KEWAUNEE NUCLEAR POWER PLANT

SEMI-ANNUAL
EFFLUENT RELEASE REPORT
JULY - DECEMBER, 1992

WISCONSIN PUBLIC SERVICE CORPORATION
WISCONSIN POWER & LIGHT COMPANY
MADISON GAS & ELECTRIC COMPANY

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KEWAUNEE NUCLEAR POWER PLANT

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

July 1 - December 31, 1992

Wisconsin Public Service Corporation
Green Bay, Wisconsin
February 17, 1993

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1.0 **INTRODUCTION**

This report is being submitted in accordance with the requirements of Kewaunee Technical Specifications, Section 6.9.3.b. It includes data from all effluent releases made from July 1 - December 31, 1992. The report contains summaries of the gaseous and liquid releases made to the environment including the quantity, characterization, time duration and calculated radiation dose at the site boundary resulting from these releases. The report also includes a summation of solid waste disposal, revisions to the Process Control Program and the Offsite Dose Calculation Manual, and addresses the cumulative meteorological data.

1.1 **Technical Specification Limits**

Specifications are set to insure that offsite doses are maintained as low as reasonably achievable while still allowing for practical and dependable operation of the Kewaunee Plant.

The Kewaunee Offsite Dose Calculation Manual (ODCM) is used in conjunction with Section 7/8 of the Technical Specifications. The ODCM describes the methodology and parameters used in:

1. The calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints.

2. The calculation of radioactive liquid and gaseous concentrations, dose rates and cumulative quarterly and annual doses. The ODCM methodology is acceptable for use in demonstrating compliance with 10 CFR 20.106; 10 CFR 50, Appendix I; and 40 CFR 190.

2.0 GASEOUS EFFLUENTS

2.1 Lower Limits of Detection (LLD) for Gaseous Effluents

Gaseous radioactive effluents are released in both the continuous mode and the batch mode. The auxiliary building stack is sampled continuously for particulates, halogens and Strontium by an "off-line" sample train. This stack is also grab-sampled daily for gaseous gamma emitters. Batch releases are sampled prior to release for principal gaseous and particulate gamma emitters, halogens and tritium.

*** The November and December proportional composites for Gross Alpha, Strontium 89 and Strontium 90 were not available at the time this report was written. When these values are available, applicable revisions shall be submitted.

The LLD's for gaseous radioanalyses, as listed in Table 8.4 of the Kewaunee Technical Specifications, are:

Analysis	LLD (μCi/cc)
Gaseous Gamma Emitters	1.00 E-04
Iodine 131	3.00 E-12
Particulate Gamma Emitters	1.00 E-11
Particulate Gross Alpha	1.00 E-11
Strontium 89, 90	1.00 E-11
Noble Gases, Gross Beta or Gamma	1.00 E-06

The nominal "a priori" LLD values are shown below.

Isotope	a priori LLD (μCi/cc)
a. Gaseous emissions:	
Kr-87	2.63 E-8
Kr-88	4.27 E-8
Xe-133	3.24 E-8
Xe-133m	8.75 E-8
Xe-135	1.22 E-8
Xe-138	5.91 E-8
b. Particulate emissions:	
Mn-54	5.65 E-14
Fe-59	7.42 E-14
Co-58	5.99 E-14
Co-60	1.39 E-13
Zn-65	8.29 E-14
Mo-99	3.12 E-14
Cs-134	5.11 E-14
Cs-137	5.52 E-14
Ce-141	3.85 E-14
Ce-144	1.93 E-13

c. Other identifiable gamma emitters:

Ar-41	1.56 E-8
Kr-85	3.40 E-6
Kr-85m	1.25 E-8
Kr-89	1.04 E-6
Xe-127	1.46 E-8
Xe-131m	5.23 E-7
Xe-135m	3.22 E-8
Xe-137	1.59 E-7
I-131	4.40 E-14

d. Composite particulate samples:

Sr-89	1 E-14
Sr-90	1 E-14
Gross Alpha	1.00 E-14

These "a priori" LLDs represent the capabilities of the counting systems in use, not an after the fact "a posteriori" limit for a particular measurement.

2.2 **Gaseous Batch Release Statistics**

The following is a summation of all gaseous batch releases made during the second half of 1992.

Number of batch releases.....8

Total time for all batch releases (sec)..... 2.812E+005

Maximum time for a batch release (sec)..... 5.802E+004

Average time for a batch release (sec)..... 3.515E+004

Minimum time for a batch release (sec)..... 2.520E+003

2.3 **Gaseous Effluent Data**

The following table 2.1 presents a quarterly summation of the total activity released and average release rates of four categories of gaseous effluents. Table 2.2 lists the quarterly sums of individual gaseous radionuclides released by continuous and batch modes. Table 2.3 is essentially the same data, but is presented as monthly summations. Table 2.4 presents the dose limits for gaseous effluents and for the 3rd and 4th quarters, and the calculated doses this year from gaseous effluents.

Table 2.1
Semiannual Radioactive Effluent Release Report 1992
Gaseous Effluents - Summation cf all Releases

Fission and Activation Gases	3rd Quarter	4th Quarter
Total Activity Released (Ci)	0.000E+000	2.124E-003
Average Release Rate (μCi/sec)	0.000E+000	2.702E-004
Iodines		
Total Activity Released (Ci)	0.000E+000	0.000E+000
Average Release Rate (μCi/sec)	0.000E+000	0.000E+000
Particulates		
Total Activity Released (Ci)	3.964E-007	9.094E-007
Average Release Rate (μCi/sec)	5.042E-008	1.157E-007
Gross Alpha Released (Ci)	4.265E-004	3.985E-004
Tritium		
Total Activity Released (Ci)	4.838E+000	3.338E+000
Average Release Rate (μCi/sec)	6.153E-001	4.245E-001

Table 2.2
Semiannual Radioactive Effluent Release Report 1992
Gaseous Effluents

Nuclides Released (Ci)

	Continuous Mode		Batch Mode	
	3rd Quarter	4th Quarter	3rd Quarter	4th Quarter
Fission Gases				
Xe-133	0.000E+000	0.000E+000	0.000E+000	2.111E-003
Xe-133m	0.000E+000	0.000E+000	0.000E+000	1.351E-005
Total	0.000E+000	0.000E+000	0.000E+000	2.124E-003
Iodines				
I-131	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Particulates				
Co-58	0.000E+000	9.094E-007	0.000E+000	0.000E+000
Co-60	3.964E-007	0.000E+000	0.000E+000	0.000E+000
Sr-89	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Sr-90	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total	3.964E-007	9.094E-007	0.000E+000	0.000E+000

Table 2.3A
Semiannual Radioactive Effluent Release Report 1992
3rd Quarter Gaseous Release
Total of all Releases

Noble Gasses (Curies)

Isotope	July	August	September	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Particulates (Curies)

Isotope	July	August	September	Total
Co-60	0.000E+000	0.000E+000	3.964E-007	3.964E-007
Total	0.000E+000	0.000E+000	3.964E-007	3.964E-007

Halogens (Curies)

Isotope	July	August	September	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Table 2.3A (Con't)
Semiannual Radioactive Effluent Release Report 1992
3rd Quarter Gaseous Release
Total of all Releases

Summary

	July	August	September	Total
Total Noble Gases (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Halogens (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+000	0.000E+000	3.964E-007	3.964E-007
Total Tritium (Ci)	4.200E+000	0.000E+000	6.373E-001	4.838E+000
Total Particulate Gross Alpha (Ci)	1.459E-004	1.102E-004	1.704E-004	4.265E-004

Table 2.3A (Con't)
Semiannual Radioactive Effluent Release Report 1992
4th Quarter Gaseous Release
Total of all Releases

Noble Gasses (Curies)

Isotope	October	November	December	Total
Xe-133	0.000E+000	2.111E-003	0.000E+000	2.111E-003
Xe-133m	0.000E+000	1.351E-005	0.000E+000	1.351E-005
Total	0.000E+000	2.124E-003	0.000E+000	2.124E-003

Particulates (Curies)

Isotope	October	November	December	Total
Co-58	0.000E+000	9.094E-007	0.000E+000	9.094E-007
Total	0.000E+000	9.094E-007	0.000E+000	9.094E-007

Halogens (Curies)

Isotope	October	November	December	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Table 2.3A (Con't)
Semiannual Radioactive Effluent Release Report 1992
4th Quarter Gaseous Release
Total of all Releases

Summary

	October	November	December	Total
Total Noble Gases (Ci)	0.000E+000	2.124E-003	0.000E+000	2.124E-003
Total Halogens (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+000	9.094E-007	0.000E+000	9.094E-007
Total Tritium (Ci)	2.027E+000	1.002E+000	3.086E-001	3.338E+000
Total Particulate Gross Alpha (Ci)	1.280E-004	1.019E-004	1.687E-004	3.985E-004

Table 2.3B
Semiannual Radioactive Effluent Release Report 1992
3rd Quarter Gaseous Release
Continuous Mode Only

Noble Gasses (Curies)

Isotope	July	August	September	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Particulates (Curies)

Isotope	July	August	September	Total
Co-60	0.000E+000	0.000E+000	3.964E-007	3.964E-007
Total	0.000E+000	0.000E+000	3.964E-007	3.964E-007

Halogens (Curies)

Isotope	July	August	September	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Table 2.3B (Con't)
Semiannual Radioactive Effluent Release Report 1992
3rd Quarter Gaseous Release
Continuous Mode Only

Summary

	July	August	September	Total
Total Noble Gases (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Halogens (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+000	0.000E+000	3.964E-007	3.964E-007
Total Tritium (Ci)	4.139E+000	0.000E+000	6.373E-001	4.776E+000
Total Particulate Gross Alpha (Ci)	1.172E-008	9.465E-008	5.389E-007	6.453E-007

Table 2.3B (Con't)
Semiannual Radioactive Effluent Release Report 1992
4th Quarter Gaseous Release
Continuous Mode Only

Noble Gasses (Curies)

Isotope	October	November	December	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Particulates (Curies)

Isotope	October	November	December	Total
Co-58	0.000E+000	9.094E-007	0.000E+000	9.094E-007
Total	0.000E+000	9.094E-007	0.000E+000	9.094E-007

Halogens (Curies)

Isotope	October	November	December	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Table 2.3B (Con't)
Semiannual Radioactive Effluent Release Report 1992
4th Quarter Gaseous Release
Continuous Mode Only

Summary

	October	November	December	Total
Total Noble Gases (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Halogens (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+000	9.094E-007	0.000E+000	9.094E-007
Total Tritium (Ci)	2.027E+000	9.853E-001	3.086E-001	3.321E+000
Total Particulate Gross Alpha (Ci)	7.747E-007	2.102E-007	1.247E-007	1.110E-006

Table 2.3C
Semiannual Radioactive Effluent Release Report 1992
3rd Quarter Gaseous Release
Batch Mode Only

Noble Gasses (Curies)

Isotope	July	August	September	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Particulates (Curies)

Isotope	July	August	September	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Halogens (Curies)

Isotope	July	August	September	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Table 2.3C (Con't)
Semiannual Radioactive Effluent Release Report 1992
3rd Quarter Gaseous Release
Batch Mode Only

Summary

	July	August	September	Total
Total Noble Gases (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Halogens (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Tritium (Ci)	6.176E-002	0.000E+000	0.000E+000	6.176E-002
Total Particulate Gross Alpha (Ci)	1.458E-004	1.101E-004	1.699E-004	4.259E-004

Table 2.3C (Con't)
Semiannual Radioactive Effluent Release Report 1992
4th Quarter Gaseous Release
Batch Mode Only

Noble Gasses (Curies)

Isotope	October	November	December	Total
Xe-133	0.000E+000	2.111E-003	0.000E+000	2.111E-003
Xe-133m	0.000E+000	1.351E-005	0.000E+000	1.351E-005
Total	0.000E+000	2.124E-003	0.000E+000	2.124E-003

Particulates (Curies)

Isotope	October	November	December	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Halogens (Curies)

Isotope	October	November	December	Total
Total	0.000E+000	0.000E+000	0.000E+000	0.000E+000

Table 2.3C (Con't)
Semiannual Radioactive Effluent Release Report 1992
4th Quarter Gasecus Release
Batch Mode Only

Summary

	October	November	December	Total
Total Noble Gases (Ci)	0.000E+000	2.124E-003	0.000E+000	2.124E-003
Total Halogens (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Total Tritium (Ci)	0.000E+000	1.676E-002	0.000E+000	1.676E-002
Total Particulate Gross Alpha (Ci)	1.272E-004	1.017E-004	1.685E-004	3.974E-004

Table 2.4
Semiannual Radioactive Effluent Release Report 1992
Dose From Gaseous Effluents

The offsite dose limits from radioactive materials in gaseous effluents are specified in Section 7/8 of the Kewaunee Technical Specifications and can be summarized as follows:

	Whole Body Gamma	Skin Beta	Organ
Quarterly	5.0 mRad	10.0 mRad	7.5 mRem
Annual	10.0 mRad	20.0 mRad	15.0 mRem

The total release of gaseous effluents during the second six months of 1992 was within Technical Specification limits. The following offsite doses were calculated using equations 2.7, 2.8, and 2.11 from the Kewaunee ODCM. Calculated offsite doses versus quarterly Technical Specification limits are shown below:

	3rd Quarter	4th Quarter
1. Gamma-Whole Body		
Specification (mRads)	5.000E+000	5.000E+000
Actual Dose (mRads)	0.000E+000	8.554E-008
% of Specification	0.000E+000	1.711E-006
2. Beta-Skin		
Specification (mRads)	1.000E+001	1.000E+001
Actual Dose (mRads)	0.000E+000	2.552E-007
% of Specification	0.000E+000	2.552E-006
3. Ingestion Pathway-Organ		
Specification (mRems)	7.500E+000	7.500E+000
Actual Dose (mRems)	1.037E-004	7.057E-005
% of Specification	1.383E-003	9.410E-004
	GI-LLI	TBody

Table 2.4 (Con't)
Semiannual Radioactive Effluent Release Report 1992
Dose From Gaseous Effluents

In addition, the cumulative annual offsite doses for the period July 1 - December 31, 1992 versus the annual Technical Specification limits were:

	Annual
1. Gamma-Whole Body	
Specification (mRads)	1.000E+001
Actual Dose (mRads)	7.850E-004
% of Specification	7.850E-003
2. Beta-Skin	
Specification (mRads)	2.000E+001
Actual Dose (mRads)	3.610E-004
% of Specification	1.805E-003
3. Ingestion Pathway-Organ	
Specification (mRems)	1.500E+001
Actual Dose (mRems)	2.768E-004
% of Specification	1.846E-003
	Thyroid

3.0 LIQUID EFFLUENTS

3.1 Lower Limits of Detection (LLD) for Liquid Effluents

Liquid radioactive effluents are released as both batch releases and continuous releases. Each batch is sampled prior to release and analyzed for gamma emitters and tritium. A fraction of each sample is retained for a monthly proportional composite which is then analyzed for Gross Alpha, Strontium 89, Strontium 90 and Iron 55.

*** The November and December proportional composites for Gross Alpha, Strontium 89, Strontium 90 and Iron 55 were not available at the time that this report was written. When these values are available, applicable revisions shall be submitted.

The LLD's for liquid batch release radioanalyses, as listed in Table 8.3 of the Kewaunee Technical Specifications, are:

Analysis	LLD (μCi/ml)
Principal Gamma Emitters	1.00 E-06
Iodine 131	1.00 E-06
Tritium	1.00 E-05
Gross Alpha	5.00 E-07
Strontium 89, 90	5.00 E-08
Iron 55	1.00 E-06

The actual obtained "a priori" LLD values for batch releases are shown below.

Isotope	3rd Qtr	4th Qtr	Average a priori LLD (μCi/ml)
Mn-54	1.21 E-7	8.54 E-8	1.03 E-7
Fe-59	2.66 E-7	1.88 E-7	2.27 E-7
Co-58	8.39 E-8	8.39 E-8	8.39 E-8
Co-60	1.24 E-7	1.12 E-7	1.18 E-7
Zn-65	2.12 E-7	2.12 E-7	2.12 E-7
Mo-99	5.73 E-8	4.68 E-8	5.21 E-8
Cs-134	1.36 E-7	9.62 E-8	1.16 E-7
Cs-137	8.34 E-8	8.34 E-8	8.34 E-8
Ce-141	7.95 E-8	1.12 E-7	9.58 E-8
Ce-144	3.62 E-7	3.62 E-7	3.62 E-7
I-131	7.75 E-8	9.50 E-8	8.63 E-8
H-3	4.28 E-6	3.73 E-6	4.01 E-6
Sr-89	2.67 E-9	5.00 E-9	3.83 E-9
Sr-90	3.67 E-9	5.00 E-9	4.33 E-9
Gross Alpha	4.33 E-9	3.00 E-9	3.67 E-9

Continuous liquid releases are grab sampled weekly and analyzed for principal gamma emitters. A fraction of each weekly sample is retained for a monthly proportional composite which is then analyzed for Tritium, Gross Alpha, Strontium 89, Strontium 90 and Iron 55.

The LLD's for liquid continuous release radioanalyses, as listed in Table 8.3 of the Kewaunee Technical Specifications, are:

Analysis	LLD (μCi/ml)
Principal Gamma Emitters	5.00 E-07
Iodine 131	1.00 E-06
Tritium	1.00 E-05
Gross Alpha	5.00 E-07
Strontium 89, 90	5.00 E-08
Iron 55	1.00 E-06

The actual obtained "a priori" LLD values for continuous releases are shown below.

Isotope	3rd Qtr	4th Qtr	Average a priori LLD (μCi/ml)
Mn-54	3.18 E-8	2.46 E-8	2.82 E-8
Fe-59	6.27 E-8	7.68 E-8	6.98 E-8
Co-58	3.96 E-8	2.80 E-8	3.38 E-8
Co-60	4.93 E-8	4.93 E-8	4.93 E-8
Zn-65	7.06 E-8	8.65 E-8	7.86 E-8
Mo-99	2.36 E-8	2.42 E-8	2.39 E-8
Cs-134	2.78 E-8	3.69 E-8	3.24 E-8
Cs-137	2.78 E-8	3.11 E-8	2.95 E-8
Ce-141	3.38 E-8	3.51 E-8	3.45 E-8
Ce-144	1.96 E-7	1.60 E-7	1.78 E-7
I-131	2.05 E-8	3.54 E-8	2.80 E-8
H-3	4.28 E-6	3.73 E-6	4.01 E-6
Sr-89	2.50 E-9	4.00 E-9	3.25 E-9
Sr-90	1.50 E-9	2.50 E-9	2.00 E-9
Gross Alpha	2.00 E-9	3.50 E-9	2.75 E-9
Fe-55	5.00 E-8	3.00 E-8	4.00 E-8

3.2 **Liquid Batch Release Statistics**

The following is a summation of all liquid batch releases made during the second half of 1992.

Release Type	Number	Gallons Released
A SGBT Monitor Tk.	3	29104.4
B SGBT Monitor Tk.	5	48359.7
A Waste Condensate	40	36902.9
B Waste Condensate	40	36425.9
A CVC Monitor	10	64165.6
B CVC Monitor	9	58325.8

Total time for all batch releases..... 12919.0 Min.

Maximum time for a batch release..... 1095.0 Min.

Minimum time for a batch release..... 18.0 Min.

Average time for a batch release..... 120.7 Min.

3.3 **Liquid Effluent Data**

The following Table 3.1 presents a quarterly summation of the total activity released and average concentration for all liquid effluents. It also presents the gross alpha activity released, volume of waste released and volume of dilution water used. Tables 3.2 and 3.3 are monthly summations of the same information in Table 3.1. Table 3.2 contains the quantity of the individual isotopes released to the unrestricted area for batch releases. Table 3.3 presents a monthly summation of gross radioactivity, tritium, gross alpha and isotopic activity for the secondary blowdown and leakage releases. It also presents the monthly total volume for these releases and dilution volumes. Table 3.4 presents the doses from liquid effluents for the 3rd and 4th quarter and the calculated doses this year from liquid effluents.

TABLE 3.1
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Summation of all Releases

	3rd Quarter	4th Quarter	Total
Fission and Activation Products			
Total Release Excluding H3 and Dissolved Gases (Ci)	8.897E-003	1.056E-002	1.946E-002
Average Concentration (μCi/ml)	4.336E-011	7.527E-011	
Tritium			
Total Release (Ci)	1.091E+002	5.129E+001	1.604E+002
Average Concentration (μCi/ml)	5.316E-007	3.655E-007	
% of Tech. Spec. Limit(3.0E-3 μCi/ml)	1.772E-002	1.218E-002	
Dissolved Gases			
Total Release (Ci)	0.000E+000	5.006E-005	5.006E-005
Average Concentration (μCi/ml)	0.000E+000	3.567E-013	
% of Tech. Spec. Limit(2.0E-4 μCi/ml)	0.000E+000	1.784E-007	
Gross Alpha Activity			
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000
Volume of Waste Released			
Batch (liters)	5.285E+005	5.059E+005	1.034E+006
Continuous (liters)	2.921E+007	3.981E+007	6.902E+007
Total (liters)	2.974E+007	4.032E+007	7.005E+007
Volume of Dilution Water			
Batch (liters)	8.957E+009	5.146E+009	1.410E+010
Continuous (liters)	1.962E+011	1.352E+011	3.314E+011
Total (liters)	2.052E+011	1.403E+011	3.455E+011

TABLE 3.2A
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Batch Releases

	July	August	September	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	2.413E-003	3.760E-003	1.055E-003	7.228E-003
Avg. Conc. (μCi/ml)	8.147E-010	1.489E-009	3.041E-010	
Tritium				
Total Release (Ci)	9.905E+000	7.197E+000	9.198E+001	1.091E+002
Avg. Conc. (μCi/ml)	3.344E-006	2.849E-006	2.651E-005	
Dissolved Gases				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Gross Alpha Activity				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Volume of Waste Released (liters)	1.116E+005	1.199E+005	2.970E+005	5.285E+005
Volume of Dilution Water (liters)	2.962E+009	2.526E+009	3.470E+009	8.957E+009

TABLE 3.2A (Con't)
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Batch Releases

Isotope (Ci)	July	August	September	Total
H-3	9.905E+000	7.197E+000	9.198E+001	1.091E+002
Fe-55	3.683E-005	1.103E-004	1.515E-004	2.986E-004
Co-57	0.000E+000	3.147E-005	0.000E+000	3.147E-005
Co-58	1.868E-003	2.601E-003	5.518E-004	5.020E-003
Co-60	3.980E-004	9.342E-004	2.769E-004	1.609E-003
Nb-95	0.000E+000	0.000E+000	3.125E-005	3.125E-005
Zr-95	0.000E+000	0.000E+000	1.253E-005	1.253E-005
Ag-110m	1.102E-004	8.346E-005	1.630E-005	2.100E-004
Sb-125	0.000E+000	0.000E+000	1.475E-005	1.475E-005
Total	9.907E+000	7.200E+000	9.198E+001	1.091E+002

TABLE 3.2B
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Batch Releases

	October	November	December	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	1.844E-004	1.578E-003	6.850E-004	2.447E-003
Avg. Conc. (μCi/ml)	1.885E-010	5.125E-010	6.287E-010	
Tritium				
Total Release (Ci)	2.911E+000	4.559E+001	2.794E+000	5.129E+001
Avg. Conc. (μCi/ml)	2.976E-006	1.481E-005	2.565E-006	
Dissolved Gases				
Total Release (Ci)	2.640E-005	2.366E-005	0.000E+000	5.006E-005
Avg. Conc. (μCi/ml)	2.699E-011	7.685E-012	0.000E+000	
Gross Alpha Activity				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Volume of Waste Released (liters)	7.175E+004	3.358E+005	9.837E+004	5.059E+005
Volume of Dilution Water (liters)	9.781E+008	3.078E+009	1.089E+009	5.146E+009

TABLE 3.2B (Con't)
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Batch Releases

Isotope (Ci)	October	November	December	Total
H-3	2.911E+000	4.559E+001	2.794E+000	5.129E+001
Fe-55	3.659E-005	1.713E-004	5.017E-005	2.580E-004
Co-57	0.000E+000	0.000E+000	1.236E-005	1.236E-005
Co-58	1.208E-004	1.099E-003	4.236E-004	1.644E-003
Co-60	2.696E-005	3.070E-004	1.988E-004	5.328E-004
Xe-133	2.078E-005	2.366E-005	0.000E+000	4.444E-005
Xe-135	5.622E-006	0.000E+000	0.000E+000	5.622E-006
Total	2.912E+000	4.559E+001	2.795E+000	5.129E+001

TABLE 3.3A
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Continuous Releases

	July	August	September	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	1.714E-005	2.508E-004	1.401E-003	1.669E-003
Avg. Conc. (μCi/ml)	2.536E-013	3.710E-012	2.295E-011	
Tritium				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Dissolved Gases				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Gross Alpha Activity				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Volume of Waste Released (liters)	7.939E+006	1.077E+007	1.050E+007	2.921E+007
Volume of Dilution Water (liters)	6.759E+010	6.759E+010	6.105E+010	1.962E+011

TABLE 3.3A (Con't)
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Continuous Releases

Isotope (Ci)	July	August	September	Total
Fe-55	0.000E+000	2.508E-004	1.401E-003	1.652E-003
Sr-90	1.714E-005	0.000E+000	0.000E+000	1.714E-005
Total	1.714E-005	2.508E-004	1.401E-003	1.669E-003

TABLE 3.3B
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Continuous Releases

	October	November	December	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	1.226E-003	3.666E-003	3.223E-003	8.115E-003
Avg. Conc. (μCi/ml)	1.814E-011	1.085E-010	9.538E-011	
Tritium				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Dissolved Gases				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Gross Alpha Activity				
Total Release (Ci)	0.000E+000	0.000E+000	0.000E+000	0.000E+000
Avg. Conc. (μCi/ml)	0.000E+000	0.000E+000	0.000E+000	
Volume of Waste Released (liters)	8.436E+006	1.681E+007	1.456E+007	3.981E+007
Volume of Dilution Water (liters)	6.759E+010	3.380E+010	3.380E+010	1.352E+011

TABLE 3.3B (Con't)
Semiannual Radioactive Effluent Release Report 1992
Liquid Effluents - Continuous Releases

Isotope (Ci)	October	November	December	Total
Fe-55	1.226E-003	3.651E-003	3.223E-003	8.100E-003
Co-60	0.000E+000	6.822E-006	0.000E+000	6.822E-006
Sb-125	0.000E+000	8.564E-006	0.000E+000	8.564E-006
Total	1.226E-003	3.666E-003	3.223E-003	8.115E-003

Table 3.4
Semiannual Radioactive Effluent Report 1992
Dose From Liquid Effluents

The dose to a member of the public from total liquid radioactive release for each quarter was well below the Technical specification limits of 1.5 mRem to the body and less than or equal to 5 mRem to any organ.

Instantaneous release concentrations are limited by the individual radionuclide concentrations established in 10 CFR 20, Appendix B, for unrestricted areas. During the report period, none of the isotopes released exceed the concentrations specified in Appendix B. The following offsite doses were calculated using equation 1.5 from the Kewaunee ODCM.

Organ 3rd Qtr Dose	Dose Total mRem	Quarterly Limit mRem	Percent of Limit
Total Body	6.121E-004	1.5	0.04
Bone	1.206E-004	5.0	0.00
Liver	5.820E-004	5.0	0.01
Thyroid	5.598E-004	5.0	0.01
Kidney	5.599E-004	5.0	0.01
Lung	5.660E-004	5.0	0.01
GI-LLI	1.822E-003	5.0	0.04

Organ 4th Qtr Dose	Dose Total mRem	Quarterly Limit mRem	Percent of Limit
Total Body	3.930E-004	1.5	0.03
Bone	1.084E-004	5.0	0.00
Liver	4.431E-004	5.0	0.01
Thyroid	3.620E-004	5.0	0.01
Kidney	3.620E-004	5.0	0.01
Lung	4.038E-004	5.0	0.01
GI-LLI	5.247E-004	5.0	0.01

Calculated Dose This Year

Organ	Dose Total mRem	Quarterly Limit mRem	Percent of Limit
Total Body	2.186E-003	3.0	0.07
Bone	6.492E-004	10.0	0.01
Liver	2.341E-003	10.0	0.02
Thyroid	1.831E-003	10.0	0.02
Kidney	1.855E-003	10.0	0.02
Lung	2.024E-003	10.0	0.02
GI-LLI	7.724E-002	10.0	0.77

4.0 UNPLANNED RELEASES

No unplanned releases were made from the Kewaunee Plant during the report period.

The January-June, 1991 Semi-Annual Effluent Release Report described an unplanned release which occurred on April 25, 1991. Offsite doses attributable to this release were well below the established Technical Specification limits.

As corrective action, WPSC stated in this report that valves WG-301 and WG-302 were scheduled to be replaced in 1992. Also a new vent line was to be added between valves WG-301 and WG-300 to allow local leak rate testing with the Waste Gas Decay Tanks isolated.

The valves were to be replaced with like-for-like replacements. However, after receipt inspection, the replacement valves failed to pass the seat leakage tests. To date, WPSC has not been able to locate a suitable replacement for these valves. WPSC is continuing to evaluate options associated with these valves and will continue to provide status updates in the Effluent Release Reports until resolution of this incident and completion of corrective actions.

5.0 METEOROLOGICAL DATA

Meteorological data for the 3rd Quarter and 4th Quarter of 1992 is retained on file at the Kewaunee Nuclear Power Plant. The data on file includes a continuous strip chart recording and a 15-minute interval listing of wind speed, wind direction and atmospheric stability. This is more conservative than the requirements of Technical Specification 6.9.3.b (1)(b). See Appendix A for missing meteorological data times and joint frequency distribution tables.

6.0 SOLID WASTE DISPOSAL

Table 6.1 is a summation of solid wastes shipped for the second half of 1992. Presented are the types of wastes, major nuclide composition, disposition of the wastes and shipping containers used.

The containers utilized have the following volumes:

High Integrity Container (HIC)	158 ft3
LSA Box (B-25)	98 ft3
DOT-17H Drum	7.5 ft3

A composite sample from the 1992 dewatered resin shipments was analyzed by a contractor for transuranic nuclides. The results showed an average transuranic concentration of 5.83 E-2 nanocuries/gram, well within the disposal site limit of 10 nanocuries/gram.

Table 6.1 contains the radionuclide content (curies) and percent abundance for each type of waste.

Isotopes denoted by an asterisk (*) in Table 6.1 are correlated values.

Table 6.1
Semiannual Radioactive Effluent Report 1992
Solid Waste and Irradiated Fuel Shipments

A. Solid Waste Shipped Off-Site for Burial or Disposal (Not Irradiated Fuel)

1. Type of waste	July - December Ci	CU/M
a. Dewatered Resin	0.00E+00	0.00E+00
b. Dewatered Cloth Filters	0.00E+00	0.00E+00
c. DAW (Compactible)	3.95E-01	2.59E+01
d. DAW (Noncompactible)	4.18E-03	5.55E+00

2. Estimate of Major Nuclide by Composition (By Type of Waste)

	%	Ci
a. Dewatered Resin	None	None
b. Dewatered Cloth Filters	None	None
c. DAW (Compactible)		
Cr-51	1.59E-02	6.28E-05
Mn-54	1.03E+00	4.08E-03
Co-57	1.74E-01	6.87E-04
Co-58	4.11E+00	1.62E-02
Co-60	2.47E+01	9.73E-02
Zr-95	2.42E-01	9.57E-04
Nb-95	1.12E-01	4.43E-04
Ag-110m	2.05E+00	8.10E-03
Sb-124	1.22E-02	4.83E-05
Sb-125	7.99E-01	3.16E-03
Sn-113	1.10E-01	4.33E-04
*Fe-55	6.20E+01	2.45E-01
Fe-59	7.45E-03	2.94E-05
*C-14	1.17E+00	4.61E-03
*TRU	3.95E-02	1.56E-04
*Ni-63	3.45E+00	1.36E-02
d. DAW (Uncompactible)		
Cr-51	5.89E-01	2.46E-05
Mn-54	1.12E+00	4.66E-05
Co-57	2.02E-01	8.44E-06
Co-58	2.09E+01	8.75E-04
Co-60	1.78E+01	7.43E-04
Zr-95	1.46E+00	6.08E-05
Nb-95	2.71E+00	1.13E-04
Ag-110m	2.49E+00	1.04E-04
Sb-124	8.74E-02	3.65E-06
Sb-125	6.20E-01	2.59E-05
Sn-113	2.66E-01	1.11E-05
*Fe-55	4.83E+01	2.02E-03
Fe-59	1.04E-01	4.35E-06
*C-14	8.43E-01	3.52E-05
*TRU	2.85E-02	1.19E-06
*Ni-63	2.47E+00	1.03E-04

Table 6.1 (Con't)
Semiannual Radioactive Effluent Report 1992
Solid Waste and Irradiated Fuel Shipments

3. Solid Waste Disposition

a. Date of Shipment | Mode of Transportation | Destination

12/01/92	CNSI Van	Barnwell, SC
12/16/92	CNSI Van	Barnwell, SC

b. Irradiated Fuel Shipments

No irradiated fuel shipments were made from the Kewaunee Nuclear Power Plant during the second half of 1992.

7.0 PROGRAM REVISIONS

In accordance with Technical Specifications 6.9.3.b (1)(e), 6.17.2.a, 6.18.2.a and 6.19.1.a, the revisions to the Process Control Program, Offsite Dose Calculation Manual and radioactive waste systems are listed below.

7.1 Process Control Program

The Kewaunee Nuclear Power Plant Process Control Program has not been revised during this report period.

7.2 Offsite Dose Calculation Manual

The Offsite Dose Calculation Manual (ODCM) was revised during this reporting period. Due to the renumbering of pages, the manual was reissued in its entirety. In accordance with Technical Specification 6.18.2, a copy of the revised ODCM is enclosed in Appendix B to this report.

The revisions made to the ODCM do not reduce the accuracy or reliability of dose calculations or setpoint determinations. All revisions were reviewed and found acceptable by the Plant Operations Review Committee (PORC). The specific changes are discussed below.

ODCM, Revision 4 Changes

1. Section 1.6 was added to describe the recently approved plan to dispose of low level radioactively contaminated sludge from the sewage treatment lagoon by land spreading. This section gives a general explanation of the different types of wastes generated on site. This section refers to Appendix E of the ODCM which includes the Nuclear Regulatory Commission's (NRC) Safety Evaluation.

2. Section 2.2.1; corrected a typo for the monitor sensitivity parameter associated with equation 2.3. The unit for monitor sensitivity was changed to micro curies per cm^3.

3. Section 2.6; the last sentence was added to refer to NUREG-0543 for methods that can be used to demonstrate compliance with 40 CFR 190.

4. Figure 1 and Figure 2 were redrawn using RFFlow program. This will aid in future changes to these drawings.

5. Table E; new default sensitivity values were determined for the four gaseous radiation monitors and new default setpoints were calculated. This was necessary for Radiation Monitors R-13 and R-14 to insure that the default setpoint for each monitor was more conservative then the calculated setpoint. The default sensitivity for Radiation Monitors R-12 and R-21 was adjusted slightly to provide a larger margin between the calculated and default setpoints. A typo for parameter C_i was corrected to micro curies per cm^3 and an incorrect comment was deleted.

6. Table G-12; five nucleates were added (Co-57, Br-82, Nb-97, Sb-124, and Sb-125). This information was provided by JSB Associates in response to a request from the Kewaunee Nuclear Power Plant to develop site specific dose conversion factors for these nucleates.

7. Appendix C; added discussion for new information added to Table C-1. This discussion reaffirms the assumptions currently used in this section. Table C-1 was updated to include 1984 through 1991 data.

8. Appendix D; added sentence which states where referenced drawings are located. Also Figure D-1 was modified to show new buildings on site and to clearly show the forebay letter designation "C".

9. Appendix E was added which includes the NRC Safety Evaluation related to land spreading of the lagoon waste sludge. Adding this Safety Evaluation to the ODCM was a requirement of the Safety Evaluation. This is related to the addition of Section 1.6 as stated above.

7.3 Major Changes to the Radioactive Liquid, Gaseous and Solid Waste Treatment Systems

Major changes to the radioactive liquid, gaseous or solid waste systems are submitted in the annual Updated Final Safety Analysis Report consistent with Technical Specification 6.19.

8.0 REPORTABLE OCCURRENCES

None.

9.0 ADDITIONAL INFORMATION

Kewaunee Nuclear Power Plant incident report 92-148 addresses a spill of slightly contaminated radioactive oil. The spilled oil leaked into substation gravel. Twenty drums of gravel were excavated from the area. A vendor laboratory analyzed gravel samples from the excavated area and determined that the samples are within normal background radioactivity levels consistent with the Kewaunee Nuclear Power Plant Radiological Environmental Monitoring Program.

Appendix A

Meteorological Data

July 1, 1992 - December 31, 1992

Missing Data Totals

Third Quarter 1992: 1 Hour

Fourth Quarter 1992: 27 Hours

Kewaunee Nuclear Power Plant Meteorological Data
Missing Data
July 1992 - December 1992

Date	MPH @10 Meters M0308G	Delta-T M0304G	Wind Direction @10 Meters M0309G	Wind Direction @60 Meters M0302G
18AUG92:08:30	X	X	X	X
19OCT92:10:30	X	X	X	X
26OCT92:08:30	X	X	X	X
26OCT92:09:30	X	X	X	X
26OCT92:10:30	X	X	X	X
26OCT92:11:30	X	X	X	X
26OCT92:12:30	X	X	X	X
26OCT92:13:30	X	X	X	X
01DEC92:08:30	X	X	X	X
01DEC92:09:30	X	X	X	X
01DEC92:11:30	X	X	X	X
01DEC92:13:30	X	X	X	X
31DEC92:08:30	X	X	X	X
31DEC92:09:30	X	X	X	X
31DEC92:10:30	X	X	X	X
31DEC92:11:30	X	X	X	X
31DEC92:12:30	X	X	X	X
31DEC92:13:30	X	X	X	X
31DEC92:14:30	X	X	X	X
31DEC92:15:30	X	X	X	X
31DEC92:16:30	X	X	X	X
31DEC92:17:30	X	X	X	X
31DEC92:18:30	X	X	X	X
31DEC92:19:30	X	X	X	X
31DEC92:20:30	X	X	X	X
31DEC92:21:30	X	X	X	X
31DEC92:22:30	X	X	X	X
31DEC92:23:30	X	X	X	X
01JAN93:00:30	X	X	X	X

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9217

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
ESE	0	2	0	0	0	0	0	2
SE	0	1	1	0	0	0	0	2
SSE	0	0	2	0	0	0	0	2
S	0	0	1	0	0	0	0	1
SSW	0	0	2	0	0	0	0	2
Total	0	3	6	0	0	0	0	9

Stability Class C	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
ESE	0	1	0	0	0	0	0	1
SE	0	0	1	0	0	0	0	1
Total	0	1	1	0	0	0	0	2

Stability Class D	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
ESE	0	0	1	0	0	0	0	1
SE	0	1	2	0	0	0	0	3
SSE	0	2	1	0	0	0	0	3
S	0	0	1	0	0	0	0	1
Total	0	3	5	0	0	0	0	8

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9217

Stability Class E	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
ESE	0	2	0	0	0	0	0	2
S	0	1	1	0	0	0	0	2
SSW	0	0	2	0	0	0	0	2
SW	0	1	1	0	0	0	0	2
WSW	0	0	4	0	0	0	0	4
Total	0	4	8	0	0	0	0	12

Stability Class F	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
ESE	0	0	1	0	0	0	0	1
S	0	0	1	0	0	0	0	1
WSW	0	1	0	0	0	0	0	1
W	0	0	1	0	0	0	0	1
Total	0	1	3	0	0	0	0	4

Stability Class G	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
SE	0	0	1	0	0	0	0	1
SSE	0	0	4	0	0	0	0	4
S	0	0	3	0	0	0	0	3
SSW	0	0	1	0	0	0	0	1
WSW	0	0	1	0	0	0	0	1
W	0	1	3	0	0	0	0	4
Total	0	1	13	0	0	0	0	14

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9218

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
NNE	0	0	0	6	0	0	0	6
NE	0	0	7	12	0	0	0	19
ENE	0	0	0	1	0	0	0	1
Total	0	0	7	19	0	0	0	26

Stability Class B	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
NE	0	0	1	0	0	0	0	1
Total	0	0	1	0	0	0	0	1

Stability Class C	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
NNE	0	0	1	0	0	0	0	1
NE	0	0	1	0	0	0	0	1
Total	0	0	2	0	0	0	0	2

Stability Class D	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
NE	0	0	1	0	0	0	0	1
ENE	0	0	0	1	0	0	0	1
Total	0	0	1	1	0	0	0	2

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9218

Stability Class E	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
NNE	0	1	0	0	0	0	0	1
Total	0	1	0	0	0	0	0	1

Stability Class F	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
NNW	0	0	1	0	0	0	0	1
Total	0	0	1	0	0	0	0	1

Stability Class G	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
WNW	0	0	1	0	0	0	0	1
NW	0	0	15	0	0	0	0	15
NNW	0	0	4	0	0	0	0	4
Total	0	0	20	0	0	0	0	20

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9219

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
S	0	0	1	2	0	0	0	3
W	0	0	1	0	0	0	0	1
WNW	0	0	1	0	0	0	0	1
NW	0	0	0	1	0	0	0	1
NNW	0	0	0	1	0	0	0	1
Total	0	0	3	4	0	0	0	7

Stability Class D	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
S	0	0	2	2	0	0	0	4
SSW	0	0	2	5	0	0	0	7
Total	0	0	4	7	0	0	0	11

Stability Class E	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
S	0	0	6	2	0	0	0	8
SSW	0	0	3	3	0	0	0	6
SW	0	0	1	1	0	0	0	2
Total	0	0	10	6	0	0	0	16

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9219

Stability Class F	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
S	0	0	1	0	0	0	0	1
Total	0	0	1	0	0	0	0	1

Stability Class G	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
SSE	0	0	2	2	0	0	0	4
S	0	0	5	0	0	0	0	5
SSW	0	0	5	0	0	0	0	5
Total	0	0	12	2	0	0	0	14

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9220

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	3	13	3	0	19
NNE	0	0	1	1	9	2	0	13
NW	0	0	0	0	1	0	0	1
NNW	0	0	0	1	3	0	0	4
Total	0	0	1	5	26	5	0	37

Stability Class B	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	5	2	0	0	7
Total	0	0	0	5	2	0	0	7

Stability Class C	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	2	2	0	0	4
NNE	0	0	0	0	0	1	0	1
Total	0	0	0	2	2	1	0	5

Stability Class D	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	0	3	0	0	3
NNE	0	0	0	0	1	0	0	1
Total	0	0	0	0	4	0	0	4

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9221

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
SSW	0	0	1	2	0	0	0	3
SW	0	0	0	2	0	0	0	2
Total	0	0	1	4	0	0	0	5

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9222

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	1	0	0	0	1
NNE	0	0	0	0	6	0	0	6
NE	0	0	0	1	6	1	0	8
ENE	0	0	0	1	4	0	0	5
E	0	0	0	9	4	0	0	13
ESE	0	0	0	8	2	0	0	10
SE	0	0	0	1	1	0	0	2
Total	0	0	0	21	23	1	0	45

Stability Class B	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
NE	0	0	0	0	1	0	0	1
Total	0	0	0	0	1	0	0	1

Stability Class C	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	2	4	0	0	0	6
Total	0	0	2	4	0	0	0	6

Stability Class D	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	5	0	0	0	5
NNW	0	0	0	4	0	0	0	4
Total	0	0	0	9	0	0	0	9

Stability Class E	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	1	0	0	0	1
NNW	0	0	0	3	0	0	0	3
Total	0	0	0	4	0	0	0	4

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9223

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
SW	0	0	0	2	3	0	0	5
Total	0	0	0	2	3	0	0	5

Kewaunee Nuclear Power Plant Meteorological Data
Gaseous Batch Release Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - December 1992

Release Summary - Permit = 9224

Stability Class C	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
S	0	0	0	0	5	0	0	5
Total	0	0	0	0	5	0	0	5

Stability Class D	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
SSE	0	0	0	0	3	3	0	6
S	0	0	1	9	6	0	0	16
Total	0	0	1	9	9	3	0	22

Stability Class E	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
SSE	0	0	0	2	9	0	0	11
S	0	0	0	2	1	0	0	3
Total	0	0	0	4	10	0	0	14

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - September 1992

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	5	5	3	0	13
NNE	0	1	5	17	5	0	0	28
NE	0	1	10	13	1	0	0	25
ENE	0	1	7	14	5	0	0	27
E	0	4	16	21	10	0	0	51
ESE	0	3	23	14	2	0	0	42
SE	0	2	12	4	0	0	0	18
SSE	0	4	17	9	5	0	0	35
S	0	3	16	9	5	0	0	33
SSW	0	1	2	3	3	0	0	9
SW	0	1	8	9	11	0	0	29
WSW	0	0	11	13	14	10	0	48
W	0	0	10	20	24	18	0	72
WNW	0	0	7	8	20	8	0	43
NW	0	0	4	15	7	1	0	27
NNW	0	0	2	14	4	0	0	20
Total	0	21	150	188	121	40	0	520

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - September 1992

Stability Class B	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	0	2	0	0	2
NNE	0	0	2	1	0	0	0	3
NE	0	0	2	0	0	0	0	2
ENE	0	0	2	3	2	0	0	7
E	0	0	4	3	4	0	0	11
ESE	0	0	3	1	1	0	0	5
SE	0	0	2	0	1	0	0	3
SSE	0	0	0	1	1	1	0	3
S	0	0	5	2	1	0	0	8
SW	0	0	2	0	0	0	0	2
W	0	0	2	1	2	1	0	6
WNW	0	0	1	3	2	0	0	6
NW	0	0	1	2	1	0	0	4
NNW	0	0	1	1	0	0	0	2
Total	0	0	27	18	17	2	0	64

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - September 1992

Stability Class C	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	0	1	0	0	1
NNE	0	0	2	1	0	0	0	3
NE	0	0	0	1	0	0	0	1
ENE	0	0	0	2	1	0	0	3
E	0	0	4	1	1	1	0	7
ESE	0	0	2	2	2	0	0	6
SE	0	0	0	0	0	1	0	1
SSE	0	1	1	1	0	0	0	3
S	0	1	1	3	0	0	0	5
SSW	0	0	6	1	1	0	0	8
SW	0	0	4	0	0	0	0	4
WSW	0	0	4	1	0	0	0	5
W	0	0	1	0	3	0	0	4
NW	0	0	0	1	1	0	0	2
NNW	0	0	0	1	0	0	0	1
Total	0	2	25	15	10	2	0	54

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - September 1992

Stability Class D	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	2	14	3	0	0	19
NNE	0	2	2	1	0	0	0	5
NE	0	1	4	1	0	0	0	6
ENE	0	0	3	3	1	0	0	7
E	0	1	7	8	3	0	0	19
ESE	0	0	4	4	1	0	0	9
SE	0	1	8	2	0	0	0	11
SSE	0	1	7	8	1	2	0	19
S	0	5	13	5	4	0	0	27
SSW	0	1	5	2	1	0	0	9
SW	0	1	6	1	2	0	0	10
WSW	0	2	17	5	3	0	0	27
W	0	2	19	8	20	4	0	53
WNW	0	0	3	6	4	1	0	14
NW	0	0	1	6	1	0	0	8
NNW	0	0	1	1	0	0	0	2
Total	0	17	102	75	44	7	0	245

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - September 1992

Stability Class E	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	4	3	0	0	7
NNE	0	0	6	4	1	0	0	11
NE	0	0	8	3	0	0	0	11
ENE	0	2	8	4	1	0	0	15
E	0	4	7	1	0	0	0	12
ESE	0	6	11	4	2	0	0	23
SE	0	2	8	4	0	0	0	14
SSE	0	1	15	4	7	2	0	29
S	0	4	38	31	6	0	0	79
SSW	0	1	19	5	0	0	0	25
SW	0	1	10	5	3	0	0	19
WSW	0	4	13	10	3	0	0	30
W	0	7	10	9	7	0	0	33
WNW	0	1	7	4	1	0	0	13
NW	0	1	4	3	2	0	0	10
NNW	0	1	5	6	0	0	0	12
Total	0	35	169	101	36	2	0	343

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - September 1992

Stability Class F	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	1	2	1	0	0	0	4
NNE	0	2	7	2	1	0	0	12
NE	0	4	8	3	0	0	0	15
ENE	0	2	5	0	0	0	0	7
E	0	4	4	1	1	0	0	10
ESE	0	2	2	1	0	0	0	5
SE	0	5	5	7	1	0	0	18
SSE	0	4	18	14	15	5	0	56
S	0	3	34	14	2	0	0	53
SSW	0	6	26	2	0	0	0	34
SW	0	2	5	6	3	0	0	16
WSW	0	3	11	6	0	0	0	20
W	0	4	9	4	0	0	0	17
WNW	0	2	5	1	1	0	0	9
NW	0	1	10	5	0	0	0	16
NNW	0	0	1	3	0	0	0	4
Total	0	45	152	70	24	5	0	296

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
July 1992 - September 1992

Stability Class G	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	3	1	0	0	0	4
NNE	0	8	7	2	0	0	0	17
NE	0	3	10	1	0	0	0	14
ENE	0	5	10	1	0	0	0	16
E	0	7	3	1	0	0	0	11
ESE	0	7	6	0	0	0	0	13
SE	0	7	17	9	1	0	0	34
SSE	0	15	53	44	17	0	0	129
S	0	20	27	18	1	0	0	66
SSW	0	21	33	5	1	0	0	60
SW	0	12	33	9	3	0	0	57
WSW	0	10	26	11	0	0	0	47
W	0	11	50	14	2	0	0	77
WNW	0	11	50	6	0	0	0	67
NW	0	3	42	8	0	0	0	53
NNW	0	2	16	3	0	0	0	21
Total	0	142	386	133	25	0	0	686

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
October 1992 - December 1992

Stability Class A	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	2	7	18	2	0	29
NNE	0	0	0	10	7	10	4	31
NE	0	0	7	4	5	3	1	20
ENE	0	0	2	5	14	0	6	27
E	0	0	5	16	13	23	5	62
ESE	0	0	8	12	4	1	1	26
SE	0	0	9	15	5	3	0	32
SSE	0	0	3	7	19	18	4	51
S	0	0	12	12	15	0	0	39
SSW	0	1	11	14	4	2	0	32
SW	0	0	4	17	10	0	0	31
WSW	0	0	14	16	22	0	0	52
W	0	0	9	20	21	10	5	65
WNW	0	0	7	34	24	10	2	77
NW	0	0	5	17	12	1	0	35
NNW	0	0	4	5	3	0	0	12
Total	0	1	102	211	196	83	28	621

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
October 1992 - December 1992

Stability Class B	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	2	7	8	0	0	17
NNE	0	0	0	1	0	1	0	2
NE	0	0	0	1	0	0	0	1
ENE	0	1	1	1	2	0	0	5
E	0	0	3	1	1	0	0	5
ESE	0	1	2	0	1	1	0	5
SE	0	0	6	0	0	0	0	6
SSE	0	0	0	3	3	0	0	6
S	0	0	4	8	3	0	0	15
SSW	0	1	2	2	4	0	0	9
SW	0	0	2	4	5	0	0	11
WSW	0	0	3	6	4	0	0	13
W	0	0	3	9	5	0	1	18
WNW	0	0	2	3	2	0	0	7
NW	0	0	3	3	4	0	0	10
NNW	0	0	3	7	2	0	0	12
Total	0	3	36	56	44	2	1	142

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
October 1992 - December 1992

Stability Class C	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	8	5	0	0	13
NNE	0	0	0	0	1	0	0	1
ENE	0	0	3	1	0	0	0	4
E	0	0	2	2	3	0	0	7
SE	0	0	1	0	0	1	0	2
SSE	0	0	4	0	0	1	0	5
S	0	0	3	4	8	0	0	15
SSW	0	0	1	6	7	0	0	14
SW	0	0	2	4	3	2	0	11
WSW	0	1	5	2	5	2	0	15
W	0	0	2	3	4	0	1	10
WNW	1	1	2	3	2	0	0	9
NW	0	0	0	5	6	0	0	11
NNW	0	0	2	2	1	0	0	5
Total	1	2	27	40	45	6	1	122

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
October 1992 - December 1992

Stability Class D	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	1	8	8	0	0	17
NNE	0	0	1	4	1	0	0	6
NE	0	1	5	1	0	0	0	7
ENE	0	0	2	0	0	0	0	2
E	0	0	4	6	2	0	0	12
ESE	0	1	0	1	2	0	0	4
SE	0	0	4	1	1	0	0	6
SSE	0	0	1	5	4	4	0	14
S	0	1	18	41	17	0	0	77
SSW	0	0	18	16	12	1	0	47
SW	0	2	15	18	10	2	3	50
WSW	0	0	11	16	24	5	1	57
W	0	1	21	27	41	15	6	111
WNW	0	3	18	14	21	1	0	57
NW	0	0	20	11	9	0	0	40
NNW	0	0	8	11	3	0	0	22
Total	0	9	147	180	155	28	10	529

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
October 1992 - December 1992

Stability Class E	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	3	3	4	0	0	10
NNE	0	0	3	5	1	0	0	9
NE	0	1	6	6	1	0	0	14
ENE	0	0	3	3	0	0	0	6
E	0	0	4	0	4	0	0	8
ESE	0	1	1	0	6	2	0	10
SE	0	1	5	2	1	0	0	9
SSE	0	0	3	4	5	4	0	16
S	0	2	17	4	0	0	0	23
SSW	0	4	6	5	0	0	0	15
SW	0	4	15	7	8	0	0	34
WSW	0	6	13	8	11	0	0	38
W	0	2	16	23	9	0	0	50
WNW	0	1	4	9	4	0	0	18
NW	0	0	6	18	2	0	0	26
NNW	0	1	8	3	3	0	0	15
Total	0	23	113	100	59	6	0	301

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
October 1992 - December 1992

Stability Class F	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	2	3	0	0	0	5
NNE	0	1	5	2	0	0	0	8
NE	0	0	4	1	0	1	0	6
ENE	0	2	0	0	0	0	0	2
E	0	3	6	0	1	0	0	10
ESE	0	2	6	6	1	3	0	18
SE	0	3	3	2	0	0	0	8
SSE	0	1	2	3	4	0	0	10
S	0	5	13	3	0	0	0	21
SSW	0	5	2	3	0	0	0	10
SW	0	4	10	8	1	0	0	23
WSW	0	1	9	13	4	0	0	27
W	0	2	16	15	2	0	0	35
WNW	0	2	6	3	0	0	0	11
NW	0	0	2	0	0	0	0	2
NNW	0	0	3	3	0	0	0	6
Total	0	31	89	65	13	4	0	202

Kewaunee Nuclear Power Plant Meteorological Data
Wind Speed Hourly Average vs. Direction by Stability Class
October 1992 - December 1992

Stability Class G	Calm	1-3	4-7	8-12	13-18	19-24	>24	Total
Wind Direction (from)								
N	0	0	0	0	1	0	0	1
NE	0	0	0	1	0	0	0	1
E	0	2	2	0	0	0	0	4
ESE	0	1	0	0	1	3	0	5
SE	0	1	1	0	0	1	0	3
SSE	0	1	4	6	3	0	0	14
S	0	4	8	1	0	0	0	13
SSW	0	8	24	1	0	0	0	33
SW	0	7	21	8	0	0	0	36
WSW	0	6	25	7	4	0	0	42
W	0	7	23	29	0	0	0	59
WNW	0	0	15	2	0	0	0	17
NW	0	2	12	0	0	0	0	14
NNW	0	0	26	0	0	0	0	26
Total	0	39	161	55	9	4	0	268

APPENDIX B

Revised ODCM

(Rev. 4, October 26, 1992)

KEWAUNEE NUCLEAR POWER PLANT

OFFSITE DOSE CALCULATION MANUAL

Revision 4

October 26, 1992

Reviewed By: DC Cook (Acting Secretary) Mtg # 92-092 **Date:** 10/26/92
Plant Operations Review Committee

Approved By: _____ **Date:** 10/26/92
Superintendent - Plant Radiation Protection

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KEWAUNEE NUCLEAR POWER PLANT

OFFSITE DOSE CALCULATION MANUAL

Revision 4

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Abstract

This document has been developed in accordance with the Wisconsin Public Service Corporation (WPSC) commitment made by letter dated August 21, 1984 (from D. C. Hintz to S. A. Varga). It provides the current methodologies and parameters to be used in the calculation of offsite doses due to radioactive gaseous and liquid effluents and gaseous and liquid effluent monitoring alarm/trip setpoints for the Kewaunee Nuclear Power Plant. To develop this document, WPSC contracted the J. Stewart Bland Consultants, Inc. of Maryland; however, rigorous review and final acceptance of this document has been provided by WPSC. Implementation of this document is the responsibility of WPSC.

December 18, 1984

KEWAUNEE NUCLEAR POWER PLANT
OFFSITE DOSE CALCULATION MANUAL

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Introduction

The Kewaunee Offsite Dose Calculation Manual (ODCM) describes the methodology and parameters used in: 1) the calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints; and 2) the calculation of radioactive liquid and gaseous concentrations, dose rates and cumulative quarterly and yearly doses. The methodology stated in this manual is acceptable for use in demonstrating compliance with 10 CFR 20.106, 10 CFR 50, Appendix I and 40 CFR 190.

More conservative calculational methods and/or conditions (e.g., location and/or exposure pathways) expected to yield higher computed doses than appropriate for the maximally exposed person may be assumed in the dose evaluations.

The ODCM will be maintained at the station for use as a reference guide and training document of accepted methodologies and calculations. Changes will be made to the ODCM calculational methodologies and parameters as is deemed necessary to assure reasonable conservatism in keeping with the principles of 10 CFR 50.36a and Appendix I for demonstrating radioactive effluents are ALARA.

1.0 Liquid Effluents

1.1 Radiation Monitoring Instrumentation and Controls

The liquid effluent monitoring instrumentation and controls installed at Kewaunee for controlling and monitoring normal radioactive material releases in accordance with 10 CFR 50, Appendix A, Criteria 60 and 64, are summarized as follows:

1) Alarm (and Automatic Termination) - R-18 provides this function on the liquid radwaste effluent line, R-19 on the Steam Generator blowdown.

2) Alarm (only) - R-20 and R-16 provide alarm functions for the Service Water discharges.

3) Composite Samples - Samples are collected weekly from the steam generator blowdown and analyzed by gamma spectroscopy. Samples are collected weekly from the Turbine Building Sump and analyzed by gamma spectroscopy. The weekly samples are composited for monthly tritium and gross alpha analyses and for quarterly Sr-89 and 90 analyses. During periods of identified primary-to-secondary leakage (with the secondary activity > 1.0E-05 μCi/ml), grab samples from the Turbine Building sump are collected daily and analyzed by gamma spectroscopy. These

samples are composited for monthly tritium and gross alpha analyses and for quarterly Sr-89 and 90 analyses.

4) Liquid Tank Controls - All radioactive liquid tanks are located inside the Auxiliary Building and contain the suitable confinement systems and drains to prevent direct, unmonitored release to the environment. A liquid radioactive waste flow diagram with the applicable, associated radiation monitoring instrumentation and controls is presented as Figure 1.

1.2 Liquid Effluent Monitor Setpoint Determination

Per the requirements of Technical Specification 7.1, alarm setpoints shall be established for the liquid effluent monitoring instrumentation to ensure that the release concentration limits of Specification 7.3.1 are met (i.e., the concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2, for radionuclides and 2.0E-04 μCi/ml for dissolved or entrained noble gases). The following equation* must be satisfied to meet the liquid effluent restrictions:

$$c \leq \frac{C\,(F+f)}{f} \qquad (1.1)$$

where:

C = the effluent concentration limit of Technical Specification 7.3.1 implementing the 10 CFR 20 MPC for the site, in μCi/ml

c = the setpoint, in μCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint, which is inversely proportional to the volumetric flow of the effluent line and proportional to the volumetric flow of the dilution stream plus the effluent stream, represents a value which, if exceeded, would result in concentrations exceeding the limits of 10 CFR 20 in the unrestricted area

* Adapted from NUREG-0133

f = the flow rate at the radiation monitor location in volume per unit time, but in the same units as F, below

F = the dilution water flow rate as measured prior to the release point, in volume per unit time

[Note that if no dilution is provided, $c \leq C$. Also, note that when (F) is large compared to (f), then $(F + f) \approx F$.]

1.2.1 Liquid Effluent Monitors (Radwaste, Steam Generator Blowdown and Service Water). The setpoints for the liquid effluent monitors at the Kewaunee Nuclear Power Plant are determined by the following equations:

$$SP \leq \frac{MPC_e \times SEN \times CW}{RR} + bkg \qquad (1.2)$$

and

$$MPC_e = \frac{\sum C_i}{\sum \frac{C_i}{MPC_i}} \qquad (1.3)$$

where:

SP = alarm setpoint corresponding to the maximum allowable release rate (cpm)

MPC_e = an effective MPC value for the mixture of radionuclides in the effluent stream (μCi/ml)

C_i = the concentration of radionuclide i in the liquid effluent (μCi)

MPC_i = the MPC value corresponding to radionuclide i from 10 CFR 20, Appendix B, Table II, Column 2 (μCi/ml)

SEN = the sensitivity value to which the monitor is calibrated (cpm per μCi/ml)

CW = the circulating water flow rate (dilution water flow) at the time of

release (gal/min)

RR = the liquid effluent release rate (gal/min)

bkg = the background of the monitor (cpm)

The radioactivity monitor setpoint equation (1.2) remains valid during outages when the circulating water dilution is at its lowest. Reduction of the waste stream flow (RR) may be necessary during these periods to meet the discharge criteria. At its lowest value, CW will equal RR and equation (1.2) reverts to the following equation:

$$SP \leq MPC_e \times SEN + bkg \qquad (1.4)$$

1.2.2 Conservative Default Values: Conservative alarm setpoints may be determined through the use of generic, default parameters. Table A summarizes all current default values in use for Kewaunee. They are based upon the following:

a) substitution of the default effective MPC value of 1.0E-05 μCi/ml (refer to Appendix C for justification);

b) substitutions of the lowest operational circulating water flow, in gal/min; and,

c) substitutions of the highest effluent release rate, in gal/min.

1.3 Liquid Effluent Concentration Limits - 10 CFR 20

Technical Specification 7.3.1 limits the concentration of radioactive material in liquid effluents (after dilution in the Circulating Water System) to less than the concentrations as specified in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides other than noble gases. Noble gases are limited to a diluted concentration of 2E-04 μCi/ml. Release rates are controlled and radiation monitor alarm setpoints are established to ensure that these concentration limits are not exceeded. In the event any liquid release results in an alarm setpoint being exceeded, an evaluation of compliance with the concentration limits of Technical Specification 7.3.1 may be performed using the following equation:

$$\sum [(C_i \div MPC_i) \times (RR \div CW)] \leq 1$$

where:

C_i = concentration of radionuclide i in the undiluted liquid effluent (μCi/ml)

MPC_i = the MPC value corresponding to radionuclide i from 10 CFR 20, Appendix B, Table II, Column 2 (μCi/ml)

= 2E-04 μCi/ml for dissolved or entrained noble gases

RR = the liquid effluent release rate (gal/min)

CW = the circulating water flow rate (dilution water flow) at the time of the release (gal/min)

1.4 Liquid Effluent Dose Calculation - 10 CFR 50

Technical Specification 7.3.2 limits the dose or dose commitment to members of the public from radioactive materials in liquid effluents from the Kewaunee Nuclear Power Plant to:

- during any calendar quarter;

  ≤ 1.5 mrem to total body

  ≤ 5.0 mrem to any organ

- during any calendar year;

  ≤ 3.0 mrem to total body

  ≤ 10.0 mrem to any organ.

Per the surveillance requirements of Technical Specification 8.3.2, the following calculational methods may be used for determining the dose or dose commitment due to the liquid radioactive effluents from Kewaunee.

$$D_o = \frac{1.67E-02 \times VOL}{CW} \times \sum (C_i \times A_{io})$$

(1.5)

where:

D_o = dose or dose commitment to organ o, including total body (mrem)

A_{io} = site-related ingestion dose commitment factor to the total body or any organ o for radionuclide i (mrem/hr per μCi/ml) (Table B)

C_i = average concentration of radionuclide i, in undiluted liquid effluent representative of the volume VOL (μCi/ml)

VOL = volume of liquid effluent released (gal)

CW = average circulating water discharge rate during release period (gal/min)

1.67E-02 = conversion factor (hr/min)

The site-related ingestion dose/dose commitment factors (A_{io}) are presented in Table B and have been derived in accordance with guidance of NUREG-0133 by the equation:

$$A_{io} = 1.14E+05 \left[(U_w \div D_w) + (U_F \times BF_i)\right] DF_i$$

(1.6)

where:

A_{io} = composite dose parameter for the total body or critical organ o of an adult for radionuclide i, for the fish ingestion and water consumption pathways (mrem/hr per μCi/ml)

1.14E+05 = conversion factor (pCi/μCi x ml/kg ÷ hr/yr)

U_w = adult water consumption (730 kg/yr)

D_w = dilution factor from the near field area within 1/4 mile of the release point to the nearest potable water intake for the adult water consumption (84**, unitless)

U_F = adult fish consumption (21 kg/yr)

BF_i = bioaccumulation factor for radionuclide i in fish from Table C (pCi/kg per pCi/l)

DF_i = dose conversion factor for nuclide i for adults in preselected organ, o, from Table E-11 of Regulatory Guide 1.109, 1977 and NUREG 0172, 1977 (mrem/pCi)

The radionuclides included in the periodic dose assessment per the requirements of Technical Specification 7/8.3.2 are those as identified by gamma spectral analysis of the liquid waste samples collected and analyzed per the requirements of Technical Specification 8.3.1.1, Table 8.3.

Radionuclides requiring radiochemical analysis (e.g., Sr-89 and Sr-90) will be added to the dose analysis at a frequency consistent with the required minimum analysis frequency of Table 8.3.

In lieu of the individual radionuclide dose assessment as presented above, the following simplified dose calculational equation may be used for demonstrating compliance with the dose limits of Technical Specification 7.3.2. (Refer to Appendix A for the derivation and justification for this simplified method.)

Total Body

$$D_{tb} = \frac{9.67E+03 \times VOL}{CW} \times \sum C_i \qquad (1.7)$$

Maximum Organ

$$D_{max} = \frac{1.18E+04 \times VOL}{CW} \times \sum C_i \qquad (1.8)$$

** Adapted from the Kewaunee Final Environmental Statement, Section V.

where:

C_i	=	average concentration of radionuclide i, in undiluted liquid effluent representative of the volume VOL (μCi/ml)
VOL	=	volume of liquid effluent released (gal)
CW	=	average circulating water discharge rate during release period (gal/mim)
D_{tb}	=	conservatively evaluated total body dose (mrem)
D_{max}	=	conservatively evaluated maximum organ dose (mrem)
9.67E+03	=	conversion factor (hr/min) and the conservative total body dose conversion factor (Cs-134, total body -- 5.79E+05 mrem/hr per μCi/ml)
1.18E+04	=	conversion factor (hr/min) and the conservative maximum organ dose conversion factor (Cs-134, liver -- 7.09E+05 mrem/hr per μCi/ml)

1.5 Liquid Effluent Dose Projections

Technical Specification 7.3.3 requires that the liquid radioactive waste processing system be used to reduce the radioactive material levels in the liquid waste prior to release when the quarterly projected doses exceed:

- 0.18 mrem to the total body, or
- 0.62 mrem to any organ.

The applicable liquid waste streams and processing systems are as delineated in Figure 1.

Dose projections are made at least once per 31 days by the following equations:

$$D_{tbp} = D_{tb} (91 \div d) \quad (1.9)$$

$$D_{maxp} = D_{max} (91 \div d) \quad (1.10)$$

where:

D_{tbp} = the total body dose projection for current calendar quarter (mrem)

D_{tb} = the total body dose to date for current calendar quarter as determined by equation (1.5) or (1.7) (mrem)

D_{maxp} = the maximum organ dose projection for current calendar quarter (mrem)

D_{max} = the maximum organ dose to date for current calendar quarter as determined by equation (1.5) or (1.8) (mrem)

d = the number of days to date for current calendar quarter

91 = the number of days in a calendar quarter

1.6 Onsite Disposal of Low-Level Radioactively Contaminated Waste Streams

During the normal operation of Kewaunee, the potential exists for in-plant process streams which are not normally radioactive to become contaminated with very low levels of radioactive materials. These waste streams are normally separated from the radioactive streams. However, due mainly to infrequent, minor system leaks, and anticipated operational occurrences, the potential exists for these systems to become slightly contaminated. At Kewaunee, the secondary system demineralizer resins, the service water pretreatment system sludges, the make-up water system resins, and the sewage treatment plant sludges are waste streams that have the potential to become contaminated at very low levels. During the yearly testing of a batch of pre-treatment sludge, it was found that approximately 15,000 cubic feet of sludge had been contaminated with Cs-137 and Co-60.

The potential radiation doses to members of the public from these onsite disposal methods are well below 1 mrem per year. This dose is in keeping with the guidelines of the National Council on Radiation Protection (NCRP) in their Report No. 91, in which the NCRP established a "negligible individual risk level" at a dose rate of 1 mrem per year.

It is for these type wastes that the NRC acknowledged in Information Notice No. 83-05 and 88-22 that the levels of radioactive material are so low that control and disposal as a radwaste are not warranted. The potential risks to man are negligible and the disposal costs as a radwaste are unwarranted and costly.

This waste material will be monitored and evaluated prior to disposal to ensure its radioactive material content is negligible. It shall then be disposed of in a normal conventional manner with records being maintained of all materials

disposed of using these methods.

Approvals for specific alternate disposal methods are listed in Appendix E.

2.0 Gaseous Effluents

2.1 Radiation Monitoring Instrumentation and Controls

The gaseous effluent monitoring instrumentation and controls at Kewaunee for controlling and monitoring normal radioactive material releases in accordance with 10 CFR 50, Appendix A, Criteria 60 and 64, are summarized as follows:

1) Waste Gas Holdup System - The vent header gases are collected by the waste gas holdup system. Gases may be recycled to provide cover gas for the CVCS hold-up tanks or held in the waste gas tanks for decay prior to release. Waste gas decay tanks are batch released after sampling and analysis. The tanks are discharged via the Auxiliary Building vent. R-13 and/or R-14 provide noble gas monitoring and automatic isolation.

2) Condenser Evacuation System - The air ejector discharge is monitored by R-15. Releases from this system are via the Auxiliary Building vent and are monitored by R-13 and/or R-14.

3) Containment Purge - Containment purge and ventilation is via the containment stack. The stack radiation monitoring system consists of: a) a noble gas activity monitor providing alarm and automatic termination of release (R-12 and R-21); b) an iodine sampler; and c) a particulate sampler. Effluent flow rates are determined empirically as a function of a fan operation (fan curves). Sampler flow rates are determined by flow rate instrumentation.

4) Auxiliary Building Vent - The Auxiliary Building vent receives discharges from the waste gas holdup system, condenser evacuation system, fuel storage area ventilation, Auxiliary Building radwaste processing area ventilation, and Auxiliary Building general area. All effluents pass through: a) a noble gas monitor - (R-13 and/or R-14; b) an iodine sampler (R-13A); and c) a particulate sampler (R-13A). The noble gas monitor (R-13 and/or R-14) provides auto isolation of any waste gas decay tank releases and diverts other releases through the special ventilation system. Effluent flow rates are determined by installed flow measurement equipment or as a function of fan operation (fan curves). Sampler flow rates are determined by flow rate instrumentation.

A gaseous radioactive waste flow diagram with the applicable, associated

radiation monitoring instrumentation and controls is presented as Figure 2.

2.2 Gaseous Effluent Monitor Setpoint Determination

2.2.1 Containment and Auxiliary Building Vent Monitor. Per the requirements of Technical Specification 7.2, alarm setpoints shall be established for the gaseous effluent monitoring instrumentation to ensure that the release rate of noble gases does not exceed corresponding dose rate at the site boundary of 500 mrem/year to the total body or 3000 mrem/year to the skin. Based on a grab sample analysis of the applicable release (i.e., grab sample of the Containment vent or Auxiliary Building vent), the radiation monitoring alarm setpoints may be established by the following calculational method:

$$FRAC = [4.72E+02 \times X/Q \times VF \times \sum (C_i \times K_i)] \div 500 \quad (2.1)$$

$$FRAC = [4.72E+02 \times X/Q \times VF \times \sum (C_i \times (L_i + 1.1\ M_i))] \div 3000 \quad (2.2)$$

where:

FRAC	=	fraction of the allowable release rate based on the identified radionuclide concentrations and the release flow rate
X/Q	=	annual average meteorological dispersion to the controlling site boundary location (sec/m^3)
VF	=	ventilation system flow rate for the applicable release point and monitor (ft^3/min)
C_i	=	concentration of noble gas radionuclide i as determined by radioanalysis of grab sample ($\mu Ci/cm^3$)
K_i	=	total body dose conversion factor for noble gas radionuclide i (mrem/yr per $\mu Ci/m^3$, from Table D)
L_i	=	beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per $\mu Ci/m^3$, from Table D)
M_i	=	gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per $\mu Ci/m^3$, from Table D)

1.1	=	mrem skin dose per mrad gamma air dose (mrem/mrad)
4.72E+02	=	conversion factor (cm^3/ft^3 x min/sec)
500	=	total body dose rate limit (mrem/yr)
3000	=	skin dose rate limit (mrem/yr)

Based on the more limiting FRAC (i.e., higher value) as determined above, the alarm setpoint for the Containment and Auxiliary Building vent monitors at Kewaunee may be calculated:

$$SP = [\sum C_i \times SEN \div FRAC] + bkg \qquad (2.3)$$

where:

SP	=	alarm setpoint corresponding to the maximum allowable release rate (cpm)
SEN	=	monitor sensitivity (cpm per $\mu Ci/cm^3$)
bkg	=	background of the monitor (cpm)

2.2.2 Conservative Default Values. A conservative alarm setpoint can be established, in lieu of the individual radionuclide evaluation based on the grab sample analysis, to eliminate the potential of periodically having to adjust the setpoint to reflect minor changes in radionuclide distribution and variations in release flow rate. The alarm setpoint may be conservatively determined by the default values presented in Table E. These values are based upon:

- the maximum ventilation flow rate;
- a radionuclide distribution*** comprised of 95% Xe-133, 2% Xe-135, 1% Xe-133m, 1% Kr-88 and 1% Kr-85; and
- an administrative multiplier of 0.5 to conservatively assure that any simultaneous releases do not exceed the maximum allowable release rate.

For this radionuclide distribution, the alarm setpoint based on the total

***Adopted from ANSI N237-1976/ANS-18.1, Source Term Specifications, Table 6.

body dose rate is more restrictive than the corresponding setpoint based on the skin dose rate. The resulting conservative, default setpoints are presented in Table E.

2.3 Gaseous Effluent Instantaneous Dose Rate Calculations - 10 CFR 20

2.3.1 Site Boundary Dose Rate - Noble Gases. Technical Specification 7.4.1.a limits the dose rate at the site boundary due to noble gas releases to $\leq$ 500 mrem/yr to the total body, and $\leq$ 3000 mrem/yr to the skin. Radiation monitor alarm setpoints are established to ensure that these release limits are not exceeded. In the event any gaseous releases from the station results in the alarm setpoints being exceeded, an evaluation of the unrestricted area dose rate resulting from the release may be performed using the following equations:

$$\dot{D}_{tb} = X/Q \times \sum (K_i \times \dot{Q}_i)$$

and (2.4)

$$\dot{D}_s = X/Q \times \sum ((L_i + 1.1M_i) \times \dot{Q}_i) \quad (2.5)$$

where:

$\dot{D}_{tb}$ = total body dose rate (mrem/yr)

$\dot{D}_s$ = skin dose rate (mrem/yr)

X/Q = atmospheric dispersion to the controlling site boundary (sec/m^3)

$\dot{Q}_i$ = average release rate of radionuclide i over the release period under evaluation ($\mu Ci/sec$)

K_i = total body dose conversion factor for noble gas radionuclide i (mrem/yr per $\mu Ci/m^3$, from Table D)

L_i = beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per $\mu Ci/m^3$, from Table D)

M_i = gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per $\mu Ci/m^3$, from Table D)

1.1 = mrem skin dose per mrad gamma air dose (mrem/mrad)

Actual meteorological conditions concurrent with the release period or the default, annual average dispersion parameters as presented in Table F may be used for evaluating the gaseous effluent dose rate.

2.3.2 Site Boundary Dose Rate - Radioiodine and Particulates. Technical Specification 7.4.1.b limits the dose rate to ≤ 1500 mrem/yr to any organ for I-131, I-133, tritium and particulates with half-lives greater than 8 days. To demonstrate compliance with this limit, an evaluation is performed at a frequency no greater than that corresponding to the sampling and analysis time period for continuous releases (e.g., nominally once per 7 days) and for batch releases on the time period over which any batch release is to occur. The following equation may be used for the dose rate evaluation:

$$\dot{D}_o = X/Q \times \sum (R_i \times \dot{Q}_i) \qquad (2.6)$$

where:

$\dot{D}_o$ = average organ dose rate over the sampling time period (mrem/yr)

X/Q = atmospheric dispersion to the controlling site boundary for the inhalation pathway (sec/m^3)

R_i = dose parameter for radionuclide i, (mrem/yr per $\mu Ci/m^3$) for the child inhalation pathway from Table G

$\dot{Q}_i$ = average release rate over the appropriate sampling period and analysis frequency for radionuclide i I-131, I-133, tritium or other radionuclide in particulate form with half-life greater than 8 days ($\mu Ci/sec$)

By substituting 1500 mrem/yr for $\dot{D}_o$ solving for $\dot{Q}$, an allowable release rate for I-131 can be determined. Based on the annual average meteorological dispersion (see Table F) and the most limiting potential pathway, age group and organ (inhalation pathway, child thyroid -- R_i = 1.62E+07 mrem/yr per $\mu Ci/m^3$) the allowable release rate for I-131 is 12.8 $\mu Ci/sec$. An added conservatism factor of 0.25 has been included in this calculation to account for any potential dose contribution from other radioactive particulate material. For a 7 day period which is the nominal sampling and analysis frequency for I-131, the cumulative allowable release is 3.9 Ci. Therefore, as long as the I-131 releases in any 7 day period do not exceed 3.9 Ci, no additional analyses are needed to verify compliance with the Technical Specification 7.4.1.b limits on allowable release rate.

2.4 Gaseous Effluent Dose Calculations - 10 CFR 50

2.4.1 Unrestricted Area Dose - Noble Gases. Technical Specification 7.4.2 requires a periodic assessment of releases of noble gases to evaluate compliance with the quarterly dose limits of ($\leq$5 mrad, gamma-air and $\leq$10 mrad, beta-air) and the calendar year limits ($\leq$10 mrad, gamma-air and $\leq$20 mrad, beta-air). The following equations may be used to calculate the gamma-air and beta-air doses:

$$D\gamma = 3.17E\text{-}08 \times X/Q \times \sum (M_i \times Q_i) \quad (2.7)$$

and

$$D_\beta = 3.17E\text{-}08 \times X/Q \times \sum (N_i \times Q_i) \quad (2.8)$$

where:

$D\gamma$	=	air dose due to gamma emissions for noble gas radionuclides (mrad)
D_β	=	air dose due to beta emissions for noble gas radionuclides (mrad)
X/Q	=	atmospheric dispersion to the controlling site boundary (sec/m^3)
Q_i	=	cumulative release of noble gas radionuclide i over the period of interest (μCi)
M_i	=	air dose factor due to gamma emissions from noble gas radionuclide i (mrad/yr per $\mu Ci/m^3$ from Table D)
N_i	=	air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per $\mu Ci/m^3$, Table D)
3.17E-08	=	conversion factor (yr/sec)

In lieu of the individual noble gas radionuclide dose assessment as presented above, the following simplified dose calculational equation may be used for verifying compliance with the dose limits of Technical Specification 7.4.2. (Refer to Appendix B for the derivation and justification for this simplified method.)

$$D\gamma = \frac{3.17E-08}{0.50} \times X/Q \times M_{eff} \times \sum Q_i$$

and (2.9)

$$D_\beta = \frac{3.17E-08}{0.50} \times X/Q \times N_{eff} \times \sum Q_i$$

(2.10)

where:

M_{eff} = 5.3E+02 effective gamma-air dose factor (mrad/yr per $\mu Ci/m^3$)

N_{eff} = 1.1E+03 effective beta-air dose factor (mrad/yr per $\mu Ci/m^3$)

0.50 = conservatism factor

Actual meteorological conditions concurrent with the release period or the default, annual average dispersion parameters as presented in Table F, may be used for the evaluation of the gamma-air and beta-air doses.

2.4.2 Unrestricted Area Dose - Radioiodine and Particulates. Per the requirements of Technical Specification 7.4.3, a periodic assessment shall be performed to evaluate compliance with the quarterly dose limit ($\leq$7.5 mrem) and calendar year limit ($\leq$15 mrem) to any organ. The following equation may be used to evaluate the maximum organ dose due to releases of I-131, I-133, tritium and particulates with half-lives greater than 8 days:

$$D_{aop} = 3.17E-08 \times W \times SF_p \times \sum (R_i \times Q_i)$$

(2.11)

where:

D_{aop} = dose or dose commitment for age group a to organ o, including the total body, via pathway p from I-131, I-133, tritium and radionuclides in particulate form with half-life greater than eight days (mrem)

W = atmospheric dispersion parameter to the controlling location(s) as identified in Table F

X/Q = atmospheric dispersion for inhalation pathway and H-3 dose contribution via other pathways (sec/m^3)

D/Q = atmospheric deposition for vegetation, milk and ground plane exposure pathways (l/m^2)

R_i = dose factor for radionuclide i, (mrem/yr per $\mu Ci/m^3$) or (m^2 - mrem/yr per $\mu Ci/sec$) from Table G-1 through G-12 for each age group a and the applicable pathway p as identified in Table F. Values for R_i were derived in accordance with the methods described in NUREG-0133.

Q_i = cumulative release over the period of interest for radionuclide i -- I-131 or radioactive material in particulate form with halflife greater than 8 days (μCi).

SF_p = seasonal correction factor to account for the fraction of the period that the applicable exposure pathway does not exist.

1) For milk and vegetation exposure pathways:

$$= \frac{\text{\# of months in the period that grazing is absent}}{\text{total \# of months in period}}$$

= 0.5 for annual calculations

2) For inhalation and ground plane exposure pathways: = 1.0

In lieu of the individual radionuclide (I-131 and particulates) dose assessment as presented above, the following simplified dose calculational equation may be used for verifying compliance with the dose limits of Technical Specification 7.4.3.

$$D_{max} = 3.17E\text{-}08 \times W \times SF_p \times R_{I\text{-}131} \times \sum Q_i \qquad (2.12)$$

where:

D_{max} = maximum organ dose (mrem)

$R_{I\text{-}131}$ = I-131 dose parameter for the thyroid for the identified controlling pathway

= 1.05E+12, infant thyroid dose parameter with the grass-cow-milk pathway controlling (m^2 - mrem/yr per μCi/sec)

The ground plane exposure and inhalation pathways need not be considered when the above simplified calculational method is used because of the overall negligible contribution of these pathways to the total thyroid dose. It is recognized that for some particulate radionuclides (e.g. Co-60 and Cs-137), the ground plane exposure pathway may represent a higher dose contribution than either the vegetation or grass-cow-milk pathway. However, use of the I-131 thyroid dose parameter for all radionuclides will maximize the organ dose calculation, especially considering that no other radionuclide has a higher dose parameter for any organ via any pathway than I-131 for the thyroid via the grass-cow-milk pathway.

The location of exposure pathways and the maximum organ dose calculation may be based on the available pathways in the surrounding environment of Kewaunee as identified by the annual land-use census (Technical Specification 7.7.2). Otherwise, the dose will be evaluated based on the predetermined controlling pathways as identified in Table F.

2.5 Gaseous Effluent Dose Projection

Technical Specification 7.4.4 requires that the Ventilation Exhaust Treatment System be used to reduce radioactive material levels prior to discharge when projected doses exceed one-half the annual design objective rate in any calendar quarter, i.e., exceeding:

- 0.62 mrad/quarter, gamma air;
- 1.25 mrad/quarter, beta air; or
- 0.94 mrem/quarter, maximum organ.

The applicable gaseous release sources and processing systems are as delincated in Figure 2.

Dose projections are performed at least once per 31 days by the following equations:

$$D_{\gamma p} = D_{\gamma} \times (91 \div d) \tag{2.13}$$

$$D_{\beta p} = D_{\beta} \times (91 \div d) \tag{2.14}$$

$$D_{maxp} = D_{max} \times (91 \div d) \tag{2.15}$$

where:

$D_{\gamma p}$ = gamma air dose projection for current calendar quarter (mrad)

U_{γ} = gamma air dose to date for current calendar quarter as determined by equation (2.7) or (2.9) (mrad)

$D_{\beta p}$ = beta air dose projection for current calendar quarter (mrad)

D_{β} = beta air dose to date for current calendar quarter as determined by equation (2.8) or (2.10) (mrad)

D_{maxp} = maximum organ dose projection for current calendar quarter (mrem)

D_{max} = maximum organ dose to date for current calendar quarter as determined by equation (2.11) or (2.12) (mrem)

d = number of days to date in current calendar quarter

91 = number of days in a calendar quarter

2.6 Environmental Radiation Protection Standards 40 CFR 190

For the purpose of implementing RETS Technical Specification 7.6 on the EPA environmental radiation protection standard and 6.9.3.b on reporting requirements, dose calculations may be performed using the above equations with the substitution of average or actual meteorological parameters for the period of interest and actual applicable pathways. Any exposure attributable to on-site sources will be evaluated based on the results of the environmental monitoring program (TLD measurements) or by calculational methods. NUREG-0543 describes acceptable methods for demonstrating compliance with 40 CFR Part 190 when radioactive effluents exceed the Appendix I portion of the specifications.

Figure 1
Liquid Radioactive Effluent Flow Diagram

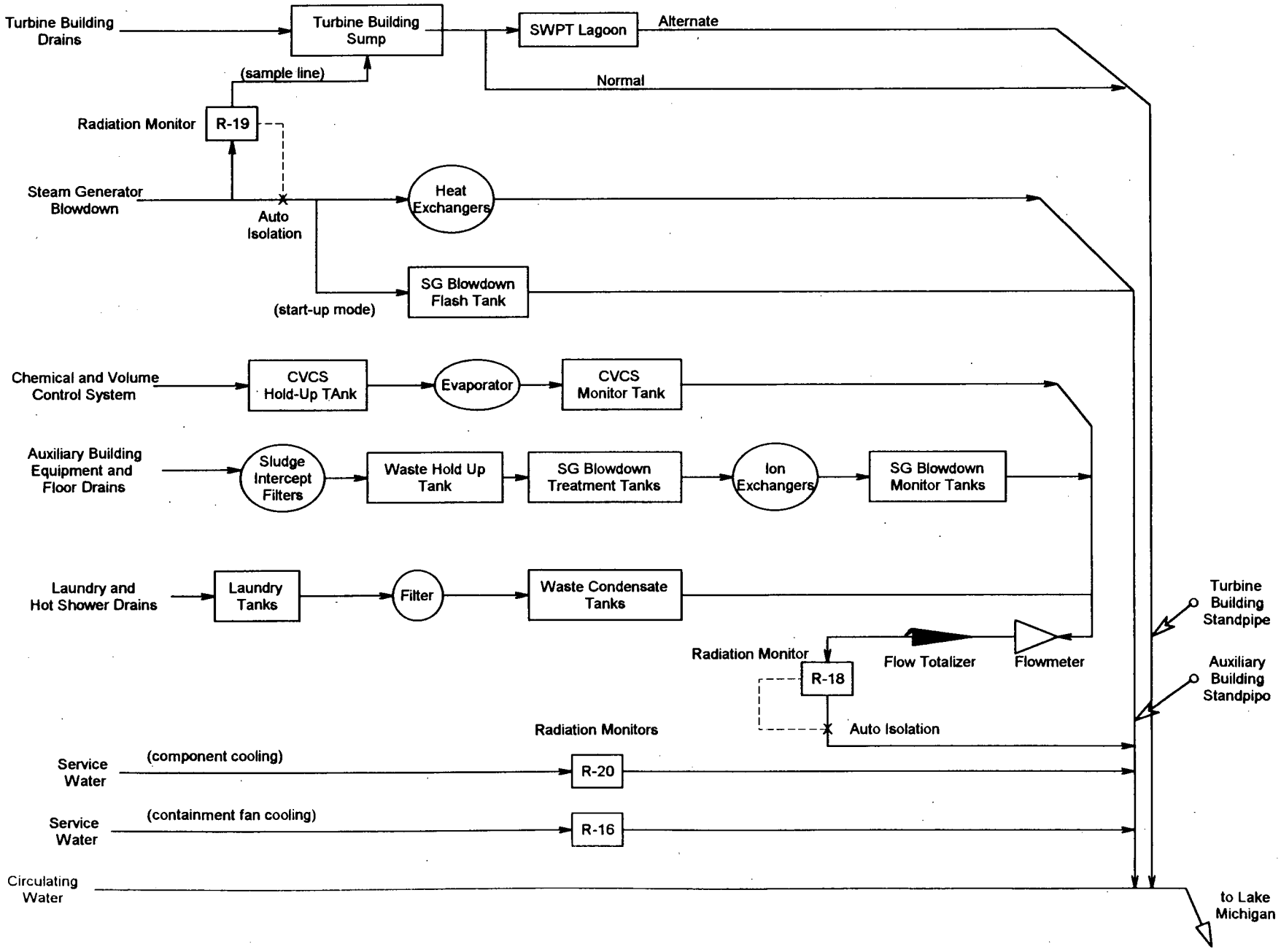

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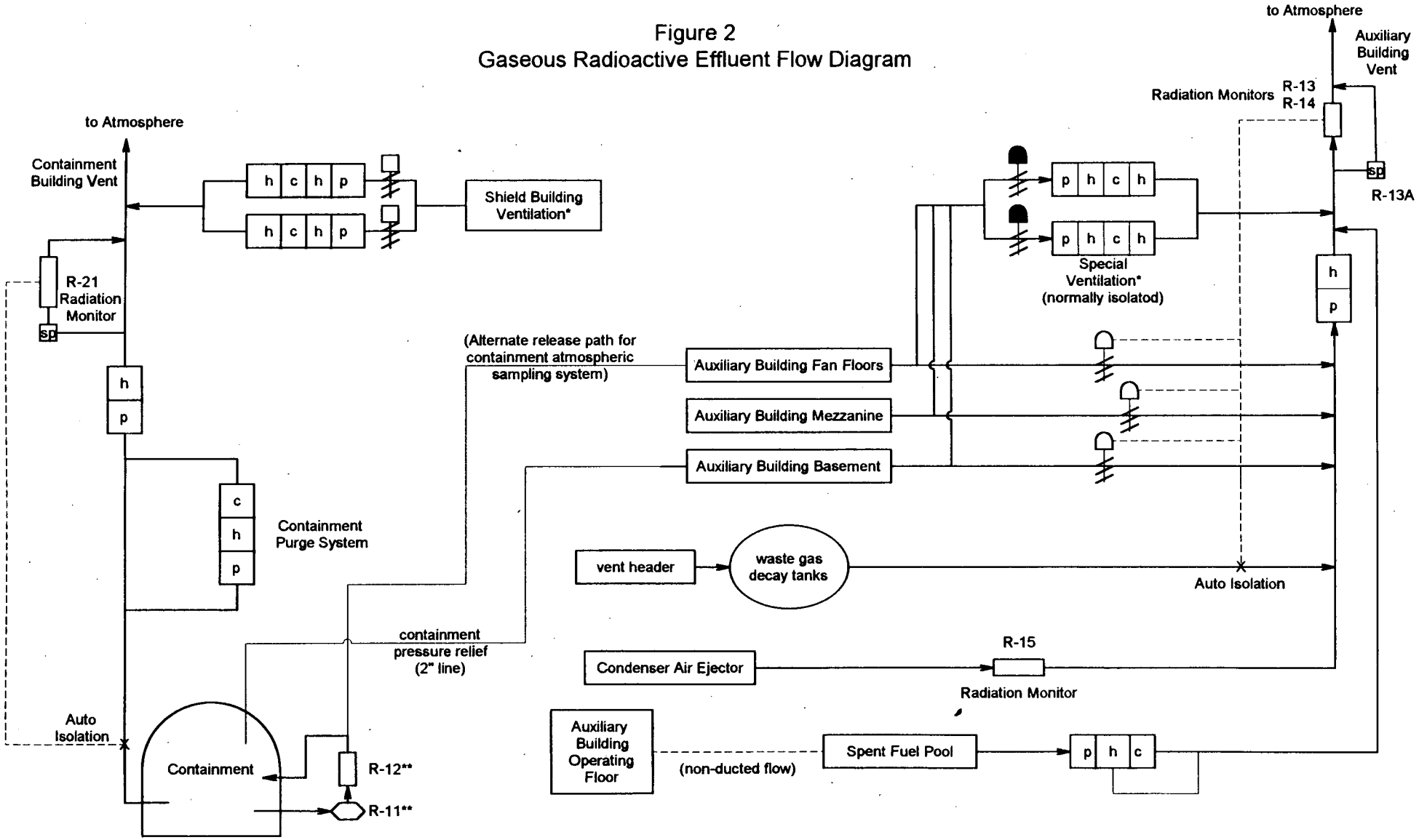
Figure 2
Gaseous Radioactive Effluent Flow Diagram



* The shield building ventilation and special ventilation are ESF systems and are not part of the normal effluent processing system. They are included for completeness only.

** The containment air sampler (R-11) and radiation monitor (R-12) can also be aligned as needed for sampling containment vent

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Table A

Parameters for Liquid Alarm Setpoint Determinations

Parameter		Actual Value	Default Value	Units	Comments
MPC_e		calculated	1.0E-05*	μCi/ml	Calculate for each batch to be released
C_i		measured	N/A	μCi/ml	Taken from gamma spectral analysis of liquid effluent
MPC_i		as determined	N/A	μCi/ml	Taken from 10 CFR 20, Appendix B, Table II, Col. 2.
SEN	R-18	as determined	2.0E+6	cpm per μCi/ml	Radwaste effluent
	R-19		2.0E+6		Steam Generator blowdown
	R-20		7.0E+7		Service Water - component cooling
	R-16		2.0E+6		Service Water - Containment fan cooling
CW		as determined	2.58E+05	gpm	Circulating Water System default = winter, single CW pump
RR	R-18	as determined	8.0E+01	gpm	Determined prior to release; release rate can be adjusted for Technical Specification compliance
	R-19	as determined	2.0E+02		Steam Generator A and B combined
	R-20		5.0E+03		Service Water - component cooling
	R-16		1.5E+03		Service Water - Containment fan cooling
bkg	R-18	as determined	2.0E+03	cpm	Nominal values only; actual values may be used in lieu of these reference values
	R-19		8.0E+01		
	R-20		6.0E+01		
	R-16		8.0E+01		
SP	R-18	calculated	6.45E+4 +bkg	cpm	Default alarm setpoints; more conservative values may be used as deem appropriate and desirable for assuring regulatory compliance and for maintaining releases ALARA.
	R-19	calculated	2.58E+4 +bkg		
	R-20	calculated	3.61E+4 +bkg		
	R-16	calculated	3.44E+3 +bkg		
SP (with no Circulating Water System flow, CW=0)					
	R-18	calculated	2.50E+3 +bkg	cpm	For outages with no Circulating Water System flow (CW=0) and a dilution flow as provided by the Service Water system of 10,000 gpm, total.
	R-19	calculated	1.00E+3 +bkg		
	R-20	calculated	1.40E+3 +bkg		
	R-16	calculated	1.33E+2 +bkg		

* Refer to Appendix C for derivation

Table B

A_{io} Site Related Ingestion Dose Commitment Factors (mrem/hr per μCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	3.30E-1	3.30E-1	3.30E-1	3.30E-1	3.30E-1	3.30E-1
C-14	3.13E+4	6.26E+3	6.26E+3	6.26E+3	6.26E+3	6.26E+3	6.26E+3
Na-24	4.09E+2	4.09E+2	4.09E+2	4.09E+2	4.09E+2	4.09E+2	4.09E+2
P-32	1.39E+6	8.62E+4	5.36E+4	-	-	-	1.56E+5
Cr-51	-	-	1.28E+0	7.63E-1	2.81E-1	1.69E+0	3.21E+2
Mn-54	-	4.38E+3	8.36E+2	-	1.30E+3	-	1.34E+4
Mn-56	-	1.10E+2	1.96E+1	-	1.40E+2	-	3.52E+3
Fe-55	6.61E+2	4.57E+2	1.06E+2	-	-	2.55E+2	2.62E+2
Fe-59	1.04E+3	2.45E+3	9.40E+2	-	-	6.85E+2	8.17E+3
Co-57	-	2.11E+1	3.51E+1	-	-	-	5.36E+2
Co-58	-	8.99E+1	2.02E+2	-	-	-	1.82E+3
Co-60	-	2.58E+2	5.70E+2	-	-	-	4.85E+3
Ni-63	3.13E+4	2.17E+3	1.05E+3	-	-	-	4.52E+2
Ni-65	1.27E+2	1.65E+1	7.52E+0	-	-	-	4.18E+2
Cu-64	-	1.01E+1	4.72E+0	-	2.53E+1	-	8.57E+2
Zn-65	2.32E+4	7.38E+4	3.33E+4	-	4.93E+4	-	4.65E+4
Zn-69	4.93E+1	9.43E+1	6.56E+0	-	6.13E+1	-	1.42E+1
Br-82	-	-	2.27E+3	-	-	-	2.61E+3
Br-83	-	-	4.05E+1	-	-	-	5.83E+1
Br-84	-	-	5.24E+1	-	-	-	4.12E-4
Br-85	-	-	2.15E+0	-	-	-	-
Rb-86	-	1.01E+5	4.71E+4	-	-	-	1.99E+4
Rb-88	-	2.90E+2	1.54E+2	-	-	-	4.00E-9
Rb-89	-	1.92E+2	1.35E+2	-	-	-	-
Sr-89	2.24E+4	-	6.44E+2	-	-	-	3.60E+3
Sr-90	5.52E+5	-	1.35E+5	-	-	-	1.59E+4
Sr-91	4.13E+2	-	1.67E+1	-	-	-	1.97E+3
Sr-92	1.57E+2	-	6.77E+0	-	-	-	3.10E+3
Y-90	5.85E-1	-	1.57E-2	-	-	-	6.21E+3
Y-91m	5.53E-3	-	2.14E-4	-	-	-	1.62E-2
Y-91	8.58E+0	-	2.29E-1	-	-	-	4.72E+3
Y-92	5.14E-2	-	1.50E-3	-	-	-	9.00E+2
Y-93	1.63E-1	-	4.50E-3	-	-	-	5.17E+3
Zr-95	2.70E-1	8.67E-2	5.87E-2	-	1.36E-1	-	2.75E+2
Zr-97	1.49E-2	3.01E-3	1.38E-3	-	4.55E-3	-	9.34E+2
Nb-95	4.47E+2	2.49E+2	1.34E+2	-	2.46E+2	-	1.51E+6
Nb-97	3.75E+0	9.48E-1	3.46E-1	-	1.11E+0	-	3.50E+3
Mo-99	-	1.07E+2	2.04E+1	-	2.43E+2	-	2.49E+2
Tc-99m	9.11E-3	2.58E-2	3.28E-1	-	3.91E-1	1.26E-2	1.52E+1
Tc-101	9.37E-3	1.35E-2	1.32E-1	-	2.43E-1	6.90E-3	-

Table B (Continued)

A_{io} Site Related Ingestion Dose Commitment Factors
(mrem/hr per μCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Ru-103	4.61E+0	-	1.99E+0	-	1.76E+1	-	5.39E+2
Ru-105	3.84E-1	-	1.52E-1	-	4.96E+0	-	2.35E+2
Ru-106	6.86E+1	-	8.68E+0	-	1.32E+2	-	4.44E+3
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.04E+0	9.62E-1	5.71E-1	-	1.89E+0	-	3.92E+2
Sb-124	9.48E+0	1.79E-1	3.76E+0	2.30E-2	-	7.38E+0	2.69E+2
Sb-125	6.06E+0	6.77E-2	1.44E+0	6.16E-3	-	4.67E+0	6.67E+1
Te-125m	2.57E+3	9.31E+2	3.44E+2	7.73E+2	1.04E+4	-	1.03E+4
Te-127m	6.49E+3	2.32E+3	7.91E+2	1.66E+3	2.64E+4	-	2.18E+4
Te-127	1.05E+2	3.79E+1	2.28E+1	7.81E+1	4.29E+2	-	8.32E+3
Te-129m	1.10E+4	4.11E+3	1.74E+3	3.79E+3	4.60E+4	-	5.55E+4
Te-129	3.01E+1	1.13E+1	7.33E+0	2.31E+1	1.27E+2	-	2.27E+1
Te-131m	1.66E+3	8.11E+2	6.76E+2	1.28E+3	8.22E+3	-	8.05E+4
Te-131	1.89E+1	7.89E+0	5.96E+0	1.55E+1	8.27E+1	-	2.67E+0
Te-132	2.42E+3	1.56E+3	1.47E+3	1.73E+3	1.50E+4	-	7.39E+4
I-130	2.79E+1	8.23E+1	3.25E+1	6.97E+3	1.28E+2	-	7.08E+1
I-131	1.54E+2	2.20E+2	1.26E+2	7.20E+4	3.76E+2	-	5.79E+1
I-132	7.49E+0	2.00E+1	7.01E+0	7.01E+2	3.19E+1	-	3.76E+0
I-133	5.24E+1	9.11E+1	2.78E+1	1.34E+4	1.59E+2	-	8.19E+1
I-134	3.91E+0	1.06E+1	3.80E+0	1.84E+2	1.69E+1	-	9.26E-3
I-135	1.63E+1	4.28E+1	1.58E+1	2.82E+3	6.86E+1	-	4.83E+1
Cs-134	2.98E+5	7.09E+5	5.79E+5	-	2.29E+5	7.61E+4	1.24E+4
Cs-136	3.12E+4	1.23E+5	8.86E+4	-	6.85E+4	9.39E+3	1.40E+4
Cs-137	3.82E+5	5.22E+5	3.42E+5	-	1.77E+5	5.89E+4	1.01E+4
Cs-138	2.64E+2	5.22E+2	2.59E+2	-	3.84E+2	3.79E+1	2.23E-3
Ba-139	1.02E+0	7.30E-4	3.00E-2	-	6.83E-4	4.14E-4	1.82E+0
Ba-140	2.15E+2	2.69E-1	1.41E+1	-	9.16E-2	1.54E-1	4.42E+2
Ba-141	4.98E-1	3.76E-4	1.68E-2	-	3.50E-4	2.13E-4	-
Ba-142	2.25E-1	2.31E-4	1.42E-2	-	1.95E-4	1.31E-4	-
La-140	1.52E-1	7.67E-2	2.03E-2	-	-	-	5.63E+3
La-142	7.79E-3	3.54E-3	8.82E-4	-	-	-	2.59E+1
Ce-141	3.17E-2	2.14E-2	2.43E-3	-	9.95E-3	-	8.19E+1
Ce-143	5.58E-3	4.13E+0	4.57E-4	-	1.82E-3	-	1.54E+2
Ce-144	1.65E+0	6.90E-1	8.87E-2	-	4.10E-1	-	5.58E+2
Pr-143	5.60E-1	2.25E-1	2.77E-2	-	1.30E-1	-	2.45E+3
Pr-144	1.83E-3	7.61E-4	9.31E-5	-	4.29E-4	-	-
Nd-147	3.83E-1	4.42E-1	2.65E-2	-	2.59E-1	-	2.12E+3
W-187	2.96E+2	2.47E+2	8.65E+1	-	-	-	8.10E+4
Np-239	2.97E-2	2.92E-3	1.61E-3	-	9.10E-3	-	5.98E+2

Table C

Bioaccumulation Factors(BFi) (pCi/kg per pCi/liter)*

Element	Freshwater Fish
H	9.0E-01
C	4.6E+03
Na	1.0E+02
P	3.0E+03
Cr	2.0E+02
Mn	4.0E+02
Fe	1.0E+02
Co	5.0E+01
Ni	1.0E+02
Cu	5.0E+01
Zn	2.0E+03
Br	4.2E+02
Rb	2.0E+03
Sr	3.0E+01
Y	2.5E+01
Zr	3.3E+00
Nb	3.0E+04
Mo	1.0E+01
Tc	1.5E+01
Ru	1.0E+01
Rh	1.0E+01
Ag	2.3E+00
Sb	1.0E+00
Te	4.0E+02
I	1.5E+01
Cs	2.0E+03
Ba	4.0E+00
La	2.5E+01
Ce	1.0E+00
Pr	2.5E+01
Nd	2.5E+01
W	1.2E+03
Np	1.0E+01

* Values in this Table are taken from Regulatory Guide 1.109 except for phosphorus which is adapted from NUREG/CR-1336 and silver and antimony which are taken from UCRL 50564, Rev. 1, October 1972.

Table D

Dose Factors for Noble Gases

Radionuclide	Total Body Dose Factor Ki (mrem/yr per $\mu Ci/m^3$)	Skin Dose Factor Li (mrem/yr per $\mu Ci/m^3$)	Gamma Air Dose Factor Mi (mrad/yr per $\mu Ci/m^3$)	Beta Air Dose Factor Ni (mrad/yr per $\mu Ci/m^3$)
Kr-83m	7.56E-02	------	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+0l	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

Table E

Parameters for Gaseous Alarm Setpoint Determinations

Parameter	Actual Value	Default Value	Units	Comments
X/Q	calculated	3.6E-06	sec/m^3	Licensing technical specification value
VF	fan curves	33,000 54,000	cfm cfm	Containment - normal plus purge modes Auxiliary Building - normal operation
C_i	measured	N/A	$\mu Ci/cm^3$	
K_i	nuclide specific	N/A	mrem/yr per $\mu Ci/m^3$	Values from Table D
L_i	nuclide specific	N/A	mrem/yr per $\mu Ci/m^3$	Values from Table D
M_i	nuclide specific	N/A	mrad/yr per $\mu Ci/m^3$	Values from Table D
SEN*				
R-12	as determined	1.0E+06	cpm per $\mu Ci/cm^3$	Containment
R-21		2.0E+07		Containment
R-13		2.0E+07		Auxiliary Building
R-14		2.0E+07		Auxiliary Building
bkg				
R-12	as determined	4.0E+02	cpm	Nominal values only; actual values may be used in lieu of these reference values.
R-21		4.0E+01		
R-13		6.0E+02		
R-14		9.0E+02		
SP				
R-12	calculated	9.60E+03 (+bkg)	cpm	Default alarm setpoints; more conservative values may be used as deemed appropriate and desirable for ensuring regulatory compliance and for maintaining releases ALARA.
R-21	calculated	1.92E+05 (+bkg)		
R-13	calculated	1.17E+05 (+bkg)		
R-14	calculated	1.17E+05 (+bkg)		

*Conservatively based on Xe-133 sensitivity

Table F
Controlling Locations, Pathways and Atmospheric Dispersion for Dose Calculations

Technical Specification	Location	Pathway(s)	Atmospheric Dispersion X/Q (sec/m^3)	Atmospheric Dispersion D/Q ($1/m^2$)
7.4.1.a	site boundary (1300 m, N)	noble gases direct exposure	3.6E-06	N/A
7.4.1.b	site boundary (1300 m, N)	inhalation	3.6E-06	N/A
7.4.2	site boundary (1300 m, N)	gamma-air beta-air	3.6E-06	N/A
7.4.3	residence/dairy (1 mile W)	vegetation, milk and ground plane	5.6E-07	5.6E-09

Table G-1

R_i Inhalation Pathway Dose Factors - ADULT
(mrem/yr per μCi/m^3)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.26E+3	1.26E+3	1.26E+3	1.26E+3	1.26E+3	1.26E+3
C-14	1.82E+4	3.41E+3	3.41E+3	3.41E+3	3.41E+3	3.41E+3	3.41E+3
Na-24	1.02E+4	1.02E+4	1.02E+4	1.02E+4	1.02E+4	1.02E+4	1.02E+4
P-32	1.32E+6	7.71E+4	-	-	-	8.64E+4	5.01E+4
Cr-51	-	-	5.95E+1	2.28E+1	1.44E+4	3.32E+3	1.00E+2
Mn-54	-	3.96E+4	-	9.84E+3	1.40E+6	7.74E+4	6.30E+3
Mn-56	-	1.24E+0	-	1.30E+0	9.44E+3	2.02E+4	1.83E-1
Fe-55	2.46E+4	1.70E+4	-	-	7.21E+4	6.03E+3	3.94E+3
Fe-59	1.18E+4	2.78E+4	-	-	1.02E+6	1.88E+5	1.06E+4
Co-57	-	6.92E+2	-	-	3.70E+5	3.14E+4	6.71E+2
Co-58	-	1.58E+3	-	-	9.28E+5	1.06E+5	2.07E+3
Co-60	-	1.15E+4	-	-	5.97E+6	2.85E+5	1.48E+4
Ni-63	4.32E+5	3.14E+4	-	-	1.78E+5	1.34E+4	1.45E+4
Ni-65	1.54E+0	2.10E-1	-	-	5.60E+3	1.23E+4	9.12E-2
Cu-64	-	1.46E+0	-	4.62E+0	6.78E+3	4.90E+4	6.15E-1
Zn-65	3.24E+4	1.03E+5	-	6.90E+4	8.64E+5	5.34E+4	4.66E+4
Zn-69	3.38E-2	6.51E-2	-	4.22E-2	9.20E+2	1.63E+1	4.52E-3
Br-82	-	-	-	-	-	1.04E+4	1.35E+4
Br-83	-	-	-	-	-	2.32E+2	2.41E+2
Br-84	-	-	-	-	-	1.64E-3	3.13E+2
Br-85	-	-	-	-	-	-	1.28E+1
Rb-86	-	1.35E+5	-	-	-	1.66E+4	5.90E+4
Rb-88	-	3.87E+2	-	-	-	3.34E-9	1.93E+2
Rb-89	-	2.56E+2	-	-	-	-	1.70E+2
Sr-89	3.04E+5	-	-	-	1.40E+6	3.50E+5	8.72E+3
Sr-90	9.92E+7	-	-	-	9.60E+6	7.22E+5	6.10E+6
Sr-91	6.19E+1	-	-	-	3.65E+4	1.91E+5	2.50E+0
Sr-92	6.74E+0	-	-	-	1.65E+4	4.30E+4	2.91E-1
Y-90	2.09E+3	-	-	-	1.70E+5	5.06E+5	5.61E+1
Y-91m	2.61E-1	-	-	-	1.92E+3	1.33E+0	1.02E-2
Y-91	4.62E+5	-	-	-	1.70E+6	3.85E+5	1.24E+4
Y-92	1.03E+1	-	-	-	1.57E+4	7.35E+4	3.02E-1
Y-93	9.44E+1	-	-	-	4.85E+4	4.22E+5	2.61E+0
Zr-95	1.07E+5	3.44E+4	-	5.42E+4	1.77E+6	1.50E+5	2.33E+4
Zr-97	9.68E+1	1.96E+1	-	2.97E+1	7.87E+4	5.23E+5	9.04E+0
Nb-95	1.41E+4	7.82E+3	-	7.74E+3	5.05E+5	1.04E+5	4.21E+3
Nb-97	2.22E-1	5.62E-2	-	6.54E-2	2.40E+3	2.42E+2	2.05E-2
Mo-99	-	1.21E+2	-	2.91E+2	9.12E+4	2.48E+5	2.30E+1
Tc-99m	1.03E-3	2.91E-3	-	4.42E-2	7.64E+2	4.16E+3	3.70E-2
Tc-101	4.18E-5	6.02E-5	-	1.08E-3	3.99E+2	-	5.90E-4

Table G-1 (Continued)

R_i Inhalation Pathway Dose Factors - ADULT

(mrem/yr per $\mu Ci/m^3$)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	1.53E+3	-	-	5.83E+3	5.05E+5	1.10E+5	6.58E+2
Ru-105	7.90E-1	-	-	1.02E+0	1.10E+4	4.82E+4	3.11E-1
Ru-106	6.91E+4	-	-	1.34E+5	9.36E+6	9.12E+5	8.72E+3
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.08E+4	1.00E+4	-	1.97E+4	4.63E+6	3.02E+5	5.94E+3
Sb-124	3.12E+4	5.89E+2	7.55E+1	-	2.48E+6	4.06E+5	1.24E+4
Sb-125	5.34E+4	5.95E+2	5.40E+1	-	1.74E+6	1.01E+5	1.26E+4
Te-125m	3.42E+3	1.58E+3	1.05E+3	1.24E+4	3.14E+5	7.06E+4	4.67E+2
Te-127m	1.26E+4	5.77E+3	3.29E+3	4.58E+4	9.60E+5	1.50E+5	1.57E+3
Te-127	1.40E+0	6.42E-1	1.06E+0	5.10E+0	6.51E+3	5.74E+4	3.10E-1
Te-129m	9.76E+3	4.67E+3	3.44E+3	3.66E+4	1.16E+6	3.83E+5	1.58E+3
Te-129	4.98E-2	2.39E-2	3.90E-2	1.87E-1	1.94E+3	1.57E+2	1.24E-2
Te-131m	6.99E+1	4.36E+1	5.50E+1	3.09E+2	1.46E+5	5.56E+5	2.90E+1
Te-131	1.11E-2	5.95E-3	9.36E-3	4.37E-2	1.39E+3	1.84E+1	3.59E-3
Te-132	2.60E+2	2.15E+2	1.90E+2	1.46E+3	2.88E+5	5.10E+5	1.62E+2
I-130	4.58E+3	1.34E+4	1.14E+6	2.09E+4	-	7.69E+3	5.28E+3
I-131	2.52E+4	3.58E+4	1.19E+7	6.13E+4	-	6.28E+3	2.05E+4
I-132	1.16E+3	3.26E+3	1.14E+5	5.18E+3	-	4.06E+2	1.16E+3
I-133	8.64E+3	1.48E+4	2.15E+6	2.58E+4	-	8.88E+3	4.52E+3
I-134	6.44E+2	1.73E+3	2.98E+4	2.75E+3	-	1.01E+0	6.15E+2
I-135	2.68E+3	6.98E+3	4.48E+5	1.11E+4	-	5.25E+3	2.57E+3
Cs-134	3.73E+5	8.48E+5	-	2.87E+5	9.76E+4	1.04E+4	7.28E+5
Cs-136	3.90E+4	1.46E+5	-	8.56E+4	1.20E+4	1.17E+4	1.10E+5
Cs-137	4.78E+5	6.21E+5	-	2.22E+5	7.52E+4	8.40E+3	4.28E+5
Cs-138	3.31E+2	6.21E+2	-	4.80E+2	4.86E+1	1.86E-3	3.24E+2
Ba-139	9.36E-1	6.66E-4	-	6.22E-4	3.76E+3	8.96E+2	2.74E-2
Ba-140	3.90E+4	4.90E+1	-	1.67E+1	1.27E+6	2.18E+5	2.57E+3
Ba-141	1.00E-1	7.53E-5	-	7.00E-5	1.94E+3	1.16E-7	3.36E-3
Ba-142	2.63E-2	2.70E-5	-	2.29E-5	1.19E+3	-	1.66E-3
La-140	3.44E+2	1.74E+2	-	-	1.36E+5	4.58E+5	4.58E+1
La-142	6.83E-1	3.10E-1	-	-	6.33E+3	2.11E+3	7.72E-2
Ce-141	1.99E+4	1.35E+4	-	6.26E+3	3.62E+5	1.20E+5	1.53E+3
Ce-143	1.86E+2	1.38E+2	-	6.08E+1	7.98E+4	2.26E+5	1.53E+1
Ce-144	3.43E+6	1.43E+6	-	8.48E+5	7.78E+6	8.16E+5	1.84E+5
Pr-143	9.36E+3	3.75E+3	-	2.16E+3	2.81E+5	2.00E+5	4.64E+2
Pr-144	3.01E-2	1.25E-2	-	7.05E-3	1.02E+3	2.15E-8	1.53E-3
Nd-147	5.27E+3	6.10E+3	-	3.56E+3	2.21E+5	1.73E+5	3.65E+2
W-187	8.48E+0	7.08E+0	-	-	2.90E+4	1.55E+5	2.48E+0
Np-239	2.30E+2	2.26E+1	-	7.00E+1	3.76E+4	1.19E+5	1.24E+1

Table G-2

R_i Inhalation Pathway Dose Factors - TEEN

(mrem/yr per $\mu Ci/m^3$)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.27E+3	1.27E+3	1.27E+3	1.27E+3	1.27E+3	1.27E+3
C-14	2.60E+4	4.87E+3	4.87E+3	4.87E+3	4.87E+3	4.87E+3	4.87E+3
Na-24	1.38E+4	1.38E+4	1.38E+4	1.38E+4	1.38E+4	1.38E+4	1.38E+4
P-32	1.89E+6	1.10E+5	-	-	-	9.28E+4	7.16E+4
Cr-51	-	-	7.50E+1	3.07E+1	2.10E+4	3.00E+3	1.35E+2
Mn-54	-	5.11E+4	-	1.27E+4	1.98E+6	6.68E+4	8.40E+3
Mn-56	-	1.70E+0	-	1.79E+0	1.52E+4	5.74E+4	2.52E-1
Fe-55	3.34E+4	2.38E+4	-	-	1.24E+5	6.39E+3	5.54E+3
Fe-59	1.59E+4	3.70E+4	-	-	1.53E+6	1.78E+5	1.43E+4
Co-57	-	6.92E+2	-	-	5.86E+5	3.14E+4	9.20E+2
Co-58	-	2.07E+3	-	-	1.34E+6	9.52E+4	2.78E+3
Co-60	-	1.51E+4	-	-	8.72E+6	2.59E+5	1.98E+4
Ni-63	5.80E+5	4.34E+4	-	-	3.07E+5	1.42E+4	1.98E+4
Ni-65	2.18E+0	2.93E-1	-	-	9.36E+3	3.67E+4	1.27E-1
Cu-64	-	2.03E+0	-	6.41E+0	1.11E+4	6.14E+4	8.48E-1
Zn-65	3.86E+4	1.34E+5	-	8.64E+4	1.24E+6	4.66E+4	6.24E+4
Zn-69	4.83E-2	9.20E-2	-	6.02E-2	1.58E+3	2.85E+2	6.46E-3
Br-82	-	-	-	-	-	-	1.82E+4
Br-83	-	-	-	-	-	-	3.44E+2
Br-84	-	-	-	-	-	-	4.33E+2
Br-85	-	-	-	-	-	-	1.83E+1
Rb-86	-	1.90E+5	-	-	-	1.77E+4	8.40E+4
Rb-88	-	5.46E+2	-	-	-	2.92E-5	2.72E+2
Rb-89	-	3.52E+2	-	-	-	3.38E-7	2.33E+2
Sr-89	4.34E+5	-	-	-	2.42E+6	3.71E+5	1.25E+4
Sr-90	1.08E+8	-	-	-	1.65E+7	7.65E+5	6.68E+6
Sr-91	8.80E+1	-	-	-	6.07E+4	2.59E+5	3.51E+0
Sr-92	9.52E+0	-	-	-	2.74E+4	1.19E+5	4.06E-1
Y-90	2.98E+3	-	-	-	2.93E+5	5.59E+5	8.00E+1
Y-91m	3.70E-1	-	-	-	3.20E+3	3.02E+1	1.42E-2
Y-91	6.61E+5	-	-	-	2.94E+6	4.09E+5	1.77E+4
Y-92	1.47E+1	-	-	-	2.68E+4	1.65E+5	4.29E-1
Y-93	1.35E+2	-	-	-	8.32E+4	5.79E+5	3.72E+0
Zr-95	1.46E+5	4.58E+4	-	6.74E+4	2.69E+6	1.49E+5	3.15E+4
Zr-97	1.38E+2	2.72E+1	-	4.12E+1	1.30E+5	6.30E+5	1.26E+1
Nb-95	1.86E+4	1.03E+4	-	1.00E+4	7.51E+5	9.68E+4	5.66E+3
Nb-97	3.14E-1	7.78E-2	-	9.12E-2	3.93E+3	2.17E+3	2.84E-2
Mo-99	-	1.69E+2	-	4.11E+2	1.54E+5	2.69E+5	3.22E+1
Tc-99m	1.38E-3	3.86E-3	-	5.76E-2	1.15E+3	6.13E+3	4.99E-2
Tc-101	5.92E-5	8.40E-5	-	1.52E-3	6.67E+2	8.72E-7	8.24E-4

Table G-2 (Continued)

R_i Inhalation Pathway Dose Factors - TEEN

(mrem/yr per $\mu Ci/m^3$)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	2.10E+3	-	-	7.43E+3	7.83E+5	1.09E+5	8.96E+2
Ru-105	1.12E+0	-	-	1.41E+0	1.82E+4	9.04E+4	4.34E-1
Ru-106	9.84E+4	-	-	1.90E+5	1.61E+7	9.60E+5	1.24E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.38E+4	1.31E+4	-	2.50E+4	6.75E+6	2.73E+5	7.99E+3
Sb-124	4.30E+4	7.94E+2	9.76E+1	-	3.85E+6	3.98E+5	1.68E+4
Sb-125	7.38E+4	8.08E+2	7.04E+1	-	2.74E+6	9.92E+4	1.72E+4
Te-125m	4.88E+3	2.24E+3	1.40E+3	-	5.36E+5	7.50E+4	6.67E+2
Te-127m	1.80E+4	8.16E+3	4.38E+3	6.54E+4	1.66E+6	1.59E+5	2.18E+3
Te-127	2.01E+0	9.12E-1	1.42E+0	7.28E+0	1.12E+4	8.08E+4	4.42E-1
Te-129m	1.39E+4	6.58E+3	4.58E+3	5.19E+4	1.98E+6	4.05E+5	2.25E+3
Te-129	7.10E-2	3.38E-2	5.18E-2	2.66E-1	3.30E+3	1.62E+3	1.76E-2
Te-131m	9.84E+1	6.01E+1	7.25E+1	4.39E+2	2.38E+5	6.21E+5	4.02E+1
Te-131	1.58E-2	8.32E-3	1.24E-2	6.18E-2	2.34E+3	1.51E+1	5.04E-3
Te-132	3.60E+2	2.90E+2	2.46E+2	1.95E+3	4.49E+5	4.63E+5	2.19E+2
I-130	6.24E+3	1.79E+4	1.49E+6	2.75E+4	-	9.12E+3	7.17E+3
I-131	3.54E+4	4.91E+4	1.46E+7	8.40E+4	-	6.49E+3	2.64E+4
I-132	1.59E+3	4.38E+3	1.51E+5	6.92E+3	-	1.27E+3	1.58E+3
I-133	1.22E+4	2.05E+4	2.92E+6	3.59E+4	-	1.03E+4	6.22E+3
I-134	8.88E+2	2.32E+3	3.95E+4	3.66E+3	-	2.04E+1	8.40E+2
I-135	3.70E+3	9.44E+3	6.21E+5	1.49E+4	-	6.95E+3	3.49E+3
Cs-134	5.02E+5	1.13E+6	-	3.75E+5	1.46E+5	9.76E+3	5.49E+5
Cs-136	5.15E+4	1.94E+5	-	1.10E+5	1.78E+4	1.09E+4	1.37E+5
Cs-137	6.70E+5	8.48E+5	-	3.04E+5	1.21E+5	8.48E+3	3.11E+5
Cs-138	4.66E+2	8.56E+2	-	6.62E+2	7.87E+1	2.70E-1	4.46E+2
Ba-139	1.34E+0	9.44E-4	-	8.88E-4	6.46E+3	6.45E+3	3.90E-2
Ba-140	5.47E+4	6.70E+1	-	2.28E+1	2.03E+6	2.29E+5	3.52E+3
Ba-141	1.42E-1	1.06E-4	-	9.84E-5	3.29E+3	7.46E-4	4.74E-3
Ba-142	3.70E-2	3.70E-5	-	3.14E-5	1.91E+3	-	2.27E-3
La-140	4.79E+2	2.36E+2	-	-	2.14E+5	4.87E+5	6.26E+1
La-142	9.60E-1	4.25E-1	-	-	1.02E+4	1.20E+4	1.06E-1
Ce-141	2.84E+4	1.90E+4	-	8.88E+3	6.14E+5	1.26E+5	2.17E+3
Ce-143	2.66E+2	1.94E+2	-	8.64E+1	1.30E+5	2.55E+5	2.16E+1
Ce-144	4.89E+6	2.02E+6	-	1.21E+6	1.34E+7	8.64E+5	2.62E+5
Pr-143	1.34E+4	5.31E+3	-	3.09E+3	4.83E+5	2.14E+5	6.62E+2
Pr-144	4.30E-2	1.76E-2	-	1.01E-2	1.75E+3	2.35E-4	2.18E-3
Nd-147	7.86E+3	8.56E+3	-	5.02E+3	3.72E+5	1.82E+5	5.13E+2
W-187	1.20E+1	9.76E+0	-	-	4.74E+4	1.77E+5	3.43E+0
Np-239	3.38E+2	3.19E+1	-	1.00E+2	6.49E+4	1.32E+5	1.77E+1

Table G-3

R_i Inhalation Pathway Dose Factors - CHILD

(mrem/yr per $\mu Ci/m^3$)

Nnclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.12E+3	1.12E+3	1.12E+3	1.12E+3	1.12E+3	1.12E+3
C-14	3.59E+4	6.73E+3	6.73E+3	6.73E+3	6.73E+3	6.73E+3	6.73E+3
Na-24	1.61E+4	1.61E+4	1.61E+4	1.61E+4	1.61E+4	1.61E+4	1.61E+4
P-32	2.60E+6	1.14E+5	-	-	-	4.22E+4	9.88E+4
Cr-51	-	-	8.55E+1	2.43E+1	1.70E+4	1.08E+3	1.54E+2
Mn-54	-	4.29E+4	-	1.00E+4	1.58E+6	2.29E+4	9.51E+3
Mn-56	-	1.66E+0	-	1.67E+0	1.31E+4	1.23E+5	3.12E-1
Fe-55	4.74E+4	2.52E+4	-	-	1.11E+5	2.87E+3	7.77E+3
Fe-59	2.07E+4	3.34E+4	-	-	1.27E+6	7.07E+4	1.67E+4
Co-57	-	9.03E+2	-	-	5.07E+5	1.32E+4	1.07E+3
Co-58	-	1.77E+3	-	-	1.11E+6	3.44E+4	3.16E+3
Co-60	-	1.31E+4	-	-	7.07E+6	9.62E+4	2.26E+4
Ni-63	8.21E+5	4.63E+4	-	-	2.75E+5	6.33E+3	2.80E+4
Ni-65	2.99E+0	2.96E-1	-	-	8.18E+3	8.40E+4	1.64E-1
Cu-64	-	1.99E+0	-	6.03E+0	9.58E+3	3.67E+4	1.07E+0
Zn-65	4.26E+4	1.13E+5	-	7.14E+4	9.95E+5	1.63E+4	7.03E+4
Zn-69	6.70E-2	9.66E-2	-	5.85E-2	1.42E+3	1.02E+4	8.92E-3
Br-82	-	-	-	-	-	-	2.09E+4
Br-83	-	-	-	-	-	-	4.74E+2
Br-84	-	-	-	-	-	-	5.48E+2
Br-85	-	-	-	-	-	-	2.53E+1
Rb-86	-	1.98E+5	-	-	-	7.99E+3	1.14E+5
Rb-88	-	5.62E+2	-	-	-	1.72E+1	3.66E+2
Rb-89	-	3.45E+2	-	-	-	1.89E+0	2.90E+2
Sr-89	5.99E+5	-	-	-	2.16E+6	1.67E+5	1.72E+4
Sr-90	1.01E+8	-	-	-	1.48E+7	3.43E+5	6.44E+6
Sr-91	1.21E+2	-	-	-	5.33E+4	1.74E+5	4.59E+0
Sr-92	1.31E+1	-	-	-	2.40E+4	2.42E+5	5.25E-1
Y-90	4.11E+3	-	-	-	2.62E+5	2.68E+5	1.11E+2
Y-91m	5.07E-1	-	-	-	2.81E+3	1.72E+3	1.84E-2
Y-91	9.14E+5	-	-	-	2.63E+6	1.84E+5	2.44E+4
Y-92	2.04E+1	-	-	-	2.39E+4	2.39E+5	5.81E-1
Y-93	1.86E+2	-	-	-	7.44E+4	3.89E+5	5.11E+0
Zr-95	1.90E+5	4.18E+4	-	5.96E+4	2.23E+6	6.11E+4	3.70E+4
Zr-97	1.88E+2	2.72E+1	-	3.89E+1	1.13E+5	3.51E+5	1.60E+1
Nb-95	2.35E+4	9.18E+3	-	8.62E+3	6.14E+5	3.70E+4	6.55E+3
Nb-97	4.29E-1	7.70E-2	-	8.55E-2	3.42E+3	2.78E+4	3.60E-2
Mo-99	-	1.72E+2	-	3.92E+2	1.35E+5	1.27E+5	4.26E+1
Tc-99m	1.78E-3	3.48E-3	-	5.07E-2	9.51E+2	4.81E+3	5.77E-2
Tc-101	8.10E-5	8.51E-5	-	1.45E-3	5.85E+2	1.63E+1	1.08E-3

Table G-3 (Continued)

R_i Inhalation Pathway Dose Factors - CHILD

(mrem/yr per $\mu Ci/m^3$)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	2.79E+3	-	-	7.03E+3	6.62E+5	4.48E+4	1.07E+3
Ru-105	1.53E+0	-	-	1.34E+0	1.59E+4	9.95E+4	5.55E-1
Ru-106	1.36E+5	-	-	1.84E+5	1.43E+7	4.29E+5	1.69E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.69E+4	1.14E+4	-	2.12E+4	5.48E+6	1.00E+5	9.14E+3
Sb-124	5.74E+4	7.40E+2	1.26E+2	-	3.24E+6	1.64E+5	2.00E+4
Sb-125	9.84E+4	7.59E+2	9.10E+1	-	2.32E+6	4.03E+4	2.07E+4
Te-125m	6.73E+3	2.33E+3	1.92E+3	-	4.77E+5	3.38E+4	9.14E+2
Te-127m	2.49E+4	8.55E+3	6.07E+3	6.36E+4	1.48E+6	7.14E+4	3.02E+3
Te-127	2.77E+0	9.51E-1	1.96E+0	7.07E+0	1.00E+4	5.62E+4	6.11E-1
Te-129m	1.92E+4	6.85E+3	6.33E+3	5.03E+4	1.76E+6	1.82E+5	3.04E+3
Te-129	9.77E-2	3.50E-2	7.14E-2	2.57E-1	2.93E+3	2.55E+4	2.38E-2
Te-131m	1.34E+2	5.92E+1	9.77E+1	4.00E+2	2.06E+5	3.08E+5	5.07E+1
Te-131	2.17E-2	8.44E-3	1.70E-2	5.88E-2	2.05E+3	1.33E+3	6.59E-3
Te-132	4.81E+2	2.72E+2	3.17E+2	1.77E+3	3.77E+5	1.38E+5	2.63E+2
I-130	8.18E+3	1.64E+4	1.85E+6	2.45E+4	-	5.11E+3	8.44E+3
I-131	4.81E+4	4.81E+4	1.62E+7	7.88E+4	-	2.84E+3	2.73E+4
I-132	2.12E+3	4.07E+3	1.94E+5	6.25E+3	-	3.20E+3	1.88E+3
I-133	1.66E+4	2.03E+4	3.85E+6	3.38E+4	-	5.48E+3	7.70E+3
I-134	1.17E+3	2.16E+3	5.07E+4	3.30E+3	-	9.55E+2	9.95E+2
I-135	4.92E+3	8.73E+3	7.92E+5	1.34E+4	-	4.44E+3	4.14E+3
Cs-134	6.51E+5	1.01E+6	-	3.30E+5	1.21E+5	3.85E+3	2.25E+5
Cs-136	6.51E+4	1.71E+5	-	9.55E+4	1.45E+4	4.18E+3	1.16E+5
Cs-137	9.07E+5	8.25E+5	-	2.82E+5	1.04E+5	3.62E+3	1.28E+5
Cs-138	6.33E+2	8.40E+2	-	6.22E+2	6.81E+1	2.70E+2	5.55E+2
Ba-139	1.84E+0	9.84E-4	-	8.62E-4	5.77E+3	5.77E+4	5.37E-2
Ba-140	7.40E+4	6.48E+1	-	2.11E+1	1.74E+6	1.02E+5	4.33E+3
Ba-141	1.96E-1	1.09E-4	-	9.47E-5	2.92E+3	2.75E+2	6.36E-3
Ba-142	5.00E-2	3.60E-5	-	2.91E-5	1.64E+3	2.74E+0	2.79E-3
La-140	6.44E+2	2.25E+2	-	-	1.83E+5	2.26E+5	7.55E+1
La-142	1.30E+0	4.11E-1	-	-	8.70E+3	7.59E+4	1.29E-1
Ce-141	3.92E+4	1.95E+4	-	8.55E+3	5.44E+5	5.66E+4	2.90E+3
Ce-143	3.66E+2	1.99E+2	-	8.36E+1	1.15E+5	1.27E+5	2.87E+1
Ce-144	6.77E+6	2.12E+6	-	1.17E+6	1.20E+7	3.89E+5	3.61E+5
Pr-143	1.85E+4	5.55E+3	-	3.00E+3	4.33E+5	9.73E+4	9.14E+2
Pr-144	5.96E-2	1.85E-2	-	9.77E-3	1.57E+3	1.97E+2	3.00E-3
Nd-147	1.08E+4	8.73E+3	-	4.81E+3	3.28E+5	8.21E+4	6.81E+2
W-187	1.63E+1	9.66E+0	-	-	4.11E+4	9.10E+4	4.33E+0
Np-239	4.66E+2	3.34E+1	-	9.73E+1	5.81E+4	6.40E+4	2.35E+1

Table G-4

R_i Inhalation Pathway Dose Factors - INFANT

(mrem/yr per $\mu Ci/m^3$)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	6.47E+2	6.47E+2	6.47E+2	6.47E+2	6.47E+2	6.47E+2
C-14	2.65E+4	5.31E+3	5.31E+3	5.31E+3	5.31E+3	5.31E+3	5.31E+3
Na-24	1.06E+4	1.06E+4	1.06E+4	1.06E+4	1.06E+4	1.06E+4	1.06E+4
P-32	2.03E+6	1.12E+5	-	-	-	1.61E+4	7.74E+4
Cr-51	-	-	5.75E+1	1.32E+1	1.28E+4	3.57E+2	8.95E+1
Mn-54	-	2.53E+4	-	4.98E+3	1.00E+6	7.06E+3	4.98E+3
Mn-56	-	1.54E+0	-	1.10E+0	1.25E+4	7.17E+4	2.21E-1
Fe-55	1.97E+4	1.17E+4	-	-	8.69E+4	1.09E+3	3.33E+3
Fe-59	1.36E+4	2.35E+4	-	-	1.02E+6	2.48E+4	9.48E+3
Co-57	-	6.51E+2	-	-	3.79E+5	4.86E+3	6.41E+2
Co-58	-	1.22E+3	-	-	7.77E+5	1.11E+4	1.82E+3
Co-60	-	8.02E+3	-	-	4.51E+6	3.19E+4	1.18E+4
Ni-63	3.39E+5	2.04E+4	-	-	2.09E+5	2.42E+3	1.16E+4
Ni-65	2.39E+0	2.84E-1	-	-	8.12E+3	5.01E+4	1.23E-1
Cu-64	-	1.88E+0	-	3.98E+0	9.30E+3	1.50E+4	7.74E-1
Zn-65	1.93E+4	6.26E+4	-	3.25E+4	6.47E+5	5.14E+4	3.11E+4
Zn-69	5.39E-2	9.67E-2	-	4.02E-2	1.47E+3	1.32E+4	7.18E-3
Br-82	-	-	-	-	-	-	1.33E+4
Br-83	-	-	-	-	-	-	3.81E+2
Br-84	-	-	-	-	-	-	4.00E+2
Br-85	-	-	-	-	-	-	2.04E+1
Rb-86	-	1.90E+5	-	-	-	3.04E+3	8.82E+4
Rb-88	-	5.57E+2	-	-	-	3.39E+2	2.87E+2
Rb-89	-	3.21E+2	-	-	-	6.82E+1	2.06E+2
Sr-89	3.98E+5	-	-	-	2.03E+6	6.40E+4	1.14E+4
Sr-90	4.09E+7	-	-	-	1.12E+7	1.31E+5	2.59E+6
Sr-91	9.56E+1	-	-	-	5.26E+4	7.34E+4	3.46E+0
Sr-92	1.05E+1	-	-	-	2.38E+4	1.40E+5	3.91E-1
Y-90	3.29E+3	-	-	-	2.69E+5	1.04E+5	8.82E+1
Y-91m	4.07E-1	-	-	-	2.79E+3	2.35E+3	1.39E-2
Y-91	5.88E+5	-	-	-	2.45E+6	7.03E+4	1.57E+4
Y-92	1.64E+1	-	-	-	2.45E+4	1.27E+5	4.61E-1
Y-93	1.50E+2	-	-	-	7.64E+4	1.67E+5	4.07E+0
Zr-95	1.15E+5	2.79E+4	-	3.11E+4	1.75E+6	2.17E+4	2.03E+4
Zr-97	1.50E+2	2.56E+1	-	2.59E+1	1.10E+5	1.40E+5	1.17E+1
Nb-95	1.57E+4	6.43E+3	-	4.72E+3	4.79E+5	1.27E+4	3.78E+3
Nb-97	3.42E-1	7.29E-2	-	5.70E-2	3.32E+3	2.69E+4	2.63E-2
Mo-99	-	1.65E+2	-	2.65E+2	1.35E+5	4.87E+4	3.23E+1
Tc-99m	1.40E-3	2.88E-3	-	3.11E-2	8.11E+2	2.03E+3	3.72E-2
Tc-101	6.51E-5	8.23E-5	-	9.79E-4	5.84E+2	8.44E+2	8.12E-4

Table G-4 (Continued)

R_i Inhalation Pathway Dose Factors - INFANT

(mrem/yr per $\mu Ci/m^3$)

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	2.02E+3	-	-	4.24E+3	5.52E+5	1.61E+4	6.79E+2
Ru-105	1.22E+0	-	-	8.99E-1	1.57E+4	4.84E+4	4.10E-1
Ru-106	8.68E+4	-	-	1.07E+5	1.16E+7	1.64E+5	1.09E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	9.98E+3	7.22E+3	-	1.09E+4	3.67E+6	3.30E+4	5.00E+3
Sb-124	3.79E+4	5.56E+2	1.01E+2	-	2.65E+6	5.91E+4	1.20E+4
Sb-125	5.17E+4	4.77E+2	6.23E+1	-	1.64E+6	1.47E+4	1.09E+4
Te-125m	4.76E+3	1.99E+3	1.62E+3	-	4.47E+5	1.29E+4	6.58E+2
Te-127m	1.67E+4	6.90E+3	4.87E+3	3.75E+4	1.31E+6	2.73E+4	2.07E+3
Te-127	2.23E+0	9.53E-1	1.85E+0	4.86E+0	1.03E+4	2.44E+4	4.89E-1
Te-129m	1.41E+4	6.09E+3	5.47E+3	3.18E+4	1.68E+6	6.90E+4	2.23E+3
Te-129	7.88E-2	3.47E-2	6.75E-2	1.75E-1	3.00E+3	2.63E+4	1.88E-2
Te-131m	1.07E+2	5.50E+1	8.93E+1	2.65E+2	1.99E+5	1.19E+5	3.63E+1
Te-131	1.74E-2	8.22E-3	1.58E-2	3.99E-2	2.06E+3	8.22E+3	5.00E-3
Te-132	3.72E+2	2.37E+2	2.79E+2	1.03E+3	3.40E+5	4.41E+4	1.76E+2
I-130	6.36E+3	1.39E+4	1.60E+6	1.53E+4	-	1.99E+3	5.57E+3
I-131	3.79E+4	4.44E+4	1.48E+7	5.18E+4	-	1.06E+3	1.96E+4
I-132	1.69E+3	3.54E+3	1.69E+5	3.95E+3	-	1.90E+3	1.26E+3
I-133	1.32E+4	1.92E+4	3.56E+6	2.24E+4	-	2.16E+3	5.60E+3
I-134	9.21E+2	1.88E+3	4.45E+4	2.09E+3	-	1.29E+3	6.65E+2
I-135	3.86E+3	7.60E+3	6.96E+5	8.47E+3	-	1.83E+3	2.77E+3
Cs-134	3.96E+5	7.03E+5	-	1.90E+5	7.97E+4	1.33E+3	7.45E+4
Cs-136	4.83E+4	1.35E+5	-	5.64E+4	1.18E+4	1.43E+3	5.29E+4
Cs-137	5.49E+5	6.12E+5	-	1.72E+5	7.13E+4	1.33E+3	4.55E+4
Cs-138	5.05E+2	7.81E+2	-	4.10E+2	6.54E+1	8.76E+2	3.98E+2
Ba-139	1.48E+0	9.84E-4	-	5.92E-4	5.95E+3	5.10E+4	4.30E-2
Ba-140	5.60E+4	5.60E+1	-	1.34E+1	1.60E+6	3.84E+4	2.90E+3
Ba-141	1.57E-1	1.08E-4	-	6.50E-5	2.97E+3	4.75E+3	4.97E-3
Ba-142	3.98E-2	3.30E-5	-	1.90E-5	1.55E+3	6.93E+2	1.96E-3
La-140	5.05E+2	2.00E+2	-	-	1.68E+5	8.48E+4	5.15E+1
La-142	1.03E+0	3.77E-1	-	-	8.22E+3	5.95E+4	9.04E-2
Ce-141	2.77E+4	1.67E+4	-	5.25E+3	5.17E+5	2.16E+4	1.99E+3
Ce-143	2.93E+2	1.93E+2	-	5.64E+1	1.16E+5	4.97E+4	2.21E+1
Ce-144	3.19E+6	1.21E+6	-	5.38E+5	9.84E+6	1.48E+5	1.76E+5
Pr-143	1.40E+4	5.24E+3	-	1.97E+3	4.33E+5	3.72E+4	6.99E+2
Pr-144	4.79E-2	1.85E-2	-	6.72E-3	1.61E+3	4.28E+3	2.41E-3
Nd-147	7.94E+3	8.13E+3	-	3.15E+3	3.22E+5	3.12E+4	5.00E+2
W-187	1.30E+1	9.02E+0	-	-	3.96E+4	3.56E+4	3.12E+0
Np-239	3.71E+2	3.32E+1	-	6.62E+1	5.95E+4	2.49E+4	1.88E+1

Table G-5

R_i Vegetation Pathway Dose Factors - ADULT

(mrem/yr per $\mu Ci/m^3$) for H-3 and C-14 (m^2 x mrem/yr per $\mu Ci/sec$) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.26E+3	2.26E+3	2.26E+3	2.26E+3	2.26E+3	2.26E+3
C-14	8.97E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5	1.79E+5
Na-24	2.76E+5	2.76E+5	2.76E+5	2.76E+5	2.76E+5	2.76E+5	2.76E+5
P-32	1.40E+9	8.73E+7	-	-	-	1.58E+8	5.42E+7
Cr-51	-	-	2.79E+4	1.03E+4	6.19E+4	1.17E+7	4.66E+4
Mn-54	-	3.11E+8	-	9.27E+7	-	9.54E+8	5.94E+7
Mn-56	-	1.61E+1	-	2.04E+1	-	5.13E+2	2.85E+0
Fe-55	2.09E+8	1.45E+8	-	-	8.06E+7	8.29E+7	3.37E+7
Fe-59	1.27E+8	2.99E+8	-	-	8.35E+7	9.96E+8	1.14E+8
Co-57	-	1.17E+7	-	-	-	8.97E+8	1.95E+7
Co-58	-	3.09E+7	-	-	-	6.26E+8	6.92E+7
Co-60	-	1.67E+8	-	-	-	3.14E+9	3.69E+8
Ni-63	1.04E+10	7.21E+8	-	-	-	1.50E+8	3.49E+8
Ni-65	6.15E+1	7.99E+0	-	-	-	2.03E+2	3.65E+0
Cu-64	-	9.27E+3	-	2.34E+4	-	7.90E+5	4.35E+3
Zn-65	3.17E+8	1.01E+9	-	6.75E+8	-	6.36E+8	4.56E+8
Zn-69	8.75E-6	1.67E-5	-	1.09E-5	-	2.51E-6	1.16E-6
Br-82	-	-	-	-	-	1.73E+6	1.51E+6
Br-83	-	-	-	-	-	4.63E+0	3.21E+0
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	2.19E+8	-	-	-	4.32E+7	1.02E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	9.96E+9	-	-	-	-	1.60E+9	2.86E+8
Sr-90	6.05E+11	-	-	-	-	1.75E+10	1.48E+11
Sr-91	3.20E+5	-	-	-	-	1.52E+6	1.29E+4
Sr-92	4.27E+2	-	-	-	-	8.46E+3	1.85E+1
Y-90	1.33E+4	-	-	-	-	1.41E+8	3.56E+2
Y-91m	5.83E-9	-	-	-	-	1.71E-8	-
Y-91	5.13E+6	-	-	-	-	2.82E+9	1.37E+5
Y-92	9.01E-1	-	-	-	-	1.58E+4	2.63E-2
Y-93	1.74E+2	-	-	-	-	5.52E+6	4.80E+0
Zr-95	1.19E+6	3.81E+5	-	5.97E+5	-	1.21E+9	2.58E+5
Zr-97	3.33E+2	6.73E+1	-	1.02E+2	-	2.08E+7	3.08E+1
Nb-95	1.42E+5	7.91E+4	-	7.81E+4	-	4.80E+8	4.25E+4
Nb-97	2.90E-6	7.34E-7	-	8.56E-7	-	2.71E-3	2.68E-7
Mo-99	-	6.25E+6	-	1.41E+7	-	1.45E+7	1.19E+6
Tc-99m	3.06E+0	8.66E+0	-	1.32E+2	4.24E+0	5.12E+3	1.10E+2
Tc-101	-	-	-	-	-	-	-

Table G-5 (Continued)

R_i Vegetation Pathway Dose Factors - ADULT

(mrem/yr per μCi/m^3) for H-3 and C-14(m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	4.80E+6	-	-	1.83E+7	-	5.61E+8	2.07E+6
Ru-105	5.39E+1	-	-	6.96E+2	-	3.30E+4	2.13E+1
Ru-106	1.93E+8	-	-	3.72E+8	-	1.25E+10	2.44E+7
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.06E+7	9.76E+6	-	1.92E+7	-	3.98E+9	5.80E+6
Sb-124	1.04E+8	1.96E+6	2.52E+5	-	8.08E+7	2.95E+9	4.11E+7
Sb-125	1.36E+8	1.52E+6	1.39E+5	-	1.05E+8	1.50E+9	3.25E+7
Te-125m	9.66E+7	3.50E+7	2.90E+7	3.93E+8	-	3.86E+8	1.29E+7
Te-127m	3.49E+8	1.25E+8	8.92E+7	1.42E+9	-	1.17E+9	4.26E+7
Te-127	5.76E+3	2.07E+3	4.27E+3	2.35E+4	-	4.54E+5	1.25E+3
Te-129m	2.55E+8	9.50E+7	8.75E+7	1.06E+9	-	1.28E+9	4.03E+7
Te-129	6.65E-4	2.50E-4	5.10E-4	2.79E-3	-	5.02E-4	1.62E-4
Te-131m	9.12E+5	4.46E+5	7.06E+5	4.52E+6	-	4.43E+7	3.72E+5
Te-131	-	-	-	-	-	-	-
Te-132	4.29E+6	2.77E+6	3.06E+6	2.67E+7	-	1.31E+8	2.60E+6
I-130	3.96E+5	1.17E+6	9.90E+7	1.82E+6	-	1.01E+6	4.61E+5
I-131	8.09E+7	1.16E+8	3.79E+10	1.98E+8	-	3.05E+7	6.63E+7
I-132	5.74E+1	1.54E+2	5.38E+3	2.45E+2	-	2.89E+1	5.38E+1
I-133	2.12E+6	3.69E+6	5.42E+8	6.44E+6	-	3.31E+6	1.12E+6
I-134	1.06E-4	2.88E-4	5.00E-3	4.59E-4	-	2.51E-7	1.03E-4
I-135	4.08E+4	1.07E+5	7.04E+6	1.71E+5	-	1.21E+5	3.94E+4
Cs-134	4.66E+9	1.11E+10	-	3.59E+9	1.19E+9	1.94E+8	9.07E+9
Cs-136	4.20E+7	1.66E+8	-	9.24E+7	1.27E+7	1.89E+7	1.19E+8
Cs-137	6.36E+9	8.70E+9	-	2.95E+9	9.81E+8	1.68E+8	5.70E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	2.95E-2	2.10E-5	-	1.96E-5	1.19E-5	5.23E-2	8.64E-4
Ba-140	1.29E+8	1.62E+5	-	5.49E+4	9.25E+4	2.65E+8	8.43E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	1.97E+3	9.92E+2	-	-	-	7.28E+7	2.62E+2
La-142	1.40E-4	6.35E-5	-	-	-	4.64E-1	1.58E-5
Ce-141	1.96E+5	1.33E+5	-	6.17E+4	-	5.08E+8	1.51E+4
Ce-143	1.00E+3	7.42E+5	-	3.26E+2	-	2.77E+7	8.21E+1
Ce-144	3.29E+7	1.38E+7	-	8.16E+6	-	1.11E+10	1.77E+6
Pr-143	6.34E+4	2.54E+4	-	1.47E+4	-	2.78E+8	3.14E+3
Pr-144	-	-	-	-	-	-	-
Nd-147	3.34E+4	3.86E+4	-	2.25E+4	-	1.85E+8	2.31E+3
W-187	3.82E+4	3.19E+4	-	-	-	1.05E+7	1.12E+4
Np-239	1.42E+3	1.40E+2	-	4.37E+2	-	2.87E+7	7.72E+1

Table G-6

R_i Vegetation Pathway Dose Factors - TEEN

(mrem/yr per $\mu Ci/m^3$) for H-3 and C-14(m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	2.59E+3	2.59E+3	2.59E+3	2.59E+3	2.59E+3	2.59E+3
C-14	1.45E+6	2.91E+5	2.91E+5	2.91E+5	2.91E+5	2.91E+5	2.91E+5
Na-24	2.45E+5	2.45E+5	2.45E+5	2.45E+5	2.45E+5	2.45E+5	2.45E+5
P-32	1.61E+9	9.96E+7	-	-	-	1.35E+8	6.23E+7
Cr-51	-	-	3.44E+4	1.36E+4	8.85E+4	1.04E+7	6.20E+4
Mn-54	-	4.52E+8	-	1.35E+8	-	9.27E+8	8.97E+7
Mn-56	-	1.45E+1	-	1.83E+1	-	9.54E+2	2.58E+0
Fe-55	3.25E+8	2.31E+8	-	-	1.46E+8	9.98E+7	5.38E+7
Fe-59	1.81E+8	4.22E+8	-	-	1.33E+8	9.98E+8	1.63E+8
Co-57	-	1.79E+7	-	-	-	3.34E+8	3.00E+7
Co-58	-	4.38E+7	-	-	-	6.04E+8	1.01E+8
Co-60	-	2.49E+8	-	-	-	3.24E+9	5.60E+8
Ni-63	1.61E+10	1.13E+9	-	-	-	1.81E+8	5.45E+8
Ni-65	5.73E+1	7.32E+0	-	-	-	3.97E+2	3.33E+0
Cu-64	-	8.40E+3	-	2.12E+4	-	6.51E+5	3.95E+3
Zn-65	4.24E+8	1.47E+9	-	9.41E+8	-	6.23E+8	6.86E+8
Zn-69	8.19E-6	1.56E-5	-	1.02E-5	-	2.88E-5	1.09E-6
Br-82	-	-	-	-	-	-	1.33E+6
Br-83	-	-	-	-	-	-	3.01E+0
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	2.73E+8	-	-	-	4.05E+7	1.28E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	1.51E+10	-	-	-	-	1.80E+9	4.33E+8
Sr-90	7.51E+11	-	-	-	-	2.11E+10	1.85E+11
Sr-91	2.99E+5	-	-	-	-	1.36E+6	1.19E+4
Sr-92	3.97E+2	-	-	-	-	1.01E+4	1.69E+1
Y-90	1.24E+4	-	-	-	-	1.02E+8	3.34E+2
Y-91m	5.43E-9	-	-	-	-	2.56E-7	-
Y-91	7.87E+6	-	-	-	-	3.23E+9	2.11E+5
Y-92	8.47E-1	-	-	-	-	2.32E+4	2.45E-2
Y-93	1.63E+2	-	-	-	-	4.98E+6	4.47E+0
Zr-95	1.74E+6	5.49E+5	-	8.07E+5	-	1.27E+9	3.78E+5
Zr-97	3.09E+2	6.11E+1	-	9.26E+1	-	1.65E+7	2.81E+1
Nb-95	1.92E+5	1.06E+5	-	1.03E+5	-	4.55E+8	5.86E+4
Nb-97	2.69E-6	6.67E-7	-	7.80E-7	-	1.59E-2	2.44E-7
Mo-99	-	5.74E+6	-	1.31E+7	-	1.03E+7	1.09E+6
Tc-99m	2.70E+0	7.54E+0	-	1.12E+2	4.19E+0	4.95E+3	9.77E+1
Tc-101	-	-	-	-	-	-	-

Table G-6 (Continued)

R_i Vegetation Pathway Dose Factors - TEEN

(mrem/yr per μCi/m^3) for H-3 and C-14(m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	6.87E+6	-	-	2.42E+7	-	5.74E+8	2.94E+6
Ru-105	5.00E+1	-	-	6.31E+2	-	4.04E+4	1.94E+1
Ru-106	3.09E+8	-	-	5.97E+8	-	1.48E+10	3.90E+7
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	1.52E+7	1.44E+7	-	2.74E+7	-	4.04E+9	8.74E+6
Sb-124	1.55E+8	2.85E+6	3.51E+5	-	1.35E+8	3.11E+9	6.03E+7
Sb-125	2.14E+8	2.34E+6	2.04E+5	-	1.88E+8	1.66E+9	5.00E+7
Te-125m	1.48E+8	5.34E+7	4.14E+7	-	-	4.37E+8	1.98E+7
Te-127m	5.51E+8	1.96E+8	1.31E+8	2.24E+9	-	1.37E+9	6.56E+7
Te-127	5.43E+3	1.92E+3	3.74E+3	2.20E+4	-	4.19E+5	1.17E+3
Te-129m	3.67E+8	1.36E+8	1.18E+8	1.54E+9	-	1.38E+9	5.81E+7
Te-129	6.22E-4	2.32E-4	4.45E-4	2.61E-3	-	3.40E-3	1.51E-4
Te-131m	8.44E+5	4.05E+5	6.09E+5	4.22E+6	-	3.25E+7	3.38E+5
Te-131	-	-	-	-	-	-	-
Te-132	3.90E+6	2.47E+6	2.60E+6	2.37E+7	-	7.82E+7	2.32E+6
I-130	3.54E+5	1.02E+6	8.35E+7	1.58E+6	-	7.87E+5	4.09E+5
I-131	7.70E+7	1.08E+8	3.14E+10	1.85E+8	-	2.13E+7	5.79E+7
I-132	5.18E+1	1.36E+2	4.57E+3	2.14E+2	-	5.91E+1	4.87E+1
I-133	1.97E+6	3.34E+6	4.66E+8	5.86E+6	-	2.53E+6	1.02E+6
I-134	9.59E-5	2.54E-4	4.24E-3	4.01E-4	-	3.35E-6	9.13E-5
I-135	3.68E+4	9.48E+4	6.10E+6	1.50E+5	-	1.05E+5	3.52E+4
Cs-134	7.09E+9	1.67E+10	-	5.30E+9	2.02E+9	2.08E+8	7.74E+9
Cs-136	4.29E+7	1.69E+8	-	9.19E+7	1.45E+7	1.36E+7	1.13E+8
Cs-137	1.01E+10	1.35E+10	-	4.59E+9	1.78E+9	1.92E+8	4.69E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	2.77E-2	1.95E-5	-	1.84E-5	1.34E-5	2.47E-1	8.08E-4
Ba-140	1.38E+8	1.69E+5	-	5.75E+4	1.14E+5	2.13E+8	8.91E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	1.80E+3	8.84E+2	-	-	-	5.08E+7	2.35E+2
La-142	1.28E-4	5.69E-5	-	-	-	1.73E+0	1.42E-5
Ce-141	2.82E+5	1.88E+5	-	8.86E+4	-	5.38E+8	2.16E+4
Ce-143	9.37E+2	6.82E+5	-	3.06E+2	-	2.05E+7	7.62E+1
Ce-144	5.27E+7	2.18E+7	-	1.30E+7	-	1.33E+10	2.83E+6
Pr-143	7.12E+4	2.84E+4	-	1.65E+4	-	2.34E+8	3.55E+3
Pr-144	-	-	-	-	-	-	-
Nd-147	3.63E+4	3.94E+4	-	2.32E+4	-	1.42E+8	2.36E+3
W-187	3.55E+4	2.90E+4	-	-	-	7.84E+6	1.02E+4
Np-239	1.38E+3	1.30E+2	-	4.09E+2	-	2.10E+7	7.24E+1

Table G-7

R_i Vegetation Pathway Dose Factors - CHILD

(mrem/yr per μCi/m^3) for H-3 and C-14(m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	4.01E+3	4.01E+3	4.01E+3	4.01E+3	4.01E+3	4.01E+3
C-14	3.50E+6	7.01E+5	7.01E+5	7.01E+5	7.01E+5	7.01E+5	7.01E+5
Na-24	3.83E+5	3.83E+5	3.83E+5	3.83E+5	3.83E+5	3.83E+5	3.83E+5
P-32	3.37E+9	1.58E+8	-	-	-	9.30E+7	1.30E+8
Cr-51	-	-	6.54E+4	1.79E+4	1.19E+5	6.25E+6	1.18E+5
Mn-54	-	6.61E+8	-	1.85E+8	-	5.55E+8	1.76E+8
Mn-56	-	1.90E+1	-	2.29E+1	-	2.75E+3	4.28E+0
Fe-55	8.00E+8	4.24E+8	-	-	2.40E+8	7.86E+7	1.31E+8
Fe-59	4.01E+8	6.49E+8	-	-	1.88E+8	6.76E+8	3.23E+8
Co-57	-	2.99E+7	-	-	-	3.45E+8	6.04E+7
Co-58	-	6.47E+7	-	-	-	3.77E+8	1.98E+8
Co-60	-	3.78E+8	-	-	-	2.10E+9	1.12E+9
Ni-63	3.95E+10	2.11E+9	-	-	-	1.42E+8	1.34E+9
Ni-65	1.05E+2	9.89E+0	-	-	-	1.21E+3	5.77E+0
Cu-64	-	1.11E+4	-	2.68E+4	-	5.20E+5	6.69E+3
Zn-65	8.12E+8	2.16E+9	-	1.36E+9	-	3.80E+8	1.35E+9
Zn-69	1.51E-5	2.18E-5	-	1.32E-5	-	1.38E-3	2.02E-6
Br-82	-	-	-	-	-	-	2.04E+6
Br-83	-	-	-	-	-	-	5.55E+0
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	4.52E+8	-	-	-	2.91E+7	2.78E+8
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	3.59E+10	-	-	-	-	1.39E+9	1.03E+9
Sr-90	1.24E+12	-	-	-	-	1.67E+10	3.15E+11
Sr-91	5.50E+5	-	-	-	-	1.21E+6	2.08E+4
Sr-92	7.28E+2	-	-	-	-	1.38E+4	2.92E+1
Y-90	2.30E+4	-	-	-	-	6.56E+7	6.17E+2
Y-91m	9.94E-9	-	-	-	-	1.95E-5	-
Y-91	1.87E+7	-	-	-	-	2.49E+9	5.01E+5
Y-92	1.56E+0	-	-	-	-	4.51E+4	4.46E-2
Y-93	3.01E+2	-	-	-	-	4.48E+6	8.25E+0
Zr-95	3.90E+6	8.58E+5	-	1.23E+6	-	8.95E+8	7.64E+5
Zr-97	5.64E+2	8.15E+1	-	1.17E+2	-	1.23E+7	4.81E+1
Nb-95	4.10E+5	1.59E+5	-	1.50E+5	-	2.95E+8	1.14E+5
Nb-97	4.90E-6	8.85E-7	-	9.82E-7	-	2.73E-1	4.13E-7
Mo-99	-	7.83E+6	-	1.67E+7	-	6.48E+6	1.94E+6
Tc-99m	4.65E+0	9.12E+0	-	1.33E+2	4.63E+0	5.19E+3	1.51E+2
Tc-101	-	-	-	-	-	-	-

Table G-7 (Continued)

R_i Vegetation Pathway Dose Factors - CHILD

(mrem/yr per μCi/m^3) for H-3 and C-14(m^2 x mrem/yr per μCi/sec) for others

Nuclide	Boue	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	1.55E+7	-	-	3.89E+7	-	3.99E+8	5.94E+6
Ru-105	9.17E+1	-	-	8.06E+2	-	5.98E+4	3.33E+1
Ru-106	7.45E+8	-	-	1.01E+9	-	1.16E+10	9.30E+7
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	3.22E+7	2.17E+7	-	4.05E+7	-	2.58E+9	1.74E+7
Sb-124	3.52E+8	4.57E+6	7.78E+5	-	1.96E+8	2.20E+9	1.23E+8
Sb-125	4.99E+8	3.85E+6	4.62E+5	-	2.78E+8	1.19E+9	1.05E+8
Te-125m	3.51E+8	9.50E+7	9.84E+7	-	-	3.38E+8	4.67E+7
Te-127m	1.32E+9	3.56E+8	3.16E+8	3.77E+9	-	1.07E+9	1.57E+8
Te-127	1.00E+4	2.70E+3	6.93E+3	2.85E+4	-	3.91E+5	2.15E+3
Te-129m	8.54E+8	2.39E+8	2.75E+8	2.51E+9	-	1.04E+9	1.33E+8
Te-129	1.15E-3	3.22E-4	8.22E-4	3.37E-3	-	7.17E-2	2.74E-4
Te-131m	1.54E+6	5.33E+5	1.10E+6	5.16E+6	-	2.16E+7	5.68E+5
Te-131	-	-	-	-	-	-	-
Te-132	6.98E+6	3.09E+6	4.50E+6	2.87E+7	-	3.11E+7	3.73E+6
I-130	6.21E+5	1.26E+6	1.38E+8	1.88E+6	-	5.87E+5	6.47E+5
I-131	1.43E+8	1.44E+8	4.76E+10	2.36E+8	-	1.28E+7	8.18E+7
I-132	9.20E+1	1.69E+2	7.84E+3	2.59E+2	-	1.99E+2	7.77E+1
I-133	3.59E+6	4.44E+6	8.25E+8	7.40E+6	-	1.79E+6	1.68E+6
I-134	1.70E-4	3.16E-4	7.28E-3	4.84E-4	-	2.10E-4	1.46E-4
I-135	6.54E+4	1.18E+5	1.04E+7	1.81E+5	-	8.98E+4	5.57E+4
Cs-134	1.60E+10	2.63E+10	-	8.14E+9	2.92E+9	1.42E+8	5.54E+9
Cs-136	8.06E+7	2.22E+8	-	1.18E+8	1.76E+7	7.79E+6	1.43E+8
Cs-137	2.39E+10	2.29E+10	-	7.46E+9	2.68E+9	1.43E+8	3.38E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	5.11E-2	2.73E-5	-	2.38E-5	1.61E-5	2.95E+0	1.48E-3
Ba-140	2.77E+8	2.43E+5	-	7.90E+4	1.45E+5	1.40E+8	1.62E+7
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	3.23E+3	1.13E+3	-	-	-	3.15E+7	3.81E+2
La-142	2.32E-4	7.40E-5	-	-	-	1.47E+1	2.32E-5
Ce-141	6.35E+5	3.26E+5	-	1.43E+5	-	4.07E+8	4.84E+4
Ce-143	1.73E+3	9.36E+5	-	3.93E+2	-	1.37E+7	1.36E+2
Ce-144	1.27E+8	3.98E+7	-	2.21E+7	-	1.04E+10	6.78E+6
Pr-143	1.48E+5	4.46E+4	-	2.41E+4	-	1.60E+8	7.37E+3
Pr-144	-	-	-	-	-	-	-
Nd-147	7.16E+4	5.80E+4	-	3.18E+4	-	9.18E+7	4.49E+3
W-187	6.47E+4	3.83E+4	-	-	-	5.38E+6	1.72E+4
Np-239	2.55E+3	1.83E+2	-	5.30E+2	-	1.36E+7	1.29E+2

Table G-8

R_i Grass-Cow-Milk Pathway Dose Factors - ADULT
(mrem/yr per μCi/m^3) for H-3 and C-14(m^2 x mrem/yr per μCi/sec) for others

Nuclide	Boue	Liver	Thyroid	Kidney	Luug	GI-LLI	T.Body
H-3	-	7.63E+2	7.63E+2	7.63E+2	7.63E+2	7.63E+2	7.63E+2
C-14	3.63E+5	7.26E+4	7.26E+4	7.26E+4	7.26E+4	7.26E+4	7.26E+4
Na-24	2.54E+6	2.54E+6	2.54E+6	2.54E+6	2.54E+6	2.54E+6	2.54E+6
P-32	1.71E+10	1.06E+9	-	-	-	1.92E+9	6.60E+8
Cr-51	-	-	1.71E+4	6.30E+3	3.80E+4	7.20E+6	2.86E+4
Mn-54	-	8.40E+6	-	2.50E+6	-	2.57E+7	1.60E+6
Mn-56	-	4.23E-3	-	5.38E-3	-	1.35E-1	7.51E-4
Fe-55	2.51E+7	1.73E+7	-	-	9.67E+6	9.95E+6	4.04E+6
Fe-59	2.98E+7	7.00E+7	-	-	1.95E+7	2.33E+8	2.68E+7
Co-57	-	1.28E+6	-	-	-	3.25E+7	2.13E+6
Co-58	-	4.72E+6	-	-	-	9.57E+7	1.06E+7
Co-60	-	1.64E+7	-	-	-	3.08E+8	3.62E+7
Ni-63	6.73E+9	4.66E+8	-	-	-	9.73E+7	2.26E+8
Ni-65	3.70E-1	4.81E-2	-	-	-	1.22E+0	2.19E-2
Cu-64	-	2.41E+4	-	6.08E+4	-	2.05E+6	1.13E+4
Zn-65	1.37E+9	4.36E+9	-	2.92E+9	-	2.75E+9	1.97E+9
Zn-69	-	-	-	-	-	-	-
Br-82	-	-	-	-	-	3.72E+7	3.25E+7
Br-83	-	-	-	-	-	1.49E-1	1.03E-1
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	2.59E+9	-	-	-	5.11E+8	1.21E+9
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	1.45E+9	-	-	-	-	2.33E+8	4.16E+7
Sr-90	4.68E+10	-	-	-	-	1.35E+9	1.15E+10
Sr-91	3.13E+4	-	-	-	-	1.49E+5	1.27E+3
Sr-92	4.89E-1	-	-	-	-	9.68E+0	2.11E-2
Y-90	7.07E+1	-	-	-	-	7.50E+5	1.90E+0
Y-91m	-	-	-	-	-	-	-
Y-91	8.60E+3	-	-	-	-	4.73E+6	2.30E+2
Y-92	5.42E-5	-	-	-	-	9.49E-1	1.58E-6
Y-93	2.33E-1	-	-	-	-	7.39E+3	6.43E-3
Zr-95	9.46E+2	3.03E+2	-	4.76E+2	-	9.62E+5	2.05E+2
Zr-97	4.26E-1	8.59E-2	-	1.30E-1	-	2.66E+4	3.93E-2
Nb-95	8.25E+4	4.59E+4	-	4.54E+4	-	2.79E+8	2.47E+4
Nb-97	-	-	-	-	-	5.47E-9	-
Mo-99	-	2.52E+7	-	5.72E+7	-	5.85E+7	4.80E+6
Tc-99m	3.25E+0	9.19E+0	-	1.40E+2	4.50E+0	5.44E+3	1.17E+2
Tc-101	-	-	-	-	-	-	-

Table G-8 (Continued)

R_i Grass-Cow-Milk Pathway Dose Factors - ADULT

(mrem/yr per μCi/m^3) for H-3 and C-14 (m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	1.02E+3	-	-	3.89E+3	-	1.19E+5	4.39E+2
Ru-105	8.57E-4	-	-	1.11E-2	-	5.24E-1	3.38E-4
Ru-106	2.04E+4	-	-	3.94E+4	-	1.32E+6	2.58E+3
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	5.83E+7	5.39E+7	-	1.06E+8	-	2.20E+10	3.20E+7
Sb-124	2.57E+7	4.86E+5	6.24E+4	-	2.00E+7	7.31E+8	1.02E+7
Sb-125	2.04E+7	2.28E+5	2.08E+4	-	1.58E+7	2.25E+8	4.86E+6
Te-125m	1.63E+7	5.90E+6	4.90E+6	6.63E+7	-	6.50E+7	2.18E+6
Te-127m	4.58E+7	1.64E+7	1.17E+7	1.86E+8	-	1.54E+8	5.58E+6
Te-127	6.72E+2	2.41E+2	4.98E+2	2.74E+3	-	5.30E+4	1.45E+2
Te-129m	6.04E+7	2.25E+7	2.08E+7	2.52E+8	-	3.04E+8	9.57E+6
Te-129	-	-	-	-	-	-	-
Te-131m	3.61E+5	1.77E+5	2.80E+5	1.79E+6	-	1.75E+7	1.47E+5
Te-131	-	-	-	-	-	-	-
Te-132	2.39E+6	1.55E+6	1.71E+6	1.49E+7	-	7.32E+7	1.45E+6
I-130	4.26E+5	1.26E+6	1.07E+8	1.96E+6	-	1.08E+6	4.96E+5
I-131	2.96E+8	4.24E+8	1.39E+11	7.27E+8	-	1.12E+8	2.43E+8
I-132	1.64E-1	4.37E-1	1.53E+1	6.97E-1	-	8.22E-2	1.53E-1
I-133	3.97E+6	6.90E+6	1.01E+9	1.20E+7	-	6.20E+6	2.10E+6
I-134	-	-	-	-	-	-	-
I-135	1.39E+4	3.63E+4	2.40E+6	5.83E+4	-	4.10E+4	1.34E+4
Cs-134	5.65E+9	1.34E+10	-	4.35E+9	1.44E+9	2.35E+8	1.10E+10
Cs-136	2.61E+8	1.03E+9	-	5.74E+8	7.87E+7	1.17E+8	7.42E+8
Cs-137	7.38E+9	1.01E+10	-	3.43E+9	1.14E+9	1.95E+8	6.61E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	4.70E-8	-	-	-	-	8.34E-8	1.38E-9
Ba-140	2.69E+7	3.38E+4		1.15E+4	1.93E+4	5.54E+7	1.76E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	4.49E+0	2.26E+0	-	-	-	1.66E+5	5.97E-1
La-142	-	-	-	-	-	3.03E-8	-
Ce-141	4.84E+3	3.27E+3	-	1.52E+3	-	1.25E+7	3.71E+2
Ce-143	4.19E+1	3.09E+4	-	1.36E+1	-	1.16E+6	3.42E+0
Ce-144	3.58E+5	1.50E+5	-	8.87E+4	-	1.21E+8	1.92E+4
Pr-143	1.59E+2	6.37E+1	-	3.68E+1	-	6.96E+5	7.88E+0
Pr-144	-	-	-	-	-	-	-
Nd-147	9.42E+1	1.09E+2	-	6.37E+1	-	5.23E+5	6.52E+0
W-187	6.56E+3	5.48E+3	-	-	-	1.80E+6	1.92E+3
Np-239	3.66E+0	3.60E-1	-	1.12E+0	-	7.39E+4	1.98E-1

Table G-9

R_i Grass-Cow-Milk Pathway Dose Factors - TEEN

(mrem/yr per μCi/m^3) for H-3 and C-14 (m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	9.94E+2	9.94E+2	9.94E+2	9.94E+2	9.94E+2	9.94E+2
C-14	6.70E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5	1.34E+5
Na-24	4.44E+6	4.44E+6	4.44E+6	4.44E+6	4.44E+6	4.44E+6	4.44E+6
P-32	3.15E+10	1.95E+9	-	-	-	2.65E+9	1.22E+9
Cr-51	-	-	2.78E+4	1.10E+4	7.13E+4	8.40E+6	5.00E+4
Mn-54	-	1.40E+7	-	4.17E+6	-	2.87E+7	2.78E+6
Mn-56	-	7.51E-3	-	9.50E-3	-	4.94E-1	1.33E-3
Fe-55	4.45E+7	3.16E+7	-	-	2.00E+7	1.37E+7	7.36E+6
Fe-59	5.20E+7	1.21E+8	-	-	3.82E+7	2.87E+8	4.68E+7
Co-57	-	2.25E+6	-	-	-	4.19E+7	3.76E+6
Co-58	-	7.95E+6	-	-	-	1.10E+8	1.83E+7
Co-60	-	2.78E+7	-	-	-	3.62E+8	6.26E+7
Ni-63	1.18E+10	8.35E+8	-	-	-	1.33E+8	4.01E+8
Ni-65	6.78E-1	8.66E-2	-	-	-	4.70E+0	3.94E-2
Cu-64	-	4.29E+4	-	1.09E+5	-	3.33E+6	2.02E+4
Zn-65	2.11E+9	7.31E+9	-	4.68E+9	-	3.10E+9	3.41E+9
Zn-69	-	-	-	-	-	-	-
Br-82	-	-	-	-	-	-	5.64E+7
Br-83	-	-	-	-	-	-	1.91E-1
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	4.73E+9	-	-	-	7.00E+8	2.22E+9
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	2.67E+9	-	-	-	-	3.18E+8	7.66E+7
Sr-90	6.61E+10	-	-	-	-	1.86E+9	1.63E+10
Sr-91	5.75E+4	-	-	-	-	2.61E+5	2.29E+3
Sr-92	8.95E-1	-	-	-	-	2.28E+1	3.81E-2
Y-90	1.30E+2	-	-	-	-	1.07E+6	3.50E+0
Y-91m	-	-	-	-	-	-	-
Y-91	1.58E+4	-	-	-	-	6.48E+6	4.24E+2
Y-92	1.00E-4	-	-	-	-	2.75E+0	2.90E-6
Y-93	4.30E-1	-	-	-	-	1.31E+4	1.18E-2
Zr-95	1.65E+3	5.22E+2	-	7.67E+2	-	1.20E+6	3.59E+2
Zr-97	7.75E-1	1.53E-1	-	2.32E-1	-	4.15E+4	7.06E-2
Nb-95	1.41E+5	7.80E+4	-	7.57E+4	-	3.34E+8	4.30E+4
Nb-97	-	-	-	-	-	6.34E-8	-
Mo-99	-	4.56E+7	-	1.04E+8	-	8.16E+7	8.69E+6
Tc-99m	5.64E+0	1.57E+1	-	2.34E+2	8.73E+0	1.03E+4	2.04E+2
Tc-101	-	-	-	-	-	-	-

Table G-9 (Continued)

R_i Grass-Cow-Milk Pathway Dose Factors - TEEN

(mrem/yr per μCi/m^3) for H-3 and C-14 (m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Luug	GI-LLI	T.Body
Ru-103	1.81E+3	-	-	6.40E+3	-	1.52E+5	7.75E+2
Ru-105	1.57E-3	-	-	1.97E-2	-	1.26E+0	6.08E-4
Ru-106	3.75E+4	-	-	7.23E+4	-	1.80E+6	4.73E+3
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	9.63E+7	9.11E+7	-	1.74E+8	-	2.56E+10	5.54E+7
Sb-124	4.59E+7	8.46E+5	1.04E+5	-	4.01E+7	9.25E+8	1.79E+7
Sb-125	3.65E+7	3.99E+5	3.49E+4	-	3.21E+7	2.84E+8	8.54E+6
Te-125m	3.00E+7	1.08E+7	8.39E+6	-	-	8.86E+7	4.02E+6
Te-127m	8.44E+7	2.99E+7	2.01E+7	3.42E+8	-	2.10E+8	1.00E+7
Te-127	1.24E+3	4.41E+2	8.59E+2	5.04E+3	-	9.61E+4	2.68E+2
Te-129m	1.11E+8	4.10E+7	3.57E+7	4.62E+8	-	4.15E+8	1.75E+7
Te-129	-	-	-	1.67E-9	-	2.18E-9	-
Te-131m	6.57E+5	3.15E+5	4.74E+5	3.29E+6	-	2.53E+7	2.63E+5
Te-131	-	-	-	-	-	-	-
Te-132	4.28E+6	2.71E+6	2.86E+6	2.60E+7	-	8.58E+7	2.55E+6
I-130	7.49E+5	2.17E+6	1.77E+8	3.34E+6	-	1.67E+6	8.66E+5
I-131	5.38E+8	7.53E+8	2.20E+11	1.30E+9	-	1.49E+8	4.04E+8
I-132	2.90E-1	7.59E-1	2.56E+1	1.20E+0	-	3.31E-1	2.72E-1
I-133	7.24E+6	1.23E+7	1.72E+9	2.15E+7	-	9.30E+6	3.75E+6
I-134	-	-	-	-	-	-	-
I-135	2.47E+4	6.35E+4	4.08E+6	1.00E+5		7.03E+4	2.35E+4
Cs-134	9.81E+9	2.31E+10	-	7.34E+9	2.80E+9	2.87E+8	1.07E+10
Cs-136	4.45E+8	1.75E+9	-	9.53E+8	1.50E+8	1.41E+8	1.18E+9
Cs-137	1.34E+10	1.78E+10	-	6.06E+9	2.35E+9	2.53E+8	6.20E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	8.69E-8	-	-	-	-	7.75E-7	2.53E-9
Ba-140	4.85E+7	5.95E+4	-	2.02E+4	4.00E+4	7.49E+7	3.13E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	8.06E+0	3.96E+0	-	-	-	2.27E+5	1.05E+0
La-142	-	-	-	-	-	2.23E-7	-
Ce-141	8.87E+3	5.92E+3	-	2.79E+3	-	1.69E+7	6.81E+2
Ce-143	7.69E+1	5.60E+4	-	2.51E+1	-	1.68E+6	6.25E+0
Ce-144	6.58E+5	2.72E+5	-	1.63E+5	-	1.66E+8	3.54E+4
Pr-143	2.92E+2	1.17E+2	-	6.77E+1	-	9.61E+5	1.45E+1
Pr-144	-	-	-	-	-	-	-
Nd-147	1.81E+2	1.97E+2	-	1.16E+2	-	7.11E+5	1.18E+1
W-187	1.20E+4	9.78E+3	-	-	-	2.65E+6	3.43E+3
Np-239	6.99E+0	6.59E-1	-	2.07E+0	-	1.06E+5	3.66E-1

Table G-10

R_i Grass-Cow-Milk Pathway Dose Factors - CHILD

(mrem/yr per μCi/m^3) for H-3 and C-14 (m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
H-3	-	1.57E+3	1.57E+3	1.57E+3	1.57E+3	1.57E+3	1.57E+3
C-14	1.65E+6	3.29E+5	3.29E+5	3.29E+5	3.29E+5	3.29E+5	3.29E+5
Na-24	9.23E+6	9.23E+6	9.23E+6	9.23E+6	9.23E+6	9.23E+6	9.23E+6
P-32	7.77E+10	3.64E+9	-	-	-	2.15E+9	3.00E+9
Cr-51	-	-	5.66E+4	1.55E+4	1.03E+5	5.41E+6	1.02E+5
Mn-54	-	2.09E+7	-	5.87E+6	-	1.76E+7	5.58E+6
Mn-56	-	1.31E-2	-	1.58E-2	-	1.90E+0	2.95E-3
Fe-55	1.12E+8	5.93E+7	-	-	3.35E+7	1.10E+7	1.84E+7
Fe-59	1.20E+8	1.95E+8	-	-	5.65E+7	2.03E+8	9.71E+7
Co-57	-	3.84E+6	-	-	-	3.14E+7	7.77E+6
Co-58	-	1.21E+7	-	-	-	7.08E+7	3.72E+7
Co-60	-	4.32E+7	-	-	-	2.39E+8	1.27E+8
Ni-63	2.96E+10	1.59E+9	-	-	-	1.07E+8	1.01E+9
Ni-65	1.66E+0	1.56E-1	-	-	-	1.91E+1	9.11E-2
Cu-64	-	7.55E+4	-	1.82E+5	-	3.54E+6	4.56E+4
Zn-65	4.13E+9	1.10E+10	-	6.94E+9	-	1.93E+9	6.85E+9
Zn-69	-	-	-	-	-	2.14E-9	-
Br-82	-	-	-	-	-	-	1.15E+8
Br-83	-	-	-	-	-	-	4.69E-1
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	8.77E+9	-	-	-	5.64E+8	5.39E+9
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	6.62E+9	-	-	-	-	2.56E+8	1.89E+8
Sr-90	1.12E+11	-	-	-	-	1.51E+9	2.83E+10
Sr-91	1.41E+5	-	-	-	-	3.12E+5	5.33E+3
Sr-92	2.19E+0	-	-	-	-	4.14E+1	8.76E-2
Y-90	3.22E+2	-	-	-	-	9.15E+5	8.61E+0
Y-91m	-	-	-	-	-	-	-
Y-91	3.91E+4	-	-	-	-	5.21E+6	1.04E+3
Y-92	2.46E-4	-	-	-	-	7.10E+0	7.03E-6
Y-93	1.06E+0	-	-	-	-	1.57E+4	2.90E-2
Zr-95	3.84E+3	8.45E+2	-	1.21E+3	-	8.81E+5	7.52E+2
Zr-97	1.89E+0	2.72E-1	-	3.91E-1	-	4.13E+4	1.61E-1
Nb-95	3.18E+5	1.24E+5	-	1.16E+5	-	2.29E+8	8.84E+4
Nb-97	-	-	-	-	-	1.45E-6	-
Mo-99	-	8.29E+7	-	1.77E+8	-	6.86E+7	2.05E+7
Tc-99m	1.29E+1	2.54E+1	-	3.68E+2	1.29E+1	1.44E+4	4.20E+2
Tc-101	-	-	-	-	-	-	-

Table G-10 (Continued)

R_i Grass-Cow-Milk Pathway Dose Factors - CHILD

(mrem/yr per $\mu Ci/m^3$) for H-3 and C-14 (m^2 x mrem/yr per $\mu Ci/sec$) for others

Nuclide	Boue	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	4.29E+3	-	-	1.08E+4	-	1.11E+5	1.65E+3
Ru-105	3.82E-3	-	-	3.36E-2	-	2.49E+0	1.39E-3
Ru-106	9.24E+4	-	-	1.25E+5	-	1.44E+6	1.15E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	2.09E+8	1.41E+8	-	2.63E+8	-	1.68E+10	1.13E+8
Sb-124	1.09E+8	1.41E+8	2.40E+5	-	6.03E+7	6.79E+8	3.81E+7
Sb-125	8.70E+7	1.41E+6	8.06E+4	-	4.85E+7	2.08E+8	1.82E+7
Te-125m	7.38E+7	2.00E+7	2.07E+7	-	-	7.12E+7	9.84E+6
Te-127m	2.08E+8	5.60E+7	4.97E+7	5.93E+8	-	1.68E+8	2.47E+7
Te-127	3.06E+3	8.25E+2	2.12E+3	8.71E+3	-	1.20E+5	6.56E+2
Te-129m	2.72E+8	7.61E+7	8.78E+7	8.00E+8	-	3.32E+8	4.23E+7
Te-129	-	-	-	2.87E-9	-	6.12E-8	-
Te-131m	1.60E+6	5.53E+5	1.14E+6	5.35E+6	-	2.24E+7	5.89E+5
Te-131	-	-	-	-	-	-	-
Te-132	1.02E+7	4.52E+6	6.58E+6	4.20E+7	-	4.55E+7	5.46E+6
I-130	1.75E+6	3.54E+6	3.90E+8	5.29E+6	-	1.66E+6	1.82E+6
I-131	1.30E+9	1.31E+9	4.34E+11	2.15E+9	-	1.17E+8	7.46E+8
I-132	6.86E-1	1.26E+0	5.85E+1	1.93E+0	-	1.48E+0	5.80E-1
I-133	1.76E+7	2.18E+7	4.04E+9	3.63E+7	-	8.77E+6	8.23E+6
I-134	-	-	-	-	-	-	-
I-135	5.84E+4	1.05E+5	9.30E+6	1.61E+5	-	8.00E+4	4.97E+4
Cs-134	2.26E+10	3.71E+10	-	1.15E+10	4.13E+9	2.00E+8	7.83E+9
Cs-136	1.00E+9	2.76E+9	-	1.47E+9	2.19E+8	9.70E+7	1.79E+9
Cs-137	3.22E+10	3.09E+10	-	1.01E+10	3.62E+9	1.93E+8	4.55E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	2.14E-7	-	-	-	-	1.23E-5	6.19E-9
Ba-140	1.17E+8	1.03E+5	-	3.34E+4	6.12E+4	5.94E+7	6.84E+6
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	1.93E+1	6.74E+0	-	-	-	1.88E+5	2.27E+0
La-142	-	-	-	-	-	2.51E-6	-
Ce-141	2.19E+4	1.09E+4	-	4.78E+3	-	1.36E+7	1.62E+3
Ce-143	1.89E+2	1.02E+5	-	4.29E+1	-	1.50E+6	1.48E+1
Ce-144	1.62E+6	5.09E+5	-	2.82E+5	-	1.33E+8	8.66E+4
Pr-143	7.23E+2	2.17E+2	-	1.17E+2	-	7.80E+5	3.59E+1
Pr-144	-	-	-	-	-	-	-
Nd-147	4.45E+2	3.60E+2	-	1.98E+2	-	5.71E+5	2.79E+1
W-187	2.91E+4	1.72E+4	-	-	-	2.42E+6	7.73E+3
Np-239	1.72E+1	1.23E+0	-	3.57E+0	-	9.14E+4	8.68E-1

Table G-11

R_i Grass-Cow-Milk Pathway Dose Factors - INFANT

(mrem/yr per $\mu Ci/m^3$) for H-3 and C-14 (m^2 x mrem/yr per $\mu Ci/sec$) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Luug	GI-LLI	T.Body
H-3	-	2.38E+3	2.38E+3	2.38E+3	2.38E+3	2.38E+3	2.38E+3
C-14	3.23E+6	6.89E+5	6.89E+5	6.89E+5	6.89E+5	6.89E+5	6.89E+5
Na-24	1.61E+7	1.61E+7	1.61E+7	1.61E+7	1.61E+7	1.61E+7	1.61E+7
P-32	1.60E+11	9.42E+9	-	-	-	2.17E+9	6.21E+9
Cr-51	-	-	1.05E+5	2.30E+4	2.05E+5	4.71E+6	1.61E+5
Mn-54	-	3.89E+7	-	8.63E+6	-	1.43E+7	8.83E+6
Mn-56	-	3.21E-2	-	2.76E-2	-	2.91E+0	5.53E-3
Fe-55	1.35E+8	8.72E+7	-	-	4.27E+7	1.11E+7	2.33E+7
Fe-59	2.25E+8	3.93E+8	-	-	1.16E+8	1.88E+8	1.55E+8
Co-57	-	8.95E+6	-	-	-	3.05E+7	1.46E+7
Co-58	-	2.43E+7	-	-	-	6.05E+7	6.06E+7
Co-60	-	8.81E+7	-	-	-	2.10E+8	2.08E+8
Ni-63	3.49E+10	2.16E+9	-	-	-	1.07E+8	1.21E+9
Ni-65	3.51E+0	3.97E-1	-	-	-	3.02E+1	1.81E-1
Cu-64	-	1.88E+5	-	3.17E+5	-	3.85E+6	8.69E+4
Zn-65	5.55E+9	1.90E+10	-	9.23E+9	-	1.61E+10	8.78E+9
Zn-69	-	-	-	-	-	7.36E-9	-
Br-82	-	-	-	-	-	-	1.94E+8
Br-83	-	-	-	-	-	-	9.95E-1
Br-84	-	-	-	-	-	-	-
Br-85	-	-	-	-	-	-	-
Rb-86	-	2.22E+10	-	-	-	5.69E+8	1.10E+10
Rb-88	-	-	-	-	-	-	-
Rb-89	-	-	-	-	-	-	-
Sr-89	1.26E+10	-	-	-	-	2.59E+8	3.61E+8
Sr-90	1.22E+11	-	-	-	-	1.52E+9	3.10E+10
Sr-91	2.94E+5	-	-	-	-	3.48E+5	1.06E+4
Sr-92	4.65E+0	-	-	-	-	5.01E+1	1.73E-1
Y-90	6.80E+2	-	-	-	-	9.39E+5	1.82E+1
Y-91m	-	-	-	-	-	-	-
Y-91	7.33E+4	-	-	-	-	5.26E+6	1.95E+3
Y-92	5.22E-4	-	-	-	-	9.97E+0	1.47E-5
Y-93	2.25E+0	-	-	-	-	1.78E+4	6.13E-2
Zr-95	6.83E+3	1.66E+3	-	1.79E+3	-	8.28E+5	1.18E+3
Zr-97	3.99E+0	6.85E-1	-	6.91E-1	-	4.37E+4	3.13E-1
Nb-95	5.93E+5	2.44E+5	-	1.75E+5	-	2.06E+8	1.41E+5
Nb-97	-	-	-	-	-	3.70E-6	-
Mo-99	-	2.12E+8	-	3.17E+8	-	6.98E+7	4.13E+7
Tc-99m	2.69E+1	5.55E+1	-	5.97E+2	2.90E+1	1.61E+4	7.15E+2
Tc-101	-	-	-	-	-	-	-

Table G-11 (Continued)

R_i Grass-Cow-Milk Pathway Dose Factors - INFANT

(mrem/yr per μCi/m^3) for H-3 and C-14 (m^2 x mrem/yr per μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	T.Body
Ru-103	8.69E+3	-	-	1.81E+4	-	1.06E+5	2.91E+3
Ru-105	8.06E-3	-	-	5.92E-2	-	3.21E+0	2.71E-3
Ru-106	1.90E+5	-	-	2.25E+5	-	1.44E+6	2.38E+4
Rh-103m	-	-	-	-	-	-	-
Rh-106	-	-	-	-	-	-	-
Ag-110m	3.86E+8	2.82E+8	-	4.03E+8	-	1.46E+10	1.86E+8
Sb-124	2.09E+8	3.08E+6	5.56E+5	-	1.31E+8	6.46E+8	6.49E+7
Sb-125	1.49E+8	1.45E+6	1.87E+5	-	9.38E+7	1.99E+8	3.07E+7
Te-125m	1.51E+8	5.04E+7	5.07E+7	-	-	7.18E+7	2.04E+7
Te-127m	4.21E+8	1.40E+8	1.22E+8	1.04E+9	-	1.70E+8	5.10E+7
Te-127	6.50E+3	2.18E+3	5.29E+3	1.59E+4	-	1.36E+5	1.40E+3
Te-129m	5.59E+8	1.92E+8	2.15E+8	1.40E+9	-	3.34E+8	8.62E+7
Te-129	2.08E-9	-	1.75E-9	5.18E-9	-	1.66E-7	-
Te-131m	3.38E+6	1.36E+6	2.76E+6	9.35E+6	-	2.29E+7	1.12E+6
Te-131	-	-	-	-	-	-	-
Te-132	2.10E+7	1.04E+7	1.54E+7	6.51E+7	-	3.85E+7	9.72E+6
I-130	3.60E+6	7.92E+6	8.88E+8	8.70E+6	-	1.70E+6	3.18E+6
I-131	2.72E+9	3.21E+9	1.05E+12	3.75E+9	-	1.15E+8	1.41E+9
I-132	1.42E+0	2.89E+0	1.35E+2	3.22E+0	-	2.34E+0	1.03E+0
I-133	3.72E+7	5.41E+7	9.84E+9	6.36E+7	-	9.16E+6	1.58E+7
I-134	-	-	1.01E-9	-	-	-	-
I-135	1.21E+5	2.41E+5	2.16E+7	2.69E+5	-	8.74E+4	8.80E+4
Cs-134	3.65E+10	6.80E+10	-	1.75E+10	7.18E+9	1.85E+8	6.87E+9
Cs-136	1.96E+9	5.77E+9	-	2.30E+9	4.70E+8	8.76E+7	2.15E+9
Cs-137	5.15E+10	6.02E+10	-	1.62E+10	6.55E+9	1.88E+8	4.27E+9
Cs-138	-	-	-	-	-	-	-
Ba-139	4.55E-7	-	-	-	-	2.88E-5	1.32E-8
Ba-140	2.41E+8	2.41E+5	-	5.73E+4	1.48E+5	5.92E+7	1.24E+7
Ba-141	-	-	-	-	-	-	-
Ba-142	-	-	-	-	-	-	-
La-140	4.03E+1	1.59E+1	-	-	-	1.87E+5	4.09E+0
La-142	-	-	-	-	-	5.21E-6	-
Ce-141	4.33E+4	2.64E+4	-	8.15E+3	-	1.37E+7	3.11E+3
Ce-143	4.00E+2	2.65E+5	-	7.72E+1	-	1.55E+6	3.02E+1
Ce-144	2.33E+6	9.52E+5	-	3.85E+5	-	1.33E+8	1.30E+5
Pr-143	1.49E+3	5.59E+2	-	2.08E+2	-	7.89E+5	7.41E+1
Pr-144	-	-	-	-	-	-	-
Nd-147	8.82E+2	9.06E+2	-	3.49E+2	-	5.74E+5	5.55E+1
W-187	6.12E+4	4.26E+4	-	-	-	2.50E+6	1.47E+4
Np-239	3.64E+1	3.25E+0	-	6.49E+0	-	9.40E+4	1.84E+0

Table G-12

R_i Ground Plane Pathway Dose Factors
(m^2 x mrem/yr per μCi/sec)

Nuclide	Any Organ
H-3	-
C-14	-
Na-24	1.21E+7
P-32	-
Cr-51	4.68E+6
Mn-54	1.34E+9
Mn-56	9.05E+5
Fe-55	-
Fe-59	2.75E+8
Co-57	4.37E+8
Co-58	3.82E+8
Co-60	2.16E+10
Ni-63	-
Ni-65	2.97E+5
Cu-64	6.09E+5
Zn-65	7.45E+8
Zn-69	-
Br-82	4.57E+7
Br-83	4.89E+3
Br-84	2.03E+5
Br-85	-
Rb-86	8.98E+6
Rb-88	3.29E+4
Rb-89	1.21E+5
Sr-89	2.16E+4
Sr-90	-
Sr-91	2.19E+6
Sr-92	7.77E+5
Y-90	4.48E+3
Y-91m	1.01E+5
Y-91	1.08E+6
Y-92	1.80E+5
Y-93	1.85E+5
Zr-95	2.48E+8
Zr-97	2.94E+6
Nb-95	1.36E+8
Nb-97	2.28E+6
Mo-99	4.05E+6
Tc-99m	1.83E+5
Tc-101	2.04E+4
Ru-103	1.09E+8
Ru-105	6.36E+5
Ru-106	4.21E+8

Table G-12 (Continued)

R_i Ground Plane Pathway Dose Factors

(m^2 x mrem/yr per μCi/sec)

Nuclide	Any Organ
Rh-103m	-
Rh-106	-
Ag-110m	3.47E+9
Sb-124	2.87E+9
Sb-125	6.49E+9
Te-125m	1.55E+6
Te-127m	9.17E+4
Te-127	3.00E+3
Te-129m	2.00E+7
Te-129	2.60E+4
Te-131m	8.03E+6
Te-131	2.93E+4
Te-132	4.22E+6
I-130	5.53E+6
I-131	1.72E+7
I-132	1.24E+6
I-133	2.47E+6
I-134	4.49E+5
I-135	2.56E+6
Cs-134	6.75E+9
Cs-136	1.49E+8
Cs-137	1.04E+10
Cs-138	3.59E+5
Ba-139	1.06E+5
Ba-140	2.05E+7
Ba-141	4.18E+4
Ba-142	4.49E+4
La-140	1.91E+7
La-142	7.36E+5
Ce-141	1.36E+7
Ce-143	2.32E+6
Ce-144	6.95E+7
Pr-143	-
Pr-144	1.83E+3
Nd-147	8.40E+6
W-187	2.36E+6
Np-239	1.71E+6

APPENDIX A

TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS -

LIQUID RADIOACTIVE EFFLUENTS

APPENDIX A

Technical Basis for Effective Dose Factors - Liquid Effluent Releases

The radioactive liquid effluents for the fuel cycle years 1983, 1982 and 1981 were evaluated to determine the dose contribution of the radionuclide distribution. This analysis was performed to evaluate the use of a limited dose analysis for determining environmental doses, providing a simplified method of determining compliance with the dose limits of Technical Specification 7.3.2. For the radionuclide distribution of effluents from the Kewaunee Nuclear Power Plant, the controlling organ is either the GI-LLI or the liver. The calculated GI-LLI dose is almost exclusively dictated by the Nb-95 releases; the liver dose is mostly a function of the Cs-134 and Cs-137 releases. The radionuclides, Co-58, Co-60, Sr-90, Cs-134 and Cs-137 contribute essentially all of the calculated total body dose. The results of this evaluation are presented in Table A-1.

For purposes of simplifying the details of the dose calculational process, it is conservative to identify a controlling, dose significant radionuclide and limit the calculational process to the use of the dose conversion factor for this nuclide. Multiplication of the total release (i.e., cumulative activity for all radionuclides) by this dose conversion factor provides for a dose calculational method that is simplified while also being conservative.

For the evaluation of the maximum organ dose, it is conservative to use the Cs-134 dose conversion factor (7.09E+05 mrem/hr per μCi/ml, liver). Only the reactor-generated radionuclide Nb-95 has a higher dose conversion factor (1.51E+06 mrem/hr per μCi/ml, GI-LLI). However, since Nb-95 releases are typically less than 5% of the total releases, it is conservative to use the Cs-134 factor. By this approach, the maximum organ dose will be routinely overestimated. For 1983, using this simplified conservative method would overestimate the maximum organ dose by a factor of 85; for 1982, the conservatism is a factor of 35; and for 1981, a factor of 21.

For the total body calculation, the Cs-134 dose factor (5.79E+05 mrem/hr per μCi/ml, total body) is the highest among the identified dominant nuclides. For 1981, using this simplified conservative dose calculational method would overestimate the total body dose by a factor of 26; for 1982, the conservatism is a factor of 50; and for 1983, a factor of 34.

For evaluating compliance with the dose limits of Technical Specification 7.3.2 the following simplified equations may be used:

Total Body

$$D_{tb} = \frac{1.67E-02 \times VOL}{CW} \times A_{Cs-134,TB} \times \sum C_i \qquad (A.1)$$

where:

D_{tb} = dose to the total body (mrem)

$A_{Cs-134,TB}$ = 5.79E+05, total body ingestion dose conversion factor for Cs-134 (mrem/hr per μCi/ml)

VOL = volume of liquid effluent released (gal)

$\sum C_i$ = total concentration of all radionuclides (μCi/ml)

CW = average circulating water discharge rate during release period (gal/min)

1.67E-02 = conversion factor (hr/min)

Substituting the value for the Cs-134 total body dose conversion factor, the equation simplifies to:

$$D_{tb} = \frac{9.67E+03 \times VOL}{CW} \times \sum C_i \qquad (A.2)$$

Maximum Organ

$$D_{max} = \frac{1.67E-02 \times VOL \times A_{Cs-134,L}}{CW} \times \sum C_i \qquad (A.3)$$

where:

D_{max} = maximum organ dose (mrem)

$A_{Cs-134,L}$ = 7.09E+05, liver ingestion dose conversion factor for Cs-134 (mrem/hr per μCi/ml)

Substituting the value for $A_{Cs-134,Liver}$, the equation simplifies to:

$$D_{max} = \frac{1.18E+04 \times VOL}{CW} \times \sum C_i \qquad (A.4)$$

Only the total body dose need be evaluated by this simplified method since it represents the more limiting (compared with the maximum organ dose) for demonstrating compliance with Technical Specification 7.3.2.

Tritium is not included in the limited analysis dose assessment for liquid releases, because the potential dose resulting from normal reactor releases is negligible. The average annual tritium release from the Kewaunee Nuclear Plant to Lake Michigan is approximately 300 curies. The calculated total body dose from such a release is 1.36E-02 mrem/yr via the fish ingestion and drinking water pathways. This amounts to 0.45% of the design objective dose of 3 mrem/yr. Furthermore, the release of tritium is a function of operating time and power level and is essentially unrelated to radwaste system operation.

Appendix A

Table A-1
Adult Dose Contributions
Fish and Drinking Water Patbways

	1983-84 Fuel Cycle				1982-83 Fuel Cycle				1981-82 Fuel Cycle			
Radio-Nuclide	Rclease (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frac.	Release (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frae.	Release (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frac.
Co-58	5.91E-01	0.01	0.02	*	2.27E-01	0.01	0.18	*	8.51E-01	0.01	0.37	*
Co-60	1.29E-01	*	0.01	*	2.36E-01	0.02	0.49	0.01	3.66E-01	0.01	0.43	*
Ag-110m	8.41E-02	*	*	*	1.57E-01	*	*	*	2.06E-02	*	*	*
Sb-124	9.46E-02	*	*	*	3.78E-03	*	*	*	2.88E-02	*	*	*
Sb-125	4.60E-02	*	*	*	8.06E-03	*	*	*	2.07E-02	*	*	*
Nb-95	3.91E-02	*	0.96	*	3.67E-04	*	0.24	*	N/D		*	*
Cs-137	3.24E-02	0.64	0.01	0.69	2.08E-02	0.94	0.09	0.96	5.53E-02	0.62	0.14	0.68
Cs-134	1.06E-02	0.35	*	0.31	4.52E-04	0.03	*	0.03	1.93E-02	0.37	0.06	0.32
Total	1.03E+00			6.53E-01				1.36E+00				

*Less than 0.01

N/D = not detected

APPENDIX B

TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS - GASEOUS RADIOACTIVE EFFLUENTS

APPENDIX B

Technical Bases for Effective Dose Factors - Gaseous Radioactive Effluents

Overview

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 can be based on typical radionuclide distributions of releases, can be applied to the total radioactivity released to approximate the dose in the environment (i.e., instead of having to perform individual radionuclide dose analyses only a single multiplication (K_{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 calculational technique.

Determination of Effective Dose Factors

Effective dose transfer factors are calculated by the following equations:

$$K_{eff} = \sum (K_i \times f_i) \qquad \text{(B.1)}$$

where:

K_{eff} = the effective total body dose factor due to gamma emissions from all noble gases released

K_i = the total body dose factor due to gamma emissions from each noble gas radionuclide i released

f_i = the fractional abundance of noble gas radionuclide i relative to the total noble gas activity

$$(L + 1.1\ M_{eff}) = \sum ((L_i + 1.1\ M_i) \times f_i) \qquad \text{(B.2)}$$

where:

$(L + 1.1\ M_{eff})$ = the effective skin dose factor due to beta and gamma emissions from all noble gases released

$(L_i + 1.1\ M_i)$ = the skin dose factor due to beta and gamma emissions from each noble gas radionuclide i released

$$M_{eff} = \sum (M_i \times f_i)$$

(B.3)

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

$$N_{eff} = \sum (N_i \times f_i)$$

(B.4)

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

Normally, it would be expected that past radioactive effluent data would be used for the determination of the effective dose factors. However, the noble gas releases from Kewaunee have been maintained to such negligible quantities that the inherent variability in the data makes any meaningful evaluations difficult. For the years of 1981, 1982 and 1983, the total noble gas releases have been limited to 6 Ci for 1981, 56 Ci for 1982, and 167 Ci for 1983. Therefore, in order to provide a reasonable basis for the derivation of the effective noble gas dose factors, the primary coolant source term from ANSI N237-1976/ANS-18.1, "Source Term Specifications," has been used as representing a typical distribution. The effective dose factors as derived are presented in Table B-1.

Application

To provide an additional degree of conservatism, a factor of 0.50 is introduced into the dose calculational process when the effective dose transfer factor is used. This conservatism provides additional assurance that the evaluation of doses by the use of a single effective factor will not significantly underestimate any actual doses in the environment.

For evaluating compliance with the dose limits of Technical Specification 7.4.2, the following simplified equations may be used:

$$D\gamma = \frac{3.17E-08}{0.50} \times X/Q \times M_{eff} \times \sum Q_i \qquad (B.5)$$

$$D_\beta = \frac{3.17E-08}{0.50} \times X/Q \times N_{eff} \times \sum Q_i \qquad (B.6)$$

where:

$D\gamma$	=	air dose due to gamma emissions for the cumulative release of all noble gases (mrad)
D_β	=	air dose due to beta emissions for the cumulative release of all noble gases (mrad)
X/Q	=	atmospheric dispersion to the controlling site boundary (sec/m^3)
M_{eff}	=	5.3E+02, effective gamma-air dose factor (mrad/yr per $\mu Ci/m^3$)
N_{eff}	=	1.1E+03, effective beta-air dose factor (mrad/yr per $\mu Ci/m^3$)
$\sum$ Qi	=	cumulative release for all noble gas radionuclides (μCi)
3.17E-08	=	conversion factor (yr/sec)
0.50	=	conservatism factor to account for the variability in the effluent data

Combining the constants, the dose calculational equations simplify to:

$$D\gamma = 3.5E\text{-}05 \times X/Q \times \sum Q_i \quad \text{(B.7)}$$

and

$$D_\beta = 7.0E\text{-}05 \times X/Q \times \sum Q_i \quad \text{(B.8)}$$

The effective dose factors are used on a very limited basis for the purpose of facilitating the timely assessment of radioactive effluent releases, particularly during periods of computer malfunction where a detailed dose assessment may be unavailable. Dose assessments using the detailed, radionuclide dependent calculation are performed at least every six months for preparation of the Semi-Annual Radioactive Effluent Reports. Comparisons can be performed at this time to assure that the use of the effective dose factors does not substantially underestimate actual doses.

APPENDIX B

Table B-1

Effective Dose Factors - Noble Gases

Noble Gases - Total Body and Skin

Radionuclide	f_i	Total Body Effective Dose Factor K_{eff} (mrem/yr per $\mu Ci/m^3$)	Skin Effective Dose Factor $(L+1.1\ M)_{eff}$ (mrem/yr per $\mu Ci/m^3$)
Kr-85	0.01	--	1.4E+01
Kr-88	0.01	1.5E+02	1.9E+02
Xe-133m	0.01	2.5E+00	1.4E+01
Xe-133	0.95	3.0E+02	6.6E+02
Xe-135	0.02	3.6E+01	7.9E+01
TOTAL		4.8E+02	9.6E+02

Noble Gases - Air

Radionuclide	f_i	Gamma Air Effective Dose Factor M_{eff} (mrad/yr per $\mu Ci/m^3$)	Beta Air Effective Dose Factor N_{eff} (mrad/yr per $\mu Ci/m^3$)
Kr-85	0.01	--	2.0E+01
Kr-88	0.01	1.5E+02	2.9E+01
Xe-133m	0.01	3.3E+00	1.5E+01
Xe-133	0.95	3.4E+02	1.0E+03
Xe-135	0.02	3.8E+01	4.9E+01
TOTAL		5.3E+02	1.1E+03

APPENDIX C

EVALUATION OF CONSERVATIVE, DEFAULT MPC VALUE FOR LIQUID EFFLUENTS

Appendix C

Evaluation of Conservative, Default MPC Value for Liquid Effluents

In accordance with the requirements of Technical Specification 7.1 the radioactive liquid effluent monitors shall be operable with alarm setpoints established to ensure that the concentration of radioactive material at the discharge point does not exceed the MPC value of 10 CFR 20, Appendix B, Table II, Column 2. The determination of allowable radionuclide concentration and corresponding alarm setpoint is a function of the individual radionuclide distribution and corresponding MPC values.

In order to limit the need for routinely having to reestablish the alarm setpoints as a function of changing radionuclide distributions, a default alarm setpoint can be established. This default setpoint can be conservatively based on an evaluation of the radionuclide distribution of the liquid effluents from Kewaunee and the effective MPC value for this distribution.

The effective MPC value for a radionuclide distribution can be calculated by the equation:

$$MPC_e = \frac{\sum C_i}{\sum \frac{C_i}{MPC_i}} \qquad (C.1)$$

where:

MPC_e = an effective MPC value for a mixture of radionuclide (μCi/ml)

C_i = concentration of radionuclide i in the mixture

MPC_i = the 10 CFR 20, Appendix B, Table II, Column 2 MPC value for radionuclide i (μCi/ml)

Based on the above equation and the radionuclide distribution in the effluents for past years from Kewaunee, an effective MPC value can be determined. Results are presented in Table C-1.

Based on the annual radionuclide distributions, the most limiting effective MPC was for the calendar year 1983, with a calculated value of 3.8E-05 μCi/ml. For conservatism in establishing the alarm setpoints, a default effective MPC value of 1.0E-05 μCi/ml was selected. The overall conservatism of this value is reaffirmed for future releases considering that 1.0E-05 μCi/ml is more restrictive than the individual MPC values for the principal fission and activation products of Co-58, Co-60 and Cs-137 and is only slightly higher than the 9.0E-06 μCi/ml MPC value for Cs-134.

In 1992, Table C-1 was updated to include data from 1984 through 1991. The default effective MPC value of 1.0E-05 μCi/ml previously established was reaffirmed as being a conservative value. Note that the 1984 through 1991 data includes more nuclides than previous years data.

Appendix C

Table C-1
Calculation of Effective MPC

Nuclide	MPC (μCi/ml)	Activity Released (Ci) 1976 - 1981 avg.	1982	1983
Sr-89	3E-06	1.OE-03	3E-05	2E-04
Sr-90	3E-07	2.5E-04	5E-05	1.2E-04
Nb-95	1E-04	5.4E-03	2.4E-03	2.5E-03
1-131	3E-07	1.9E-02	--	3E-05
I-133	1E-06	7.4E-04	--	2E-05
Cs-134	9E-06	7.4E-02	1.1E-02	9.1E-04
Cs-136	6E-05	5.2E-04	--	--
Cs-137	2E-05	5.7E-02	4.7E-02	2.1E-02
Cs-138	--	1.2E-04	--	--
Ba-140	2E-05	4.5E-04	--	6E-06
Mn-54	1E-04	4.5E-02	9E-03	3.6E-03
Co-57	4E-04	3.1E-04	1.7E-04	1.8E-04
Co-58	9E-05	5.5E-01	8.1E-01	2.1E-01
Co-60	3E-05	1.6E-01	3.7E-01	2.OE-01
Sb-124	2E-05	3.4E-02	3E-02	3.8E-03
Sb-125	1E-04	3.4E-02	1.8E-02	8.4E-03
Cr-51	2E-03	4.6E-02	1E-02	2.8E-03
Ag-110m	3E-05	4.3E-02	1.5E-01	7.2E-02
Na-24	3E-05	9.7E-03	1E-05	8.3E-04
Fe-59	5E-05	6.1E-03	4.4E-03	--
Sn-113	8E-05	6.1E-04	1E-04	8E-05
Zr-95	6E-05	2.2E-03	8E-04	4E-04
Total		1.09	1.46	0.53
$\frac{Ci}{MPCi}$		9.2E+04	3.2E+04	1.4E+04
MPC_e (μCi/ml)		1.2E-05	4.6E-05	3.8E-05

Table C-1 (con't) - Calculation of Effective MPC

Nuclide	MPC (µCi/ml)	Activity Released (Ci)				
		1984	1985	1986	1987	1988
Na-24	3.0E-05	1.42E-03	6.90E-03	5.85E-04	6.16E-04	3.08E-04
Cr-51	2.0E-03	2.57E-03	2.94E-02	4.08E-03	2.02E-02	8.36E-03
Mn-54	1.0E-04	6.06E-03	8.53E-03	1.94E-03	3.37E-03	4.87E-03
Fe-55	8.0E-04	7.45E-03		5.24E-02	1.21E-01	7.23E-02
Mn-56	1.0E-04				8.38E-05	
Co-57	4.0E-04	9.47E-04	2.19E-04	1.01E-04	8.03E-05	3.55E-04
Co-58	9.0E-05	5.78E-01	2.69E-01	1.92E-01	1.86E-01	2.68E-01
Fe-59	5.0E-05	3.62E-04	3.36E-03	1.03E-03	5.02E-03	1.94E-03
Co-60	3.0E-05	1.03E-01	1.41E-01	6.32E-02	4.62E-02	6.22E-02
Ni-63	3.0E-05			2.24E-02		
Sr-89	3.0E-06	2.05E-03	1.40E-04		4.61E-05	6.77E-05
Sr-90	3.0E-07	2.59E-04	3.48E-05		1.54E-05	3.79E-06
Nb-95	1.0E-04	1.23E-03	1.83E-02	2.20E-03	5.32E-03	1.36E-03
Zr-95	6.0E-05	7.30E-04	1.05E-02	6.89E-04	2.36E-03	9.53E-04
Nb-97	1.0E-04	3.91E-02				
Zr-97	2.0E-05	3.55E-04				
Mo-99	4.0E-05					
Ru-103	8.0E-05					
Ag-110m	3.0E-05	8.33E-02	3.82E-02	2.97E-02	8.43E-02	2.32E-02
Sn-113	8.0E-05	1.77E-03	3.85E-03	1.27E-03	1.43E-03	7.88E-04
Sn-117m	3.0E-06					
Sb-122	3.0E-05				1.91E-04	4.48E-04
Sb-124	2.0E-05	9.51E-02	3.95E-02	2.74E-02	2.92E-02	1.52E-02
Sb-125	1.0E-04	4.73E-02	3.07E-02	1.83E-02	2.25E-02	1.15E-02
I-131	3.0E-07	4.44E-05	3.04E-04		1.31E-04	1.33E-03
I-132	8.0E-06			3.44E-05	1.88E-04	
I-133	1.0E-06	4.12E-05		3.64E-05	5.76E-04	2.62E-04
Cs-134	9.0E-06	1.31E-02	5.62E-03	6.51E-04	2.06E-04	1.75E-03
I-134	2.0E-05			1.40E-03		
I-135	4.0E-06				4.31E-04	2.60E-05
Cs-136	6.0E-05					1.92E-04
Cs-137	2.0E-05	2.04E-02	2.24E-02	3.63E-03	2.97E-03	7.91E-03
Cs-138	3.0E-06	8.01E-04				
Ce-139	3.0E-06	3.28E-07				
Ba-140	2.0E-05					
La-140	2.0E-05		7.32E-05	4.07E-05	2.09E-04	2.63E-05
Ce-144	1.0E-05		9.01E-06			
W-187	6.0E-05					
Total Activity (Ci)		1.01E+00	6.28E-01	4.23E-01	5.33E-01	4.83E-01
MPCe (µCi/ml)		4.39E-05	4.19E-05	5.24E-05	5.37E-05	3.94E-05

Table C-1 (con't) - Calculation of Effective MPC

Nuclide	MPC (µCi/ml)	Activity Released (Ci)		
		1989	1990	1991
Na-24	3.0E-05	5.12E-05	1.53E-05	3.58E-05
Cr-51	2.0E-03	9.59E-04	2.02E-02	1.38E-02
Mn-54	1.0E-04	5.75E-03	2.85E-03	2.34E-03
Fe-55	8.0E-04	1.54E-01	1.53E-02	4.07E-02
Mn-56	1.0E-04			
Co-57	4.0E-04	6.67E-04	4.16E-05	1.97E-04
Co-58	9.0E-05	4.58E-01	8.79E-02	1.01E-01
Fe-59	5.0E-05	4.18E-03	3.05E-03	3.68E-03
Co-60	3.0E-05	9.12E-02	3.36E-02	3.45E-02
Ni-63	3.0E-05			
Sr-89	3.0E-06			2.12E-06
Sr-90	3.0E-07			
Nb-95	1.0E-04	1.43E-02	5.73E-03	4.87E-03
Zr-95	6.0E-05	1.00E-02	3.97E-03	3.07E-03
Nb-97	1.0E-04			
Zr-97	2.0E-05	3.98E-04	1.17E-04	6.21E-05
Mo-99	4.0E-05	3.16E-07		
Ru-103	8.0E-05	6.95E-06		
Ag-110m	3.0E-05	6.12E-02	1.92E-02	1.31E-02
Sn-113	8.0E-05	4.38E-03	2.36E-03	1.93E-03
Sn-117m	3.0E-06			7.21E-05
Sb-122	3.0E-05	5.69E-02	1.53E-05	1.48E-04
Sb-124	2.0E-05	1.22E-02	1.90E-03	2.10E-03
Sb-125	1.0E-04	9.04E-03	2.47E-03	2.61E-03
I-131	3.0E-07	1.45E-03		
I-132	8.0E-06			
I-133	1.0E-06			
Cs-134	9.0E-06	7.47E-03	6.92E-04	1.49E-04
I-134	2.0E-05			
I-135	4.0E-06			
Cs-136	6.0E-05			
Cs-137	2.0E-05	6.25E-03	8.02E-04	1.95E-04
Cs-138	3.0E-06			
Ce-139	3.0E-06			
Ba-140	2.0E-05			
La-140	2.0E-05	2.49E-04		
Ce-144	1.0E-05			
W-187	6.0E-05	9.02E-04	6.87E-04	1.83E-04
Total Activity (Ci)		9.00E-01	2.01E-01	2.25E-01
MPCe (µCi/ml)		4.62E-05	6.16E-05	7.06E-05

APPENDIX D

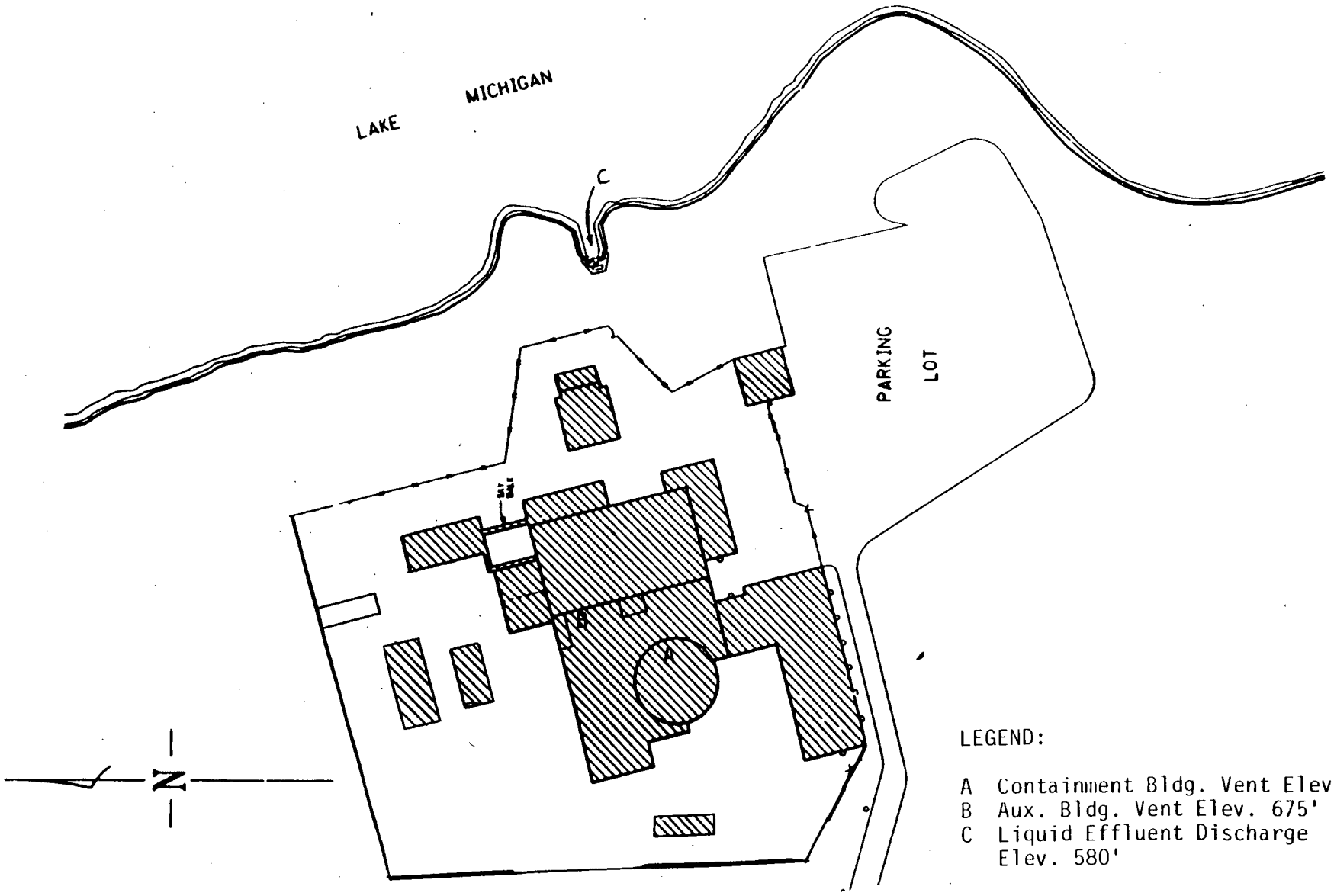
Site Maps

Appendix D

Site Maps

Plant drawing A-408, "Radiological Survey Site Map" depicts the site area by illustrating the site boundary and the restricted areas. The area within the site boundary but outside the restricted area is considered the onsite unrestricted area. Plant drawing A-449, "Plan of Plant Area, Fence, Lighting, and CCTV Support Structure" shows the layout of the site buildings. Much of the land located within the unrestricted area is used for recreational or agricultural purposes. The pier, at the liquid discharge of the plant, is often occupied by fishermen. Occupancy factors for this location is estimated to be five fishermen per day. The pier is open to the public from 4 AM to 11 PM. Admittance hours are posted. The school forest is most often visited by the Kewaunee County school system for educational purposes. It is estimated that 250 students visit this area per year.

Figure D-1 presents the locations and elevations of radioactive effluent release points at the plant. The plant drawings referenced above are not included as part of the ODCM but can be found in the plant drawing system.



LEGEND:

A Containment Bldg. Vent Elev. 775'
B Aux. Bldg. Vent Elev. 675'
C Liquid Effluent Discharge Elev. 580'

Figure D-1

Rev. 4
10/26/92

APPENDIX E

Onsite Disposal of Low-Level Radioactively Contaminated Waste Streams

K 92-114
Rec'd
6-22-92

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

June 17, 1992

Docket No. 50-305

Mr. C. A. Schrock
Manager - Nuclear Engineering
Wisconsin Public Service
Corporation
P. O. Box 19002
Green Bay, Wisconsin 54037-9002

Dear Mr. Schrock:

SUBJECT: PROPOSED DISPOSAL OF LOW LEVEL RADIOACTIVE WASTE SLUDGE ONSITE AT THE KEWAUNEE NUCLEAR POWER PLANT (TAC NO. M75047)

By letters dated September 12, 1989, and October 17, 1991, you submitted a request pursuant to 10 CFR 20.302 for the disposal of waste sludge onsite at the Kewaunee Nuclear Power Plant. We have completed our review of the request and find your procedures, including documented commitments, to be acceptable.

This approval is granted provided that the enclosed safety evaluation is permanently incorporated into your Offsite Dose Calculation Manual (ODCM) as an Appendix, and that future modifications of these commitments are reported to the NRC.

Issuance of this safety evaluation completes all effort on TAC No. M75047.

Sincerely,

Allen G. Hansen, Project Manager
Project Directorate III-3
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc w/enclosure:
See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO ONSITE DISPOSAL OF LOW-LEVEL RADIOACTIVELY

CONTAMINATED WASTE SLUDGE

AT THE KEWAUNEE NUCLEAR POWER PLANT

WISCONSIN PUBLIC SERVICE CORPORATION
WISCONSIN POWER AND LIGHT COMPANY
MADISON GAS AND ELECTRIC COMPANY

DOCKET NO. 50-305

1.0 INTRODUCTION

In reference 1, Wisconsin Public Service Corporation (WPSC) requested approval pursuant to Section 20.302 of Title 10 of the Code of Federal Regulations (CFR) for the disposal of licensed material not previously considered in the Kewaunee Final Environmental Statement (FES) dated December 1972. Additional related material from the licensee, from the State of Wisconsin, and from the staff are contained in references 2 through 5.

The WPSC request contains a detailed description of the licensed material (i.e., contaminated sludge) subject to this 10 CFR 20.302 request, based on radioactivity absorbed from liquid discharges of licensed material. The 15,000 cubic feet of contaminated sludge identified in the request contains a total radionuclide inventory of 0.17 mCi of Cesium-137 and Cobalt-60.

In its submittal, the licensee addressed specific information requested in accordance with 10 CFR 20.302(a), provided a detailed description of the licensed material, thoroughly analyzed and evaluated the information pertinent to the effects on the environment of the proposed disposal of licensed material, and committed to follow specific procedures to minimize the risk of unexpected exposures.

2.0 DESCRIPTION OF WASTE

During the normal operation of Kewaunee, the potential exists for in-plant process streams which are not normally radioactive to become contaminated with very low levels of radioactive materials. These waste streams are normally separated from the radioactive streams. However, due mainly to infrequent, minor system leaks, and anticipated operational occurrences, the potential exists for these systems to become slightly contaminated. At Kewaunee, the secondary system demineralizer resins, the service water pre-treatment system sludges, the make-up water system resins, and the sewage treatment plant sludges are waste streams that have the potential to become contaminated at very low levels.

During the yearly testing of a batch of pre-treatment sludge, it was found that approximately 15,000 cubic feet of sludge had been contaminated with Cs-137 and Co-60.

3.0 PROPOSED DISPOSAL METHOD

WPSC plans to dispose of the 15,000 cubic feet of contaminated sludge onsite pursuant to 10 CFR 20.302. The sludge is currently contained in an onsite lagoon at the KNPP sewage treatment facility. The disposal of the sludge will be by land application to an area located onsite at KNPP, as shown in Figure 1. The area will be periodically plowed to a depth of 6 inches.

Table 1 lists the principal nuclides identified in the sludge. The activity is based on measurements made in 1989. The radionuclide half-lives, which are dominated by 30-year Cs-137, meet the staff's 10 CFR 20.302 guidelines (reference 6), which apply to radionuclides with half-lives less than 35 years.

Table 1

Nuclide	Total Activity (mCi)
Co-60	0.076
Cs-137	0.094
	0.170

4.0 RADIOLOGICAL IMPACTS

The licensee has evaluated the following potential exposure pathways to members of the general public from the radionuclides in the sludge: (1) external exposure caused by groundshine from the disposal site; (2) internal exposure from inhalation of re-suspended radionuclides; and (3) internal exposure from ingesting ground water. The staff has reviewed the licensee's calculational methods and assumptions and finds that they are consistent with NRC Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977. The staff finds the assessment methodology acceptable.

Table 2 lists the doses calculated by the licensee for the maximally exposed member of the public based on a total activity of 0.170 mCi disposed of in the current year, as well as the cumulative impact of similar disposals during subsequent years. For any repetitive disposals, the licensee must reapply to the NRC when a particular disposal would exceed the following boundary conditions: (1) the annual disposal must be less than a total activity of 0.2 mCi; (2) the whole body dose to the hypothetical maximally exposed individual must be less than 0.1 mrem/year; and (3) the disposal must be at the same site as described in Figure 1.

TABLE 2

Pathway	Whole Body Dose Received by Maximally Exposed Individual (mrem/year)
Groundshine	0.034
Inhalation	0.008
Groundwater Ingestion	0.007
TOTAL	0.049

As shown in Table 2, the annual dose is expected to be on the order of 0.1 mrem or less. Such a dose is a small fraction of the 300 mrem received annually by members of the general public from sources of natural background radiation.

The guidelines used by the NRC staff for onsite disposal of licensed material are presented in Table 3, along with the staff's evaluation of how each guideline has been satisfied.

The licensee's procedures and commitments as documented in the submittal are acceptable, provided that they are permanently incorporated into the licensee's Offsite Dose Calculation Manual (ODCM) as an Appendix, and that future modifications be reported to NRC in accordance with the applicable ODCM change protocol.

Based on the above findings, the staff finds the licensee's proposal to dispose of the low level radioactive waste sludge onsite in the manner described in the WPSC letter dated September 12, 1989, to be acceptable. The State of Wisconsin has also approved these procedures (reference 5).

TABLE 3

20.302 Guideline for Onsite Disposal	Staff's Evaluation
1. The radioactive material should be disposed of in a manner that it is unlikely that the material would be recycled.	1. Due to the nature of the disposed material, recycling to the general public is not considered likely.
2. Doses to the total body and any body organ of a maximally exposed individual (a member of the general public or a non-occupationally exposed worker) from the probable pathways of exposure to the disposed material should be less than 1 mrem/year.	2. This guideline is addressed in Table 2.
3. Doses to the total body and any body organ of an inadvertent intruder from the probable pathways of exposure should be less than 5 mrem/year.	3. Because the material will be land-spread, the staff considers the maximally exposed individual scenario to also address the intruder scenario.
4. Doses to the total body and any body organ of an individual from assumed recycling of the disposed material at the time the disposal site is released from regulatory control from all likely pathways of exposure should be less than 1 mrem.	4. Even if recycling were to occur after release from regulatory control, the dose to the maximally exposed member of the public is not expected to exceed 1 mrem/year, based on the exposure scenarios considered in this analysis.

REFERENCES

(1) WPSC letter from K. H. Evers to NRC Document Control Desk, September 12, 1989.

(2) Memorandum from L. J. Cunningham, DREP, to J. N. Hannon, "Request For Additional Information," December 11, 1989.

(3) NRC letter from M. J. Davis to K. H. Evers of WPSC dated February 13, 1990.

(4) WPSC letter from K. H. Evers to NRC Document Control Desk, October 17, 1991.

(5) Letter from L. Sridharon of the State of Wisconsin Department of Natural Resources to M. Vandenbusch of WPSC, dated June 13, 1991.

(6) E. F. Branagan Jr. and F. J. Congel, "Disposal of Contaminated Radioactive Wastes from Nuclear Power Plants," presented at the Health Physics Society's midyear Symposium on Health Physics Considerations in Decontamination/Decommissioning, Knoxville, TN, February 1986 (CONF-860203).

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Figure 1

Kewaunee Nuclear Power Plant Site Area Map