8.646E-10
NNE	2.831E-08	1.195E-08	4.113E-09	1.839E-09	1.092E-09	8.622E-10
NE	2.433E-08	1.035E-08	3.679E-09	1.802E-09	1.091E-09	8.636E-10
ENE	2.248E-08	8.997E-09	3.623E-09	1.798E-09	1.100E-09	8.672E-10
E	1.850E-08	8.152E-09	3.457E-09	1.792E-09	1.096E-09	8.705E-10
ESE	1.618E-08	7.794E-09	3.226E-09	1.746E-09	1.094E-09	8.718E-10
SE	1.571E-08	7.255E-09	3.160E-09	1.748E-09	1.091E-09	8.694E-10
SSE	1.606E-08	7.248E-09	3.154E-09	1.790E-09	1.087E-09	8.633E-10
S	1.556E-08	7.412E-09	3.201E-09	1.765E-09	1.089E-09	8.651E-10
SSW	1.833E-08	7.403E-09	3.328E-09	1.773E-09	1.086E-09	8.637E-10
SW	2.098E-08	8.312E-09	3.361E-09	1.789E-09	1.083E-09	8.606E-10
WSW	2.451E-08	1.061E-08	3.594E-09	1.728E-09	1.078E-09	8.604E-10
W	2.912E-08	1.229E-08	4.144E-09	1.869E-09	1.081E-09	8.576E-10
WNW	3.619E-08	1.527E-08	5.019E-09	1.940E-09	1.088E-09	8.569E-10
NW	3.702E-08	1.563E-08	4.880E-09	1.914E-09	1.092E-09	8.605E-10
NNW	3.440E-08	1.450E-08	4.799E-09	1.929E-09	1.096E-09	8.631E-10

TABLE C-24
SECTOR AVERAGE DEPOSITION VALUES
FOR UNMONITORED GROUND LEVEL RELEASES DETERMINED
FROM GRAZING METEOROLOGICAL DATA (1985-1992)
(FOR USE WITH LONG TERM RELEASES)
(D/Q) Sector Average Deposition ($1/m^2$)
SEGMENT BOUNDARIES IN MILES

Direction	0.5	0.75	1.0	1.5	2.5	3.5
N	2.265E-08	1.167E-08	7.177E-09	3.585E-09	1.474E-09	8.132E-10
NNE	1.028E-08	5.295E-09	3.258E-09	1.627E-09	6.691E-10	3.691E-10
NE	8.034E-09	4.134E-09	2.542E-09	1.269E-09	5.213E-10	2.874E-10
ENE	2.078E-08	1.079E-08	6.675E-09	3.361E-09	1.397E-09	7.762E-10
E	1.924E-08	1.002E-08	6.213E-09	3.138E-09	1.309E-09	7.293E-10
ESE	1.159E-08	6.054E-09	3.762E-09	1.906E-09	7.979E-10	4.456E-10
SE	7.983E-09	4.184E-09	2.605E-09	1.324E-09	5.563E-10	3.114E-10
SSE	5.124E-09	2.690E-09	1.677E-09	8.534E-10	3.593E-10	2.014E-10
S	7.383E-09	3.880E-09	2.421E-09	1.233E-09	5.198E-10	2.916E-10
SSW	6.769E-09	3.525E-09	2.186E-09	1.104E-09	4.602E-10	2.563E-10
SW	8.471E-09	4.384E-09	2.706E-09	1.358E-09	5.619E-10	3.113E-10
WSW	5.062E-09	2.608E-09	1.605E-09	8.019E-10	3.298E-10	1.820E-10
W	5.392E-09	2.777E-09	1.708E-09	8.529E-10	3.506E-10	1.933E-10
WNW	1.123E-08	5.780E-09	3.555E-09	1.774E-09	7.289E-10	4.019E-10
NW	1.792E-08	9.223E-09	5.671E-09	2.830E-09	1.162E-09	6.408E-10
NNW	1.976E-08	1.018E-08	6.260E-09	3.126E-09	1.285E-09	7.091E-10

Direction	4.5	7.5	15.0	25.0	35.0	45.0
N	5.188E-10	2.099E-10	6.626E-11	2.672E-11	1.429E-11	8.820E-12
NNE	2.355E-10	9.527E-11	3.006E-11	1.212E-11	6.476E-12	3.995E-12
NE	1.833E-10	7.418E-11	2.341E-11	9.442E-12	5.048E-12	3.116E-12
ENE	4.965E-10	2.010E-10	6.352E-11	2.565E-11	1.374E-11	8.493E-12
E	4.669E-10	1.890E-10	5.976E-11	2.415E-11	1.294E-11	8.006E-12
ESE	2.855E-10	1.156E-10	3.653E-11	1.476E-11	7.905E-12	4.888E-12
SE	1.997E-10	8.083E-11	2.553E-11	1.031E-11	5.516E-12	3.408E-12
SSE	1.292E-10	5.225E-11	1.648E-11	6.643E-12	3.550E-12	2.189E-12
S	1.871E-10	7.570E-11	2.390E-11	9.637E-12	5.153E-12	3.181E-12
SSW	1.641E-10	6.637E-11	2.094E-11	8.442E-12	4.512E-12	2.783E-12
SW	1.988E-10	8.042E-11	2.536E-11	1.021E-11	5.453E-12	3.361E-12
WSW	1.161E-10	4.691E-11	1.476E-11	5.930E-12	3.158E-12	1.942E-12
W	1.233E-10	4.981E-11	1.567E-11	6.292E-12	3.349E-12	2.058E-12
WNW	2.562E-10	1.036E-10	3.262E-11	1.311E-11	6.990E-12	4.301E-12
NW	4.086E-10	1.652E-10	5.209E-11	2.097E-11	1.119E-11	6.894E-12
NNW	4.523E-10	1.830E-10	5.771E-11	2.325E-11	1.242E-11	7.660E-12

APPENDIX D

LIMITED ANALYSIS APPROACH

DOSE ASSESSMENT FOR LIQUID RADIOACTIVE EFFLUENTS

APPENDIX D
LIMITED ANALYSIS APPROACH
DOSE ASSESSMENT FOR LIQUID RADIOACTIVE EFFLUENTS

LIMITED ANALYSIS APPROACH

DOSE ASSESSMENT FOR LIQUID RADIOACTIVE EFFLUENTS

The radioactive liquid effluents for the years 1980 through 1987 (from the JAFNPP Semi-Annual Effluent release reports) were evaluated to determine the critical pathways, organs, age groups, and nuclides which contributed to environmental doses. The liquid release nuclide distribution used in this analysis is shown in Table D-1. This analysis was performed to develop a limited dose analysis for determination of liquid effluent environmental doses. Limiting the dose calculation to a few selected nuclides that contribute the majority of the dose, along with the application of an appropriate conservatism factor to compensate for variations in isotopic mixtures, provides a simplified method of determining compliance with the dose limits of Technical Specification 2.3.

Tables D-2 through D-8 show the results of this evaluation. Table D-2 presents the dose for 8 organs and 4 age groups from all available pathways. The adult's whole body and teenager's age groups (adult, teenager, child, and infant) and all organs (bone, liver, kidney, thyroid, lung, skin, and GI-LLI). The dominant pathway contribution to these doses is freshwater fish ingestion. Table D-3 presents the percent of the adult's whole body dose contribution by the major radionuclides through the dominant pathway, ingestion of freshwater fish. Table D-4 presents the same data for the teenager's liver dose. The data in Tables D-3 and D-4 show that the fish pathway contributes at least 92% to the adult's whole body dose and at least 80.9% to the teenager's liver dose from all pathways considered. The data in the tables also show that during 1980-1987 the radionuclides Cs-134, Cs-137, Zn-65, Co-60, and Mn-54 contributed over 91% of the total dose to the whole body and over 80% of the total liver dose via the freshwater fish ingestion pathway.

The data in Tables D-5 and D-6 show that the potable water pathway contributed no more than 1% to the adult's whole body dose and no more than 0.5% to the teenager's liver dose. This pathway is necessary to demonstrate compliance with 10CFR50 as specified in Sections 4.2 and 4.3.1 of NUREG-0133. As mentioned in Appendix A, Table A-4.3, this pathway is considered for all required analysis.

Table D-7 shows that 17.9% of the teenager's dose to the liver in 1984 was from the lake shoreline deposits pathway. The lake shoreline pathway contributed 5.7% of the adult's whole body dose in 1984. This pathway contributed 9.3% of the teenager's liver dose in 1986 and 2.8% of the adult's whole body dose in 1986. The lake shoreline deposits pathway is second to the freshwater fish pathway when the concentrations of Cs-134, Cs-137, Zn-65, Co-60, and Mn-54 are low as in 1984 and 1986.

LIMITED ANALYSIS APPROACH

DOSE ASSESSMENT FOR LIQUID RADIOACTIVE EFFLUENTS

(Continued)

Table D-8 shows that the swimming and boating pathways, combined, contribute no more than 1.5% to the adult's whole body dose and no more than 0.8% to the teenager's liver dose from 1980 to 1987. The swimming and boating pathways are not used in the ODCM since their dose contributions are very small.

A conservatism factor of 0.8 is introduced into the equation (i.e., calculated doses using this approach should be divided by 0.8) to compensate for any unexpected variability in nuclide and pathway dose contribution. Therefore, the dose commitment to the adult's whole body and teenager's liver due to radioactive material in liquid effluents can be reasonably estimated by limiting the dose calculation to these 5 nuclides and the fish and potable water pathways, which cumulatively contribute the bulk of the total dose calculated by accounting for all nuclides and all pathways.

The radioactive liquid effluents have decreased dramatically over the years. Liquid effluent releases for the years 2002 through 2009 were reviewed. Table D-9 lists the radionuclide distribution and also lists the reduction factors per radionuclide as compared to Table D-1. The liquid effluent data from 1980-1987 is what Appendix D is currently based on. Table D-1 is based on the 1980-1987 effluent data and has 34 radionuclides compared to the updated Table D-9 which has only 12 radionuclides. The critical pathways and age groups presented in Appendix D are still valid based on the 2002-2009 effluent data (see ODCM verification document, Reference 6.13).

TABLE D-1
CALCULATION OF TOTAL Ci/yr RELEASES FOR LIQUIDS
(Based on Semi-Annual Effluent Release Reports for the Years 1980 through 1987)

ISOTOPE	1980	1981	1982	1983	1984	1985	1986	1987	AVERAGE Ci/yr
H-3	2.81E 00	4.11E 00	6.55E-01	2.72E 00	4.77E 00	4.20E 00	5.00E 00	2.48E 00	3.34E 00
Ag-110m	1.12E-04	2.21E-04	1.15E-05	9.49E-05	2.66E-05	5.34E-06	--	--	5.90E-05
Cu-64	3.42E-02	--	--	--	--	--	--	--	4.28E-03
Cs-134	7.30E-02	8.00E-02	5.47E-02	5.11E-02	2.19E-04	8.71E-03	6.68E-05	1.47E-03	3.37E-02
Cs-137	1.06E-01	1.26E-01	6.96E-02	7.77E-02	8.80E-04	1.27E-02	1.01E-03	6.65E-03	5.01E-02
I-131	2.77E-02	4.50E-02	9.05E-04	1.95E-03	4.73E-05	2.32E-05	--	--	9.45E-03
Ba/La-140	4.61E-04	1.12E-03	1.82E-03	4.49E-04	5.86E-04	5.55E-04	2.61E-06	2.58E-05	6.27E-04
Co-58	1.07E-01	2.08E-01	2.94E-02	2.49E-02	3.23E-03	6.82E-03	--	2.90E-03	4.78E-02
Co-60	8.03E-01	1.40E 00	3.66E-01	4.86E-01	3.99E 02	9.96E-02	1.56E-02	4.32E 02	4.07E-01
Fe-59	1.31E-02	1.10E-02	3.46E-03	4.40E-03	3.21E-04	2.79E-04	--	3.49E-04	4.11E-03
Zn-65	3.11E-02	4.57E-02	9.81E-03	5.27E-03	1.29E-03	6.14E-03	7.20E-04	4.67E-04	1.26E-02
Mn-54	2.10E-01	3.44E-01	6.76E-02	1.04E-01	1.02E-02	2.86E-02	7.30E-04	1.60E-02	9.76E-02
Cr-51	4.63E-02	4.79E-02	2.77E-03	2.83E-03	8.30E-04	1.51E-04	2.95E-05	--	1.26E-02
Sb-124	4.87E-03	3.83E-03	5.37E-04	7.62E-04	1.87E-05	--	--	1.27E-04	1.27E-03
Mo-99	1.41E-02	6.44E-04	1.22E-04	7.61E-04	--	2.32E-04	2.07E-06	--	1.98E-03
Tc-99m	1.81E-04	1.67E-03	3.17E-05	2.40E-04	1.38E-04	1.94E-05	3.10E-07	--	2.85E-04
Ce-141	1.72E-05	6.99E-05	3.83E-05	1.03E-04	1.23E-04	1.32E-04	1.53E-06	--	6.06E-05
Zr/Nb-95	2.14E-03	2.54E-04	5.50E-05	1.45E-04	1.74E-04	7.02E-05	1.20E-06*	--	3.55E-04
Ce-144	6.33E-05	6.58E-04	2.46E-05	5.68E-05	1.88E-05	6.87E-04	1.27E-04	--	2.04E-04
I-133	1.22E-03	5.35E-03	1.03E-03	2.16E-03	1.08E-04	9.72E-06	1.67E-06	--	1.23E-03
Na-24	1.79E-02	3.77E-02	1.70E-03	2.01E-03	2.02E-04	2.22E-05	--	2.78E-04	7.48E-03
As-76	2.46E-04	2.08E-04	8.67E-05	3.40E-06	2.89E-04	2.24E-05	--	--	1.07E-04
Np-239	2.24E-03	4.29E-02	1.88E-02	3.55E-03	2.02E-03	2.45E-04	--	--	8.72E-03
Xe-133	9.65E-03	3.98E-02	1.05E-02	6.81E-04	2.82E-03	5.29E-03	1.82E-04	4.51E-05	8.62E-03
Xe-135	3.28E-03	5.85E-02	1.01E-02	7.03E-04	3.31E-02	9.86E-03	6.67E-04	--	1.45E-02
Kr-85m	2.88E-04	7.28E-06	7.14E-05	3.52E-05	5.40E-05	--	--	--	5.70E-05
I-135	4.97E-05	2.47E-03	1.45E-04	6.20E-04	--	--	--	--	4.11E-04
Sr-89	--	--	5.76E-04	--	--	--	--	--	7.20E-05
Sr-90	3.47E-05	1.27E-04	1.88E-04	1.38E-04	--	--	--	--	6.10E-05
Fe-55	--	--	--	--	--	2.19E-03	--	6.78E-03	1.12E-03
Co-57	--	--	--	--	--	--	1.29E-05	--	1.61E-06
Zr-97	--	--	--	--	--	--	2.26E-04	--	2.83E-05
Nb-95m	--	--	--	--	--	--	4.32E-06	--	5.40E-07
W-187	--	--	--		--	--	--	3.42E-05	4.28E-06

TABLE D-2
ORGAN DOSES FOR LIQUID RELEASES (ALL PATHWAYS)

ADULT								
YEAR	SKIN (mrem)	BONE (mrem)	LIVER (mrem)	W. BODY (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LLI (mrem)
1980	4.94E-03	7.82E-02	1.31E-01	5.58E-02	6.52E-03	4.67E-02	2.00E-02	1.50E-02
1981	8.05E-03	8.97E-02	1.48E-01	6.43E-02	1.05E-02	5.45E-02	2.44E-02	1.97E-02
1982	2.28E-03	5.17E-02	8.75E-02	3.71E-02	2.10E-03	3.03E-02	1.27E-02	5.67E-03
1983	2.92E-03	5.37E-02	8.86E-02	3.74E-02	2.74E-03	3.10E-02	1.34E-02	6.94E-03
1984	2.01E-04	6.08E-04	9.56E-04	4.94E-04	1.86E-04	4.64E-04	2.63E-04	6.44E-04
1985	6.46E-04	9.98E-03	1.68E-02	7.18E-03	5.79E-04	6.07E-03	2.55E-03	1.82E-03
1986	8.21E-05	5.31E-04	7.48E-04	3.29E-04	7.58E-05	3.17E-04	1.56E-04	1.71E-04
1987	7.35E-04	1.05E-02	1.54E-02	6.24E-03	6.57E-04	5.62E-03	2.54E-03	1.83E-03
TEENAGER								
YEAR	SKIN (mrem)	BONE (mrem)	LIVER (mrem)	W. BODY (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LLI (mrem)
1980	4.94E-03	7.82E-02	1.31E-01	5.58E-02	6.52E-03	4.67E-02	2.00E-02	1.50E-02
1981	8.05E-03	8.97E-02	1.48E-01	6.43E-02	1.05E-02	5.45E-02	2.44E-02	1.97E-02
1982	2.28E-03	5.17E-02	8.75E-02	3.71E-02	2.10E-03	3.03E-02	1.27E-02	5.67E-03
1983	2.92E-03	5.37E-02	8.86E-02	3.74E-02	2.74E-03	3.10E-02	1.34E-02	6.94E-03
1984	2.01E-04	6.08E-04	9.56E-04	4.94E-04	1.86E-04	4.64E-04	2.63E-04	6.44E-04
1985	6.46E-04	9.98E-03	1.68E-02	7.18E-03	5.79E-04	6.07E-03	2.55E-03	1.82E-03
1986	8.21E-05	5.31E-04	7.48E-04	3.29E-04	7.58E-05	3.17E-04	1.56E-04	1.71E-04
1987	7.35E-04	1.05E-02	1.54E-02	6.24E-03	6.57E-04	5.62E-03	2.54E-03	1.83E-03

TABLE D-2 (Continued)
ORGAN DOSES FOR LIQUID RELEASES (ALL PATHWAYS)

CHILD

YEAR	SKIN (mrem)	BONE (mrem)	LIVER (mrem)	W. BODY (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LLI (mrem)
1980	1.03E-03	9.27E-02	1.12E-01	2.22E-02	3.64E-03	3.68E-02	1.34E-02	4.86E-03
1981	1.68E-03	1.04E-01	1.25E-01	2.56E-02	4.79E-03	4.16E-02	1.53E-02	5.95E-03
1982	4.77E-04	6.18E-02	7.48E-02	1.43E-02	5.58E-04	2.43E-02	8.87E-03	1.74E-03
1983	6.09E-04	6.39E-02	7.57E-02	1.43E-02	7.70E-04	2.46E-02	9.13E-03	2.12E-03
1984	4.20E-05	5.96E-04	7.16E-04	2.13E-04	4.76E-05	2.78E-04	1.09E-04	2.01E-04
1985	1.35E-04	1.17E-02	1.42E-02	2.89E-03	1.41E-04	4.75E-03	1.69E-03	5.58E-04
1986	1.72E-05	5.89E-04	6.16E-04	1.38E-04	1.81E-05	2.24E-04	8.23E-05	4.99E-05
1987	1.53E-04	1.24E-02	1.33E-02	2.42E-03	1.60E-04	4.40E-03	1.66E-03	5.55E-04

INFANT

YEAR	SKIN (mrem)	BONE (mrem)	LIVER (mrem)	W. BODY (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LLI (mrem)
1980	0	4.12E-04	5.60E-04	2.58E-04	1.16E-03	2.58E-04	1.93E-04	2.34E-04
1981	0	5.45E-04	7.24E-04	4.08E-04	1.84E-03	3.69E-04	2.95E-04	3.83E-04
1982	0	2.52E-04	3.26E-04	1.20E-04	1.01E-04	1.32E-04	9.22E-05	1.01E-04
1983	0	2.67E-04	3.54E-04	1.47E-04	1.59E-04	1.52E-04	1.12E-04	1.27E-04
1984	0	7.73E-06	1.38E-05	1.31E-05	1.16E-05	1.06E-05	1.01E-05	1.34E-05
1985	0	5.14E-05	7.43E-05	3.61E-05	2.38E-05	3.57E-05	2.78E-05	3.38E-05
1986	0	3.78E-06	8.99E-06	7.81E-06	6.50E-06	7.07E-06	6.70E-06	7.83E-06
1987	0	5.64E-05	7.85E-05	4.16E-05	2.78E-05	4.00E-05	3.28E-05	3.90E-05

TABLE D-3
DOSE CONTRIBUTION TO THE ADULT'S WHOLE BODY FROM THE FRESHWATER FISH PATHWAY

(PERCENT)

ISOTOPE	1980	1981	1982	1983	1984	1985	1986	1987
Cs-134	52.7	50.3	56.5	52.2	25.2	52.1	9.2	26.8
Cs-137	45.2	46.8	42.4	46.8	59.7	44.9	82.5	71.5
Zn-65	1.3	1.7	0.6	0.3	8.5	2.1	5.7	0.5
Co-60	0.6	0.9	0.4	0.5	4.5	0.6	2.1	0.8
Mn-54	0.2	0.3	0.1	0.2	1.7	0.2	0.1	0.4
The percentage (%) of the whole body dose from five nuclides in the fish pathway	100	100	100	100	99.6	99.9	99.6	100
The percentage (%) of the total dose to the adult's whole body from the fish pathway	98.8	98.3	99.2	98.9	92.0	98.8	95.6	98.4
The percentage (%) of the total dose to the adult's whole body from the five nuclides in the fish pathway	98.8	98.3	99.2	98.9	91.6	98.7	95.2	98.4

TABLE D-4
DOSE CONTRIBUTION TO THE TEENAGER'S LIVER FROM THE FRESHWATER FISH PATHWAY

(PERCENT)

ISOTOPE	1980	1981	1982	1983	1984	1985	1986	1987
Cs-134	46.2	43.8	50.2	45.9	20.0	45.5	7.3	22.0
Cs-137	50.8	52.2	48.4	52.9	60.9	50.2	83.5	75.5
Zn-65	2.0	2.5	0.9	0.5	11.9	3.3	8.0	0.7
Co-60	0.2	0.3	0.1	0.2	1.3	0.2	0.6	0.2
Mn-54	0.8	1.1	0.4	0.6	5.6	0.9	0.5	1.4
The percentage (%) of the liver dose from five nuclides in the fish pathway	100	99.9	100	100	99.7	100	99.9	99.8
The percentage (%) of the total dose to the teen's liver from the fish pathway	96.5	95.0	97.6	97.0	80.9	96.4	89.9	95.6
The percentage (%) of the total dose to the teen's liver from the five nuclides in the fish pathway	96.5	94.9	97.6	97.0	80.7	96.4	89.8	95.4

TABLE D-5
DOSE CONTRIBUTION TO THE ADULT'S WHOLE BODY FROM THE POTABLE WATER PATHWAY

(PERCENT)

ISOTOPE	1980	1981	1982	1983	1984*	1985	1986	1987
Cs-134	41.5	35.7	47.5	41.9	3.29	35.7	1.18	15.5
Cs-137	35.6	33.2	35.7	37.6	7.82	30.7	10.5	41.5
Zn-65	1.01	1.2	0.5	0.25	1.11	1.44	0.73	0.28
Co-60	17.8	24.4	12.4	15.5	23.4	15.9	10.8	17.8
Mn-54	0.86	1.1	0.4	0.61	1.10	0.84	0.09	1.22
The percentage (%) of the whole body dose from the nuclides from the potable water pathway	96.8	95.6	96.5	95.9	36.7	84.6	23.3	76.3
The percentage (%) the total dose to the adult's whole body from the potable water pathway	0.16	0.18	0.15	0.15	0.89	0.18	0.94	0.21
The percentage (%) of the total dose of the adult's whole body from the five nuclides in the potable water pathway	0.15	0.17	0.14	0.14	0.33	0.15	0.22	0.16

* Tritium was the major contributor to the potable water pathway for 1984.

TABLE D-6
DOSE CONTRIBUTION TO THE TEENAGER'S LIVER FROM THE POTABLE WATER PATHWAY

(PERCENT)

ISOTOPE	1980	1981	1982	1983	1984*	1985	1986	1987
Cs-134	40.9	37.0	47.0	41.7	4.87	36.9	1.74	16.1
Cs-137	45.0	44.2	45.3	48.0	14.8	40.8	19.9	55.3
Zn-65	1.8	2.14	0.85	0.44	2.90	2.63	1.90	0.52
Co-60	6.43	9.25	4.49	5.66	12.7	6.03	5.8	6.77
Mn-54	3.5	4.76	1.73	2.54	6.77	3.62	0.57	5.24
The percentage (%) of the liver dose from the nuclides from the potable water pathway	97.6	97.4	99.4	98.3	42.0	90.0	29.9	83.9
The percentage (%) of the total dose to the teen's liver from the potable water pathway	0.12	0.13	0.12	0.12	0.38	0.14	0.44	0.15
The percentage (%) of the total dose to the teen's liver from the five nuclides in the potable water pathway	0.11	0.12	0.11	0.11	0.16	0.13	0.13	0.12

* Tritium was the major contributor to the potable water pathway for 1984

TABLE D-7
DOSE CONTRIBUTION TO THE ADULT'S WHOLE BODY AND TEENAGER'S LIVER FROM THE LAKE SHORELINE DEPOSITS PATHWAY

ISOTOPE	1980	1981	1982	1983	1984	1985	1986	1987
The percentage (%) of the total dose to the adult's whole body from the lake shoreline deposits pathway	0.83	1.22	0.56	0.72	5.68	0.85	2.79	1.12
Maximum percentage from 1980 to 1987 - 5.68%								
Average percentage from 1980 to 1987 - 1.72%								
The percentage (%) of the total dose to the teenager's liver from the lake shoreline deposits pathway	3.22	4.62	2.22	2.80	17.91	3.27	9.33	4.04
Maximum percentage from 1980 to 1987 -	17.9%							
Average percentage from 1980 to 1987 -	5.93%							

TABLE D-8
DOSE CONTRIBUTION TO THE ADULT'S WHOLE BODY AND TEENAGER'S LIVER FROM THE SWIMMING AND BOATING PATHWAYS

ISOTOPE	1980	1981	1982	1983	1984	1985	1986	1987
Percentage (%) of the total dose to the Adult's whole body from the swimming and boating pathways	0.21	0.31	0.13	0.17	1.39	0.20	0.62	0.27
Maximum percentage from 1980 to 1987 -		1.39%						
Average percentage from 1980 to 1987 -		0.41%						
Percentage (%) of 0.18 the total dose to the teenager's liver from the swimming and boating pathways		0.14	0.21	0.09	0.12	0.78	0.14	0.37
Maximum percentage from 1980 to 1987 -		0.78%						
Average percentage from 1980 to 1987 -		0.25%						

TABLE D-9

CALCULATION OF TOTAL Ci/yr RELEASES FOR LIQUIDS

(Based on Semi-Annual Effluent Release Reports for the Years 2002 through 2009)

ISOTOPE	2002	2003	2004	2005	2006	2007	2008	2009	AVERAGE Ci/yr	*REDUCTION FACTOR
H-3	6.25E-01	2.76E-03	5.06E-03	1.01-E02	3.81E+00	1.27E-01	3.80+00	1.70E-03	1.05E+00	3.2
Cs-137	3.14E-05								3.93E-06	12748
Co-60	8.44E-04				1.59E-05				1.07E-04	3804
Fe-59	1.88E-04								2.35E-05	175
Zn-65	7.88E-05				3.83E-05				1.46E-05	863
Mn-54	9.76E-04				1.04E-04				1.35E-04	723
Tc-99m	5.47E-07								6.84E-08	4166
Xe-133						5.36E-04			6.70E-05	128
Xe-135							9.91E-05		1.24E-05	1169
Sr-89						5.05E-06			6.31E-07	114
Sr-90	2.74E-07				7.06E-06	5.44E-07			9.85E-07	62
Fe-55	6.32E-04				2.02E-04	1.17E-05			1.06E-04	41.9

* Average Value in ODCM ÷ updated Average Value. For example for H-3, 3.34 ÷ 1.05 = 3.2

APPENDIX E

TECHNICAL BASES FOR EFFECTIVE DOSE FACTORS

APPENDIX E

TECHNICAL BASES FOR EFFECTIVE DOSE FACTORS

TECHNICAL BASES FOR EFFECTIVE DOSE FACTORS

The evaluation of doses due to releases of radioactive material to the atmosphere can be simplified by the use of effective dose transfer factors instead of using dose factors which are radionuclide specific. These effective factors, which are based on the typical radionuclide distribution in the releases, can be applied to the total radioactivity released to approximate the dose in the environment, i.e., instead of having to sum the isotopic distribution multiplied by the isotope specific dose factor, only a single multiplication (K_{eff}, L_{eff}, M_{eff} or N_{eff}) times the total quantity of radioactive material released, would be needed. This approach provides a reasonable estimate of the actual dose while eliminating the need for a detailed calculating technique.

Determination of Effective Dose Factors

The effective dose transfer factors are based on past operating data. The radioactive effluent distribution for the past years can be used to derive single effective factors by the following equations.

$$K_{eff} = \sum_{i=1}^{n} K_i \cdot f_i \qquad \text{E-1}$$

Where:

K_{eff} = the effective whole body dose factor due to gamma emissions from all noble gases released.

K_i = the whole body dose factor due to gamma emissions from each noble gas radionuclide 'i' released.

f_i = the fractional abundance of noble gas radionuclide 'i' is of the total noble gas radionuclides.

A K_{eff} is calculated for elevated releases and also for vent releases.

TECHNICAL BASES FOR EFFECTIVE DOSE FACTORS

(Continued)

$$L_{eff} = \sum_{i=1}^{n} L_i \cdot f_i$$

E-2

Where:

L_{eff} = the effective skin dose factor due to beta emissions from all noble gases released.

L_i = the skin dose factor due to the beta emissions from each noble gas radionuclide 'i' released.

For ease of calculation, L_{eff} is calculated for elevated releases and $(L + 1.1M)_{eff}$ is calculated for vent releases.

$$(L + 1.1M)_{eff} = \sum_{i=1}^{n} (L_i + 1.1 M_i) \cdot f_i$$

E-3

Where:

$(L + 1.1\ M)_{eff}$ = the effective skin dose factor due to beta and gamma emissions from all noble gases released from the vents.

$(L_i + 1.1\ M_i)$ = the skin dose factor due to beta and gamma emissions from each noble gas radionuclide 'i' released from the vents.

TECHNICAL BASES FOR EFFECTIVE DOSE FACTORS

(Continued)

$$M_{eff} = \sum_{i=1}^{n} M_i \cdot f_i$$

E-4

Where:

M_{eff} = the effective air dose factor due to gamma emissions from all noble gases released.

M_i = the air dose factor due to gamma emissions from each noble gas radionuclide 'i' released.

A M_{eff} is calculated for elevated releases and also for vent releases.

TECHNICAL BASES FOR EFFECTIVE DOSE FACTORS

(Continued)

E-5

$$N_{eff} = \sum_{i=1}^{n} N_i \cdot f_i$$

Where:

N_{eff} = the effective air dose factor due to beta emissions from all noble gases released.

N_i = the air dose factor due to beta emissions from each noble gas radionuclide 'i' released.

A N_{eff} is calculated for elevated releases and also for vent releases.

To determine the appropriate effective factors to be used and to evaluate the degree of variability, the atmospheric radioactive effluents for the years 1985 through 1991 have been evaluated. Tables E-1, E-2, and E-3 present the results of this evaluation.

To compensate for any unusual variability in the radionuclide distribution, 3 sigma was added to the average K_{eff}, M_{eff}, N_{eff}, L_{eff}, and $(L + 1.1\ M)_{eff}$ values. This added conservatism provides additional assurance that the evolution of doses by the use of a single effective factor will normally overestimate actual doses in the environment, and any underestimation will be of insignificant magnitude.

TABLE E-1

EFFECTIVE DOSE FACTORS FOR NOBLE GASES -

WHOLE BODY EFFECTIVE DOSE

[K_{eff}]

VENT RELEASE

[mrem/sec per μCi/m^3]

YEAR	Whole Body Effective Dose Factor K_{eff}
1985	4.32E-05
1986	1.42E-04
1987	4.34E-05
1988	1.08E-04
1989	1.64E-04
1990	8.80E-05
1991	6.03E-05
mean ± σ	9.27E-05 ± 4.78E-05
mean + 3σ	**2.36E-04**

NOTE: The years 1985 through 1991 were selected as representative of historical noble gas releases from the vents. Calculated K_{eff} values based on the 1985 through 1991 data produce a more conservative result providing inclusion (bounding) of K_{eff} values that may be encountered if a fuel failure occurs. An evaluation of current vent release data (i.e. 1999 through 2003) resulted in non-conservative Keff values.

TABLE E-1 (continued)

EFFECTIVE DOSE FACTORS FOR NOBLE GASES -

WHOLE BODY EFFECTIVE DOSE

[K_{eff}]

ELEVATED STACK RELEASE

[mrem/sec per μCi/m^3]

YEAR	Whole Body Effective Dose Factor K_{eff}
1999	2.34E-04
2000	2.29E-04
2001	2.41E-04
2002	2.11E-04
2003	2.47E-04
mean ± σ	2.32E-04 ± 1.38E-05
mean + 3σ	**2.73E-04**

TABLE E-2

EFFECTIVE DOSE FACTORS FOR NOBLE GASES - AIR DOSE

[M_{eff} & N_{eff}]

YEAR	VENT RELEASE [mrad/sec per μCi/m³]		ELEVATED RELEASE [mrad/sec per μCi/m³]	
	Gamma-Air Effective Dose Factor M_{eff}	Beta-Air Effective Dose Factor N_{eff}	Gamma-Air Effective Dose Factor M_{eff}	Beta-Air Effective Dose Factor N_{eff}
1985	4.57E-05	6.78E-05	2.06E-04	1.26E-04
1986	1.49E-04	1.14E-04	2.28E-04	1.30E-04
1987	4.66E-05	5.21E-05	1.13E-04	6.58E-05
1988	1.13E-04	7.25E-05	1.17E-04	7.49E-05
1989	1.71E-04	7.30E-05	1.81E-04	1.52E-04
1990	9.29E-05	8.87E-05	1.25E-04	1.39E-04
1991	6.41E-05	6.30E-05	1.31E-04	9.02E-05
mean ± σ	9.75E-05 ± 4.95E-05	7.59E-05 ± 2.01E-05	1.57E-04 ± 4.70E-05	1.11E-04 ± 3.37E-05
mean + 3σ	**2.46E-04**	**1.36E-04**	**2.98E-04**	**2.12E-04**

TABLE E-3

EFFECTIVE DOSE FACTORS FOR NOBLE GASES - SKIN EFFECTIVE DOSE

YEAR	VENT RELEASE [mrem/sec per μCi/m^3] Total Skin Effective Dose Factor $(L + 1.1M)_{eff}$	ELEVATED RELEASE [mrem/sec per μCi/m^3] Skin Effective Dose Factor L_{eff}
1985	9.87E-05	1.09E-04
1986	2.37E-04	1.13E-04
1987	8.44E-05	4.57E-05
1988	1.77E-04	5.51E-05
1989	2.43E-04	1.34E-04
1990	1.58E-04	1.20E-04
1991	1.04E-04	7.08E-05
mean $\pm$ σ	1.57E-04 $\pm$ 6.54E-05	9.25E-05 $\pm$ 3.47E-05
mean +3σ	**3.54E-04**	**1.97E-04**

TABLE E-4
TABLES OF SOURCE TERMS USED FOR DEVELOPMENT OF EFFECTIVE DOSE TRANSFER FACTORS
(Based on Semi-Annual Effluent Release Reports for the years 1985-1991 and 1999-2003)
ELEVATED RELEASE (Curies)

NUCLIDE	1985	1986	1987	1988	1989	1990	1991
Ar-41	4.34E+01	3.65E+01	6.90E+01	1.34E+01	1.73E+-1	3.86E+-1	1.57E+01
Kr-83m	--	--	--	--	--	--	--
Kr-85m	3.47E+02	7.48E+01	6.6E+02	3.85E+02	1.28E+01	7.78E+01	1.94E+02
Kr-85	--	--	--	--	--	--	--
Kr-87	1.57E+03	2.15E+02	8.39E+01	1.59E+02	9.26E+00	3.85E+01	7.30E+01
Kr-88	1.13E+03	3.32E+02	4.60E+02	5.18E+02	2.20E+01	1.17E+02	2.99E+02
Kr-89	--	--	--	--	--	--	--
Kr-90	--	--	--	--	--	--	--
Xe-131m	8.51E+02	7.79E+00	2.30E+00	--	7.41E+00	1.88E+01	1.16E+02
Xe-133m	--	9.92E+00	2.73E-01	5.88E+00	--	3.38E+00	5.23E+00
Xe-133	2.77E+02	1.01E+02	1.63E+03	1.13E+03	7.17E+00	2.97E+02	4.74E+02
Xe-135m	1.76E+03	2.03E+02	9.13E+01	3.69E+01	6.09E+00	2.99E+01	2.38E+01
Xe-135	2.22E+03	3.34E+02	2.35E+02	1.00E+03	2.49E+01	1.40E+02	4.00E+02
Xe-137	--	3.86E+01	--	--	2.40E+01	1.87E+02	7.22E+01
Xe-138	5.59E+03	7.45E+02	2.26E+02	1.53E+01	2.04E+01	1.01E+02	7.55E+01
TOTAL	1.38E+04	2.10E+03	3.47E+03	3.27E+03	1.51E+02	1.05E+03	1.75E+03

NUCLIDE	1999	2000	2001	2002	2003
Ar-41	1.95E+01	2.46E+01	2.51E+01	2.16E+01	1.38E+01
Kr-83m	--	--	--	--	--
Kr-85m	2.23E+00	3.79E+00	3.63E+00	8.59E+00	3.50E+00
Kr-85	--	--	--	--	--
Kr-87	1.24E+01	9.18E+00	5.53E-01	1.66E+01	4.99E-01
Kr-88	8.56E+00	5.80E+00	1.09E+00	1.97E+01	2.61E+00
Kr-89	--	--	--	--	--
Kr-90	--	--	--	--	--
Xe-131m	--	--	--	--	--
Xe-133m	--	--	--	--	--
Xe-133	5.17E-02	1.09E+00	1.55E+00	3.75E+00	7.60E-01
Xe-135m	9.99E+00	7.54E+00	4.09E-01	2.44E+00	2.21E-01
Xe-135	1.13E-01	8.58E+00	5.06E-01	2.67E+01	4.44E-01
Xe-137	5.36E-01	--	--	1.61E-01	--
Xe-138	3.35E+01	2.35E+01	1.16E+00	7.98E+00	8.14E-01
TOTAL	9.81E+01	8.41E+01	3.40E+01	1.08E+02	2.26E+01

TABLE E-5
TABLES OF SOURCE TERMS USED FOR DEVELOPMENT OF EFFECTIVE DOSE TRANSFER FACTORS

(Based on Semi-Annual Effluent Release Reports for the years 1985 through 1991)

VENT RELEASE (Curies)

RADIONUCLIDE	**1985**	**1986**	**1987**	**1988**
Ar-41		--	--	-- --
Kr-83m		--	--	-- --
Kr-85m	--	3.35E+01	6.42E+01	3.14E+01
Kr-85	4.36E+02	-- --	--	
Kr-87	8.95E+00	4.61E+01	1.38E+01	7.78E+00
Kr-88	1.45E+01	7.25E+01	4.81E+01	4.13E+01
Kr-89	--	--	--	--
Kr-90	--	--	--	--
Xe-131m	1.44E+02	1.24E+02	1.19E+01	1.26E+01
Xe-133m	2.81E+01	4.65E+01	4.37E+02	5.33E+01
Xe-133	6.29E+01	4.91E+01	5.06E+02	2.75E+02
Xe-135m	9.66E+00	1.33E+01	3.39E+01	1.48E+01
Xe-135	1.68E+02	3.54E+01	1.31E+02	5.14E+01
Xe-137	--	3.10E+01	--	--
Xe-138	7.27E+01	1.06E+02	3.18E+01	1.35E+02
TOTAL	**9.44E+02**	**5.57E+02**	**1.28E+03**	**6.23E+02**

RADIONUCLIDE	**1989**	**1990**	**1991**
Ar-41	3.35E-01	9.02E-01	4.70E-01
Kr-83m	--	--	--
Kr-85m	7.08E+01	1.77E+01	1.74E+01
Kr-85	--	--	--
Kr-87	3.68E+00	1.13E+01	3.72E+00
Kr-88	1.01E+02	1.36E+01	1.63E+01
Kr-89	--	--	--
Kr-90	--	--	--
Xe-131m	5.57E+01	1.67E+01	1.11E+02
Xe-133m	5.05E+01	8.95E+01	1.70E+01
Xe-133	403E+01	5.54E+01	7.19E+01
Xe-135m	1.53E+01	8.81E+00	1.35E+01
Xe-135	2.62E+01	3.27E+01	2.39E+01
Xe-137	--	1.11E+01	7.85E+00
Xe-138	4.42E+01	4.57E+01	1.74E+01
TOTAL	**4.08E+02**	**3.04E+02**	**3.01E+02**

TABLE E-6

RADIONUCLIDE DISTRIBUTION OF VENT AND ELEVATED RELEASES

(Based on Semi-Annual Effluent Release Reports for the years 1985 through 1991

FRACTION OF TOTAL VENT RELEASE

RADIONUCLIDE	1985	1986	1987	1988	1989	1990	1991
Ar-41	--	--	--	--	8.21E-04	2.97E-03	1.57E-03
Kr-83m	--	--	--	--	--	--	--
Kr-85m	--	6.01E-02	5.03E-02	5.04E-02	1.73E-01	5.83-02	5.80E-02
Kr-85	4.62E-01	--	--	--	--	--	--
Kr-87	9.48E-03	8.27E-02	1.08E-02	1.25E-02	9.02E-03	3.73E-02	1.24E-02
Kr-88	1.53E-02	1.30E-01	3.76E-02	6.63E-02	2.48E-01	4.48E-02	5.43E-02
Kr-89	--	--	--	--	--	--	--
Kr-90	--	--	--	--	--	--	--
Xe-131m	1.52E-02	2.23E-01	9.32E-03	2.02E-02	1.36E-01	5.51E-02	3.70E-01
Xe-133m	2.97E-02	8.34E-02	3.42E-01	8.56E-02	1.24E-01	2.95E-01	5.67E-02
Xe-133	6.66E-02	8.80E-02	3.96E-01	4.42E-01	9.87E-02	1.82E-01	2.39E-01
Xe-135m	1.02E-02	2.39E-02	2.65E-02	2.37E-02	3.74E-02	2.90E-02	4.49E-02
Xe-135	1.78E-01	6.35E-02	1.02E-01	8.26E-02	6.42E-02	1.08E-01	7.97E-02
Xe-137	--	5.56E-02	--	--	--	3.65E-02	2.61E-02
Xe-138	7.70E-02	1.89E-01	2.49E-02	2.17E-01	1.08E-01	1.51E-01	5.78E-02

FRACTION OF TOTAL ELEVATED RELEASE

RADIONUCLIDE	1985	1986	1987	1988	1989	1990	1991
Ar-41	3.15E-03	1.74E-02	1.99E-02	4.09E-03	1.14E-01	3.52E-02	8.97E-03
Kr-83m	--	--	--	--	--	--	--
Kr-85m	2.52E-02	3.56E-02	1.92E-01	1.18E-01	8.45E-02	7.44E-02	1.11E-01
Kr-85	--	--	--	--	--	--	--
Kr-87	1.14E-01	1.03E-01	2.42E-02	4.85E-02	6.12E-02	3.68E-02	4.17E-02
Kr-88	8.17E-02	1.58E-01	1.33E-01	1.58E-01	1.45E-01	1.12e-01	1.71E-01
Kr-89	--	--	--	--	--	--	--
Kr-90	--	--	--	--	--	--	--
Xe-131m	6.18E-02	3.71E-03	6.64E-04	--	4.90E-02	1.79E-02	6.62E-02
Xe-133m	--	4.73E-03	7.88E-05	1.80E-03	--	3.23E-03	2.99E-03
Xe-133	2.01E-02	4.83E-02	4.71E-01	3.47E-01	4.74E-02	2.84E-01	2.71E-01
Xe-135m	1.27E-01	9.68E-02	2.63E-02	1.13E-02	4.03E-02	2.86E-02	1.36E-02
Xe-135	1.61E-01	1.59E-01	6.78E-02	3.06E-01	1.65E-01	1.33E-01	2.28E-01
Xe-137	--	1.84E-02	--	--	1.59E-01	1.79E-01	4.13E-02
Xe-138	4.06E-01	3.55E-01	6.51E-02	4.67E-03	1.35E-01	9.62E-02	4.32E-02

RADIONUCLIDE	1999	2000	2001	2002	2003
Ar-41	1.99E-01	2.92E-01	7.38E-01	2.01E-01	6.09E-01
Kr-83m	--	--	--	--	--
Kr-85m	2.27E-02	4.51E-02	1.07E-01	7.99E-02	1.54E-01
Kr-85	--	--	--	--	--
Kr-87	1.26E-01	1.09E-01	1.63E-02	1.55E-01	2.20E-02
Kr-88	8.73E-02	6.91E-02	3.20E-02	1.83E-01	1.16E-01
Kr-89	--	--	--	--	--
Kr-90	--	--	--	--	--
Xe-131m	--	--	--	--	--
Xe-133m	--	--	--	--	--
Xe-133	5.00E-04	1.29E-02	4.57E-02	3.49E-02	3.36E-02
Xe-135m	1.02E-01	8.98E-02	1.20E-02	2.27E-02	9.78E-03
Xe-135	1.16E-01	1.02E-01	1.49E-02	2.48E-01	1.96E-02
Xe-137	5.50E-03	--	--	1.50E-03	--
Xe-138	3.42E-01	2.79E-01	3.41E-02	7.42E-02	3.60E-02

APPENDIX F

EFFLUENT MONITOR SAMPLING LOCATIONS AND DESCRIPTIONS

APPENDIX F

EFFLUENT MONITOR SAMPLING LOCATIONS AND DESCRIPTIONS

TABLE F-1

ATMOSPHERIC GASEOUS RELEASE POINT DATA

RELEASE POINT	STACK	REACTOR* BUILDING	TURBINE BUILDING	RADWASTE BUILDING	REFUEL* FLOOR
Height Above Grade (feet)	385	172	172	111	172
Release Mode	Elevated	Roof Top Vent	Roof Top Vent	Roof Top Vent	Roof Top Vent
Effluent Source	Turbine Gland Seal Condenser Gases Mechan-ical Vacuum Pump Exhaust Steam Jet Air Ejector Exhaust	Secondary and Auxiliary Building Exhaust Ventilation	Turbine Building Exhaust Ventilation	Waste Disposal Building Ventilation	Refuel Floor Exhaust Ventilation

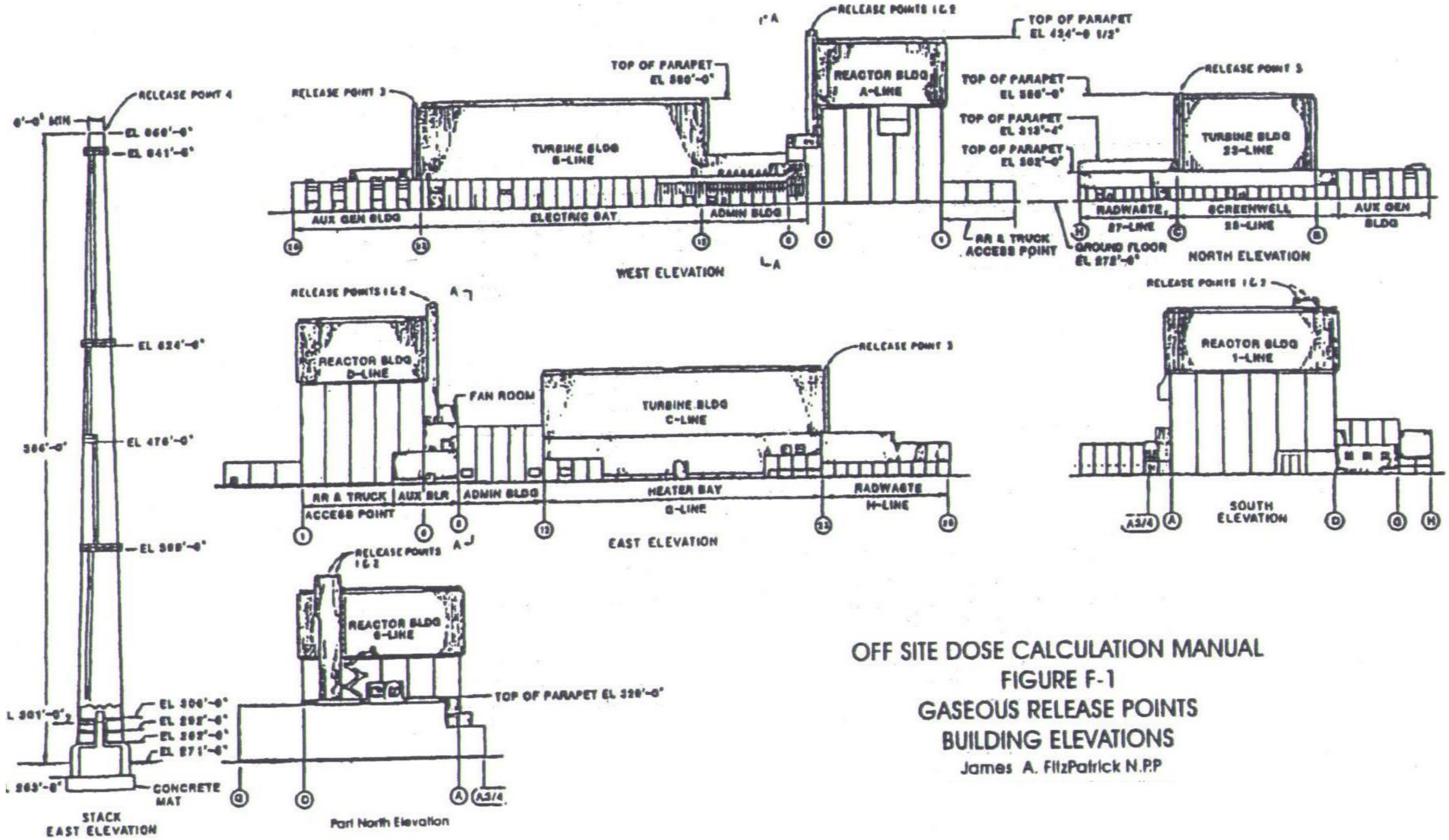
* The Refuel Floor and Reactor Building vent is a combined release point.

TABLE F-2

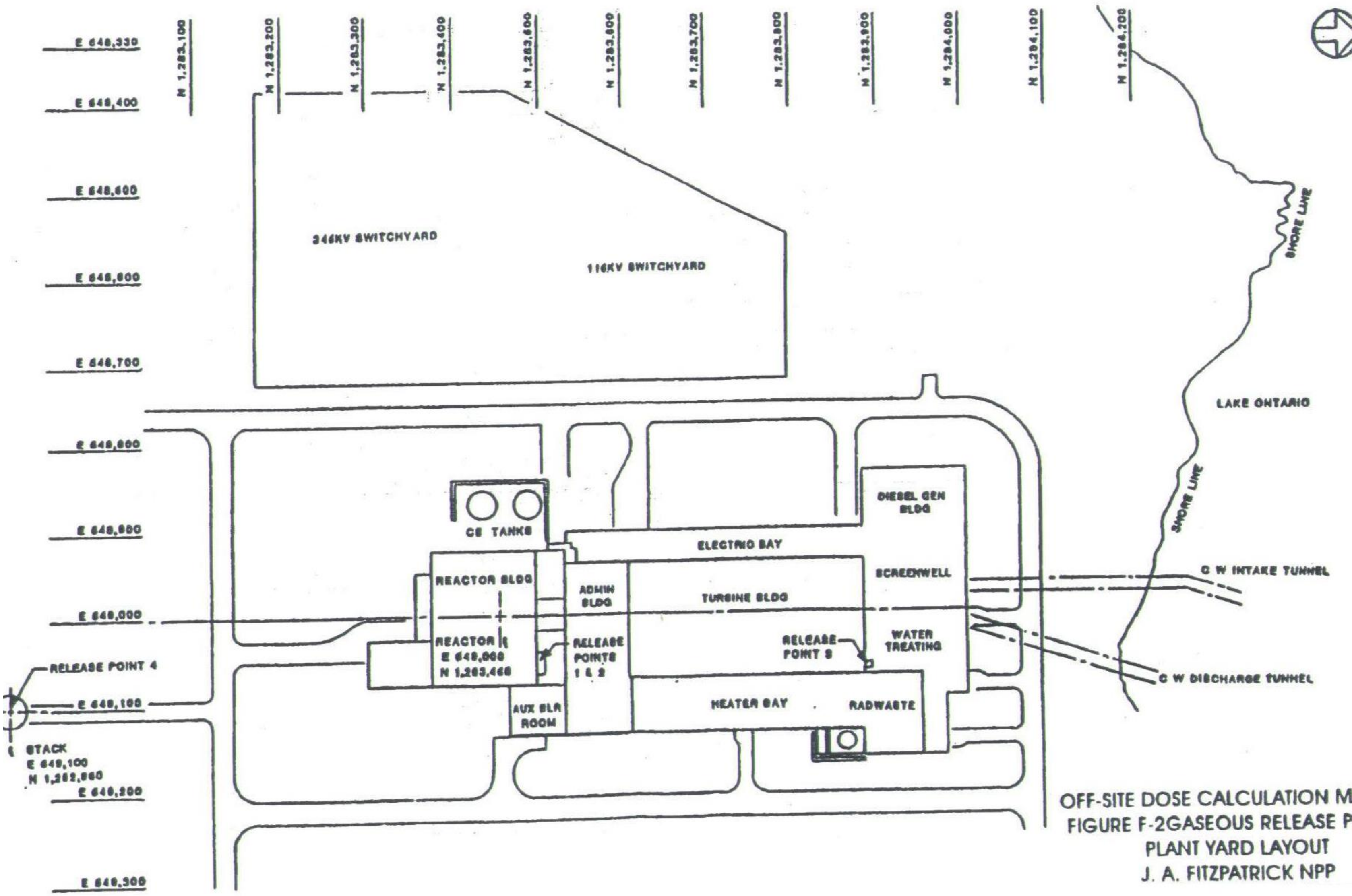
EFFLUENT MONITORING SYSTEM DATA

MONITOR DESCRIPTION	SAMPLING LOCATION	DETECTION TYPE	RANGE	CONTROL FUNCTIONS	ALARM SETPOINT USED	REFERENCE CALIBRATION SOURCE
Main steam line monitor	Located near the main steam lines downstream of the outboard MSIV's in the steam tunnel	4-gamma sensitive ion chambers	10^0-10^6mR/hr	Closure of main steam line drain motor operated valves, mechanical vacuum pump line isolation valve, recirculation loop sample valves, and initiates a trip of the mechanical vacuum pump.	Yes	Victoreen Cs^{137} gamma dose rate source
Off-gas radiation monitoring system	Turbine 252' west	2-gamma sensitive ion chambers	10^0-10^6mR/hr	Initiate closure of off-gas system isolation valves	Yes	Gas sample counted on Ge(Li)
Off-gas pipe (Stack) monitor	Stack	Scintillation detectors	10^{-1}-10^6 cps	Indicate and record rate of release of radioactive material to the environment	Yes	Gas vent marinelli counted on Ge(Li)

MONITOR DESCRIPTION	SAMPLING LOCATION	DETECTION TYPE	RANGE	CONTROL FUNCTIONS	ALARM SETPOINT USED	REFERENCE CALIBRATION SOURCE
Process liquid radiation monitors	Rad Waste - RW 272' Service H_2O Heater Bay 252'	Scintillation detectors	10^{-1}-10^{6} cps	Monitor for leaks of closed systems. Monitor normal re-lease of radio-active material to the environment	yes	Representative liquid sample counted on Ge(Li)
Plant stack & vent noble gas monitors	Turbine - MG Set 300' Reactor - RX 344' Refuel - RX 369' Radwaste - TB 300' Stack	GM Detectors Scintillation Detector	10^{1}-10^{6} CPM 10^{-1}-10^{6} CPS	Provide isolation of potentially contaminated systems	Yes	Gas marinelli counted on Ge(Li)
Drywell continuous air monitor	Reactor 300' south side	Scintillation detectors	10^{-1}-10^{6} CPM	Monitor airborne radioactivity in Drywell during normal operation	Yes	Gas marinelli counted on Ge(Li)
Containment high range monitors	Drywell penetrations X110C and X100D	2-ion chamber detectors	10^{0}-10^{8} R/hr	Accident control and initiates isolation	Yes	Victoreen Cs-137 gamma dose rate source
High range effluent monitors	Stack, Turbine Radwaste	2-ion chamber detectors	10^{-1}-10^{7} mR/hr	Accident control and initiates isolation	Yes	Victoreen Cs-137 gamma dose rate source



OFF SITE DOSE CALCULATION MANUAL
FIGURE F-1
GASEOUS RELEASE POINTS
BUILDING ELEVATIONS
James A. FitzPatrick N.P.P



OFF-SITE DOSE CALCULATION MANUAL
FIGURE F-2GASEOUS RELEASE POINTS
PLANT YARD LAYOUT
J. A. FITZPATRICK NPP

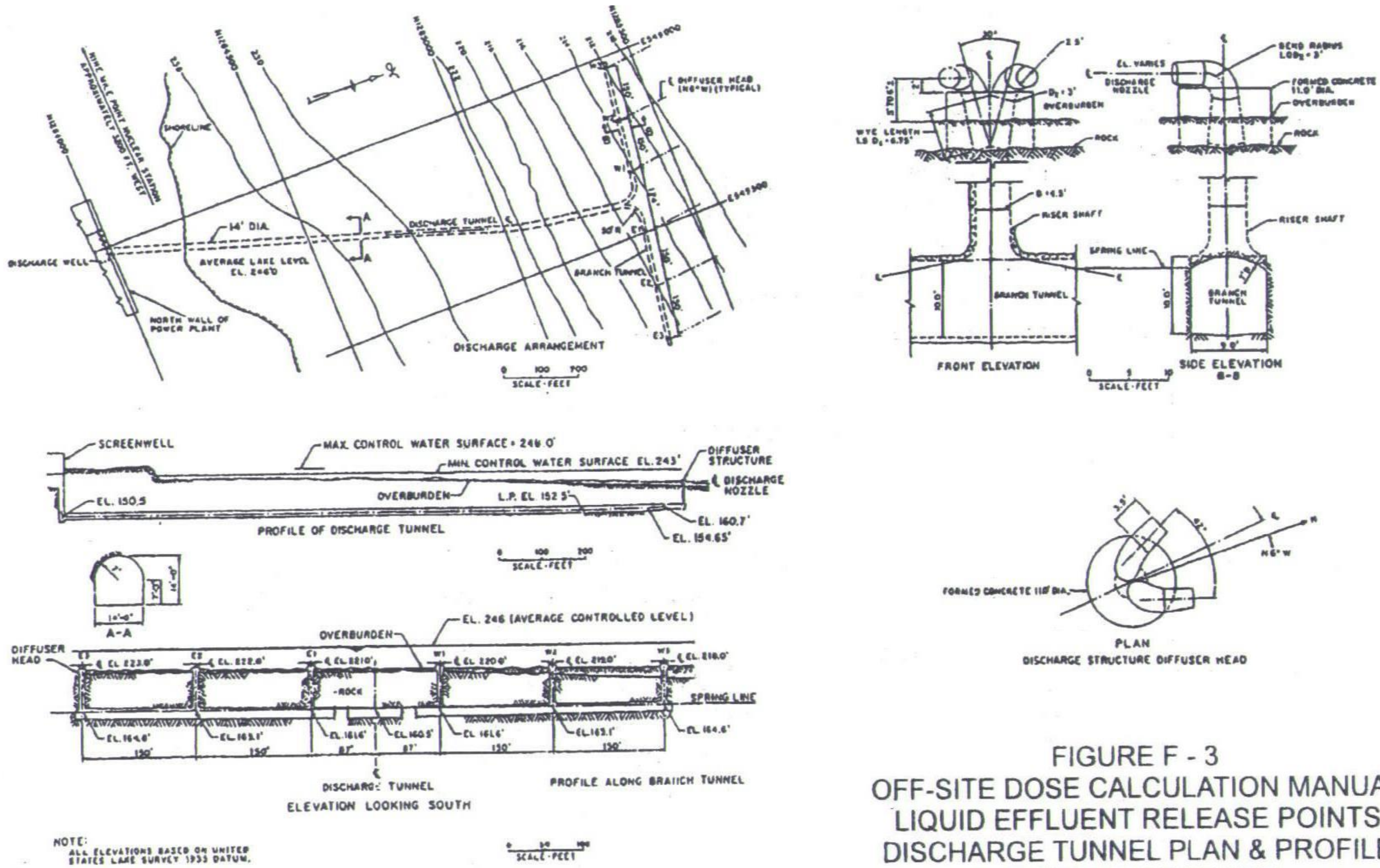


FIGURE F - 3
OFF-SITE DOSE CALCULATION MANUAL
LIQUID EFFLUENT RELEASE POINTS
DISCHARGE TUNNEL PLAN & PROFILE
J. A. FITZPATRICK N.P.P.

FIGURE F-4

GASEOUS EFFLUENT RELEASE PATHS

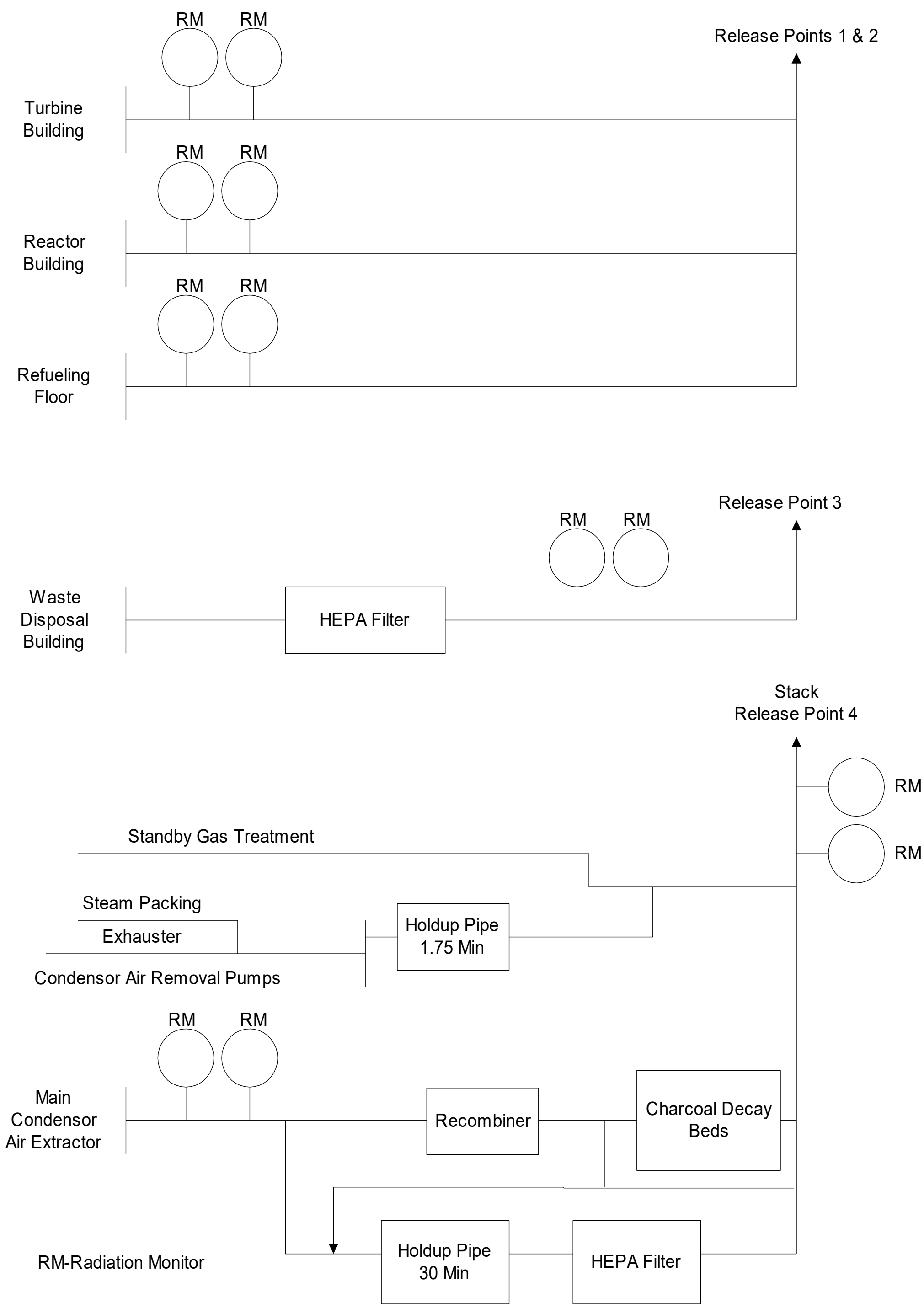


FIGURE F-5

LIQUID EFFLUENT RELEASE PATHS

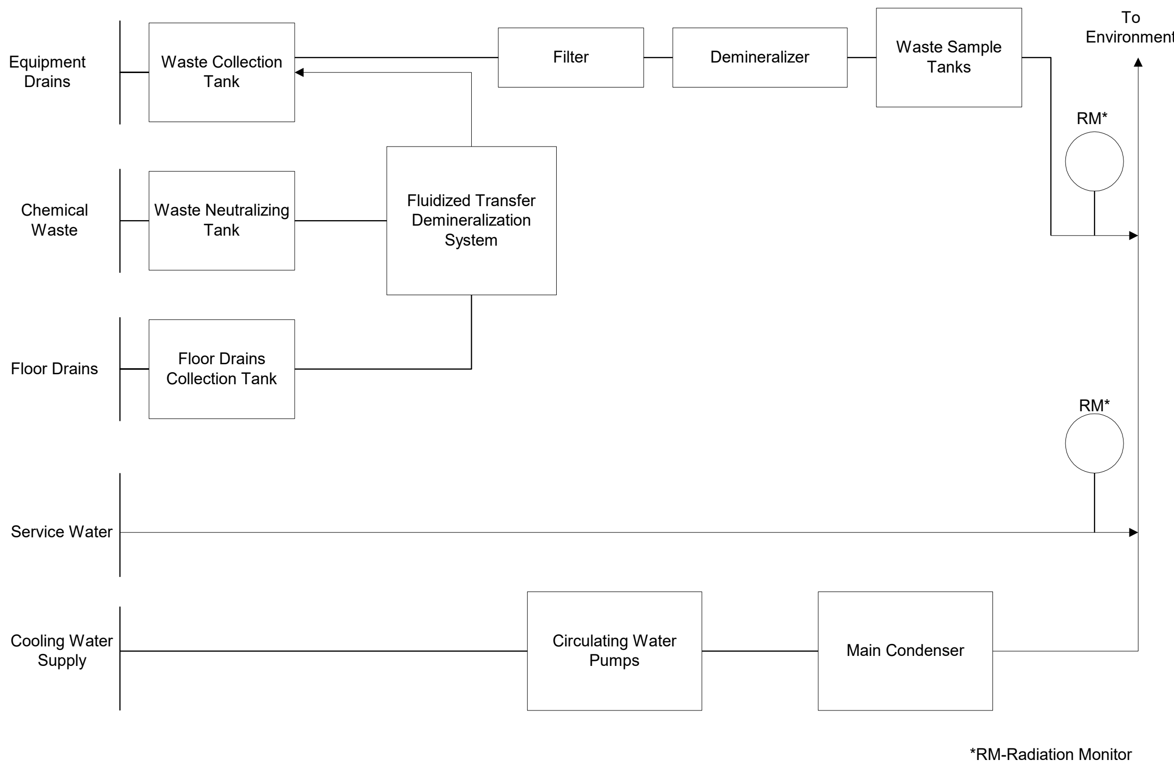


FIGURE F-5

LIQUID EFFLUENT RELEASE PATHS
(continued)

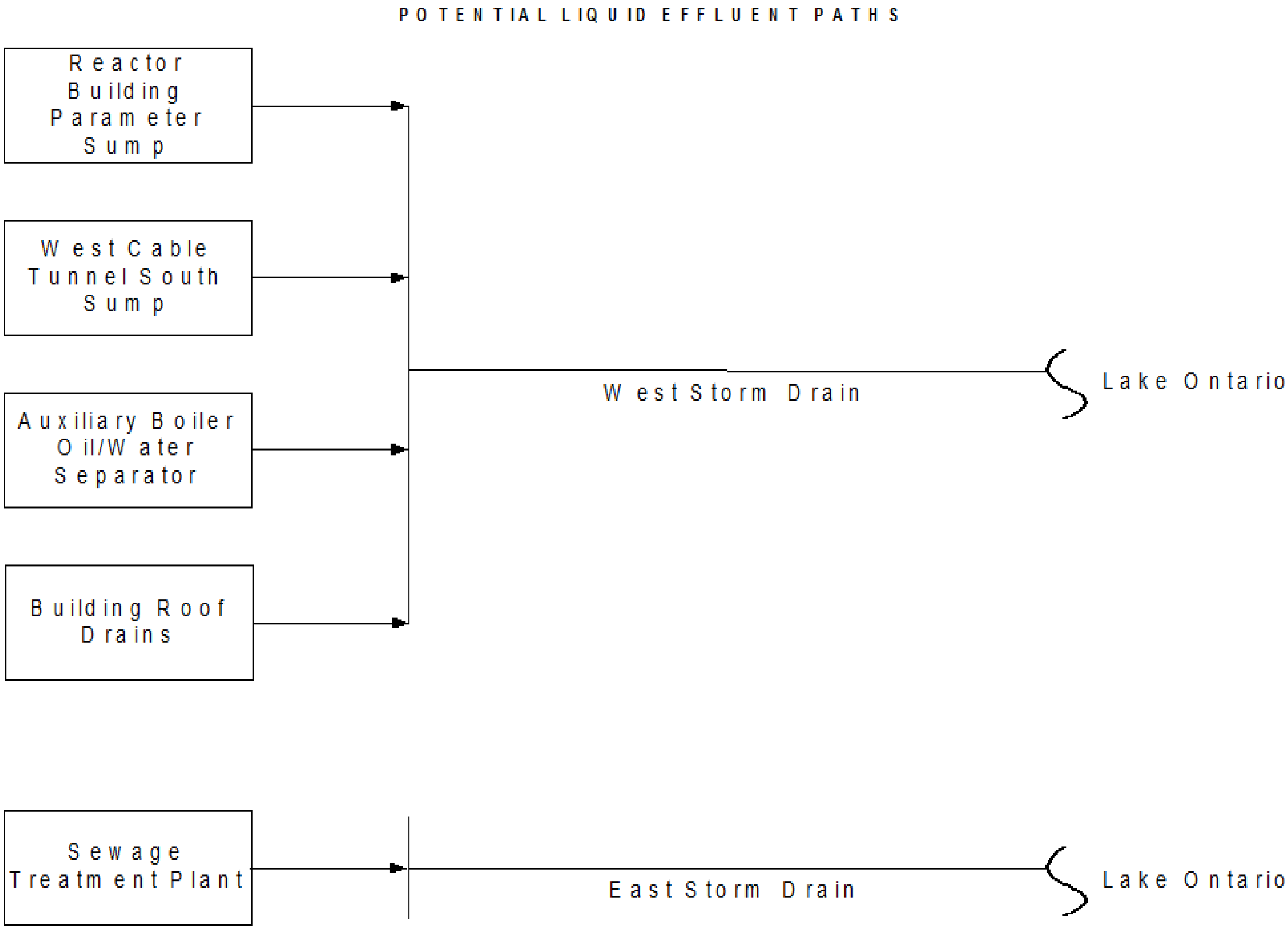


FIGURE F-6

SOLID RADWASTE TREATMENT SYSTEM

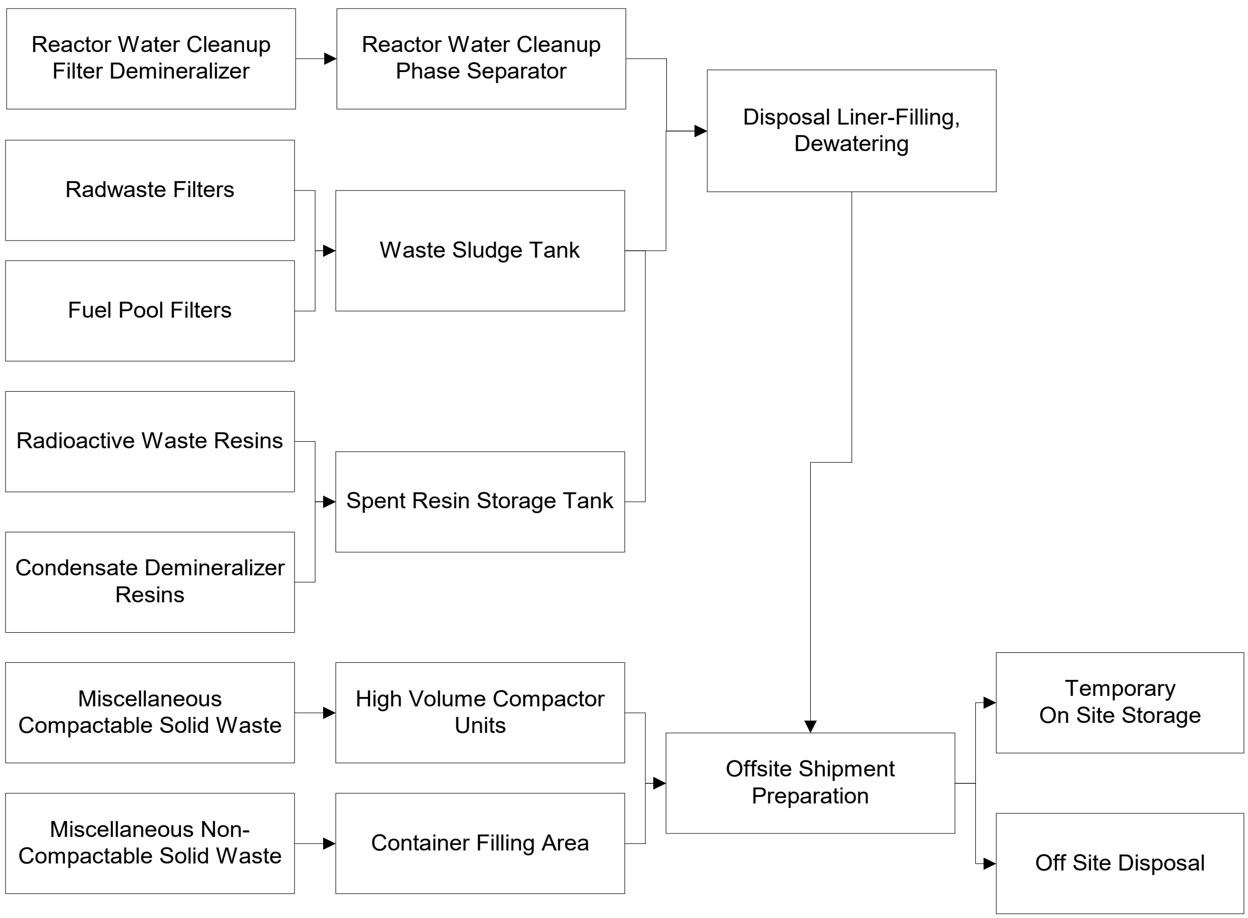
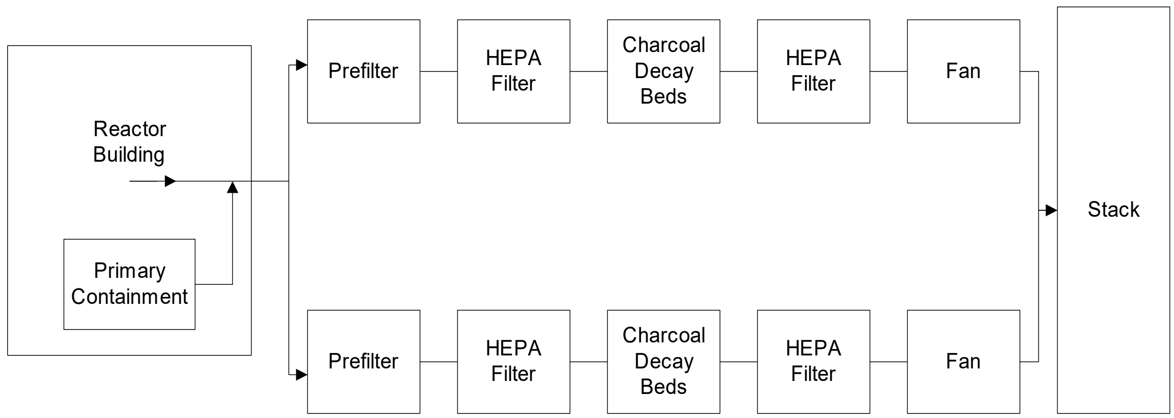


FIGURE F-7

STANDBY GAS TREATMENT SYSTEM



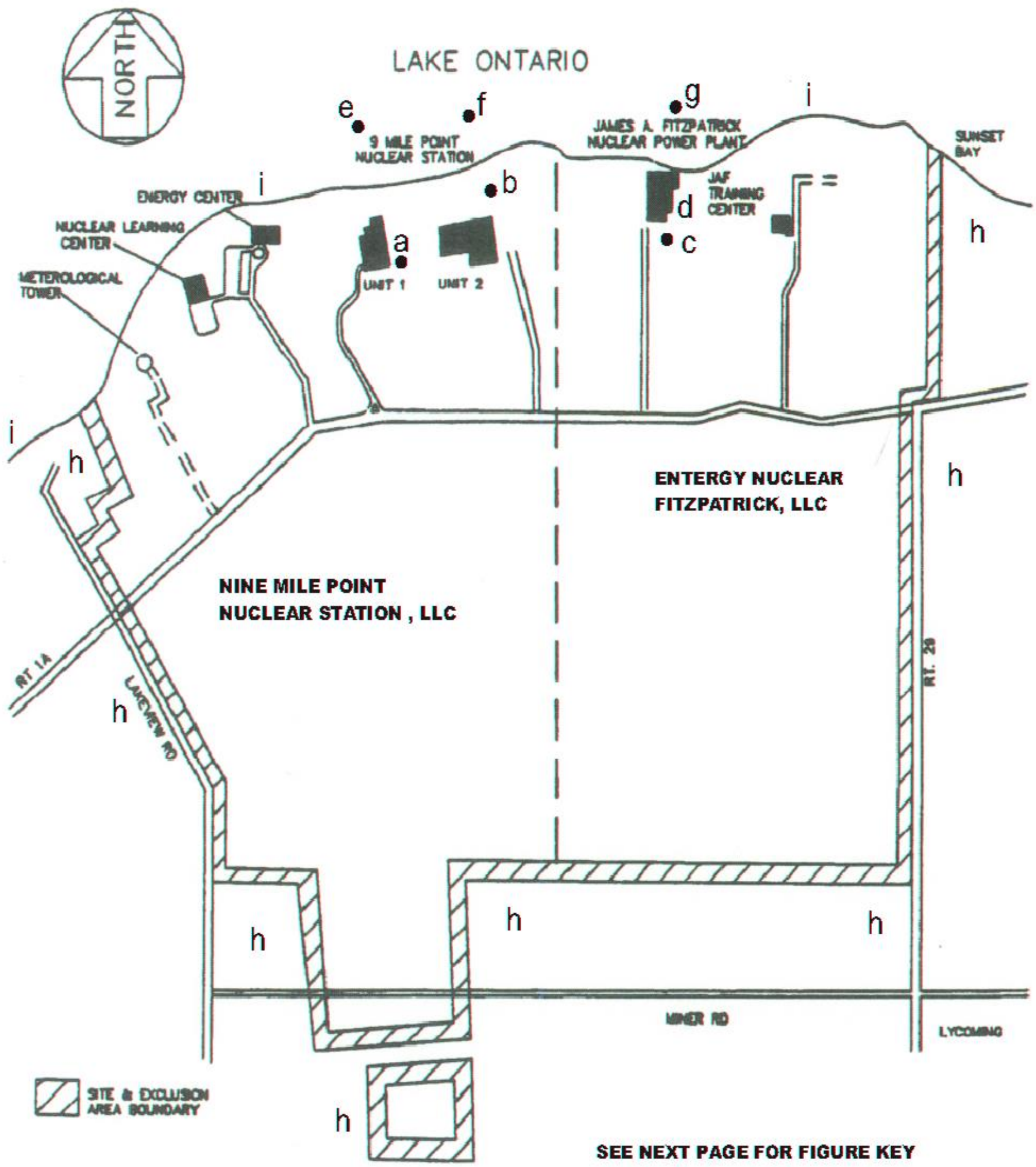
APPENDIX G

UNRESTRICTED AREA MAP

APPENDIX G
UNRESTRICTED AREA MAP

FIGURE G-1

JAFNPP SITE BOUNDARY MAP



SEE NEXT PAGE FOR FIGURE KEY

NOTES TO FIGURE G-1

(a) NMP1 stack (height is 350 feet)

(b) NMP2 stack (height is 430 feet)

(c) JAFNPP stack (height is 385 feet)

(d) Building vents

(e) NMP1 radioactive liquid discharge (Lake Ontario, bottom)

(f) NMP2 radioactive liquid discharge (Lake Ontario, bottom)

(g) JAFNPP radioactive liquid discharge (Lake Ontario, bottom)

(h) Site boundary

(i) Lake Ontario shoreline

Additional Information:

-- NMP2 reactor building vent is located 187 feet above ground level

-- JAFNPP reactor and turbine building vents are located 173 feet above ground level

-- JAFNPP radwaste building vent is 112 feet above ground level

APPENDIX H

ENVIRONMENTAL SAMPLE LOCATIONS

APPENDIX H

ENVIRONMENTAL SAMPLE LOCATIONS

RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

1.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1.1 Sampling Stations/Locations

The current sampling locations are specified on Table H-1 and Figures H-1 through H-5. The Radiological Environmental Monitoring Program is a joint effort between the owners and operators of the Nine Mile Point Unit 1, Nine Mile Point Unit 2 and James A. FitzPatrick Nuclear Power Plant, respectively. Sampling locations are chosen on the basis of historical average dispersion or deposition parameters from the three units.

The average dispersion and deposition parameters for the three reactors have been calculated for a five (5) year period, 1978 through 1982 (Reference 6.11 C.T. Main Data). Ingestion sample location evaluations are based on calculations performed by C.T. Main as this report contains grazing season X/Q and D/Q calculations for each of the seven release points in use at the JAF/NMP site. Milk animal locations are evaluated using grazing season D/Qs with the grazing season defined as (April to December). The April through December grazing season is used to coincide with the April through December milk sampling period required by Part 1 (REC) Specifications. The deposition factor is evaluated at the census locations for each of seven release points (NMP 1 stack, NMP 2 stack, NMP 2 vent, JAF stack, JAF TB vent, JAF RW vent, and JAF RB vent). An arithmetic average of all release points is calculated and used in the evaluation. If it is determined that a milk sampling location exists at a location that yields a significantly higher (e.g. 50%) calculated D/Q rate, the new milk sampling location will be added to the monitoring program within 30 days. If a new location is added, the old location that yields the lowest calculated D/Q may be dropped from the program after October 31 of that year.

1.2 Interlaboratory Comparison Program

Analyses shall be performed on samples containing known quantities of radioactive material that are supplied as part of a Commission approved or sponsored Interlaboratory Comparison Program. Sample analysis shall be only for those media, (e.g. air, milk, water, etc.), that are included in the Nine Mile Point Environmental Monitoring Program and for which cross check samples are routinely available. The Quality Control sample results shall be reported in the Annual Radiological Environmental Operating Report so that the Commission staff may evaluate the results.

Specific sample media analyzed as part of the JAF Cross Check Program include the following:

- gamma emitters in air particulate filters
- I-131 in milk
- gamma emitters in milk
- gamma emitters in water
- tritium in water
- gamma emitters in soil/sediment
- I-131 in air particulate cartridges

The availability, schedule and subsequent analysis of cross check samples are subject to change as a result of administrative changes within the JAF sampling program and commercial availability of such samples.

1.3 Thermoluminescent Dosimeters Used for Environmental Measurements

Thermoluminescent Dosimeters (TLDs) are placed in an inner ring of stations in the general area of the site boundary, and in an outer ring in the 4 to 5 mile range from the site. There are 16 land-based sectors in the inner ring and 8 land based sectors in the outer ring. TLDs are also placed in special interest areas such as population centers, nearby residences, schools, Independent Spent Fuel Storage Installation (ISFSI), and control locations.

1.4 Independent Spent Fuel Storage Installation (ISFSI) Environmental Monitoring Program

The radiological environmental monitoring program implemented at the site pursuant to JAF Technical Specifications Appendix B, contains program elements that satisfy the intent of 10 CFR 72.44(d)(2) and Certificate of Compliance No. 1014 Appendix A, Technical Specifications for the Hi-Storm 100 Cask System, Amendment 0.

TABLE H-1
RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLING LOCATIONS

TYPE OF SAMPLE	MAP* LOCATION (FIGURE NO.)	COLLECTION SITE	LOCATION+
Radioiodine and Particulates (air)	R1 (H-1)	Nine Mile Point Road North	1.8 mi @ 92° E
Radioiodine and Particulates (air)	R2 (H-2)	Co. Rt. 29 & Lake Road	1.1 mi @ 107° ESE
Radioiodine and Particulates (air)	R3 (H-2)	Co. Rt. 29	1.4 mi @ 133° SE
Radioiodine and Particulates (air)	R4 (H-2)	Village of Lycoming, NY	1.8 mi @ 145° SE
Radioiodine and Particulates (air)	R5 (H-1)	Montario Point Road	16.2 mi @ 42° NE
Direct Radiation (TLD)	75 (H-2)	North Fence, NMP-2	0.1 mi @ 354° N
Direct Radiation (TLD)	76 (H-2)	North Fence, NMP-2	0.1 mi @ 25° NNE
Direct Radiation (TLD)	77 (H-2)	North Fence, NMP-2	0.2 mi @ 36° NE
7/20 Direct Radiation (TLD)	23 (H-2)	North Shoreline Area (H-ONSITE Station)	0.8 mi @ 73° ENE
Direct Radiation (TLD)	78 (H-2)	East Boundary, JAFNPP	1.0 mi @ 85° E
Direct Radiation (TLD)	79 (H-2)	Co. Rt. 29	1.2 mi @ 120° ESE
Direct Radiation (TLD)	80 (H-2)	Co. Rt. 29	1.5 mi @ 136° SE
Direct Radiation (TLD)	81 (H-2)	Miner Road	1.6 mi @ 159° SSE
Direct Radiation (TLD)	82 (H-2)	Miner Road	1.6 mi @ 180° S
Direct Radiation (TLD)	83 (H-2)	Lakeview Road	1.2 mi @ 203° SSW
Direct Radiation (TLD)	84 (H-2)	Lakeview Road	1.1 mi @ 226° SW

* See Figures H-1, H-2, H-3, H-4, H-5 or H-6 for map locations

\+ Based on 9 Mile Point Unit 2 Reactor Centerline. Distance and direction determined using Global Positioning System (GPS) readings.

TABLE H-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLING LOCATIONS

TYPE OF SAMPLE	MAP* LOCATION (FIGURE NO.)	COLLECTION SITE	LOCATION+
Direct Radiation (TLD)	7 (H-2)	Site Meteorological Tower (G ONSITE Station)	0.7 mi @ 245° WSW
Direct Radiation (TLD)	18 (H-2)	Energy Information Center	0.4 mi @ 268° W
Direct Radiation (TLD)	85 (H-2)	North Fence, NMP-1	0.2 mi @ 292° WNW
Direct Radiation (TLD)	86 (H-2)	North Fence, NMP-1	0.1 mi @ 311° NW
Direct Radiation (TLD)	87 (H-2)	North Fence, NMP-1	0.1 mi @ 333° NNW
Direct Radiation (TLD)	88 (H-1)	Hickory Grove Road	4.5 mi @ 97° E
Direct Radiation (TLD)	89 (H-1)	Leavitt Road	4.3 mi @ 112° ESE
Direct Radiation (TLD)	90 (H-1)	Rt. 104 and Keefe Road	4.2 mi @ 135° SE
Direct Radiation (TLD)	91 (H-1)	Co. Rt. 51A	4.9 mi @ 157° SSE
7/20 Direct Radiation (TLD)	92 (H-1)	Maiden Lane Road	4.4 mi @ 183° S
Direct Radiation (TLD)	93 (H-1)	Co. Rt. 53	4.4 mi @ 206° SSW
Direct Radiation (TLD)	94 (H-1)	Co. Rt. 1 and Kocher Road	4.4 mi @ 224° SW
Direct Radiation (TLD)	95 (H-1)	Lake Shore, Alcan West Access Road	3.7 mi @ 239° WSW
Direct Radiation (TLD)	49 (H-1)	Phoenix, NY-Control	19.7 mi @ 168° SSE
Direct Radiation (TLD)	14 (H-1)	SW Oswego-Control	12.5 mi @ 227° SW
Direct Radiation (TLD)	96 (H-1)	Creamery Road	3.6 mi @ 199° SSW
Direct Radiation (TLD)	58 (H-1)	Alcan Aluminum, Rt. 1A	3.0 mi @ 222° SW
Direct Radiation (TLD)	97 (H-2)	Co. Rt. 29	1.8 mi @ 145° SE
Direct Radiation (TLD)	56 (H-1)	New Haven Elem. School	5.2 mi @ 124° SE

* See Figures H-1, H-2, H-3, H-4, H-5 or H-6 for map locations

\+ Based on 9 Mile Point Unit 2 Reactor Centerline. Distance and direction determined using Global Positioning System (GPS) readings.

TABLE H-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLING LOCATIONS

TYPE OF SAMPLE	MAP* LOCATION (FIGURE NO.)	COLLECTION SITE	LOCATION+
Direct Radiation (TLD)	15 (H-1)	West Site Boundary, Bible Camp	0.9 mi @ 240° WSW
Direct Radiation (TLD)	8 (H-1)	Montario Point Road (R5 OFFSITE Station-Control)	16.2 mi @ 42° NE
Surface Water	10 (H-3)	NRG Steam Station Inlet Canal	7.6 mi @ 237° WSW
Surface Water	03 (H-3)	JAFNPP Inlet Canal	0.6 mi @ 53° NE
Shoreline Sediment	5 (H-4)	Sunset Bay Shoreline	1.2 mi @ 84° E
7/20 Shoreline Sediment	6 (H-4)	Langs Beach-Control	4.8 mi @ 232° SW
Fish	02 (H-4)	Nine Mile Point Transect	0.4 mi @ 290° WNW
Fish	03 (H-4)	FitzPatrick Transect	0.8 mi @ 62° ENE
Fish	00 (H-4)	Oswego Transect	5.9 mi @ 237° SW
Milk	77 (H-3)	Milk Location #77-Control Summerville	16.0 mi @ 190° S
Milk	55 (H-3)	Walthert Farm	8.6 mi @ 100° E

* See Figures H-1, H-2, H-3, H-4, H-5 or H-6 for map locations

** Food product samples need not be sampled from each location listed. Two onsite samples will be collected from the location with the highest calculated average D/Q value from which edible or non-edible broad leaf vegetation is available. One control sample will be collected at a location listed from which edible or non-edible broad leaf vegetation is available.

\+ Based on 9 Mile Point Unit 2 Reactor Centerline. Distance and direction determined using Global Positioning System (GPS) readings.

TABLE H-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLING LOCATIONS

TYPE OF SAMPLE	MAP* LOCATION (FIGURE NO.)	COLLECTION SITE	LOCATION+
Food Products ** (Broad Leaf Vegetation)	79 (H-5)	Garden - Narewski	1.5 mi @ 84° E
Food Products ** (Broad Leaf Vegetation)	48 (H-5)	Garden - Kronenbitter	1.5 mi @ 83° E
Food Products ** (Broad Leaf Vegetation)	133 (H-5)	Garden - Culeton	1.6 mi @ 83° E
Food Products ** (Broad Leaf Vegetation)	77 (H-5)	Garden - Vitullo	1.9 mi @ 101° E
Food Products ** (Broad Leaf Vegetation)	55 (H-5)	Garden - Woolson	1.9 mi @ 132° SE
Food Products ** (Broad Leaf Vegetation)	57 (H-5)	Garden - Parkhurst, P.	1.8 mi @ 126° SE
Food Products ** (Broad Leaf Vegetation)	422 (H-5)	Garden - Parkhurst, C.	2.0 mi @ 112° ESE
Food Products ** (Broad Leaf Vegetation)	132 (H-5)	Garden - Barton	2.0 mi @ 110° ESE
Food Products ** (Broad Leaf Vegetation)	142 (H-5)	Garden - Hall	1.7 mi @ 143° SE
Food Products ** (Broad Leaf Vegetation)	69 (H-5)	Garden – Lawton	2.3 mi @ 123° ESE

7/20

* See Figures H-1, H-2, H-3, H-4, H-5 or H-6 for map locations

** Food product samples need not be sampled from each location listed. Two onsite samples will be collected from the location with the highest calculated average D/Q value from which edible or non-edible broad leaf vegetation is available. One control sample will be collected at a location listed from which edible or non-edible broad leaf vegetation is available.

\+ Based on 9 Mile Point Unit 2 Reactor Centerline. Distance and direction determined using Global Positioning System (GPS) readings.

TABLE H-1 (Continued)
RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLING LOCATIONS

TYPE OF SAMPLE	MAP* LOCATION (FIGURE NO.)	COLLECTION SITE	LOCATION+
Food Products ** (Broad Leaf Vegetation)	143 (H-5)	Garden - Whaley, P.	1.6 mi @ 138° SE
Food Products ** (Broad Leaf Vegetation)	144 (H-5)(1)	Garden - Whaley, C.	1.6 mi @ 139° SE
Food Products ** (Broad Leaf Vegetation)	425 (H-5)	Garden - Barsuch	1.8 mi @ 144° SE
Food Products ** (Broad Leaf Vegetation)	426 (H-5)	Garden - Larroca	1.8 mi @ 145° SE
Food Products ** (Broad Leaf Vegetation)	145 (H-5)(2)	Control - Flack	15.4 mi @ 222° SW
7/20 Food Products ** (Broad Leaf Vegetation)	240 (H-5)	Garden - Walcott	1.9 mi @ 96° E
Food Products ** (Broad Leaf Vegetation)	260 (H-5)	Garden - Battles	1.7 mi @ 98° E
Food Products ** (Broad Leaf Vegetation)	290 (H-5)	Garden - Lee, R.	1.8 mi @ 98° E
Food Products ** (Broad Leaf Vegetation)	274 (H-5)	Garden - Oldenberg	1.4 mi @ 106° ESE
Food Products ** (Broad Leaf Vegetation)	343 (H-5)	Garden - Fredette/Sheldon	1.8 mi @ 88° E
Food Products** (Broad Leaf Vegetation)	484 (H-5)(3)	Garden - O'Connor	1.4 mi @ 132°SE

* See Figures H-1, H-2, H-3, H-4, H-5, or H-6 for map locations

** Food product samples need not be sampled from each location listed. Two onsite samples will be collected from the location with the highest calculated average D/Q value from which edible or non-edible broad leaf vegetation is available. One control sample will be collected at a location listed from which edible or non-edible broad leaf vegetation is available.

\+ Based on 9 Mile Point Unit 2 Reactor Centerline. Distance and direction determined using Global Positioning System (GPS) readings.

7/20
(1) Location 144 is the same as NMP ODCM location 62
(2) Location 145 is the same as NMP ODCM location 60
(3) Location 484 is the same as NMP ODCM location 69

TABLE H-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLING LOCATIONS

TYPE OF SAMPLE	MAP* LOCATION (FIGURE NO.)	COLLECTION SITE	LOCATION
Direct Radiation	I-1 (H-6)	ISFSI++	West Fence, South
Direct Radiation	I-2 (H-6)	ISFSI++	West Fence, Center
Direct Radiation	I-3 (H-6)	ISFSI++	West Fence, North
Direct Radiation	I-4 (H-6)	ISFSI++	North Fence, West
Direct Radiation	I-5 (H-6)	ISFSI++	North Fence, Center
Direct Radiation	I-6 (H-6)	ISFSI++	North Fence, East
Direct Radiation	I-7 (H-6)	ISFSI++	East Fence, North
Direct Radiation	I-8 (H-6)	ISFSI++	East Fence, Center
Direct Radiation	I-9 (H-6)	ISFSI++	East Fence, South
Direct Radiation	I-10 (H-6)	ISFSI++	South Fence, East
Direct Radiation	I-11 (H-6)	ISFSI++	South Fence, Center
Direct Radiation	I-12 (H-6)	ISFSI++	South Fence, West

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* See Figures H-1, H-2, H-3, H-4, H-5 or H-6 for map locations

++ Independent Spent Fuel Storage Installation

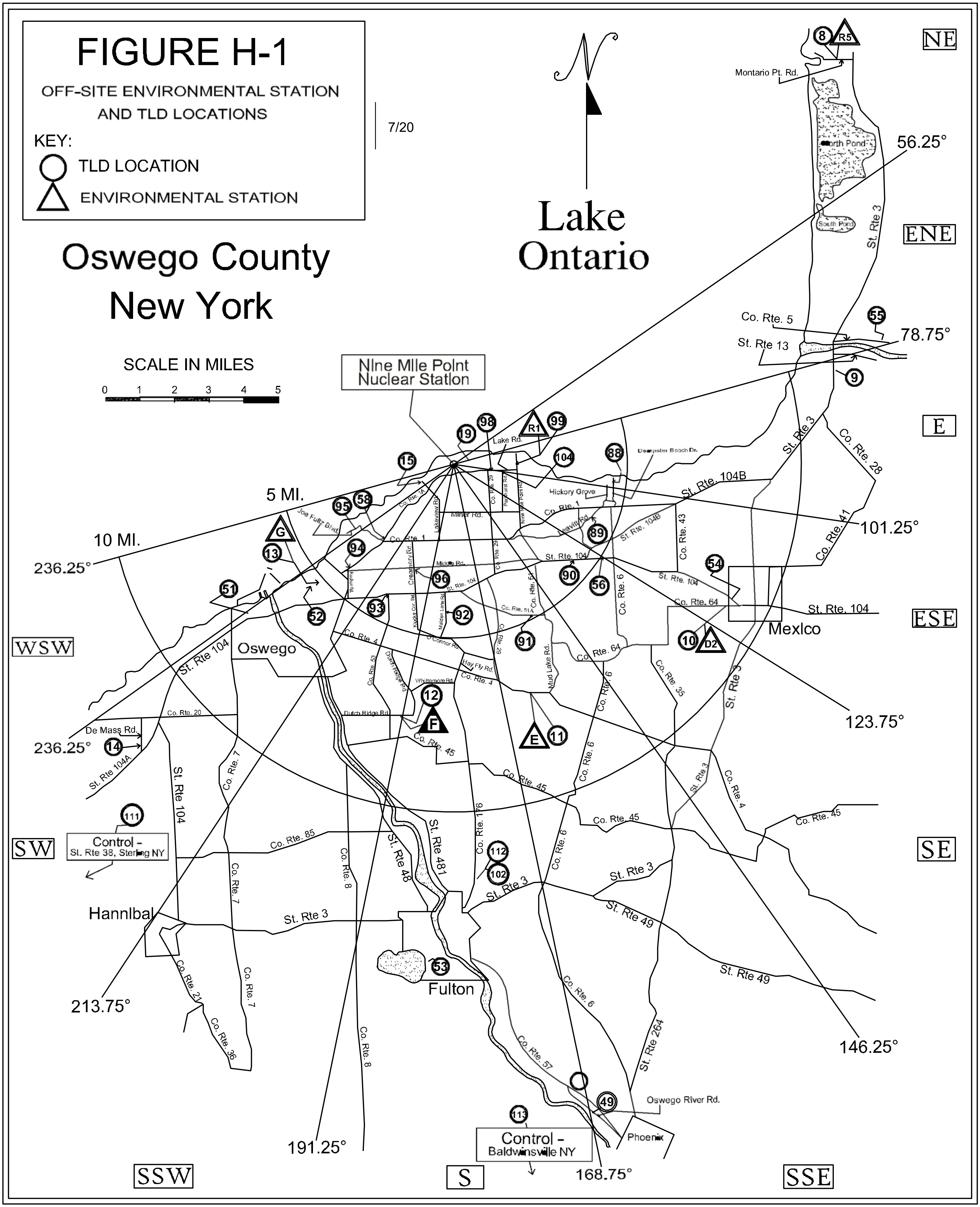


FIGURE H-1
OFF-SITE ENVIRONMENTAL STATION AND TLD LOCATIONS
KEY:
TLD LOCATION
ENVIRONMENTAL STATION
7/20
Lake Ontario
Oswego County New York
SCALE IN MILES
0 1 2 3 4 5
Nine Mile Point Nuclear Station
5 MI.
10 MI.
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
56.25°
78.75°
101.25°
123.75°
146.25°
168.75°
191.25°
213.75°
236.25°
236.25°
Montario Pt. Rd.
North Pond
South Pond
St. Rte 3
Co. Rte. 5
St. Rte 13
Co. Rte. 28
Co. Rte. 41
St. Rte. 104B
St. Rte. 104
Co. Rte. 64
Co. Rte. 43
Co. Rte. 6
Co. Rte. 35
Co. Rte. 4
Co. Rte. 45
Co. Rte. 176
Co. Rte. 85
Co. Rte. 20
Co. Rte. 7
Co. Rte. 8
Co. Rte. 21
Co. Rte. 36
Co. Rte. 57
St. Rte 48
St. Rte 481
St. Rte 49
St. Rte 264
St. Rte 104A
Lake Rd.
Dempster Beach Dr.
Hickory Grove
Leavitt Rd.
Co. Rte. 1
Co. Rte. 1A
Joe Fultz Blvd.
Miner Rd.
Middle Rd.
Hay Fly Rd.
Whittemore Rd.
Dutch Ridge Rd.
Mud Lake Rd.
De Mass Rd.
Oswego River Rd.
Oswego
Mexico
Hannibal
Fulton
Phoenix
Control - St. Rte 38, Sterling NY
Control - Baldwinsville NY
R1
R5
D2
E
F
G
8
9
10
11
12
13
14
15
19
49
51
52
53
54
55
56
58
88
89
90
91
92
93
94
95
96
98
99
102
104
111
112
113

FIGURE H-2

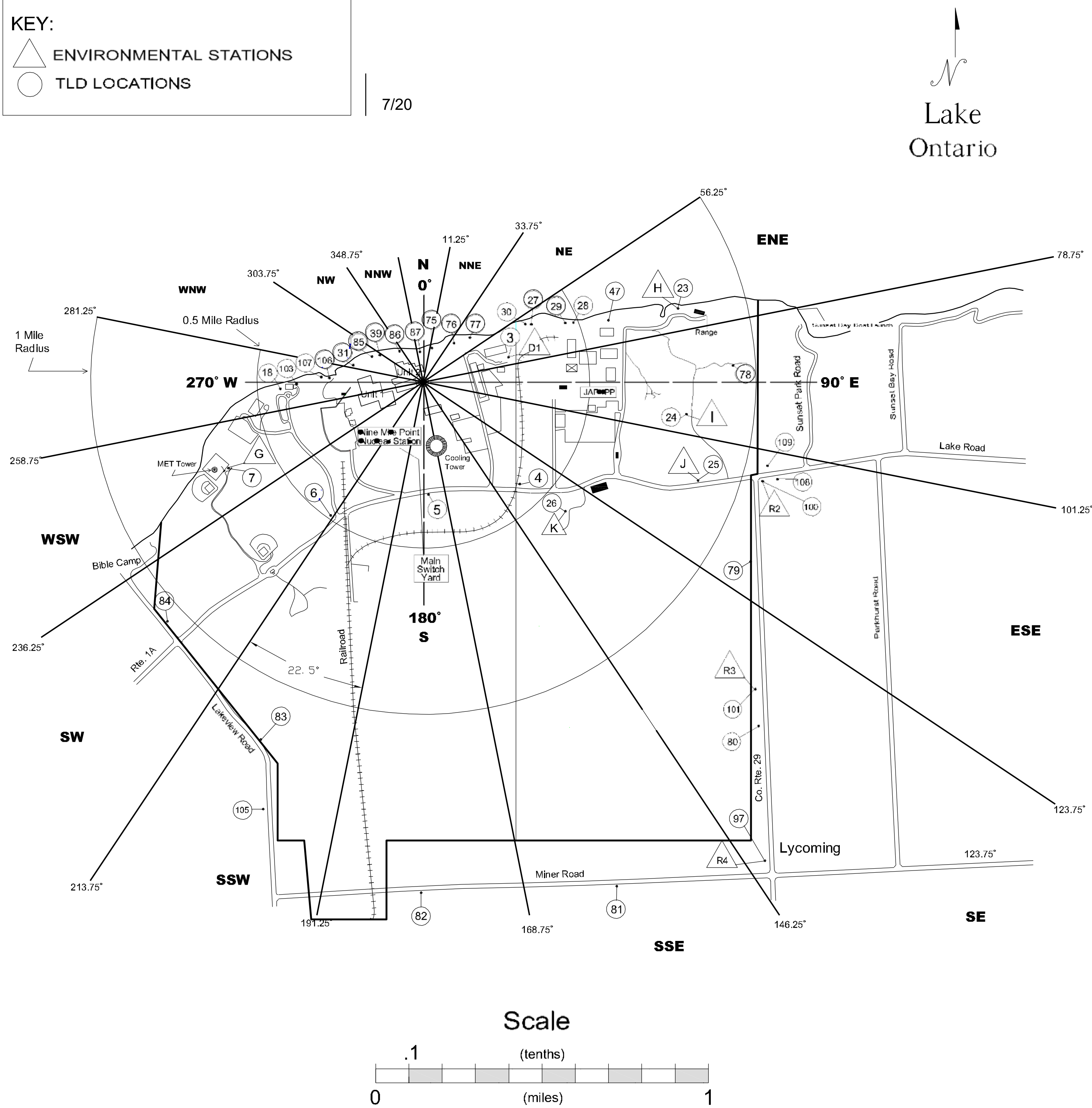
ON-SITE ENVIRONMENTAL
STATION AND TLD LOCATIONS

KEY:

△ ENVIRONMENTAL STATIONS

○ TLD LOCATIONS

7/20



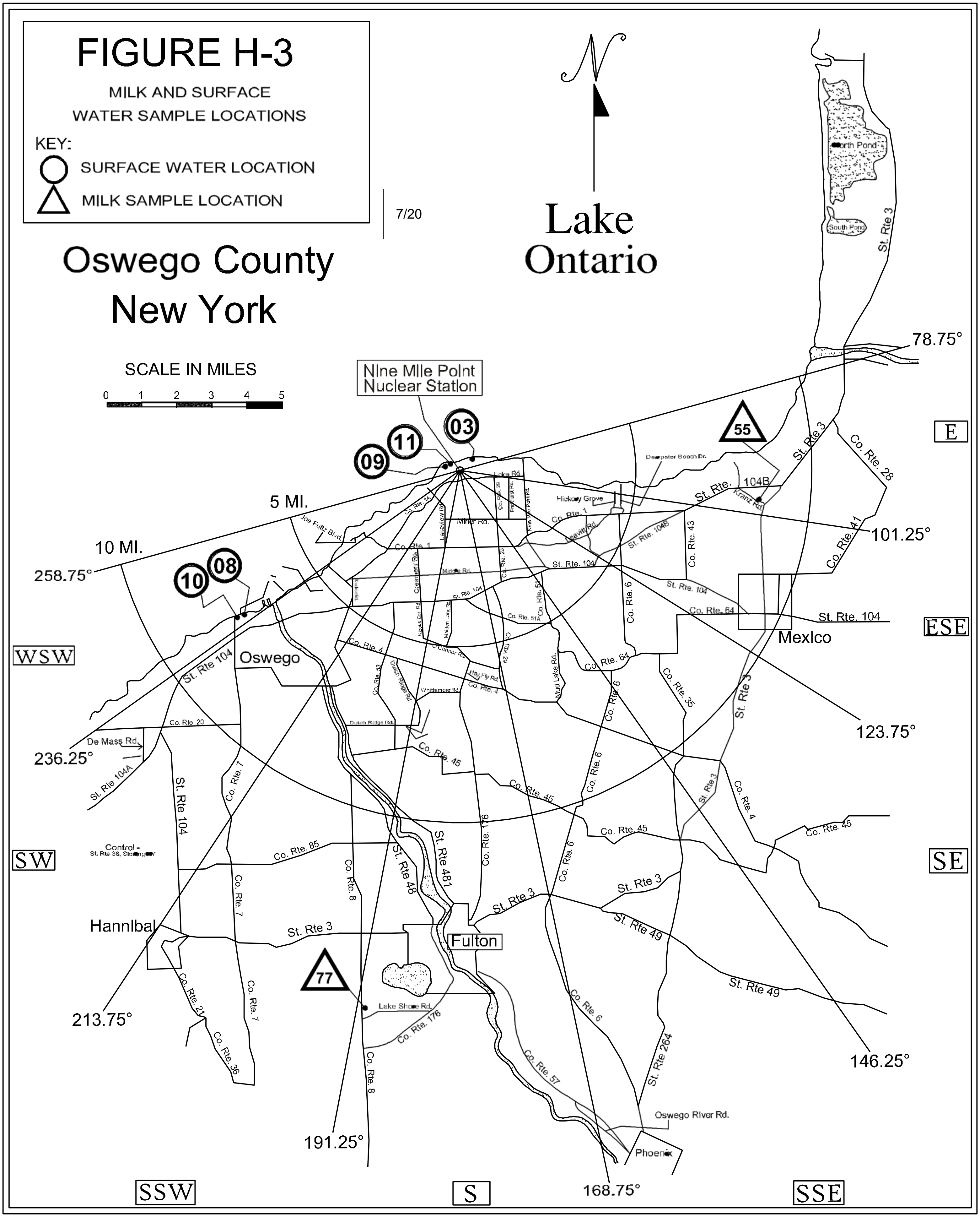


FIGURE H-3

MILK AND SURFACE WATER SAMPLE LOCATIONS

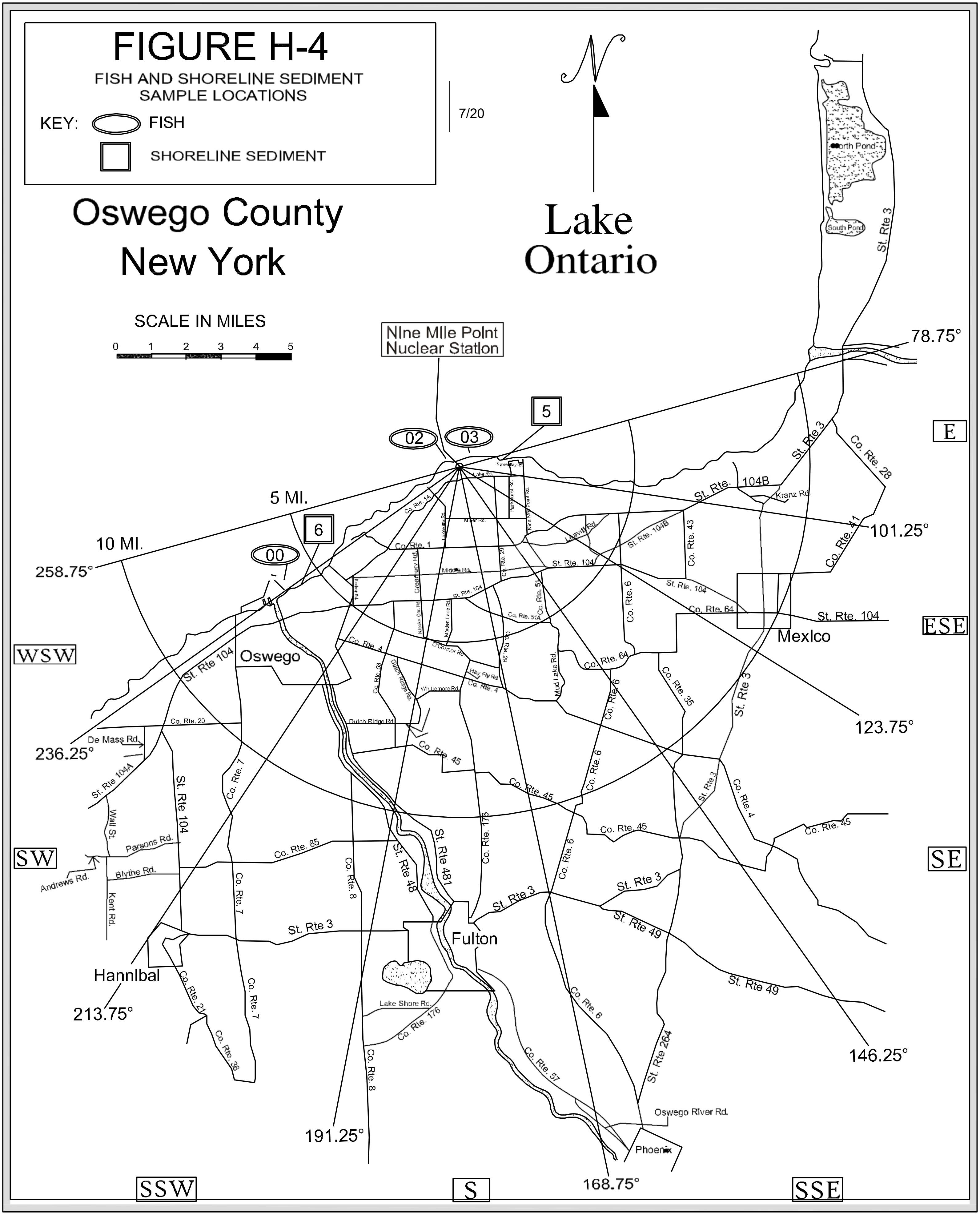


FIGURE H-4
FISH AND SHORELINE SEDIMENT SAMPLE LOCATIONS
KEY: FISH
SHORELINE SEDIMENT
7/20
Oswego County New York
Lake Ontario
SCALE IN MILES
0 1 2 3 4 5
Nine Mile Point Nuclear Station
5
02
03
6
00
5 MI.
10 MI.
78.75°
101.25°
123.75°
146.25°
168.75°
191.25°
213.75°
236.25°
258.75°
E
ESE
SE
SSE
S
SSW
SW
WSW
North Pond
South Pond
St. Rte 3
St. Rte. 104B
Kranz Rd.
Co. Rte. 28
Co. Rte. 41
Co. Rte. 43
St. Rte. 104
Co. Rte. 64
Mexico
Oswego
St. Rte 104
Co. Rte. 1
Co. Rte. 14
Co. Rte. 4
Co. Rte. 6
Co. Rte. 35
Co. Rte. 51
Co. Rte. 29
Co. Rte. 53
Co. Rte. 20
De Mass Rd.
St. Rte 104A
Wall St.
Parsons Rd.
Andrews Rd.
Blythe Rd.
Kent Rd.
Co. Rte. 7
Co. Rte. 85
Co. Rte. 8
St. Rte 48
St. Rte 481
Co. Rte. 176
Co. Rte. 45
St. Rte 3
St. Rte 49
Fulton
Hannibal
Co. Rte. 21
Co. Rte. 36
Lake Shore Rd.
Co. Rte. 57
St. Rte 264
Oswego River Rd.
Phoenix
Mud Lake Rd.
Dutch Ridge Rd.
Whittemore Rd.
O'Connor Rd.
Hay Fly Rd.
Middle Rd.
Miller Rd.
Lake Rd.
Leavitt Rd.
Co. Rte. 51A
Co. Rte. 4
Co. Rte. 45

FIGURE H-5

FOOD PRODUCT SAMPLE LOCATIONS

KEY: △ FOOD PRODUCT SAMPLE LOCATION

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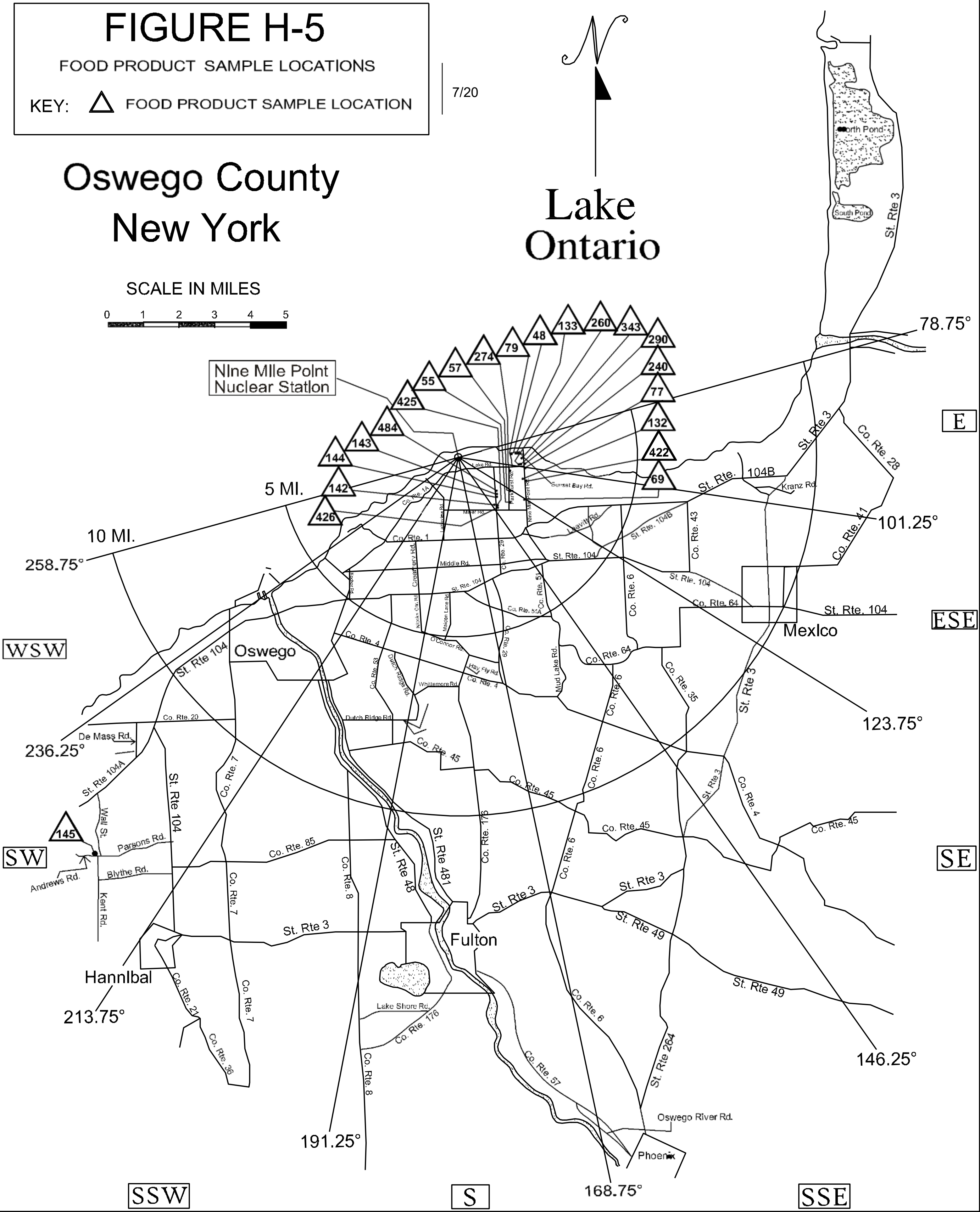

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FIGURE H-6

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

ON-SITE ENVIRONMENTAL ISFSI TLD LOCATIONS

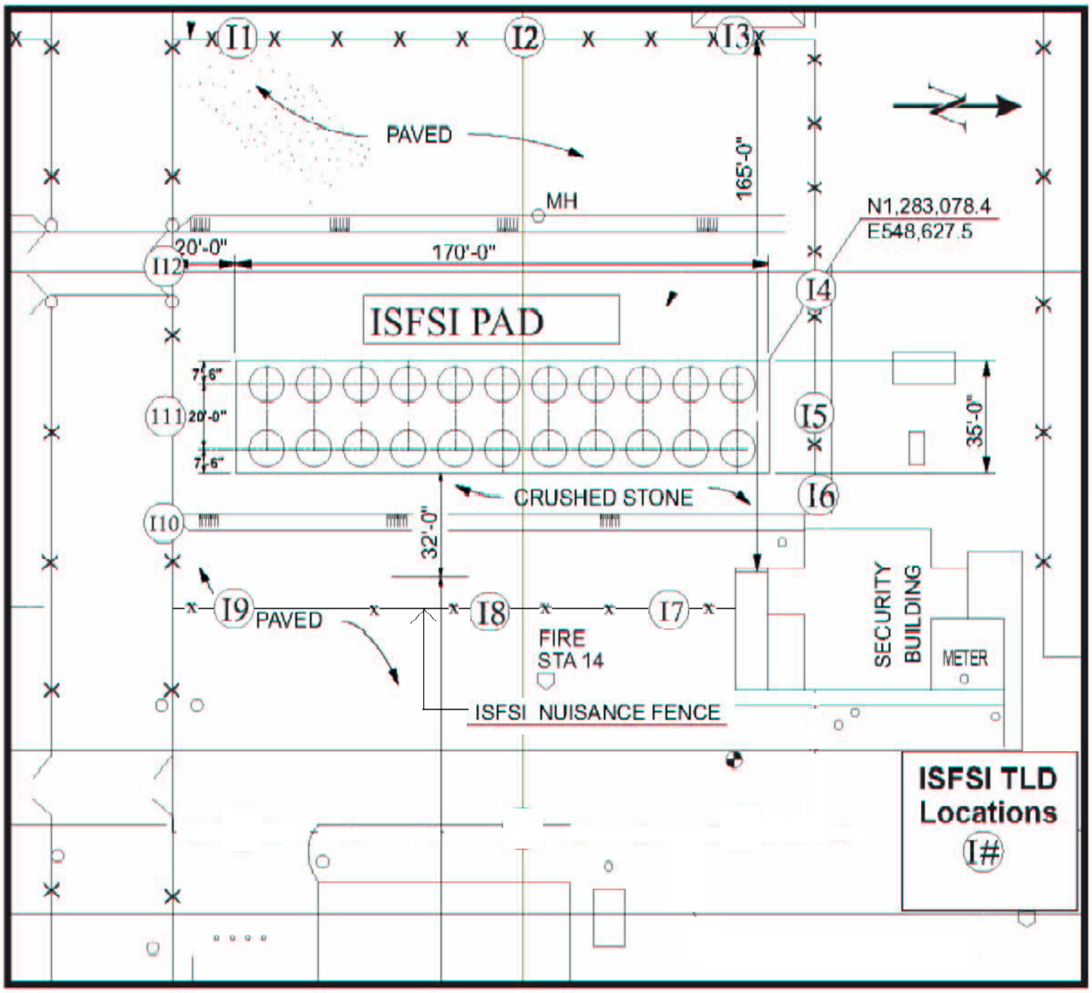
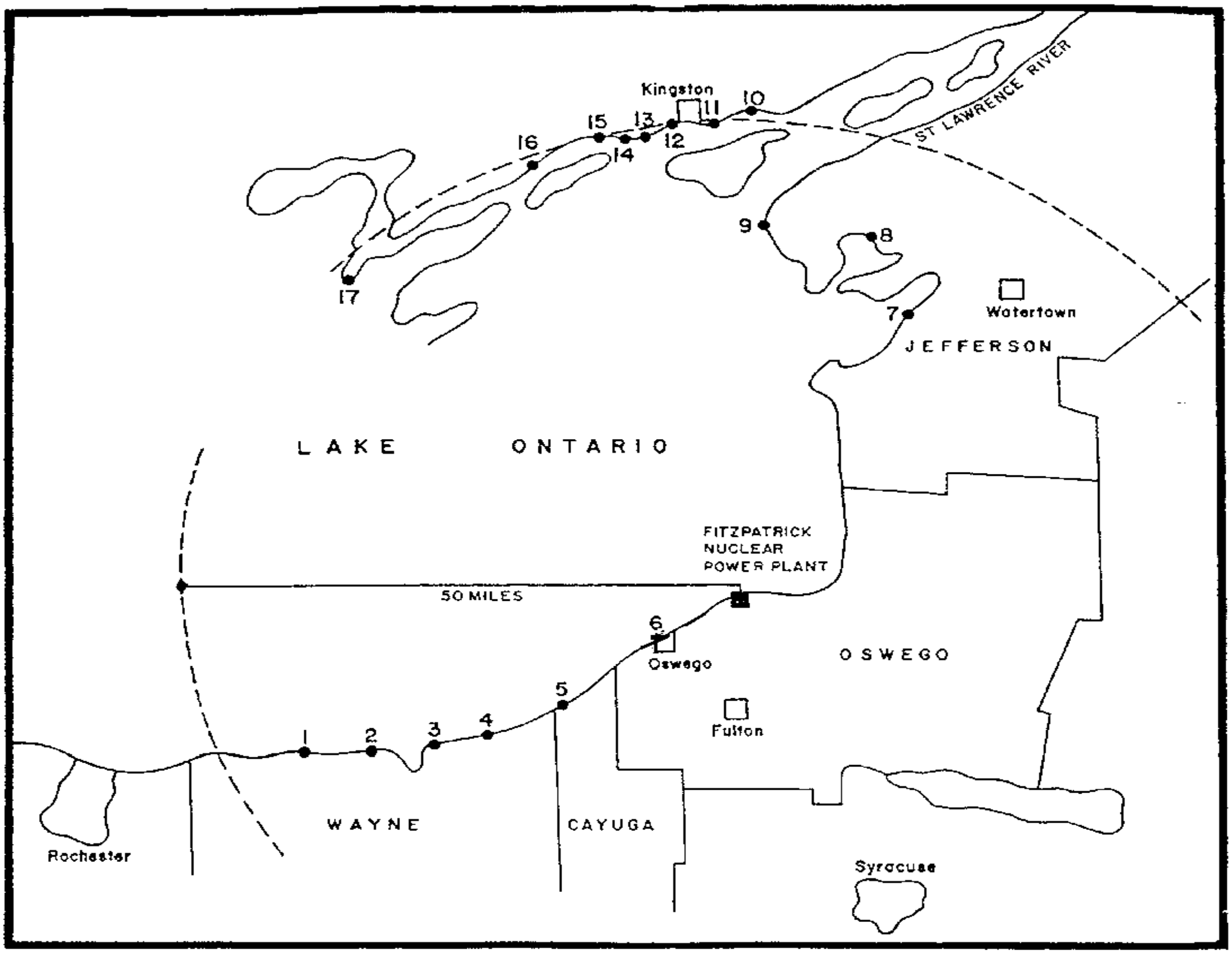


TABLE H-2
LIQUID EFFLUENT PATHWAY - WATER INTAKE POINTS
DESCRIPTION AND PUMPAGE

	Location of Water Intake*	Average Water Pumpage Millions of Gallons Per Day
1.	At a point between Dennison Creek and Bear Creek at a site north of the intersection of lake and Knickerbocker Roads	0.80
2.	At Pultneyville	1.0
3.	At a point north of the village of Sodus near the intersection of Shore Road and an extension of Maple Avenue	1.0
4.	In Sodus Point Village on Lake Road	0.133
5.	At east of Port Bay	0.095
6.	In the western part of the City of Oswego between Sixth and Sheldon Avenues and north of West Schuyler Street	20.0
7.	At east of the Village of Sackets Harbor	0.30
8.	In Sawmill Bay at a location on Independence Point approximately 0.5 miles south of Chaumont Village's southerly limit	0.04
9.	Cape Vincent	0.246
10.	Township of Pittsburg (Milton)	0.015
11.	Township of Pittsburg (Glen Lawrence)	0.015
12.	City of Kingston (2 intakes)	9.72
13.	Township of Kingston (Pt. Pleasant)	0.705
14.	Township of Kingston (Queen's Acres)	0.037
15.	Township of Ernestown (Amherstview)	0.270
16.	Village of Bath	0.150
17.	Town of Picton	0.679

7/20 * See Figure H-7 for Map Locations

FIGURE H-7
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
OFFSITE DOSE CALCULATION MANUAL (ODCM)
LIQUID EFFLUENT PATHWAY - WATER INTAKE POINTS



APPENDIX I

ODCM SUMMARY TABLES

APPENDIX I

ODCM SUMMARY TABLES

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TABLE I-1
RADIOACTIVE EFFLUENT RELEASE LIMITS - SUMMARY TABLE

DOSE/DOSE COMMITMENT	PATH/ SOURCE	ANY 31 DAY PERIOD (1)			CALENDAR QUARTER			CALENDAR YEAR		
		WHOLE BODY (MREM)	SKIN (MRAD)	ANY ORGAN (MREM)	WHOLE BODY (MREM)	SKIN (MRAD)	ANY ORGAN (MREM)	WHOLE BODY (MREM)	SKIN (MRAD)	ANY ORGAN (MREM)
Member of the Public	Plant Liquid (2) Effluents	0.06	None	0.2	1.5	None	5	3	None	10
Member of the Public	Plant Gaseous (2) Effluents	None	None	None	5*	10*	7.5	10*	20*	15
At or Beyond Site Boundary	Plant Gaseous (3) Effluents	None	None	None	None	None	None	500	3000	1500
Member of the Public	Uranium (4) Fuel Cycle (Site)	None	None	None	None	None	None	25	None	25 (5)

(1) Equipment operability requirements for projected exposures. Refer to Sections 2.4 (Liquid) and 3.6 (Gaseous).

(2) Plant Liquid and Gaseous release limitations in accordance with Appendix I to 10 CFR 50.
Refer to Part 1, Sections 2.3 (Liquids), 3.3 (Noble Gases) and 3.4 (Iodines and Particulates).

f

(3) Plant Gaseous release limitations in accordance with dose limits of 10 CFR 20.1001-20.2402. Refer to dose limits of Part 1, Section 3.2.

(4) Site Gaseous release limitations in accordance with 40 CFR 190. Refer to Section 13.

(5) Limits to any organ except the thyroid which shall be limited to 75 mrem.

* mrad, air dose.

TABLE I-2
ODCM SUMMARY

EFFLUENT PATHWAY	PURPOSE OF CALCULATION	FREQUENCY OF CALCULATION	REGULATORY REQUIREMENT	Part 1 (REC) REQUIREMENT	CORRESPONDING LIMITING VALUES	Part 2 (ODCM) SECTION	ODCM EQUATION NUMBER	INPUT DATA REQUIREMENTS	REPORTING REQUIREMENTS	MISCELLANEOUS
Liquid	Fraction of ECLs, F_L	Each batch release	10 times 10CFR20 Appendix B, Table 2, Column 2	Section 2.2	ECLs or for noble gases 2 x 10^{-4} µCi/ml	Section 11.2	3-1	. Discharge structure exit flow . Waste tank release rate . Sample concentrations	Release Permit	
Liquid	Minimum required dilution factor f_2/f_1 min.	Each batch release	10 times 10CFR20 Appendix B, Table 2, Column 2	Section 2.2	ECLs or for dissolved noble gases 2 x 10^{-4} µCi/ml	Section 11.2.3	3-2	. Sample concentrations	Release Permit	
Liquid	Determination of effluent monitor set-points	Each batch release	10 times 10CFR20 Appendix B, Table 2, Column 2	Section 2.1.4.3.A	FL less than or equal to 1 when calculating minimum dilution flow	Section 11.3.2	3-3	. FL . Sample concentrations	Input to operations	
Liquid	Annual Dose Assessment	Calendar year	USNRC Regulatory Guide 1.21	Section 6.0	N/A	Section 11.4.1	3.4a 3-4b	. Site specific dose commit-tment factors . Previous year's release volumes and curies . Site specific dilution & ingestion	Annual Radiological Effluent Report	
Liquid	Monthly Dose Assessment	Calendar month	10CFR50 Appendix I	Section 2.3	Whole Body dose - 1.5 mrem/qtr, 3 mrem/yr Organ dose - 5 mrem/qtr, 10 mrem/yr	Section 11.4.2	3-5a 3-5b	. Composite dose . Duration of release . Curies released . Volume of dilution	N/A	May use limited analysis approach of ODCM Section 11.4.2

TABLE I-2 (Continued)
ODCM SUMMARY

EFFLUENT PATHWAY	PURPOSE OF CALCULATION	FREQUENCY OF CALCULATION	REGULATORY REQUIREMENT	Part 1 (REC) REQUIREMENT	CORRESPONDING LIMITING VALUES	Part 1 (ODCM) SECTION	ODCM EQUATION NUMBER	INPUT DATA REQUIREMENTS	REPORTING REQUIREMENTS	MISCELLANEOUS
Liquid	Dose projection determination of need to operate liquid radwaste systems	Prior to release of unrestricted liquid effluents	N/A	Section 2.4	Whole body dose - 0.06 mrem per calendar month Organ dose - .2 mrem per calendar month	Section 11.5	N/A	. Number of batch releases, previous month . Projected number of releases current month	If non-compliance, 30-day NRC report	
Gaseous	Determining instantaneous noble gas release rates	Calendar week	10CFR20.105	Section 3.2.1.1	Whole body dose - 500 mrem/yr Skin dose - 3000 mrem/yr	Section 12.3.1	4-1 to 4-6	. Highest annual average X/Q for vent and elevated releases . Total body, skin, and air dose factors . Noble gas release rate (μCi/sec) . Effective dose transfer factor for vent releases, fraction of release rate limit	N/A	May use a limited analysis approach of ODCM Section 12.3.1 to determine noble gas release rate limits

TABLE I-2 (Continued)
ODCM SUMMARY

EFFLUENT PATHWAY	PURPOSE OF CALCULATION	FREQUENCY OF CALCULATION	REGULATORY REQUIREMENT	Part 1 (REC) REQUIREMENT	CORRESPONDING LIMITING VALUES	Part 2 (ODCM) SECTION	ODCM EQUATION NUMBER	INPUT DATA REQUIREMENTS	REPORTING REQUIREMENTS	MISCELLANEOUS
Gaseous	Determination of effluent monitor setpoints	Calendar month or upon major operational transients (i.e., power level changes and failed fuel)	10CFR20.105	Section 3.1 and 3.2.1.1	Elevated Release - 3.0 x 10^5 μCi/sec Vent release - 7.515 x 10^4 μCi/sec	Section 12.3.2	NA	. Maximum Volume release source . Calibration curve (μCi/cc vs CPM) for specified effluent monitor For ground level releases, fraction of release rate limit allocated to specified release point	Input to Operations	
Gaseous	Determining radioiodine, Tritium and 8 day particulate instantaneous release rates	Calendar week	10CFR20.105	Section 3.2.1.2	1500 mrem/yr. any organ	Section 12.3.3	4-9 4-10	. Long-term sector average concentration X/Q (Appendix C) . Long-term relative deposition value (Appendix C) . Dose factors for applicable environmental pathways (Table B-4 through B-6) Iodine,Tritium and 8-day particulate release rate (μCi/sec)	N/A	

TABLE I-2 (Continued)
ODCM SUMMARY

EFFLUENT PATHWAY	PURPOSE OF CALCULATION	FREQUENCY OF CALCULATION	REGULATORY REQUIREMENT	Part 1 (REC) REQUIREMENT	CORRESPONDING LIMITING VALUES	Part 2 (ODCM) SECTION	ODCM EQUATION NUMBER	INPUT DATA REQUIREMENTS	REPORTING REQUIREMENTS	MISCELLANEOUS
Gaseous	Annual Dose Assessment	Calendar Year	USNRC Regulatory Guide 1.21	Section 6.1	N/A	Section 12.4.1	4-11 to 4-19	. Previous year's annual average D/Q and X/Q . Activity released (μCi/yr) for the previous year from vent and elevated releases	Annual Radioactive Effluent Report	
Gaseous	Monthly Dose Assessment - Gamma air Dose - Beta air Dose	Calendar Month	10CFR50, Appendix I	Section 3.3.4.3	Gamma air Dose - 5 mrad/qtr 10 mrad/yr Beta air Dose - 10 mrad/qtr 20 mrad/yr	Section 12.4.2	4-20 4-23	. Gamma Air Dose factors, M . Beta Air Dose factor, N . Highest annual average X/Q for vent and elevated releases . Noble Gas curies released during the month		
Gaseous	Monthly Dose - radioiodine tritium and 8-day particulate	Calendar Month	10CFR50, Appendix I	Section 3.4.4.3	Any Organ - 7.5 mrem/qtr 15 mrem/yr	Section 12.4.2	4-24 to 4-27		N/A	May use limited analysis approach of ODCM Section 12.4.2.

TABLE I-2 (Continued)
ODCM SUMMARY

EFFLUENT PATHWAY	PURPOSE OF CALCULATION	FREQUENCY OF CALCULATION	REGULATORY REQUIREMENT	Part 1 (REC) REQUIREMENT	CORRESPONDING LIMITING VALUES	Part 2 (ODCM) SECTION	ODCM EQUATION NUMBER	INPUT DATA REQUIREMENTS	REPORTING REQUIREMENTS	MISCELLANEOUS
Gaseous	Dose Projection Determination of need to operate off gas treatment system	Prior to release of unprocessed gaseous effluents	N/A	Section 3.5	0.2 mrad gamma 0.4 mrad beta 0.3 mrem organ	Section 12.5	4-20 4-31	. Gamma and Beta air dose and particulate, iodine, and tritium organ dose during the quarter to date . Number of days the plant is projected to be operational during the coming month	If non-compliance, 30 day NRC report	May use a limited analysis approach of ODCM Section 12.5.2
Liquid	Demonstrate compliance with annual fuel/cycle dose commitment limits	Calendar year if liquid releases exceed 3 mrem, total body, or 10 mrem, any organ	40CFR190	Section 4.1.1 (except thyroid) - 25 mrem/yr thyroid - 75 mrem/yr	Whole Body or any organ	Section 13.2	3-4	. Actual dilution ingestion factors (fish and potable water) . Radiological Environmental Monitoring Program Results		

TABLE I-2 (Continued)
ODCM SUMMARY

EFFLUENT PATHWAY	PURPOSE OF CALCULATION	FREQUENCY OF CALCULATION	REGULATORY REQUIREMENT	Part 1 (REC) REQUIREMENT	CORRESPONDING LIMITING VALUES	Part 2 (ODCM) SECTION	ODCM EQUATION NUMBER	INPUT DATA REQUIREMENTS	REPORTING REQUIREMENTS	MISCELLANEOUS
Gaseous	Demonstrate compliance with annual fuel cycle dose commitment limits	Calendar year, if gaseous releases exceed 10 mrads gamma air dose, 15 mrem thyroid or any organ	40CFR190	Section 4.1.1 (except thyroid) - 25 mrem/yr. thyroid - 75 mrem/yr.	Whole Body or any organ	Section 13.3	Equation Section 4-4	Current data, including: actual location of real individuals, meteorological conditions, and consumption of food (e.g. milk, meat, and vegetation)	30 day NRC Report	Substitute the total body dose factor (Ki) for the gamma air dose factor (Mi)
Direct Radiation	Demonstrate compliance with annual fuel/cycle dose commitment limits	Calendar year, if liquids or gases exceed dose limits indicated above	40CFR190	Section 4.1.1	Whole Body -25 mrem/yr.	Section 13.4	N/A	. Shielding calculations . TLD results from environmental program		