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

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DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION
2012 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Enclosed is the Kewaunee Power Station (KPS) 2012 Annual Radioactive Effluent Release Report for January through December 2012. This report is submitted to meet the requirements of KPS Technical Specification 5.6.2 and 10 CFR 50.36a(a)(2).

If you have questions or require additional information, please feel free to contact Mr. Richard Repshas at 920-388-8217.

Very truly yours,

Jeffrey T. Stafford

Jeffrey T. Stafford
Director Safety and Licensing, Kewaunee Power Station

Commitments made by this letter: NONE

IE48
NRR

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2012 Annual Radioactive Effluent Release Report

Kewaunee Power Station

Dominion Energy Kewaunee, Inc.

DOCKET 50-305

KEWAUNEE NUCLEAR POWER PLANT

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

January 1 - December 31, 2012

Dominion Energy Kewaunee, Inc.

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0.0 SUMMARY

During 2012 all solid, liquid, and gaseous radioactive effluents from the Kewaunee Power Station were well below regulatory limits. For individual effluent streams, the quarterly limit most closely approached was:

GASEOUS:	Ingestion Pathway-Organ	TBody	
	Quarterly Limit (mRems)	7.5	
	Actual Dose (mRems)	5.766E-04	(2nd Quarter)
	% of Specification	7.688E-03	
LIQUID:	Ingestion Pathway-Organ	Bone	
	Quarterly Limit (mRems)	5.0	
	Actual Dose (mRems)	1.729E-02	(2nd Quarter)
	% of Limit	3.458E-01	
SOLID:	No upper limit for solid radioactive waste applies.		
	Cubic Meters Shipped	4.68E+01 m^3 (1.65E+03 ft^3)	

1.0 INTRODUCTION

This report is being submitted in accordance with the requirements of Kewaunee Technical Specifications, Section 5.6.2 and the Offsite Dose Calculation Manual, Section 15.2. It includes data from all effluent releases made from January 1 - December 31, 2012. 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 radioactive waste disposal, revisions to the Process Control Program and the Offsite Dose Calculation Manual, and addresses the cumulative meteorological data. Values indicated as 0 (zero) in this report refer to actual values less than the detection limits. A table of these less than detectable (LLD) values is identified in sections 2.1 and 3.1.

1.1 Effluent Dose Limits

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

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 set points.

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 20.1301/1302; 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 weekly for gaseous gamma emitters. Batch releases are sampled prior to release for principal gaseous and particulate gamma emitters, halogens and tritium.

The LLD's for gaseous radioanalyses, as listed in Table 13.2.1-1 of the Kewaunee ODCM are:

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

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

Isotope	a priori LLD (μCi/ml)
a. Gaseous emissions:	
Kr-87	5.61E-08
Kr-88	1.02E-07
Xe-133	6.68E-08
Xe-133m	2.75E-07
Xe-135	2.99E-08
Xe-138	1.13E-07

b. Particulate emissions:

Mn-54	1.11E-13
Fe-59	2.27E-13
Co-58	2.28E-13
Co-60	3.57E-13
Zn-65	1.68E-13
Mo-99	2.73E-13
Cs-134	4.69E-13
Cs-137	1.68E-13
Ce-141	2.08E-13
Ce-144	1.24E-12

c. Other identifiable gamma emitters:

Ar-41	3.97E-10
Kr-85	8.63E-05
Kr-85m	4.62E-08
Kr-89	2.04E-06
Xe-127	4.20E-08
Xe-131m	1.82E-06
Xe-135m	1.90E-08
Xe-137	2.88E-07
I-131	1.32E-13

d. Composite particulate samples:

Sr-89	1.00E-14
Sr-90	1.00E-14
Gross Alpha	1.00E-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 2012.

Number of batch releases......................................43

Total time for all batch releases (min)...............3534.0

Maximum time for a batch release (min)...........1440.0

Average time for a batch release (min)...................82.2

Minimum time for a batch release (min).................15.0

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 the calculated doses this year from gaseous effluents.

Table 2.1
Annual Radioactive Effluent Release Report 2012
Gaseous Effluents - Summation of all Releases

Carbon-14

Total Annual Activity Released (Ci)	6.290E+00

Fission and Activation Gases	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Total Activity Released (Ci)	0.000E+00	5.162E-02	0.000E+00	0.000E+00
Average Release Rate (μCi/sec)	0.000E+00	6.566E-03	0.000E+00	0.000E+00
Iodines				
Total Activity Released (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Average Release Rate (μCi/sec)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Particulates				
Total Activity Released (Ci)	0.000E+00	7.060E-07	0.000E+00	0.000E+00
Average Release Rate (μCi/sec)	0.000E+00	8.979E-08	0.000E+00	0.000E+00
Gross Alpha Released (Ci)	0.000E+00	1.139E-05	0.000E+00	0.000E+00
Tritium				
Total Activity Released (Ci)	2.900E+00	3.732E+01	1.623E+01	9.081E+00
Average Release Rate (μCi/sec)	3.689E-01	4.747E+00	2.064E+00	1.155E+00

Table 2.2
Annual Radioactive Effluent Release Report 2012
Gaseous Effluents

Nuclides Released (Ci)
Continuous Mode

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Fission Gases				
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Iodines				
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Particulates				
Co-58	0.000E+00	7.060E-07	0.000E+00	0.000E+00
Total	0.000E+00	7.060E-07	0.000E+00	0.000E+00

Table 2.2(cont)
Annual Radioactive Effluent Release Report 2012
Gaseous Effluents

Nuclides Released (Ci)
Batch Mode

Fission Gases				
Xe-133	0.000E+00	5.103E-02	0.000E+00	0.000E+00
Xe-133m	0.000E+00	4.527E-04	0.000E+00	0.000E+00
Xe-135	0.000E+00	1.446E-04	0.000E+00	0.000E+00
Total	0.000E+00	5.162E-02	0.000E+00	0.000E+00
Iodines				
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Particulates				
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3A
Annual Radioactive Effluent Release Report 2012
1st Quarter Gaseous Release
Total of all Releases

Noble Gasses (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3A (Con't)
Annual Radioactive Effluent Release Report 2012
1st Quarter Gaseous Release
Total of all Releases

Summary	January	February	March	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	8.318E-01	1.374E+00	6.948E-01	2.900E+00
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3A (Con't)
Annual Radioactive Effluent Release Report 2012
2nd Quarter Gaseous Release
Total of all Releases

Noble Gasses (Curies)

Isotope	April	May	June	Total
Xe-133	5.088E-02	1.452E-04	0.000E+00	5.103E-02
Xe-133m	4.527E-04	0.000E+00	0.000E+00	4.527E-04
Xe-135	1.446E-04	0.000E+00	0.000E+00	1.446E-04
Total	5.148E-02	1.452E-04	0.000E+00	5.162E-02

Particulates (Curies)

Isotope	April	May	June	Total
Co-58	7.060E-07	0.000E+00	0.000E+00	7.060E-07
Total	7.060E-07	0.000E+00	0.000E+00	7.060E-07

Halogens (Curies)

Isotope	April	May	June	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3A (Con't)
Annual Radioactive Effluent Release Report 2012
2nd Quarter Gaseous Release
Total of all Releases

Summary

	April	May	June	Total
Total Noble Gases (Ci)	5.148E-02	1.452E-04	0.000E+00	5.162E-02
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	7.060E-07	0.000E+00	0.000E+00	7.060E-07
Total Tritium (Ci)	2.028E+01	5.860E+00	1.119E+01	3.732E+01
Total Particulate Gross Alpha (Ci)	1.139E-05	0.000E+00	0.000E+00	1.139E-05

Table 2.3A (con't)
Annual Radioactive Effluent Release Report 2012
3rd Quarter Gaseous Release
Total of all Releases

Noble Gasses (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3A (Con't)
Annual Radioactive Effluent Release Report 2012
3rd Quarter Gaseous Release
Total of all Releases

Summary

	July	August	September	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	9.971E-01	6.422E+00	8.806E+00	1.623E+01
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3A (Con't)
Annual Radioactive Effluent Release Report 2012
4th Quarter Gaseous Release
Total of all Releases

Noble Gasses (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3A (Con't)
Annual Radioactive Effluent Release Report 2012
4th Quarter Gaseous Release
Total of all Releases

Summary	October	November	December	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	4.971E+00	2.802E+00	1.308E+00	9.081E+00
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3B
Annual Radioactive Effluent Release Report 2012
1st Quarter Gaseous Release
Continuous Mode Only

Noble Gasses (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3B (Con't)
Annual Radioactive Effluent Release Report 2012
1st Quarter Gaseous Release
Continuous Mode Only

Summary

	January	February	March	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	8.311E-01	1.373E+00	6.948E-01	2.899E+00
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3B (Con't)
Annual Radioactive Effluent Release Report 2012
2nd Quarter Gaseous Release
Continuous Mode Only

Noble Gasses (Curies)

Isotope	April	May	June	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	April	May	June	Total
Co-58	7.060E-07	0.000E+00	0.000E+00	7.060E-07
Total	7.060E-07	0.000E+00	0.000E+00	7.060E-07

Halogens (Curies)

Isotope	April	May	June	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3B (Con't)
Annual Radioactive Effluent Release Report 2012
2nd Quarter Gaseous Release
Continuous Mode Only

Summary	April	May	June	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	7.060E-07	0.000E+00	0.000E+00	7.060E-07
Total Tritium (Ci)	1.529E+01	5.858E+00	1.118E+01	3.233E+01
Total Particulate Gross Alpha (Ci)	1.138E-05	0.000E+00	0.000E+00	1.138E-05

Table 2.3B (con't)
Annual Radioactive Effluent Release Report 2012
3rd Quarter Gaseous Release
Continuous Mode Only

Noble Gasses (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3B (Con't)
Annual Radioactive Effluent Release Report 2012
3rd Quarter Gaseous Release
Continuous Mode Only

Summary

	July	August	September	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	9.947E-01	6.421E+00	8.804E+00	1.622E+01
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3B (Con't)
Annual Radioactive Effluent Release Report 2012
4th Quarter Gaseous Release
Continuous Mode Only

Noble Gasses (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3B (Con't)
Annual Radioactive Effluent Release Report 2012
4th Quarter Gaseous Release
Continuous Mode Only

Summary	October	November	December	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	4.967E+00	2.800E+00	1.296E+00	9.064E+00
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3C
Annual Radioactive Effluent Release Report 2012
1st Quarter Gaseous Release
Batch Mode Only

Noble Gasses (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	January	February	March	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3C (Con't)
Annual Radioactive Effluent Release Report 2012
1st Quarter Gaseous Release
Batch Mode Only

Summary	January	February	March	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	6.992E-04	9.365E-04	2.518E-05	1.661E-03
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3C (Con't)
Annual Radioactive Effluent Release Report 2012
2nd Quarter Gaseous Release
Batch Mode Only

Noble Gasses (Curies)

Isotope	April	May	June	Total
Xe-133	5.088E-02	1.452E-04	0.000E+00	5.103E-02
Xe-133m	4.527E-04	0.000E+00	0.000E+00	4.527E-04
Xe-135	1.446E-04	0.000E+00	0.000E+00	1.446E-04
Total	5.148E-02	1.452E-04	0.000E+00	5.162E-02

Particulates (Curies)

Isotope	April	May	June	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	April	May	June	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3C (Con't)
Annual Radioactive Effluent Release Report 2012
2nd Quarter Gaseous Release
Batch Mode Only

Summary

	April	May	June	Total
Total Noble Gases (Ci)	5.148E-02	1.452E-04	0.000E+00	5.162E-02
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	4.983E+00	2.190E-03	4.675E-03	4.990E+00
Total Particulate Gross Alpha (Ci)	2.242E-09	0.000E+00	0.000E+00	2.242E-09

Table 2.3C (con't)
Annual Radioactive Effluent Release Report 2012
3rd Quarter Gaseous Release
Batch Mode Only

Noble Gasses (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	July	August	September	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3C (Con't)
Annual Radioactive Effluent Release Report 2012
3rd Quarter Gaseous Release
Batch Mode Only

Summary

	July	August	September	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	2.389E-03	7.069E-04	2.430E-03	5.525E-03
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3C (Con't)
Annual Radioactive Effluent Release Report 2012
4th Quarter Gaseous Release
Batch Mode Only

Noble Gasses (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Particulates (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Halogens (Curies)

Isotope	October	November	December	Total
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.3C (Con't)
Annual Radioactive Effluent Release Report 2012
4th Quarter Gaseous Release
Batch Mode Only

Summary	October	November	December	Total
Total Noble Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Halogens (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Particulate Gross Beta-Gamma Half-Lives>8 Days (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Tritium (Ci)	3.315E-03	1.625E-03	1.214E-02	1.709E-02
Total Particulate Gross Alpha (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 2.4
Annual Radioactive Effluent Release Report 2012
Dose From Gaseous Effluents

The offsite dose limits from radioactive materials in gaseous effluents are specified in Section 13.2.2 and 13.2.3 of the Kewaunee ODCM and can be summarized as follows:

Limit	Air Dose Gamma	Air Dose 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 each quarter of 2012 was within 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 limits are shown below:

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1. Gamma- Air Dose				
Specification (mRads)	5.000E+00	5.000E+00	5.000E+00	5.000E+00
Actual Dose (mRads)	0.000E+00	2.104E-06	0.000E+00	0.000E+00
% of Specification	0.000E+00	4.208E-05	0.000E+00	0.000E+00
2. Beta- Air Dose				
Specification (mRads)	1.000E+01	1.000E+01	1.000E+01	1.000E+01
Actual Dose (mRads)	0.000E+00	6.231E-06	0.000E+00	0.000E+00
% of Specification	0.000E+00	6.231E-05	0.000E+00	0.000E+00
3. Ingestion Pathway-Organ				
Specification (mRems)	7.500E+00	7.500E+00	7.500E+00	7.500E+00
Actual Dose (mRems)	6.127E-05	5.766E-04	2.418E-05	1.353E-05
% of Specification	8.169E-04	7.688E-03	3.224E-04	1.804E-04
	Liver	TBody	Liver	Liver

Table 2.4 (Con't)
Annual Radioactive Effluent Release Report 2012
Dose From Gaseous Effluents

In addition, the cumulative annual offsite doses for the period January 1 - December 31, 2012 versus the Kewaunee ODCM annual limits were:

	Annual
1. Gamma- Air Dose	
Specification (mRads)	1.000E+01
Actual Dose (mRads)	2.104E-06
% of Specification	2.104E-05
2. Beta- Air Dose	
Specification (mRads)	2.000E+01
Actual Dose (mRads)	6.231E-06
% of Specification	3.116E-05
3. Ingestion Pathway-Organ	
Specification (mRems)	1.500E+01
Actual Dose (mRems)	6.755E-04
% of Specification	4.504E-03
TBody	

2.4 **Estimation of Carbon-14 in Gaseous Releases**

The total estimated C-14 released was 6.29 Ci.

30% of the estimated C-14 released was assumed to be in the form of CO_2.

The highest estimated C-14 doses at the highest X/Q for ingestion and inhalation receptor (one mile west) were:

1.94E-01 mRem as Child Bone Dose
3.88E-02 mRem as Child Whole Body

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, Iron 55 and Nickel 63.

The LLD's for liquid batch release radioanalyses, as listed in Table 13.1.1-1 of the Kewaunee ODCM 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	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Average a priori LLD (μCi/ml)
Mn-54	1.12E-07	1.35E-07	1.40E-07	9.92E-08	1.22E-07
Fe-59	2.44E-07	2.99E-09	5.30E-08	3.92E-08	8.48E-08
Co-58	1.10E-07	1.77E-07	1.80E-07	1.31E-07	1.50E-07
Co-60	1.60E-07	1.78E-07	1.80E-07	2.34E-08	1.35E-07
Zn-65	2.75E-07	5.95E-08	4.50E-07	4.42E-08	2.07E-07
Mo-99	7.98E-07	1.68E-07	9.50E-07	9.37E-07	7.13E-07
Cs-134	8.92E-08	2.67E-08	1.50E-07	7.66E-08	8.56E-08
Cs-137	1.10E-07	2.31E-08	1.80E-07	9.51E-08	1.02E-07
Ce-141	8.83E-08	1.34E-07	2.10E-07	6.93E-08	1.25E-07
Ce-144	4.72E-07	9.39E-07	8.20E-07	3.69E-07	6.50E-07
I-131	7.02E-08	1.36E-07	1.40E-07	7.77E-08	1.06E-07
H-3	2.51E-06	3.43E-06	2.90E-06	2.69E-06	2.89E-06
Sr-89	9.19E-09	1.43E-08	1.11E-08	6.35E-09	1.02E-08
Sr-90	8.76E-09	8.63E-09	6.31E-09	5.19E-09	7.22E-09
Gross Alpha	6.91E-09	7.89E-09	8.96E-09	5.63E-09	7.35E-09
Fe-55	9.08E-07	8.68E-07	8.15E-07	7.99E-07	8.48E-07
Ni-63	1.12E-07	1.28E-07	9.32E-08	1.18E-07	1.13E-07

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 Gross Alpha, Strontium 89, Strontium 90, Iron 55 and Nickel 63.

The LLD's for liquid continuous release radioanalyses, as listed in Table 13.1.1-1 of the Kewaunee ODCM 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	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Average a priori LLD (μCi/ml)
Mn-54	1.16E-08	8.87E-09	1.70E-08	7.04E-09	1.11E-08
Fe-59	2.73E-08	1.98E-08	3.80E-08	1.57E-08	2.52E-08
Co-58	1.14E-08	1.31E-08	1.80E-08	7.87E-09	1.26E-08
Co-60	1.18E-08	1.43E-08	2.00E-08	1.05E-08	1.42E-08
Zn-65	2.43E-08	3.08E-08	2.40E-08	2.02E-08	2.48E-08
Mo-99	1.05E-07	8.68E-08	1.30E-07	1.02E-07	1.06E-07
Cs-134	6.97E-09	1.13E-08	1.30E-08	9.61E-09	1.02E-08
Cs-137	1.07E-08	1.43E-08	1.70E-08	1.24E-08	1.36E-08
Ce-141	1.59E-08	1.65E-08	2.20E-08	1.54E-08	1.75E-08
Ce-144	6.93E-08	6.85E-08	8.70E-08	7.64E-08	7.53E-08
I-131	9.68E-09	1.17E-08	1.40E-08	9.39E-09	1.12E-08
H-3	2.51E-06	3.43E-06	2.90E-06	2.69E-06	2.89E-06
Sr-89	1.20E-08	1.09E-08	1.04E-08	7.15E-09	1.01E-08
Sr-90	1.05E-08	5.88E-09	5.77E-09	6.17E-09	7.08E-09
Gross Alpha	4.40E-09	4.34E-09	5.12E-09	5.31E-09	4.79E-09
Fe-55	9.03E-07	8.95E-07	7.98E-07	7.85E-07	8.45E-07
Ni-63	1.11E-07	9.28E-08	1.02E-07	1.16E-07	1.05E-07

3.2 **Liquid Batch Release Statistics**

The following is a summation of all liquid batch releases during 2012.

Release Type	Number	Gallons Released
A & B WCT	2	1,860
A CVC Monitor Tank	6	37,240
B CVC Monitor Tank	6	30,520
A SGBT Monitor Tank	19	169,833
B SGBT Monitor Tank	24	219,046

Total time for all batch releases (min).............24,080

Maximum time for a batch release (min)...........2,077

Minimum time for a batch release (min)................16

Average time for a batch release (min).................422.5

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 each quarter and the calculated doses this year from liquid effluents.

TABLE 3.1
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Summation of all Releases

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Fission and Activation Products				
Total Release Excluding H3 and Dissolved Gases (Ci)	2.061E-02	3.143E-02	5.766E-03	1.149E-02
Average Concentration (μCi/ml)	3.862E-11	1.496E-10	2.172E-11	4.106E-11
Tritium				
Total Release (Ci)	3.652E+01	1.098E+02	1.813E+01	7.208E+00
Average Concentration (μCi/ml)	6.843E-08	5.225E-07	6.828E-08	2.575E-08
% of Tech. Spec. Limit(3.0E-3 μCi/ml)	2.281E-03	1.742E-02	2.276E-03	8.583E-04
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Average Concentration (μCi/ml)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
% of Tech. Spec. Limit(2.0E-4 μCi/ml)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Volume of Waste Released				
Batch (liters)	4.579E+05	7.085E+05	3.240E+05	2.450E+05
Continuous (liters)	2.592E+07	2.266e+07	2.205E+07	2.437E+07
Total (liters)	2.638E+07	2.336E+07	2.238E+07	2.462E+07
Volume of Dilution Water				
Batch (liters)	4.761E+09	6.777E+09	3.240E+09	1.926E+09
Continuous (liters)	5.289E+11	2.034E+11	2.622E+11	2.780E+11
Total (liters)	5.336E+11	2.101E+11	2.654E+11	2.800E+11

TABLE 3.2A
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Batch Releases

	January	February	March	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	1.371E-02	4.262E-03	2.632E-03	2.061E-02
Avg. Conc. (μCi/ml)	4.607E-09	3.931E-09	3.758E-09	
Tritium				
Total Release (Ci)	2.788E+01	5.793E+00	2.844E+00	3.652E+01
Avg. Conc. (μCi/ml)	9.366E-06	5.344E-06	4.061E-06	
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (μCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (μCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Volume of Waste Released				
(liters)	2.829E+05	1.075E+05	6.751E+04	4.579E+05
Volume of Dilution Water				
(liters)	2.977E+09	1.084E+09	7.002E+08	4.761E+09

TABLE 3.2A (Con't)
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Batch Releases

Isotope (Ci)	January	February	March	Total
Ag-110m	3.021E-04	1.963E-05	3.027E-05	3.520E-04
Co-57	8.663E-06	0.000E+00	0.000E+00	8.663E-06
Co-58	8.227E-05	0.000E+00	0.000E+00	8.227E-05
Co-60	3.153E-03	4.570E-04	2.118E-04	3.822E-03
Fe-55	7.044E-03	2.678E-03	1.681E-03	1.140E-02
H-3	2.788E+01	5.793E+00	2.844E+00	3.652E+01
Mn-54	2.112E-04	0.000E+00	1.332E-05	2.245E-04
Ni-63	2.914E-03	1.108E-03	6.954E-04	4.717E-03
Total	2.790E+01	5.797E+00	2.847E+00	3.654E+01

TABLE 3.2B
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Batch Releases

	April	May	June	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	1.376E-02	1.086E-02	6.821E-03	3.143E-02
Avg. Conc. (μCi/ml)	7.708E-09	3.102E-09	4.569E-09	
Tritium				
Total Release (Ci)	2.295E+01	6.955E+01	1.725E+01	1.098E+02
Avg. Conc. (μCi/ml)	1.286E-05	1.987E-05	1.156E-05	
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (μCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (μCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Volume of Waste Released				
(liters)	2.451E+05	3.028E+05	1.606E+05	7.085E+05
Volume of Dilution Water				
(liters)	1.784E+09	3.500E+09	1.493E+09	6.777E+09

TABLE 3.2B (Con't)
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Batch Releases

Isotope (Ci)	April	May	June	Total
Ag-110m	1.484E-04	1.587E-05	1.435E-04	3.078E-04
Co-57	2.451E-05	0.000E+00	0.000E+00	2.451E-05
Co-58	1.070E-03	2.138E-03	6.569E-04	3.865E-03
Co-60	5.281E-03	2.575E-04	1.302E-04	5.669E-03
Cr-51	2.430E-04	0.000E+00	2.340E-04	4.769E-04
Fe-55	3.260E-03	4.027E-03	2.136E-03	9.423E-03
H-3	2.295E+01	6.955E+01	1.725E+01	1.098E+02
Mn-54	3.209E-04	0.000E+00	0.000E+00	3.209E-04
Ni-63	3.333E-03	4.118E-03	2.184E-03	9.635E-03
Sb-124	0.000E+00	0.000E+00	1.392E-04	1.392E-04
Sb-125	7.518E-05	2.994E-04	1.197E-03	1.571E-03
Total	2.296E+01	6.956E+01	1.726E+01	1.098E+02

TABLE 3.2C
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Batch Releases

	July	August	September	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	2.607E-03	1.742E-03	1.418E-03	5.766E-03
Avg. Conc. (µCi/ml)	2.267E-09	1.740E-09	1.301E-09	
Tritium				
Total Release (Ci)	1.024E+01	4.067E+00	3.791E+00	1.810E+01
Avg. Conc. (µCi/ml)	8.906E-06	4.064E-06	3.480E-06	
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Volume of Waste Released				
(liters)	1.152E+05	1.028E+05	1.060E+05	3.240E+05
Volume of Dilution Water				
(liters)	1.150E+09	1.001E+09	1.089E+09	3.240E+09

TABLE 3.2C (Con't)
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Batch Releases

Isotope (Ci)	July	August	September	Total
Ag-110m	6.807E-05	7.173E-05	3.090E-05	1.707E-04
Co-58	3.709E-04	2.858E-04	8.601E-05	7.428E-04
Co-60	4.391E-05	1.707E-04	5.033E-05	2.649E-04
Fe-55	1.152E-03	1.028E-03	1.060E-03	3.240E-03
H-3	1.024E+01	4.067E+00	3.791E+00	1.810E+01
Nb-95	5.633E-06	0.000E+00	0.000E+00	5.633E-06
Ni-63	2.074E-04	1.851E-04	1.907E-04	5.833E-04
Sb-124	9.158E-05	0.000E+00	0.000E+00	9.158E-05
Sb-125	6.669E-04	0.000E+00	0.000E+00	6.669E-04
Total	1.024E+01	4.069E+00	3.792E+00	1.811E+01

TABLE 3.2D
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Batch Releases

	October	November	December	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	5.869E-03	4.417E-03	1.209E-03	1.149E-02
Avg. Conc. (µCi/ml)	7.375E-09	5.996E-09	3.072E-09	
Tritium				
Total Release (Ci)	2.962E+00	1.915E+00	2.320E+00	7.198E+00
Avg. Conc. (µCi/ml)	3.723E-06	2.600E-06	5.893E-06	
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Volume of Waste Released				
(liters)	1.072E+05	1.056E+05	3.218E+04	2.450E+05
Volume of Dilution Water				
(liters)	7.956E+08	7.366E+08	3.936E+08	1.926E+09

TABLE 3.2D (Con't)
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Batch Releases

Isotope (Ci)	October	November	December	Total
Ag-110m	2.131E-04	5.172E-05	9.752E-06	2.746E-04
Co-57	1.614E-05	0.000E+00	0.000E+00	1.614E-05
Co-58	5.587E-04	1.944E-04	3.926E-05	7.923E-04
Co-60	1.106E-03	3.323E-04	0.000E+00	1.438E-03
Fe-55	3.430E-03	3.380E-03	1.030E-03	7.839E-03
H-3	2.962E+00	1.915E+00	2.320E+00	7.198E+00
Mn-54	1.111E-04	3.115E-05	0.000E+00	1.422E-04
Ni-63	4.341E-04	4.277E-04	1.303E-04	9.922E-04
Total	2.968E+00	1.920E+00	2.321E+00	7.209E+00

TABLE 3.3A
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Continuous Releases

	January	February	March	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Tritium				
Total Release (Ci)	8.528E-04	0.000E+00	1.509E-05	8.679E-04
Avg. Conc. (µCi/ml)	1.250E-11	0.000E+00	4.844E-13	
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Volume of Waste Released				
(liters)	1.115E+07	7.578E+06	7.198E+06	2.592E+07
Volume of Dilution Water				
(liters)	6.821E+10	4.295E+11	3.116E+10	5.289E+11

TABLE 3.3A (Con't)
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Continuous Releases

Isotope (Ci)	January	February	March	Total
H-3	8.528E-04	0.000E+00	1.509E-05	8.679E-04
Total	8.528E-04	0.000E+00	1.509E-05	8.679E-04

TABLE 3.3B
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Continuous Releases

	April	May	June	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (μCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Tritium				
Total Release (Ci)	5.747E-02	0.000E+00	1.148E-04	5.758E-02
Avg. Conc. (μCi/ml)	1.686E-09	0.000E+00	1.250E-12	
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (μCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (μCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Volume of Waste Released				
(liters)	6.736E+06	1.021E+07	5.713E+06	2.266E+07
Volume of Dilution Water				
(liters)	3.407E+10	7.753E+10	9.176E+10	2.034E+11

TABLE 3.3B (Con't)
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Continuous Releases

Isotope (Ci)	April	May	June	Total
H-3	5.747E-02	0.000E+00	1.148E-04	5.758E-02
Total	5.747E-02	0.000E+00	1.148E-04	5.758E-02

TABLE 3.3C
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Continuous Releases

	July	August	September	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Tritium				
Total Release (Ci)	7.549E-03	4.347E-03	1.433E-02	2.622E-02
Avg. Conc. (µCi/ml)	7.803E-11	4.163E-11	2.346E-10	
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Volume of Waste Released				
(liters)	9.595E+06	6.645E+06	5.813E+06	2.205E+07
Volume of Dilution Water				
(liters)	9.674E+10	1.044E+11	6.106E+10	2.622E+11

TABLE 3.3C (Con't)
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Continuous Releases

Isotope (Ci)	July	August	September	Total
H-3	7.549E-03	4.347E-03	1.433E-02	2.622E-02
Total	7.549E-03	4.347E-03	1.433E-02	2.622E-02

TABLE 3.3D
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Continuous Releases

	October	November	December	Total
Gross Radioactivity				
Total Release Excluding H3 and Dissolved Gases (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Tritium				
Total Release (Ci)	1.696E-03	4.928E-03	4.100E-03	1.073E-02
Avg. Conc. (µCi/ml)	1.738E-11	8.078E-11	3.433E-11	
Dissolved Gases				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Gross Alpha Activity				
Total Release (Ci)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Avg. Conc. (µCi/ml)	0.000E+00	0.000E+00	0.000E+00	
Volume of Waste Released				
(liters)	7.901E+06	6.270E+06	1.020E+07	2.437E+07
Volume of Dilution Water				
(liters)	9.761E+10	6.100E+10	1.194E+11	2.780E+11

TABLE 3.3D (Con't)
Annual Radioactive Effluent Release Report 2012
Liquid Effluents - Continuous Releases

Isotope (Ci)	October	November	December	Total
H-3	1.696E-03	4.928E-03	4.100E-03	1.073E-02
Total	1.696E-03	4.928E-03	4.100E-03	1.073E-02

Table 3.4
Annual Radioactive Effluent Report 2012
Dose From Liquid Effluents

The dose to a member of the public from total liquid radioactive releases for each quarter was below the Kewaunee ODCM limits of 1.5 mrems to the total body and less than or equal to 5 mrems to any organ. Additionally, the dose to a member of the public from total liquid radioactive releases for the year was below the Kewaunee ODCM limits of 3 mrems to the total body and less than or equal to 10 mrems 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 1.7 from the Kewaunee ODCM.

Organ 1st Qtr Dose	Dose Total mRem	Quarterly Limit mRem	Percent of Limit
Total Body	4.536E-04	1.5	3.024E-02
Bone	3.411E-03	5.0	6.822E-02
Liver	6.487E-04	5.0	1.297E-02
Thyroid	2.656E-04	5.0	5.311E-03
Kidney	2.720E-04	5.0	5.441E-03
Lung	3.295E-04	5.0	6.591E-03
GI-LLI	8.593E-04	5.0	1.719E-02

Organ 2nd Qtr Dose	Dose Total mRem	Quarterly Limit mRem	Percent of Limit
Total Body	2.995E-03	1.5	1.997E-01
Bone	1.729E-02	5.0	3.458E-01
Liver	3.727E-03	5.0	7.453E-02
Thyroid	1.981E-03	5.0	3.963E-02
Kidney	2.031E-03	5.0	4.063E-02
Lung	2.116E-03	5.0	4.232E-02
GI-LLI	6.025E-03	5.0	1.205E-01

Table 3.4 (Con't)
Annual Radioactive Effluent Report 2012
Dose From Liquid Effluents

Organ 3rd Qtr Dose	Dose Total mRem	Quarterly Limit mRem	Percent of Limit
Total Body	1.594E-04	1.5	1.063E-02
Bone	4.486E-04	5.0	8.973E-03
Liver	1.951E-04	5.0	3.903E-03
Thyroid	1.317E-04	5.0	2.634E-03
Kidney	1.318E-04	5.0	2.635E-03
Lung	1.500E-04	5.0	2.999E-03
GI-LLI	4.043E-04	5.0	8.086E-03

Organ 4th Qtr Dose	Dose Total mRem	Quarterly Limit mRem	Percent of Limit
Total Body	1.179E-04	1.5	7.857E-03
Bone	7.967E-04	5.0	1.593E-02
Liver	2.020E-04	5.0	4.040E-03
Thyroid	5.239E-05	5.0	1.048E-03
Kidney	5.649E-05	5.0	1.130E-03
Lung	9.638E-05	5.0	1.928E-03
GI-LLI	3.374E-04	5.0	6.749E-03

Calculated Dose This Year

Organ	Dose Total mRem	Quarterly Limit mRem	Percent of Limit
Total Body	3.726E-03	3.0	1.242E-01
Bone	2.195E-02	10.0	2.195E-01
Liver	4.773E-03	10.0	4.773E-02
Thyroid	2.431E-03	10.0	2.431E-02
Kidney	2.492E-03	10.0	2.492E-02
Lung	2.692E-03	10.0	2.692E-02
GI-LLI	7.626E-03	10.0	7.626E-02

3.4 Ground Water Monitoring

Sample Point Sample Date	Tritium pCi/L	Total Gamma Activity µCi/ml
AB-707		
03/01/12	919	None Detected
05/01/12	1257	None Detected
07/26/12	1764	None Detected
11/16/12	1883	None Detected
AB-708		
03/01/12	668	None Detected
05/01/12	868	None Detected
07/26/12	1245	None Detected
11/16/12	1603	None Detected
AB-709		
03/02/12	275	None Detected
05/29/12	282	None Detected
07/27/12	679	None Detected
11/16/12	424	None Detected
AB-710		
03/01/12	1025	None Detected
05/01/12	2111	None Detected
05/29/12	918	None Detected
07/26/12	945	None Detected
11/16/12	865	None Detected
AB-711		
03/01/12	872	None Detected
05/01/12	706	None Detected
07/26/12	605	None Detected
11/16/12	832	None Detected
AB-712		
03/02/12	263	None Detected
04/19/12	286	None Detected
07/27/12	236	None Detected
11/16/12	455	None Detected
AB-715		
03/01/12	309	None Detected
04/14/12	<251	None Detected
07/26/12	377	None Detected
11/16/12	287	None Detected

Sample Point Sample Date	Tritium pCi/L	Total Gamma Activity µCi/ml
AB-717		
03/01/12	<233	None Detected
05/30/12	<269	None Detected
07/26/12	<235	None Detected
11/16/12	<262	None Detected
MW-701		
03/01/12	<204	None Detected
04/14/12	<251	None Detected
07/26/12	<235	None Detected
11/16/12	<262	None Detected
MW-702		
03/02/12	<204	None Detected
05/11/12	<239	None Detected
07/27/12	<235	None Detected
11/26/12	<262	None Detected
MW-703		
03/01/12	<204	None Detected
05/11/12	<239	None Detected
07/27/12	<235	None Detected
11/26/12	<262	None Detected
MW-704		
03/01/12	<204	None Detected
05/30/12	<269	None Detected
07/27/12	<235	None Detected
MW-705		
03/01/12	351	None Detected
04/19/12	261	None Detected
07/26/12	<235	None Detected
11/16/12	<262	None Detected
MW-706		
03/02/12	<204	None Detected
04/19/12	<258	None Detected
07/26/12	<235	None Detected
11/16/12	<262	None Detected

4.0 UNPLANNED RELEASES

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

5.0 METEOROLOGICAL DATA

See Appendix A for missing meteorological data and the joint frequency distribution tables.

6.0 SOLID WASTE DISPOSAL

Table 6.1 is a summation of solid radioactive waste shipped during 2012. Presented are the types of waste, major nuclide composition, disposition of the waste and shipping containers used.

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

Table 6.1
Annual Radioactive Effluent Report 2012
Solid Waste and Irradiated Fuel Shipments

A. Solid Radioactive Waste Shipped Off-Site for Burial or Disposal

1. Type of Waste

		Ci	Ci % Error	M^3
a.	Resins, Filters and Evap Bottoms	5.75E+01	±25.0	5.27E+00
b.	Dry Active Waste (DAW)	7.25E-02	±25.0	4.15E+01
c.	Irradiated Components	0.00E+00	±25.0	0.00E+00
d.	Other Radioactive Waste	0.00E+00	±25.0	0.00E+00

2. Estimate of Major Nuclide by Composition

a. Resins, Filters and Evap Bottoms

Nuclide	% Abundance	Ci
H-3	0.181	1.04E-01
Be-7	0.003	1.94E-03
C-14	0.041	2.33E-02
Cr-51	0.097	5.60E-02
Mn-54	2.182	1.25E+00
Fe-55	20.253	1.16E+01
Fe-59	0.001	4.36E-04
Co-57	0.318	1.83E-01
Co-58	1.611	9.26E-01
Co-60	15.245	8.76E+00
Ni-59	0.671	3.86E-01
Ni-63	57.938	3.33E+01
Zn-65	0.026	1.52E-02
Sr-89	0.000	1.12E-04
Sr-90	0.004	2.11E-03
Zr-95	0.021	1.20E-02
Nb-94	0.014	7.91E-03
Nb-95	0.015	8.50E-03
Tc-99	0.096	5.53E-02
Ag-110m	0.038	2.18E-02
Sn-113	0.000	7.85E-05
Sb-125	0.577	3.32E-01
I-129	0.000	5.15E-05
Cs-137	0.168	9.63E-02
Ce-144	0.498	2.86E-01
Pu-241	0.001	8.04E-04

b. Dry Active Waste (DAW)

Nuclide	% Abundance	Ci
H-3	2.516	1.82E-03
Cr-51	1.744	1.26E-03
Mn-54	2.085	1.51E-03
Fe-55	10.494	7.60E-03
Fe-59	0.208	1.50E-04
Co-57	0.291	2.11E-04
Co-58	40.226	2.91E-02
Co-60	8.375	6.07E-03
Ni-63	14.102	1.02E-02
Zn-65	0.170	1.23E-04
Zr-95	6.551	4.75E-03
Nb-95	10.040	7.27E-03
Tc-99	1.678	1.22E-03
Ag-110m	0.103	7.47E-05
Sn-113	0.131	9.46E-05
Sb-125	1.068	7.74E-04
Cs-137	0.076	5.54E-05
Ce-144	0.142	1.03E-04

c. Irradiated Components

Nuclide	% Abundance	Ci
None	N/A	N/A

d. Other Waste

Nuclide	% Abundance	Ci
None	N/A	N/A

3. Solid Waste Disposition

Date of Shipment	Mode of Transportation	Destination
02/22/12	Hittman Transport	Studsvik Processing Facility Erwin
03/31/12	Hittman Transport	Studsvik Processing Facility Erwin
06/05/12	Hittman Transport	Bear Creek Processing Facility
09/05/12	Hittman Transport	Clive Disposal Facility

B. Irradiated Fuel Shipments

No irradiated fuel shipments were made from the Kewaunee Power Station during 2012.

7.0 PROGRAM REVISIONS

In accordance with Technical Specification 5.6.2, the revisions to the Process Control Program, Offsite Dose Calculation Manual, Radiological Environmental Monitoring Program and radioactive waste treatment systems are listed below.

7.1 Process Control Program

There were no revisions made to the Process Control Program.

7.2 Offsite Dose Calculation Manual

The Kewaunee Power Station Offsite Dose Calculation Manual (ODCM) was revised during this report period. Appendix B is a copy of the Kewaunee Power Station ODCM Revision 14, April 18, 2012.

7.3 Radiological Environmental Monitoring Manual

The Kewaunee Power Station Radiological Environmental Monitoring Manual (REMM) was revised during this report period. Appendix C is a copy of the Kewaunee Power Station REMM Revision 19, September 6, 2012.

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

There were no changes to the radioactive waste systems (liquid, gaseous or solids).

8.0 REPORTABLE OCCURRENCES

None

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Appendix A

Kewaunee Power Station

2012 Meteorological Data

Missing Data

First Quarter: 54.75 hours
Second Quarter: 79.0 hours
Third Quarter: 15.0 hours
Fourth Quarter: 54.0 hours

Note: A total of 202.75 hours of data is missing or otherwise unavailable. This represents the availability of 97.64% of the data for the year.

First Quarter 2012
Stability Class A

Wind Direction

	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	3	10	8.25	0	0	21.5
NNE	0	0.5	2	8	11.25	2	0.75	24.5
NE	0	0	3.25	26	2.5	0	0	31.75
ENE	0	0	11	12.25	0	0	0	23.25
E	0	0.5	5.5	6	4	0	0.25	16.25
ESE	0	0	7.5	3	0.75	0	0	11.25
SE	0	0.75	6.75	3.75	5.25	0	0	16.5
SSE	0	0	2.25	6.25	14.25	15.5	13.5	51.75
S	0	1.5	9.5	14.25	13	11.5	10	59.75
SSW	0	0	21.25	13.5	2.5	0	0.25	37.5
SW	0	0.5	6	5	2.75	1.25	0.5	16
WSW	0	0.25	11.5	11.5	4.25	0	0	27.5
W	0.25	2.25	10.25	23.75	14.5	0.25	0	51.25
WNW	0.25	3.75	8.75	23.5	19	0	0	55.25
NW	0.5	2	9.25	15.5	14	0.5	0	41.75
NNW	0	0	2.5	15.75	7.5	0	0	25.75
TOTAL	1	12.25	120.25	198	123.75	31	25.25	511.5

Stability Class B

Wind Direction

	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	5.25	3.75	4.25	3.5	0	16.75
NNE	0	0	1	4	3.75	0	0	8.75
NE	0	0	0	7.25	0.25	0	0	7.5
ENE	0	0	0	0.75	0	0	0	0.75
E	0	0	0	0.25	0	0	0	0.25
ESE	0	0	0	0	0	0	0.5	0.5
SE	0	0	0	0	0	0.5	4	4.5
SSE	0	0	0.5	1.25	1.75	1.25	0.75	5.5
S	0	0	1.5	0.75	3.25	0.75	0.25	6.5
SSW	0	0	6	2.75	0.75	0	0	9.5
SW	0	0.25	4.25	3.75	1	0.25	0	9.5
WSW	0	0.25	1.75	2.25	0.5	0	0	4.75
W	0	0.25	0.5	4.5	2	0	0	7.25
WNW	0.25	1.5	3	4	1.75	0	0	10.5
NW	0	0	5.5	2.25	3	0	0	10.75
NNW	0	0.75	2.25	4	7.75	0	0	14.75
TOTAL	0.25	3	31.5	41.5	30	6.25	5.5	118

Stability Class C

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	2	5.25	5.5	1.25	0	14.25
NNE	0	0	0.75	3	2.5	0	0	6.25
NE	0	0	0	4	0	0	0	4
ENE	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0
ESE	0	0	0	0.75	0.25	1.5	0.5	3
SE	0	0	0	0.25	0.5	0.5	0	1.25
SSE	0	0	0.75	0.75	1.5	0	0.5	3.5
S	0	0	1.75	3	2.25	0.25	0.75	8
SSW	0	0	8.5	6.75	0.25	0	0	15.5
SW	0	0	4	3	1.75	0.25	0	9
WSW	0	0.25	2.25	2.25	2.75	0	0	7.5
W	0.25	0	3.75	8	3.25	0	0	15.25
WNW	0.25	2	3.75	6	2.5	0	0	14.5
NW	0	0.5	5.5	3.75	1.75	0	0	11.5
NNW	0	0	2.5	2.25	15	0	0	19.75
TOTAL	0.5	3	35.5	49	39.75	3.75	1.75	133.25

Stability Class D

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.25	9.5	5	1	0	0	16.75
NNE	0	0.5	5.75	16.25	15.25	1	0	38.75
NE	0	1.5	2	4.5	0	0	0	8
ENE	0	0.5	1	0	0	0	0	1.5
E	0	0.25	0	0	0.75	4.75	1	6.75
ESE	0	1	0.25	0	1.5	0.25	0	3
SE	0	0	0.5	0.75	0.75	0.25	0	2.25
SSE	0	0.25	4.75	0.75	1.25	0.5	0	7.5
S	0	2	4.5	12.75	6	4.25	0	29.5
SSW	0	2.5	30.25	20	3.25	0	0	56
SW	0	1.75	10.25	8.25	4.75	1	0	26
WSW	0.25	3.75	19.5	10.25	4.5	0.5	0	38.75
W	0.5	2.75	9	25	26.25	0	0	63.5
WNW	0.25	6.5	11.5	41.25	10.25	0	0	69.75
NW	0.25	2.25	10.5	16.75	14	0.5	0	44.25
NNW	0	0.75	8.25	8.25	6.5	0.25	0	24
TOTAL	1.25	27.5	127.5	169.75	96	13.25	1	436.25

Stability Class E

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.25	9.25	3	0	0	0	13.5
NNE	0	0.5	6.5	18.25	12	0.25	0	37.5
NE	0	0.5	4.75	2	0	0	0	7.25
ENE	0	0	1.5	0	0	0	0	1.5
E	0	0.25	0.5	0	0	0	0	0.75
ESE	0	1	2	0.25	0	0	0	3.25
SE	0	0.75	0	0	0	0	0	0.75
SSE	0.25	1.25	1.25	0.25	0.25	2.25	0	5.5
S	1.5	2	9.5	13.75	2.75	1	0	30.5
SSW	2.5	4	17.75	21.75	0.75	0	0	46.75
SW	0.75	7.5	5.25	8.25	5.25	0.75	0	27.75
WSW	0.25	1	11.75	17.25	11.75	0	0	42
W	0	7.5	10.75	41.5	15.75	0	0	75.5
WNW	0.25	2.75	10.25	20.75	4.75	0	0	38.75
NW	0	3.25	10.25	6	4	0.25	0	23.75
NNW	0	2	9.5	2.5	0	0	0	14
TOTAL	5.5	35.5	110.75	155.5	57.25	4.5	0	369

Stability Class F

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	3.25	1	0	0	0	4.25
NNE	0	0	1.75	3.5	0.75	0	0	6
NE	0	0	0.25	0.75	0	0	0	1
ENE	0	0	0.25	0.75	0	0	0	1
E	0	0.25	1.75	1.25	0	0	0	3.25
ESE	0	0	0.5	0	0	0	0	0.5
SE	0	0	1	1.5	0	0	0	2.5
SSE	0	0.75	3.75	5	2.75	0	0	12.25
S	0.5	2	9.5	8.75	1	0	0	21.75
SSW	1.75	2.5	14.5	11.5	0.5	0	0	30.75
SW	0	2.25	10.75	6.5	3.25	0	0	22.75
WSW	0.75	4.25	16.25	16	1.5	0	0	38.75
W	4.25	4.75	18.25	26	0.25	0	0	53.5
WNW	2	2	17.25	5.5	0	0	0	26.75
NW	2.25	2.5	9	3.5	0	0	0	17.25
NNW	0.25	0.25	7.25	0.5	0	0	0	8.25
TOTAL	11.75	21.5	115.25	92	10	0	0	250.5

Stability Class G

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.5	0.75	0	0	0	0	1.25
NNE	0	1.5	1.25	0.5	0.25	0	0	3.5
NE	0	1.25	1.25	0.25	0	0	0	2.75
ENE	0	0.5	0	0	0	0	0	0.5
E	0	1.25	0	0	0	0	0	1.25
ESE	0	0.25	0	0	0	0	0	0.25
SE	0	0.75	1.5	0	0	0	0	2.25
SSE	0	3.5	15.25	19.5	0.25	0	0	38.5
S	0.5	6	32	20.5	1	0	0	60
SSW	3.75	10	17	2	0	0	0	32.75
SW	1.75	11.5	20.5	6.5	0	0	0	40.25
WSW	0.25	8.5	25.25	3.25	0	0	0	37.25
W	0.5	2.5	25.75	9.25	0.25	0	0	38.25
WNW	0.5	1.5	24	0.25	0	0	0	26.25
NW	1	3.25	17.5	1.25	0	0	0	23
NNW	0	0.75	1.75	0.25	0	0	0	2.75
TOTAL	8.25	53.5	183.75	63.5	1.75	0	0	310.75

Second Quarter 2012
Stability Class A

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	7.25	6.5	9.5	1.5	0	25
NNE	0	0	7.5	40	23.25	6.25	2	79
NE	0	0.5	27	37.25	3.5	0	0	68.25
ENE	0	1.25	24	8.5	0	0	0	33.75
E	0	1.25	24	2.75	0	0	0	28
ESE	0	0.75	16	11.25	0.75	0	0	28.75
SE	0	1.25	12.25	4.75	0.5	0	0	18.75
SSE	0	0.25	5.5	14.5	4.25	0.75	0	25.25
S	0	0.75	2.75	4	6.75	1.75	0	16
SSW	0	0	2.5	1.5	0	0	0	4
SW	0	1.25	2.25	3.75	0.75	1	0	9
WSW	0	1.5	2.25	9.75	2	0	0	15.5
W	0	0.75	5	21.25	7.5	0.25	0	34.75
WNW	0	0.25	7	12.5	17.25	1	0	38
NW	0	0.25	2.75	13.5	6.5	0	0	23
NNW	0	0	3	11	3	0	0	17
TOTAL	0	10.25	151	202.75	85.5	12.5	2	464

Stability Class B

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0.25	1	0	0	0	1.25
NNE	0	0	0.25	7.75	4.25	2.25	3.25	17.75
NE	0	0	3.75	1.75	0	0	0	5.5
ENE	0	0	2.5	2.25	0	0	0	4.75
E	0	0	2.25	0	0	0	0	2.25
ESE	0	0.5	0.5	0	0	0	0	1
SE	0	0.25	2	0	0.75	0	0	3
SSE	0	0.5	1.5	1.75	0	0	0	3.75
S	0	0.5	1	0.25	1	0.25	0	3
SSW	0	0.25	1.25	1	0	0	0	2.5
SW	0	0	0	0.5	0	0.5	0	1
WSW	0	0	0	0.75	0	0	0	0.75
W	0	0	0.25	1.75	3.75	0	0	5.75
WNW	0	0	1	4.25	1.5	0	0	6.75
NW	0	0	1	5.25	0.25	0	0	6.5
NNW	0	0	0.25	2.25	1.25	0	0	3.75
TOTAL	0	2	17.75	30.5	12.75	3	3.25	69.25

Stability Class C

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0.5	0.5	0	0	0	1
NNE	0	0	2.5	7.5	3.25	0	0	13.25
NE	0	0.5	3.75	6.5	4.25	0	0	15
ENE	0	0	4.75	3.75	0	0	0	8.5
E	0	0	3.25	1	0	0	0	4.25
ESE	0	0	1.75	0.75	0	0	0	2.5
SE	0	0.25	4	0.5	0	0	0	4.75
SSE	0	0.75	2	3.75	0.25	0	0	6.75
S	0	0	0.75	1.75	0.75	0	0	3.25
SSW	0	0	1.5	0.25	0	0	0	1.75
SW	0	0	0.5	0.75	0	0	0	1.25
WSW	0	0	0.5	1.25	0.25	0.25	0	2.25
W	0	0	0.75	2	0.5	0	0	3.25
WNW	0	0	1.25	2.75	5.5	0.75	0	10.25
NW	0	0	1.25	8.25	0	0	0	9.5
NNW	0	0	0.75	2.5	0	0	0	3.25
TOTAL	0	1.5	29.75	43.75	14.75	1	0	90.75

Stability Class D

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	3.25	7.5	1	0	0	11.75
NNE	0	0.5	13	27.5	14.25	0.75	0	56
NE	0	1.25	19	4.5	0.5	0	0	25.25
ENE	0	1	9	2.25	0	0	0	12.25
E	0	2.25	4	1.75	0	0	0	8
ESE	0	1.5	4.5	3.5	0	0	0	9.5
SE	0.25	1.5	9	0.75	0	0	0	11.5
SSE	0.25	1	8.5	9.5	1.25	0	0	20.5
S	0	1	6.25	11	1.5	0	0	19.75
SSW	0	0.25	3.25	3.75	0	0	0	7.25
SW	0	0.25	1.25	2.25	0	0.75	0	4.5
WSW	0	1	1.25	4.75	0	0.5	0.5	8
W	0	2.5	3.25	6.25	0.25	0.5	0.75	13.5
WNW	0	1.25	2.75	5	0	0.25	0	9.25
NW	0	0.75	4.25	1.75	0	0	0	6.75
NNW	0	1	6.25	4.75	0	0	0	12
TOTAL	0.5	17	98.75	96.75	18.75	2.75	1.25	235.75

Stability Class E

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.75	16.75	5.5	0.25	0	0	24.25
NNE	0	1.75	18.75	9.75	1.75	0	0	32
NE	0	1.25	21.25	3	0.25	0	0	25.75
ENE	0	3.5	7.75	0.75	0	0	0	12
E	0	4.75	5.75	0.5	0	0	0	11
ESE	0	5.75	11.75	1	0	0	0	18.5
SE	0	4.25	12.5	1	0.5	0	0	18.25
SSE	0	3.75	9.5	11.25	1.75	0	0	26.25
S	0	5.5	17	31.75	8.5	0.5	0	63.25
SSW	0	1.25	20.25	10	4	0	0	35.5
SW	0	2.25	3.75	1.75	0.25	0	0	8
WSW	0	0.75	2.25	7	0	0	0	10
W	0	1.25	5.25	8.25	0	0	0	14.75
WNW	0	3	10.25	16.25	0.25	0	0	29.75
NW	0	2.25	7.5	6.75	0.25	0.25	0	17
NNW	0	0.25	17	6.25	0	0	0	23.5
TOTAL	0	43.25	187.25	120.75	17.75	0.75	0	369.75

Stability Class F

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.25	7.5	4.75	0.25	0	0	13.75
NNE	0	2.75	7.75	1.5	0.25	0	0	12.25
NE	0	2.75	8	0.25	0	0	0	11
ENE	0	1	4.25	0.5	0	0	0	5.75
E	0	1.75	1.75	0.5	0	0	0	4
ESE	0	2	3.25	0	0	0	0	5.25
SE	0	2	3.75	0.75	0	0	0	6.5
SSE	0	4.5	15.5	14	15	0	0	49
S	0	4.25	20.5	18.25	0.5	0.25	0	43.75
SSW	0	3.75	25	2.5	0	0.25	0	31.5
SW	0	4.5	7.25	0.75	0	0	0	12.5
WSW	0	2	12.25	3	0	0	0	17.25
W	0	5	14.5	4	0.25	0	0	23.75
WNW	0	2	7	6.5	0	0	0	15.5
NW	0	2.25	5.5	4.25	0	0	0	12
NNW	0	3.5	16.25	3.75	0	0	0	23.5
TOTAL	0	45.25	160	65.25	16.25	0.5	0	287.25

Stability Class G

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2.5	8.5	0.5	0	0	0	11.5
NNE	0	1.25	3	0	0	0	0	4.25
NE	0	4.25	7.25	1	0	0	0	12.5
ENE	0.5	0.25	5.25	0.5	0	0	0	6.5
E	0.25	2	7.75	1	0	0	0	11
ESE	0	1.25	11.25	1.25	0.5	0	0	14.25
SE	0	2.25	9.5	1.25	0.75	0	0	13.75
SSE	0	3.25	41.25	31.5	12	6	0	94
S	0.25	10.5	63	53.25	6.75	0.75	0	134.5
SSW	0.25	10	25.5	2.5	0	0	0	38.25
SW	0	14	18.25	0	0	0	0	32.25
WSW	0	15	21.25	4	0	0	0	40.25
W	0	7.25	42.75	1	0	0	0	51
WNW	0	9	37.5	8.25	0	0	0	54.75
NW	0	5	16.75	10.5	0	0	0	32.25
NNW	0	5	22	10.25	0	0	0	37.25
TOTAL	1.25	92.75	340.75	126.75	20	6.75	0	588.25

Third Quarter 2012
Stability Class A

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	3.25	0.75	0.75	0	0	5
NNE	0	0	6.75	10	3.5	0	0	20.25
NE	0	0	24	6.75	0	0	0	30.75
ENE	0	0.25	11.5	8.5	0	0	0	20.25
E	0	0	15.25	11.75	0	0	0	27
ESE	0	0.5	17.25	0.25	0	0	0	18
SE	0	0.75	19.5	2	0	0	0	22.25
SSE	0	0.25	7.5	13.25	0.75	0	0	21.75
S	0	0.25	1	4.25	2.75	0	0	8.25
SSW	0	0.25	2.5	4.25	0	0	0	7
SW	0	1.25	6.5	9	3.25	0	0	20
WSW	0	0	9.75	12.25	0	0	0	22
W	0	0.25	7	6	0.25	0	0	13.5
WNW	0	0.75	13.25	12.75	0	0	0	26.75
NW	0	0.75	10.75	13.75	0.25	0	0	25.5
NNW	0	0.5	9.25	5	1.75	0	0	16.5
TOTAL	0	6	165	120.5	13.25	0	0	304.75

Stability Class B

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	0.5	1.75	0	0	0	2.5
NNE	0	0.25	2.75	5.75	6	0	0	14.75
NE	0	0	6.25	0.5	0	0	0	6.75
ENE	0	0	4	0.25	0	0	0	4.25
E	0	0.25	3.25	1	0	0	0	4.5
ESE	0	0	1.5	0	0	0	0	1.5
SE	0	0	2.75	0.25	0	0	0	3
SSE	0	0	1.5	2.25	0.5	0	0	4.25
S	0	0	0.5	0	1	0	0	1.5
SSW	0	0	1.25	0.5	0	0	0	1.75
SW	0	0.25	0.75	0	0	0	0	1
WSW	0	0.5	2.75	3.25	0	0	0	6.5
W	0	0	3.75	2.25	0	0	0	6
WNW	0	0	3.75	2	0.25	0	0	6
NW	0	0.25	0.5	1.5	0	0	0	2.25
NNW	0	0	0.75	1.5	0	0	0	2.25
TOTAL	0	1.75	36.5	22.75	7.75	0	0	68.75

Stability Class C

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0.75	1.5	0.25	0	0	2.5
NNE	0	0	2.75	3	1.75	0.75	0	8.25
NE	0	0.25	9.5	1.5	0	0	0	11.25
ENE	0	0	4	2.5	0	0	0	6.5
E	0	0.25	3.75	2.25	0	0	0	6.25
ESE	0	0	3.75	0	0	0	0	3.75
SE	0	0	3.25	0	0	0	0	3.25
SSE	0	0	3.25	1.75	0.25	0	0	5.25
S	0	0.25	0.75	1.5	0.25	0	0	2.75
SSW	0	0	1.25	1	0	0	0	2.25
SW	0	0.25	0.75	0.5	0.25	0	0	1.75
WSW	0	0.25	2	2.5	0	0	0	4.75
W	0	0.5	3.75	0.25	0	0	0	4.5
WNW	0	0	3.25	1.5	0	0	0	4.75
NW	0	0	1	2.5	0	0	0	3.5
NNW	0	0	0.5	1	0.25	0	0	1.75
TOTAL	0	1.75	44.25	23.25	3	0.75	0	73

Stability Class D

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.5	3.5	6.25	8.25	0	0	18.5
NNE	0	0	9	11.5	12.5	2	0.25	35.25
NE	0	0.75	17	7	0.25	0	0	25
ENE	0	0.5	14	9.25	0	0	0	23.75
E	0	0.25	4.5	2.5	0	0	0	7.25
ESE	0	1	6.75	0.5	0	0	0	8.25
SE	0	1	8.5	0.75	0	0	0	10.25
SSE	0	0.5	12.5	12	1.5	0	0	26.5
S	0	1.25	4	13.5	0.75	0	0	19.5
SSW	0	0	4.75	5	1.25	0	0	11
SW	0	0.25	4.5	2.25	0.5	0	0	7.5
WSW	0	1.5	3.75	3.75	0.5	0	0	9.5
W	0	0.25	9.25	2	0	0	0	11.5
WNW	0	0.5	5.5	4.75	0	0	0	10.75
NW	0	0.25	4	8.25	0.25	0	0	12.75
NNW	0	0	4.75	9	0	0	0	13.75
TOTAL	0	8.5	116.25	98.25	25.75	2	0.25	251

Stability Class E

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2.25	19.5	9.5	0.25	0	0	31.5
NNE	0	1	16.75	20.75	1.5	0.5	0	40.5
NE	0	3	19.75	2.25	0	0	0	25
ENE	0	2.75	11	3.25	0	0	0	17
E	0	3	4.75	0.75	0.25	0	0	8.75
ESE	0	1.75	6.5	1.25	0	0	0	9.5
SE	0	2.5	9	0.5	0	0	0	12
SSE	0	2.5	17.5	16.75	3.25	0	0	40
S	0	4	19	22.5	1.5	0.75	0	47.75
SSW	0	3.5	27.5	11.5	0.5	0	0	43
SW	0	2.5	9	3	0.25	0	0	14.75
WSW	0	1.75	8.5	4	1.25	0	0	15.5
W	0	2.25	7.75	0.75	0	0	0	10.75
WNW	0	1.75	14	2.75	0	0	0	18.5
NW	0	0.25	11.5	8.75	0.25	0	0	20.75
NNW	0	2	18.75	15.75	1	0	0	37.5
TOTAL	0	36.75	220.75	124	10	1.25	0	392.75

Stability Class F

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	3.5	21	5.25	0.25	0	0	30
NNE	0	2.25	8.75	4.25	0.25	0	0	15.5
NE	0	2.75	11	0.5	0	0	0	14.25
ENE	0	2.25	6.25	1	0	0	0	9.5
E	0	1.25	0.75	0	0	0	0	2
ESE	0	2	2	0.25	0	0	0	4.25
SE	0	1.25	3.5	0	0	0	0	4.75
SSE	0	4	7	12.25	0.75	0	0	24
S	0	7.75	27.75	11	0.5	0	0	47
SSW	0	8.5	64.75	2.75	0	0	0	76
SW	0	7	14.25	2	0	0	0	23.25
WSW	0	3.75	10.25	4.25	0.25	0	0	18.5
W	0	2.5	13	2.25	0.25	0	0	18
WNW	0	0.75	21.75	3.75	0	0	0	26.25
NW	0	2.5	14.5	5.25	0.25	0	0	22.5
NNW	0	3.25	23.5	1.75	0.25	0	0	28.75
TOTAL	0	55.25	250	56.5	2.75	0	0	364.5

Stability Class G

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	4.25	21.5	3	0	0	0	28.75
NNE	0	2	4.25	6.25	2	0	0	14.5
NE	0	1.75	7.25	0.5	0	0	0	9.5
ENE	0	0.75	2	0.5	0	0	0	3.25
E	0	1.5	1.5	0.25	0	0	0	3.25
ESE	0	1	1	0	0	0	0	2
SE	0	1.75	4.75	0.5	0	0	0	7
SSE	0	4	17.75	14.25	1.5	0	0	37.5
S	0	10	43.75	12.75	0.25	1.25	0	68
SSW	0.25	17.5	41.75	0.5	0	0	0	60
SW	0	18	47	0.25	0	0	0	65.25
WSW	0	21	65.5	5.25	0	0	0	91.75
W	0	17.25	82.75	7.75	0.25	0	0	108
WNW	0	20.25	52.75	2.5	0	0	0	75.5
NW	0	24.75	52.25	5.5	0	0	0	82.5
NNW	0	24.75	41.75	3	0	0	0	69.5
TOTAL	0.25	170.5	487.5	62.75	4	1.25	0	726.25

Fourth Quarter 2012
Stability Class A

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.5	6.5	6.25	5	5	1	24.25
NNE	0	0	6.75	8.25	4.75	1.5	0	21.25
NE	0	0.25	7.5	3.25	9.5	0	0	20.5
ENE	0	0.5	4.75	13.5	7.5	1.75	0	28
E	0	1	5	8.25	2.75	0.5	0	17.5
ESE	0	0.5	2	6.75	2	0	0	11.25
SE	0	1.75	2	0.75	4.25	0	0	8.75
SSE	0	1.25	3.25	8.5	1.5	0	0	14.5
S	0	0	4	5.75	6.5	1.25	0	17.5
SSW	0	0	6	8	3	0	0.25	17.25
SW	0	0.25	3.5	11.75	2.75	0	0	18.25
WSW	0	0.5	9.25	3.5	2	0	0	15.25
W	0	0.25	6.25	9.5	16.25	0.75	0	33
WNW	0	0	5.5	6.25	3.25	1	0	16
NW	0	0	3	18.25	3	4.5	0	28.75
NNW	0	0.5	5.25	18	6.5	1.25	1.25	32.75
TOTAL	0	7.25	80.5	136.5	80.5	17.5	2.5	324.75

Stability Class B

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	4.5	6	2.5	2.5	0	15.75
NNE	0	0	3	3	0.5	1.25	0	7.75
NE	0	0	4.25	0	0	0	0	4.25
ENE	0	0	1	2.25	1	0	0	4.25
E	0	0.25	0.5	8	3.75	0	0	12.5
ESE	0	0	0	2.5	0	0	0	2.5
SE	0	0.25	0	3.75	0	0	0	4
SSE	0	0.25	0	2.25	3	0	0	5.5
S	0	0	1.75	4	2.5	0	0	8.25
SSW	0	0.5	4.75	3.25	1.25	0	0	9.75
SW	0	0.25	3.75	0.75	0.25	0	0	5
WSW	0	0.5	2.75	2	2	0	0	7.25
W	0	1	3.25	1.25	1.25	0.5	0	7.25
WNW	0	1	3.5	4	0.75	0	0	9.25
NW	0	1.75	0.5	7	1.5	0	0	10.75
NNW	0	2	4.75	11.25	2.25	0	0	20.25
TOTAL	0	8	38.25	61.25	22.5	4.25	0	134.25

Stability Class C

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	7.75	12.75	3	0.75	0	24.25
NNE	0	0	2.75	3	0.5	0.25	1.25	7.75
NE	0	0	2.75	0	0	0	0	2.75
ENE	0	0	1	1.5	0.5	0	0	3
E	0	0.5	0.75	8.25	1.5	0	0	11
ESE	0	0.25	1.25	0	0	0	0	1.5
SE	0	0	0	5.25	0	0	0	5.25
SSE	0	0.5	0.25	0.75	3.25	0.25	0	5
S	0	0.5	1.5	6	4.5	0	0	12.5
SSW	0	1.25	4.75	3	2.75	0	0	11.75
SW	0	1	0.75	2	0	0	0	3.75
WSW	0	0.75	2.75	2.75	3	0	0	9.25
W	0	0.75	2	1.5	1.25	0	0	5.5
WNW	0	0	3.25	4	1.75	0	0	9
NW	0	0.5	0.5	3	2.75	0	0	6.75
NNW	0	0	3.75	8.5	6.5	4.25	0	23
TOTAL	0	6	35.75	62.25	31.25	5.5	1.25	142

Stability Class D

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.5	10	31	12.25	4.5	1.5	59.75
NNE	0	0	2.5	9.25	0	0.25	1.75	13.75
NE	0	0	4	3.25	0	0	0	7.25
ENE	0	0.25	1.25	1.5	0.5	0	0	3.5
E	0	0.75	1.5	7.25	8.5	2	0	20
ESE	0	0.5	1.25	3.25	1	2.5	0	8.5
SE	0	0.75	0.75	0.75	10.25	2	0	14.5
SSE	0	0.5	4	7.5	11.25	0.75	0	24
S	0	0	6.25	22.75	10	0	0	39
SSW	0	2	27.5	8.75	1.25	0	0	39.5
SW	0	1.5	11.25	6	0.5	0	0	19.25
WSW	0	4.5	6.5	5.75	2	0	0	18.75
W	0	5.75	18.75	14	6	1.75	0	46.25
WNW	0	4	17.25	15.25	1	0	0	37.5
NW	0	0.5	13.5	8.25	4	0	0	26.25
NNW	0	0.75	21.25	35.75	9.5	12.25	0.5	80
TOTAL	0	22.25	147.5	180.25	78	26	3.75	457.75

Stability Class E

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2.75	8.75	17	0.75	0	0	29.25
NNE	0	0.5	1.5	3.5	1.5	0	0	7
NE	0	0	1.25	0.25	0	0	0	1.5
ENE	0	0.25	0.5	0	0	0	0	0.75
E	0	0.25	0	0	0	0	0	0.25
ESE	0	0.5	2	0	0	0	0	2.5
SE	0	1.25	1	4.5	0.25	1	0	8
SSE	0	0.5	3.5	7.25	6.5	1.25	0	19
S	0	2.75	16.25	13	1.25	0	0	33.25
SSW	0	4	38.5	34	0.25	0	0	76.75
SW	0	3	16.5	13	0	0	0	32.5
WSW	0	3	13	10.25	0.75	0	0	27
W	0	4.25	9	34	5.75	2.25	0	55.25
WNW	0	1.75	27.25	15.25	0.25	0	0	44.5
NW	0	0.75	23.5	12	0	0	0	36.25
NNW	0	3	16.5	27.75	0	0	0	47.25
TOTAL	0	28.5	179	191.75	17.25	4.5	0	421

Stability Class F

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	6.75	4.5	0	0	0	11.25
NNE	0	0	0.25	0.75	0	0	0	1
NE	0	0	2.25	0.25	0	0	0	2.5
ENE	0	0.25	0.25	0	0	0	0	0.5
E	0	0	0	0	0	0	0	0
ESE	0	0.25	0	0	0	0	0	0.25
SE	0	0.25	1.25	0	0	0	0	1.5
SSE	0	1	0.25	1.75	1.5	0	0	4.5
S	0	2.25	9.75	2.25	4.5	0	0	18.75
SSW	0	3.5	23	5	0	0	0	31.5
SW	0	0.25	10	0.75	0	0	0	11
WSW	0	1.75	15.25	8.25	0.25	0	0	25.5
W	0	1.75	23.5	5.75	0.5	0	0	31.5
WNW	0	3.5	22.25	7.75	1.5	0	0	35
NW	0	2.25	11	5	1	0	0	19.25
NNW	0	0.25	18.75	8.25	0	0	0	27.25
TOTAL	0	17.25	144.5	50.25	9.25	0	0	221.25

Stability Class G

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2.75	10.5	2.5	1	0.25	0	17
NNE	0	1.25	3.5	9.25	8.75	1.75	0	24.5
NE	0	2	2.25	0	0	0	0	4.25
ENE	0	1.75	1.75	0	0	0	0	3.5
E	0	1.5	2.75	0.25	0	0	0	4.5
ESE	0	0.75	5.75	1.75	0	0	0	8.25
SE	0	1	5.5	0.75	1	0	0	8.25
SSE	0	1	15.75	6.5	0.75	1	0	25
S	0	1.5	18.75	6.25	1	2	0	29.5
SSW	0	4.25	36.25	11	3.5	0	0	55
SW	0	7	33.5	3.5	0.5	0	0	44.5
WSW	0	10.75	31	1.25	1.25	0	0	44.25
W	0	8.5	25	3.5	3.5	0	0	40.5
WNW	0	4.5	31.75	11.25	8.75	0	0	56.25
NW	0	1.75	23.5	16.75	4.5	0	0	46.5
NNW	0	7.5	19.5	10.75	3.5	0	0	41.25
TOTAL	0	57.75	267	85.25	38	5	0	453

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Appendix B

Kewaunee Power Station

Offsite Dose Calculation Manual (ODCM)

Revision 14
April 18, 2012

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Dominion Energy Kewaunee, Inc.

Kewaunee Power Station

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Revision 14
DATE: April 18, 2012

Approved By:	James M. Hale Manager - Radiological Protection and Chemistry	04-06-2012 Date
Approved By:	Thomas L. Breene Manager - Regulatory Affairs	04-09-2012 Date
Reviewed By:	Jeffrey T. Stafford Facility Safety Review Committee	04-17-2012 Date
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PART II CALCULATIONAL METHODOLOGIES

Kewaunee Power Station

Offsite Dose Calculation Manual

PART I - RADIOACTIVE EFFLUENT CONTROLS

11.0 INTRODUCTION

The Kewaunee OFFSITE DOSE CALCULATION MANUAL (ODCM) is established and maintained pursuant to Technical Specifications Section 5.5.1. The ODCM consists of two parts: Radiological Effluent Controls, Part I, and Calculational Methodologies, Part II.

Part I, Radiological Effluent Controls, includes: (1) The Radioactive Effluent Control Specifications (RECS) and Radiological Environmental Monitoring Programs (REMP) required by Technical Specification 5.5.1 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Radioactive Effluent Release Reports required by Technical Specifications 5.6.1 and 5.6.2 respectively.

Part II, Calculational Methodologies: provides the methodology to manually calculate radiation dose rates and doses to individual persons in UNRESTRICTED AREAS due to the routine release of gaseous and liquid effluents. Long term cumulative effects are usually calculated through computer programs employing approved methodology, often using real-time meteorology in the case of gaseous effluents. Other computer programs are utilized to routinely estimate the doses due to radioactivity in liquid effluents. Manual dose calculations are performed when computerized calculations are not available.

The methodology stated in this manual is acceptable for use in demonstrating compliance with 10CFR20.1302; 10CFR50, Appendix I; and 40CFR190.

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 10CFR50.36a and Appendix I for demonstrating radioactive effluents are ALARA.

11.1 Change Process

Instructions for defining the responsibilities and requirements for revision and control of both the ODCM and the RADIOLOGICAL ENVIRONMENTAL MONITORING MANUAL (REMM) are located in approved station procedure for Revision and Control of the REMM and ODCM.

13.0 USE AND APPLICATION

13.0.1 Definitions

---NOTE---

Terms defined in both Kewaunee Technical Specifications and the OFFSITE DOSE CALCULATION MANUAL appear in capitalized type and are applicable throughout the Radiological Effluent Controls Normal Conditions and Bases and the Calculational Methodologies.

Term	Definition
ACTION	Action shall be that part of a Normal Condition which prescribes remedial measures required under designated conditions.
CHANNEL CHECK	CHANNEL CHECK is a qualitative determination of acceptable FUNCTIONALITY by observation of channel behavior during operation. This determination shall include, where possible, comparison of the channel indication with other indications derived from independent channels measuring the same variable.
CHANNEL FUNCTIONAL TEST	A CHANNEL FUNCTIONAL TEST consists of injecting a simulated signal into the channel as close to the primary sensor as practicable to verify that it is FUNCTIONAL, including alarm and/or trip initiating action.
CHANNEL CALIBRATION	CHANNEL CALIBRATION consists of the adjustment of channel output as necessary, such that it responds with acceptable range and accuracy to known values of the parameter that the channel monitors. Calibration shall encompass the entire channel, including alarm and/or trip, and shall be deemed to include the CHANNEL FUNCTIONAL TEST.
FUNCTIONAL/ FUNCTIONALITY	As defined in the Technical Requirements Manual
GASEOUS RADWASTE TREATMENT SYSTEM	A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting off-gases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity released to the environment.
MEMBER(S) OF THE PUBLIC	MEMBER(S) OF THE PUBLIC means any individual except when that individual is receiving an OCCUPATIONAL DOSE.

OCCUPATIONAL DOSE	OCCUPATIONAL DOSE means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. OCCUPATIONAL DOSE does not include doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under 10 CFR 35.75, from voluntary participation in medical research programs, or as a MEMBER OF THE PUBLIC.
OFFSITE DOSE CALCULATION MANUAL	The OFFSITE DOSE CALCULATION MANUAL shall contain the current methodology and parameters used in the calculation of offsite doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, in the conduct of the Radiological Environmental Monitoring Program. Shall also contain the Radioactive Effluent Controls and Radiological Environmental Operating and Radioactive Effluent Release Reports required by TS 5.6.1 and TS 5.6.2.
ODCM NORMAL CONDITIONS (DNC)	Specify minimum requirements for ensuring safe operation of the Unit. The Contingency Measures associated with a DNC state Nonconformances that typically describe the ways in which the requirements of the DNC can fail to be met. Specified with each stated Nonconformance are Contingency Measures and Restoration Time(s).
ODCM VERIFICATION REQUIREMENTS (DVR)	Verification requirements are requirements relating to test, calibration, or inspection to assure that the necessary FUNCTIONALITY of systems and components are maintained, that facility operation will be maintained within the current licensing basis, and that the ODCM Normal Condition (DNC) for operation will be met.
PROCESS CONTROL PROGRAM	The PROCESS CONTROL PROGRAM shall contain the current formulae, sampling, analyses, tests, and determinations to be made to ensure that the processing and packaging of solid radioactive wastes, based on demonstrated processing of actual or simulated wet solid wastes, will be accomplished in such a way as to ensure compliance with 10 CFR Part 20, 10 CFR Part 61, 10 CFR Part 71, Federal and State regulations, burial ground requirements, and other requirements governing the disposal of the radioactive waste. Licensee initiated changes to the PCP, which was approved by the Commission prior to implementation: 1. Shall be documented and records of reviews performed shall be retained as required by the quality assurance program. The documentation shall contain: a. Sufficient information to support the change together with the appropriate analyses or evaluations justifying the change(s). b. A determination that the change will maintain the overall conformance of the solidified waste product to existing requirements of Federal, State, or other applicable regulations. 2. Shall become effective upon review and acceptance by the FSRC.

PUBLIC DOSE	PUBLIC DOSE means the dose received by a MEMBER OF THE PUBLIC from exposure to radiation or to radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. PUBLIC DOSE does not include OCCUPATIONAL DOSE or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under 10 CFR 35.75, or from voluntary participation in medical research programs.
PURGE - PURGING	PURGE or PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.
RADIOLOGICAL ENVIRONMENTAL MONITORING MANUAL (REMM)	The REMM shall contain the current methodology and parameters used in the conduct of the radiological environmental monitoring program.
SITE BOUNDARY	The SITE BOUNDARY shall be that line beyond which the land is neither owned, leased, nor otherwise controlled by the licensee.
SOURCE CHECK	A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.
UNRESTRICTED AREA	An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY, access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, commercial, institutional, and/or recreational purposes. (See Plant Drawing A-408)
VENTILATION EXHAUST TREATMENT SYSTEM	A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Feature atmospheric cleanup systems (i.e., Auxiliary Building special ventilation, Shield Building ventilation, spent fuel pool ventilation) are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.
VENTING	VENTING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required during venting. Vent, used in system names, does not imply a VENTING process.

13.0 USE AND APPLICATION

13.0.2 Logical Connectors

Logical Connectors are discussed in Section 1.2 of the Technical Specifications and are applicable throughout the OFFSITE DOSE CALCULATION MANUAL and Bases.

13.0 USE AND APPLICATION

13.0.3 Restoration Times

Restoration Times are the same as Completion Times as discussed in Section 1.3 of the Technical Specifications and are applicable throughout the OFFSITE DOSE CALCULATION MANUAL and Bases.

When "Immediately" is used as a Restoration Time, the Contingency Measure should be pursued without delay in a controlled manner.

13.0 USE AND APPLICATION

13.0.4 Frequency

Frequency is discussed in Section 1.4 of the Technical Specifications and is applicable throughout the OFFSITE DOSE CALCULATION MANUAL and Bases

13.0 USE AND APPLICATION

13.0.5 ODCM Normal Condition (DNC) Applicability

DNC 13.0.5.1 DNCs shall be met during the MODES or other specified conditions in the Applicability.

DNC 13.0.5.2 Upon discovery of a failure to meet the DNC, the Contingency Measures of the associated Nonconformance shall be met, except as provided in DNC 13.0.5.4.

DNC 13.0.5.3 When it is discovered that a DNC has not been met and the associated contingency measures are not satisfied within the specified restoration time (or an associated contingency measure is not provided), the equipment subject to the DNC is in a nonconforming condition. In this situation, appropriate actions shall be taken as necessary to provide assurance of continued safe plant operations. In addition a Condition Report shall be initiated and assessment of reasonable assurance of safety shall be conducted. Items to be considered for this assessment include the following:

- Availability of redundant or backup equipment;
- Compensatory measures, including limited administrative controls;
- Safety function and events protected against;
- Probability of needing the safety function;
- Conservatism and margins; and
- Probabilistic Risk Assessment or Individual Plant Evaluation results that determine how operating the plant in the manner proposed will impact core damage frequency.

If this assessment concludes that safety is sufficiently assured, the facility may continue to operate while prompt corrective action is taken.

DNC 13.0.5.4 Equipment removed from service or declared nonfunctional to comply with Contingency Measures may be returned to service under administrative control solely to perform testing required to demonstrate its FUNCTIONALITY or the FUNCTIONALITY of other equipment. This is an exception to DNC 13.0.5.2 for the system returned to service under administrative control to perform the testing required to demonstrate FUNCTIONALITY.

13.0 USE AND APPLICATION

13.0.6 ODCM VERIFICATION REQUIREMENTS (DVR) Applicability

DVR 13.0.6.1 DVRs shall be met during the MODES or other specified conditions in the Applicability for individual DNCs, unless otherwise stated in the DVR. Failure to meet a DVR, whether such failure is experienced during the performance of the DVR or between performances of the DVR, shall be failure to meet the DNC. Failure to perform a DVR within the specified Frequency shall be failure to meet the DNC except as provided in DVR 13.0.6.3. DVR's do not have to be performed on nonfunctional equipment or variables outside specified limits

DVR 13.0.6.2 Each Verification Requirement shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the specified DVR frequency.

DVR 13.0.6.3 When it is discovered that a DVR frequency (including the 1.25 times extension) has not been met, the equipment subject to the DVR is in a nonconforming condition. In this situation, a Condition Report shall be initiated and, if indicated, determination to evaluate the impact on plant safety shall be performed in a timely fashion and in accordance with plant procedures.

Actions should be taken to restore conformance with the DNCs / DVRs in a timely fashion.

13.1 RADIOACTIVE LIQUID EFFLUENTS

13.1.1 Liquid Effluents Concentration

DNC 13.1.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (Figure 14.1-1) shall be limited to:

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

b. 2×10^{-4} μCi/ml total activity concentration for dissolved or entrained noble gases.

APPLICABILITY: During release via the monitored pathway.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeds limits.	A.1 Initiate ACTION to restore concentration to within limits.	Immediately
B. CONTINGENCY MEASURES <u>OR</u> RESTORATION TIME not met.	B.1 Initiate a CR	In accordance with Corrective Action Program
	<u>AND</u>	
	B.2 Explain in the next Radioactive Effluent Release Report why the CONTINGENCY MEASURE was not met in a timely manner.	In accordance with Radioactive Effluent Release Report

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.1.1.1	Perform radioactive liquid waste sampling and activity analysis.	In accordance with Table 13.1.1-1
-------NOTE------- In this DVR the results of DVR 13.1.1.1 shall be used in accordance with the methodology and parameters of the ODCM.		In accordance with Table 13.1.1-1
DVR 13.1.1.2	Verify the results of the DVR 13.1.1.1 analyses to assure that the concentrations at the point of release are maintained within the limits of DNC 13.1.1.	

Table 13.1.1-1 (Page 1 of 2)
Radioactive Liquid Waste Sampling and Analysis

LIQUID RELEASE TYPE		TYPE OF ACTIVITY ANALYSIS	SAMPLE TYPE	SAMPLE FREQUENCY	MINIMUM ANALYSIS FREQUENCY	LOWER LIMIT OF DETECTION (LLD) (a)
1. Batch Waste Release Tanks (b)						
	a.	Principal Gamma Emitters(c)	Grab Sample	Each Batch (h)	Each Batch (h)	1 x 10^{-6} µCi/ml
	b.	I-131	Grab Sample	Each Batch (h)	Each Batch (h)	1 x 10^{-6} µCi/ml
	c.	Dissolved and Entrained Gases (gamma emitters)	Grab Sample	Each Batch (h)	31 days	1 x 10^{-5} µCi/ml
	d.	H-3	Composite (d)	Each batch (h)	31 days	1 x 10^{-5} µCi/ml
	e.	Gross Alpha	Composite (d)	Each batch (h)	31 days	5 x 10^{-7} µCi/ml
	f.	Sr-89	Composite (d)	Each batch (h)	92 days	5 x 10^{-8} µCi/ml
	g.	Sr-90	Composite (d)	Each batch (h)	92 days	5 x 10^{-8} µCi/ml
	h.	Fe-55	Composite (d)	Each batch (h)	92 days	1 x 10^{-6} µCi/ml
2. Continuous Releases (e) (SG Blowdown) (TB Sump) (g)						
	a.	Principal Gamma Emitters (c)	Grab Sample	7 days	7 days	5 x 10^{-7} µCi/ml
	b.	I-131	Grab Sample	7 days	7 days	1 x 10^{-6} µCi/ml
	c.	Dissolved and Entrained Gases (gamma emitters)	Grab Sample	7 days	7 days	1 x 10^{-5} µCi/ml
	d.	H-3	Grab Sample	7 days	31 days(f)	1 x 10^{-5} µCi/ml
	e.	Gross Alpha	Composite (f)	7 days	31 days(f)	5 x 10^{-7} µCi/ml
	f.	Sr-89	Composite (f)	7 days	92 days(f)	5 x 10^{-8} µCi/ml
	g.	Sr-90	Composite (f)	7 days	92 days(f)	5 x 10^{-8} µCi/ml
	h.	Fe-55	Composite (f)	7 days	92 days(f)	1 x 10^{-6} µCi/ml

Table 13.1.1-1 (Page 2 of 2)
Radioactive Liquid Waste Sampling and Analysis

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

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

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

Where:

- LLD is the a priori lower limit of detection as defined above, as μCi per unit mass or volume,
- s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute,
- E is the counting efficiency, as counts per disintegration,
- V is the sample size in units of mass or volume,
- 2.22×10^6 is the number of disintegrations per minute per microcurie,
- Y is the fractional radiochemical yield, when applicable,
- λ is the radioactive decay constant for the particular radionuclide, and
- Δt for plant effluents is the elapsed time between the midpoint of sample collection and time of counting.
- Typical values of E, V, Y and Δt should be used in the calculation.

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

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

(c) The principal gamma emitters for which the LLD requirement applies, includes the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identified, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to DNC 15.2.

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

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

(f) As a minimum, the monthly and quarterly composite samples shall be compromised of weekly grab samples.

(g) During periods of identified primary - to - secondary leakage (with the secondary gamma activity >1.0E-06 μCi/ml), grab samples are collected daily and analyzed by gamma spectroscopy. (Appendix C)

(h) Complete prior to each release.

BASES

This DNC is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than ten times the concentration levels specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC and (2) the limits of 10 CFR Part 20.1301 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its concentration limit in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

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

13.1 RADIOACTIVE LIQUID EFFLUENTS

13.1.2 Liquid Effluents Dose

DNC 13.1.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials released in liquid effluents released to UNRESTRICTED AREAS shall be limited to:

a. ≤ 1.5 mrem to the total body and ≤ 5 mrem to any organ during any calendar quarter; and

b. ≤ 3 mrem to the total body and ≤ 10 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents to UNRESTRICTED AREAS exceeds limits.	A.1 Prepare and submit to the NRC, pursuant to DNC 15.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and; (2) Defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with DNC 13.1.2.	30 days

ACTIONS (continued)

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.). AND B.2 Verify that the limits of DNC 13.4 have not been exceeded.	Immediately Immediately
C. CONTINGENCY MEASURE B.2 and Associated RESTORATION TIME not met.	C.1 Prepare and submit to the NRC, pursuant to DNC 15.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of CONTINGENCY MEASURE A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DNC 13.4 and the schedule for achieving conformance, (2) An analysis that estimates the dose to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.1.2.1	Determine cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This DNC is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR 50. The DNC implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

13.1 RADIOACTIVE LIQUID EFFLUENTS

13.1.3 Liquid Radwaste Treatment System

DNC 13.1.3 The Liquid Radwaste Treatment System, as described in the ODCM, shall be used to reduce the radioactive material in liquid wastes prior to their discharge when the projected dose, due to the liquid effluent, to UNRESTRICTED AREAS would exceed in a 31 day period:

a. > 0.06 mrem to the total body; or

b. > 0.2 mrem to any organ.

APPLICABILITY: At all times

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Radioactive liquid waste being discharged without treatment and in excess of the above limits.	A.1 Prepare and submit to the NRC, pursuant to DNC 15.3, a Special Report that includes: (1) An explanation of why liquid radwaste was being discharged without treatment, identification of any non-functional / inoperable equipment or subsystems, and the reason for the non-functional / inoperability, (2) ACTION(s) taken to restore the non-functional / inoperable equipment to FUNCTIONAL / OPERABLE status, and (3) Summary description of ACTION(s) taken to prevent a recurrence.	30 days

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.1.3.1	Project the doses due to liquid effluents from the unit to UNRESTRICTED AREAS in accordance with the methodology and parameters specified in the ODCM.	31 days

BASES

The requirement that the appropriate portions of this system be used, when specified, provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable."

This DNC implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50.

The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

13.1 LIQUID EFFLUENTS

13.1.4 Liquid Holdup Tanks

DNC 13.1.4 The quantity of radioactivity contained in unprotected outdoor liquid storage tanks shall be limited to less than the amount that would result in concentrations less than the limits in 10 CFR20, Appendix B, Table II, Column 2, at the nearest potable water supply and surface water supply in an UNRESTRICTED AREA, excluding tritium and dissolved or entrained gases.

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Level of radioactivity exceeds the limits in any listed tank.	A.1 Suspend addition of radioactive material.	Immediately
	<u>AND</u>	
	A.2 Initiate measures to reduce content to within the limits.	48 hours
	<u>AND</u>	
	A.3 Describe the events leading to the condition in the Radioactive Effluent Release Report.	Prior to submittal of next Radioactive Effluent Release Report

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.1.4.1	Sample and analyze radioactive liquid located in unprotected outdoor liquid storage tanks for level of radioactivity.	31 days during addition of radioactive liquid to the tanks

13.1 LIQUID EFFLUENTS

13.1.4 Liquid Holdup Tanks

BASES

The tanks listed in this Normal Condition include outdoor tanks that are not surrounded by liners, dikes or walls capable of holding the tank contents and do not have tank overflows and surrounding area drains connected to the radwaste treatment system.

Technical Specification 5.5.10.c requires a program to ensure that the quantity of radioactive material contained in the specified tanks provides assurance that, in the event of an uncontrolled release of any such tank's contents, the resulting concentration would be less than the limits of 10 CFR 20, Appendix B Table II, Column 2 at the nearest potable water supply and the nearest surface water supply in an UNRESTRECTED AREA. Tank quantities shall be determined in accordance with Standard Review Plan, Section 15.7.3, "Postulated Radioactive Release due to Tank Failures."

13.2 RADIOACTIVE GASEOUS EFFLUENTS

13.2.1 Gaseous Effluents Dose Rate

DNC 13.2.1 The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY shall be limited to the following:

a. For noble gases, ≤ 500 mrem/yr to the total body and ≤ 3000 mrem/yr to the skin and

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

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. The dose rate(s) at or beyond the SITE BOUNDARY due to radioactive gaseous effluents exceeds limits.	A.1 Restore the release rate to within the limit.	Immediately
B. CONTINGENCY MEASURES <u>OR</u> RESTORATION TIME not met.	B.1 Initiate a CR	In accordance with Corrective Action Program
	<u>AND</u>	
	B.2 Explain in the next Radioactive Effluent Release Report why the CONTINGENCY MEASURE was not met in a timely manner.	In accordance with Radioactive Effluent Release Report

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.2.1.1	The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM.	In accordance with Table 13.2.1-1
DVR 13.2.1.2	The dose rate due to I-131, I-133, tritium and all radionuclides in particulate form with half-lives > 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 13.2.1-1	In accordance with Table 13.2.1-1

Table 13.2.1-1 (Page 1 of 2)
Radioactive Gaseous Waste Sampling and Analysis

GASEOUS RELEASE TYPE	TYPE OF ACTIVITY ANALYSIS	SAMPLE TYPE	SAMPLE FREQUENCY	MINIMUM ANALYSIS FREQUENCY	LOWER LIMIT OF DETECTION (LLD) (a)
1. Waste Gas Storage Tank	Principal Gamma Emitters (b)	Grab Sample	Each Tank (d)	Each Tank (d)	1 x 10^{-4} μCi/ml
2. Containment Purge	Principal Gamma Emitters (b)	Grab Sample	Each Purge (d)	Each Purge (d)	1 x 10^{-4} μCi/ml
3. Auxiliary Building and Containment Building Vent	Principal Gamma Emitters (b)	Grab Sample	31 days	31 days	1 x 10^{-4} μCi/ml
a.	H-3	Silica Gel, Grab Sample	31 days	31 days	1 x 10^{-6} μCi/ml
b.	I-131	Charcoal Sample	Continuous (c)	7 days	3 x 10^{-12} μCi/ml
c.	Principal Gamma Emitters (b) (I-131, Others)	Particulate Sample	Continuous (c)	7 days	1 x 10^{-11} μCi/ml
d.	Gross Alpha	Composite Particulate Sample	Continuous (c)	31 days	1 x 10^{-11} μCi/ml
e.	Sr-89, Sr-90	Composite Particulate Sample	Continuous (c)	92 days	1 x 10^{-11} μCi/ml
f.	Noble Gases Gross Beta or Gamma	Noble Gas Monitor	Continuous (c)	Continuous (c)	1 x 10^{-6} μCi/ml

Table 13.2.1-1 (Page 2 of 2)
Radioactive Gaseous Waste Sampling and Analysis

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

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

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

Where:

- LLD is the a priori lower limit of detection as defined above, as μCi per unit mass or volume,
- s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, as counts per minute,
- E is the counting efficiency, as counts per disintegration,
- V is the sample size in units of mass or volume,
- 2.22×10^6 is the number of disintegrations per minute per microcurie,
- Y is the fractional radiochemical yield, when applicable,
- λ is the radioactive decay constant for the particular radionuclide, and
- Δt for plant effluents is the elapsed time between the midpoint of sample collection and time of counting.
- Typical values of E, V, Y, and Δt should be used in the calculation.

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

(b) The principal gamma emitters for which the LLD requirement applies exclusively are the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Radioactive Effluent Release Report pursuant to ODCM 15.2.

(c) The ratio of the sample flow rate to the sampled flow stream flow rate shall be known (based on sampler and ventilation system flow measuring devices or periodic flow estimates) for the time period covered by each dose or dose rate calculation made in accordance with ODCM DNC 13.2.1, 13.2.2, and 13.2.3.

(d) Complete prior to each release.

BASES

This DNC is provided to ensure that the dose rates at any time to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY are less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin. This also restricts releases, at all times, for the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/yr. These dose rate limits provide additional assurance that radioactive material discharged in gaseous effluents will be maintained ALARA, and coupled with the requirements of ODCM DNC 13.2.2, ensure that the exposures of MEMBERS OF THE PUBLIC in an UNRESTRICTED AREA, either within or outside the SITE BOUNDARY, will not exceed the annual average concentrations specified in Appendix B, Table 2, Column 1 of 10 CFR 20. For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY.

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

13.2 RADIOACTIVE GASEOUS EFFLUENTS

13.2.2 Gaseous Effluent Dose - Noble Gas

DNC 13.2.2 The air dose due to noble gases released in gaseous effluents from the unit to areas at or beyond the SITE BOUNDARY (Plant Drawing A-408) shall be limited to the following:

a. ≤ 5 mrad for gamma radiation and ≤ 10 mrad for beta radiation during any calendar quarter, and

b. ≤ 10 mrad for gamma radiation and ≤ 20 mrad for beta radiation during any calendar year.

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. The calculated air dose at or beyond the SITE BOUNDARY due to noble gases released in gaseous effluents exceeds limits.	A.1 Prepare and submit to the NRC, pursuant to DNC 15.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and; (2) Defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with DNC 13.2.2.	30 days

ACTIONS (continued)

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.).	Immediately
	AND	
	B.2 Verify that the limits of DNC 13.4 have not been exceeded.	Immediately
C. CONTINGENCY MEASURE B.2 and Associated RESTORATION TIME not met.	C.1 Prepare and submit to the NRC, pursuant to DNC 15.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of CONTINGENCY MEASURE A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DNC 13.4 and the schedule for achieving conformance, (2) An analysis that estimates the dose to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.2.2.1	Determine cumulative dose contributions for the current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This DNC is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The DNC implements the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable." The VERIFICATION REQUIREMENTS implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated.

The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

13.2 RADIOACTIVE GASEOUS EFFLUENTS

13.2.3 Gaseous Effluent Dose – Iodine, Tritium and Particulate

DNC 13.2.3 The dose to a MEMBER OF THE PUBLIC from I-131, I-133, tritium, and all radionuclides in particulate form with half-lives > 8 days, in gaseous effluents, released to areas at or beyond the SITE BOUNDARY (Plant Drawing A-408) shall be limited to the following:

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

b. ≤ 15 mrem to any organ during any calendar year.

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. The calculated dose from the release of I-131, I-133, tritium, and radionuclides in particulate form with half-lives > 8 days released in gaseous effluents at or beyond the SITE BOUNDARY exceeds limits.	A.1 Prepare and submit to the NRC, pursuant to DNC 15.3, a Special Report that (1) Identifies the cause(s) for exceeding the limit(s) and; (2) Defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with DNC 13.2.3.	30 days

ACTIONS (continued)

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
B. Calculated dose to a MEMBER OF THE PUBLIC from the release of radioactive materials in liquid effluents exceeds 2 times the limits.	B.1 Calculate the annual dose to a MEMBER OF THE PUBLIC which includes contributions from direct radiation from the units (including outside storage tanks, etc.). AND B.2 Verify that the limits of DNC 13.4 have not been exceeded.	Immediately Immediately
C. CONTINGENCY MEASURE B.2 and Associated RESTORATION TIME not met.	C.1 Prepare and submit to the NRC, pursuant to DNC 15.3, a Special Report, as defined in 10 CFR 20.2203 (a)(4), of CONTINGENCY MEASURE A.1 shall also include the following: (1) The corrective action(s) to be taken to prevent recurrence of exceeding the limits of DNC 13.4 and the schedule for achieving conformance, (2) An analysis that estimates the dose to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s), and (3) Describes the levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations.	30 days

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.2.3.1	Determine cumulative dose contributions for the current calendar quarter and current calendar year for I-131, I-133, tritium, and radionuclides in particulate form with half-lives > 8 days in accordance with the methodology and parameters in the ODCM.	31 days

BASES

This DNC is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The DNC's are the guides set forth in Section II.C of Appendix I. The contingency measures provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as is reasonably achievable."

The ODCM calculational methods specified in the DVR's implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977.

These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate limitations for iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man, in areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of these calculations were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

13.2 RADIOACTIVE GASEOUS EFFLUENTS

13.2.4 GASEOUS RADWASTE TREATMENT SYSTEM

DNC 13.2.4 The GASEOUS RADWASTE TREATMENT SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the projected gaseous effluent air doses due to gaseous effluent releases to areas at and beyond the SITE BOUNDARY (Plant Drawing A-408) would be:

a. > 0.2 mrad for gamma radiation; or

b. > 0.4 mrad for beta radiation; or

c. > 0.3 mrem to any organ in 31 day period. (Ventilation Exhaust Treatment System only)

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Radioactive gaseous waste is being discharged without treatment. <u>AND</u> Projected doses due to the gaseous effluent, from the unit, at and beyond the SITE BOUNDARY would exceed limits.	A.1 Prepare and submit to the NRC, pursuant to DNC 15.3, a Special Report that includes the following: (1) Explanation of why gaseous radwaste was being discharged without treatment, (2) Identification of any non-functional / inoperable equipment or subsystems and the reason for the non-functional / inoperability, (3) ACTION(s) taken to restore the non-functional / inoperable equipment to FUNCTIONAL / OPERABLE status, and (4) Summary description of ACTION(s) taken to prevent a recurrence.	30 days

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.2.4.1	Project the doses due to gaseous effluents from each unit at and beyond the SITE BOUNDARY in accordance with the methodology and parameters in the ODCM.	31 days

BASES

The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable."

This DNC implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in section II.D of Appendix I to 10 CFR Part 50.

The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

13.2 GASEOUS EFFLUENTS

13.2.5 Gas Storage Tanks

DNC 13.2.5 The radioactivity contained in each gas storage tank shall be limited to ≤ 52,000 Curies of noble gas. (Considered as Xe-133)

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Level of radioactivity exceeds the limits.	A.1 Suspend addition of radioactive material.	Immediately
	AND	
	A.2 Reduce tank contents to within the limits.	48 hours

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.2.5.1	Verify quantity of radioactive material contained in each gas storage tank is ≤ 52,000 curies of noble gases (considered as Xe-133).	31 days AND ---------NOTE------- Not required to be performed if the most recent Reactor Coolant System specific activity DOSE EQUIVALENT I-131 is ≤ 1.0 μCi/gm ------------------------ Once per 24 hours when radioactive materials are being added to the tank

BASES

This verification implements the requirement of Technical Specification 5.5.10.b. which requires a program to ensure that the quantity of radioactivity contained in each gas storage tank and fed into the offgas treatment system is less than the amount that would result in a whole body exposure of > 0.5 rem to any individual in an UNRESTRICTED AREA, in the event of an uncontrolled release of the tanks contents. Contents of the tank quantities shall be determined following the methodology in Branch Technical Position (BTP) ETSB 11-5, "Postulated Radioactive Release due to Waste Gas System Leak or Failure."

Radiological analysis for a waste gas decay tank rupture assumes the activity in a gas decay tank is taken to be the maximum amount that could accumulate from operation with cladding defects in 1 percent of the fuel elements. This is at least ten times the expected number of defective fuel elements. The maximum activity is obtained by assuming the noble gases, xenon and krypton, are accumulated with no release over a full core cycle. The gas decay tank inventory is calculated assuming nuclide decay, degassing of the reactor coolant with letdown at the maximum rate, and periodic purging to the gas decay tank. The maximum inventory for each nuclide during the degas and PURGE cycle is given in Appendix D, Table D.7-1. (reference 1)

The resultant dose consequence for this accident is 0.1 rem whole body at the SITE BOUNDARY. Summing the activities in USAR Table D.7-1 (reference 4) results in 42,792.74 curies. Using the noble gas dose conversion factors (DCF) contained in USAR Table D.8-1 (reference 5) referenced to Xe-133 results in a curie content of 52,000 curies when considered as Xe-133. Kewaunee Power Station does not have a calculation correcting the waste gas decay tank activity to a SITE BOUNDARY consequence of ≤ 0.5 rem, therefore by limiting the activity in a waste gas decay tank to that which results in 0.1 rem at the SITE BOUNDARY, the 0.5 rem limit will not be exceeded.

DVR 13.2.5 frequency is modified by a note that restricts performing the verification when additions are made to a tank to only when the reactor coolant system DOSE EQUIVALENT Iodine 131 (DEI-131) activity is greater than 1.0 μCi/gm (microcurie per gram). A calculation has shown that when a 1% failed fuel assumption is used the resultant RCS DOSE EQUIVALENT XE-133 activity would be 595 μCi/gm (reference 2). Engineering experience is that with 1.0 μCi/gm DEI-131 RCS activity, the associated DEX-133 activity is approximately 200 μCi/gm. If with an assumption of 1% failed fuel calculations results are 595 μCi/gm DEX-133, and the dose consequences calculation also yields a 0.1 rem whole body at the SITE BOUNDARY by calculation then a gas decay tank on fill cannot exceed the activity limits of this requirement and the once per 31 day frequency is adequate.

Reference

1. USAR Section 14.2.3, Accidental Release-Waste Gas
2. Calculation C11833, Kewaunee Power Station RCS Specific Activity Dose Equivalent Xenon -133 Indicator
3. Calculation CN-CRA-99-46, Revision 3, Kewaunee GDT Rupture and VCT Rupture Radiation Dose Analysis for the 7.4% Power Uprate Program.
4. USAR Table D.7-1 Inventory of Gas Decay Tank After Shutdown and Degassing of the RCS (Based on 1 percent of Fuel Defects)
5. USAR Table D.8-1, Nuclide Parameters

13.3 INSTRUMENTATION

13.3.1 Radioactive Liquid Effluent Monitoring Instrumentation

DNC 13.3.1 The radioactive liquid effluent monitoring instrumentation channels shown in Table 13.3.1-1 shall be FUNCTIONAL with:

a. The minimum FUNCTIONAL channel(s) in service.

b. The alarm/trip setpoints set to ensure that the limits of DNC 13.1.1 are not exceeded.

APPLICABILITY: During release via the monitored pathway.

ACTIONS

---------- NOTE ----------
Separate NON-CONFORMANCE entry is allowed for each channel.

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required.	A.1 Suspend the release of radioactive liquid effluents monitored by the affected channel.	Immediately
	OR	
	A.2 Declare the channel non-functional.	Immediately
	OR	
	A.3 Change the setpoint so it is acceptably conservative.	Immediately

ACTIONS (continued)

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
B. One or more required channels non-functional.	B.1 Restore non-functional channel(s) to FUNCTIONAL status.	30 days
C. Liquid Radwaste Effluent Line (R-18) non-functional prior to or during effluent releases.	------------NOTE---------------- Prior to initiating an effluent release, complete sections C.1.1 and C.1.2 ----------------------------------	
	C.1.1 Analyze at least 2 independent samples in accordance with Table 13.1.1-1.	Prior to initiating a release
	AND	
	C.1.2 ------------NOTE---------------- Verification ACTION will be performed by at least 2 separate technically qualified members of the facility staff. ----------------------------------	
	Independently verify the release rate calculations and discharge line valving.	Prior to initiating a release
	OR	
	C.2 Suspend release of radioactive effluents via this pathway	Immediately

ACTIONS (continued)

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
D. Steam Generator Effluent Line (R-19) non-functional prior to or during effluent releases	D.1 Collect and analyze grab samples for gross radioactivity (beta or gamma) at a lower limit of detection of at least 1 x 10^{-6} µCi/ml.	At least once every 24 hours with identified primary to secondary leakage (with secondary side activity > 1 x 10^{-5} µCi/ml). OR At least once a week when no indication of primary to secondary leakage;
E. Service Water System Effluent Line (R-20 or R-16) non-functional prior to or during effluent releases	-----NOTE----- Failure to complete sampling and analysis prior to 12 hours after the monitor is declared non-functional is a violation of this DNC. ---------- E.1 Collect and analyze grab samples for gross radioactivity (beta or gamma) at a lower limit of detection of at least 1 x 10^{-6} µCi/ml.	Once per 12 hours

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
F. CONTINGENCY MEASURES <u>OR</u> RESTORATION TIME of A, B, C, D or E not met.	F.1 Initiate a CR	In accordance with Corrective Action Program
	<u>AND</u>	
	F.2 Explain in the next Radioactive Effluent Release Report why the CONTINGENY MEASURE was not met in a timely manner.	In accordance with Radioactive Effluent Release Report

VERIFICATION REQUIREMENTS

---NOTE---
Refer to Table 13.3.1-1 to determine which DVRs apply for each function.

VERIFICATION		FREQUENCY
DVR 13.3.1.1	Perform CHANNEL CHECK.	24 hours
DVR 13.3.1.2	Perform SOURCE CHECK.	Prior to release
DVR 13.3.1.3	Perform SOURCE CHECK.	31 days
DVR 13.3.1.4	Perform CHANNEL FUNCTIONAL TEST	92 days
DVR 13.3.1.5	Perform CHANNEL CALIBRATION.	18 months

Table 13.3.1-1
Radioactive Liquid Effluent Monitoring Instrumentation

INSTRUMENT	REQUIRED CHANNELS PER INSTRUMENT	VERIFICATION REQUIREMENTS
1. Gross Radioactivity Monitors Providing Alarm and Automatic Termination of Release		
a. Liquid Radwaste Effluent Line (R-18)	1	DVR 13.3.1.1 DVR 13.3.1.2 DVR 13.3.1.4 DVR 13.3.1.5
b. Steam Generator Blowdown Effluent Line (R-19)	1	DVR 13.3.1.1 DVR 13.3.1.3 DVR 13.3.1.4 DVR 13.3.1.5
2. Gross Beta or Gamma Radioactivity Monitors Providing Alarm but not Providing Automatic Termination of Release		
a. Service Water System Effluent Line (Component Cooling R-20)	1	DVR 13.3.1.1 DVR 13.3.1.3 DVR 13.3.1.4 DVR 13.3.1.5
b. Service Water System Effluent Line (Containment Fan Cooling R-16)	1	DVR 13.3.1.1 DVR 13.3.1.3 DVR 13.3.1.4 DVR 13.3.1.5

BASES

The radioactive liquid effluent instrumentation, required FUNCTIONAL by this DNC, is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluent. The alarm/trip setpoints for these instruments shall be calculated and adjusted in accordance with methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding ten (10) times the values 10 CFR Part 20, Appendix B, Table 2, Column 2. The FUNCTIONALITY and use of this instrumentation is consistent with the appropriate requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

13.3 INSTRUMENTATION

13.3.2 Radioactive Gaseous Effluent Monitoring Instrumentation

DNC 13.3.2 The radioactive gaseous effluent monitoring instrumentation channels shown in Table 13.3.2-1 shall be FUNCTIONAL with:

a. The minimum FUNCTIONAL channel(s) in service.

b. The alarm/trip setpoints set to ensure that the limits of DNC 13.2.1 are not exceeded.

APPLICABILITY: At all times

ACTIONS

-- NOTE --
Separate NON-CONFORMANCE entry is allowed for each channel.

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required.	A.1 Suspend the release of radioactive gaseous effluents monitored by the affected channel.	Immediately
	<u>OR</u>	
	A.2 Declare the channel non-functional.	Immediately
	<u>OR</u>	
	A.3 Change the setpoint so it is acceptably conservative.	Immediately
B. Less than the minimum number of channels FUNCTIONAL.	B.1 Restore non-functional channel(s) to FUNCTIONAL status.	30 days.

ACTIONS (continued)

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
C. Noble Gas Activity effluent monitoring for the Waste Gas Holdup System non-functional prior to or during releases	-----------NOTE----------- Prior to initiating an effluent release, complete sections C.1.1 and C.1.2. ---------------------------------	Prior to initiating a release
	C.1.1 Analyze at least 2 independent samples in accordance with Table 13.2.1-1.	
	AND	
	C.1.2 -----------NOTE----------- Verification ACTION will be performed by at least 2 technically qualified members of the facility staff. --------------------------------- Independently verify the release rate calculations and discharge line valving.	Prior to initiating a release
	OR	
	C.2 Suspend release of radioactive effluents via this pathway	Immediately
D. Noble Gas Activity effluent monitoring for the Auxiliary Building Ventilation System and the Condenser Evacuation System non-functional prior to or during releases	D.1 Take grab samples.	12 hours AND Once per 12 hours thereafter
	AND	
	D.2 Analyze samples for gross activity.	24 hours from time of sampling completion

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
E. Noble Gas Activity effluent monitoring for the Containment Purge System, 2" line and 36" duct (auto-isolation) non-functional prior to or during releases	E.1 Suspend PURGING of Radioactive effluents via this pathway.	Immediately
F. Sampler Flow rate Measuring Devices (for the Auxiliary Building Ventilation or Containment Building Ventilation Sampler) non-functional prior to or during releases	F.1 Estimate the flow rate for the non-functional channel(s).	4 hours <u>AND</u> Once per 4 hours thereafter
G. Radioiodine and Particulate Samplers (for the Auxiliary Building Ventilation or Containment Building Ventilation system) non-functional prior to or during releases	G.1 Continuously collect samples using auxiliary sampling equipment as required in Table 13.2.1-1.	12 hours
H. CONTINGENCY MEASURES <u>OR</u> RESTORATION TIME A, B, C, D, E, F, or G not met.	H.1 Initiate a CR <u>AND</u> H.2 Explain in the next Radioactive Effluent Release Report why the CONTINGENCY MEASURE was not met in a timely manner.	In accordance with Corrective Action Program In accordance with Radioactive Effluent Release Report

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.3.2.1	Perform CHANNEL CHECK.	Prior to release
DVR 13.3.2.2	Perform CHANNEL CHECK.	24 hours
DVR 13.3.2.3	Perform CHANNEL CHECK.	7 days
DVR 13.3.2.4	Perform SOURCE CHECK.	Prior to release
DVR 13.3.2.5	Perform SOURCE CHECK.	31 days
DVR 13.3.2.6	Perform CHANNEL FUNCTIONAL TEST.	92 days
DVR 13.3.2.7	Perform CHANNEL CALIBRATION.	18 months

Table 13.3.2-1
Radioactive Gaseous Effluent Monitoring Instrumentation

INSTRUMENT	REQUIRED CHANNELS PER INSTRUMENT	NON-CONFORMANCE	VERIFICATION REQUIREMENTS
1. Waste Gas Holdup System			
a. Noble Gas Activity Monitor (R-13 or R-14)	1	C	DVR 13.3.2.1 DVR 13.3.2.4 DVR 13.3.2.6 DVR 13.3.2.7
2. Condenser Evacuation System			
a. Noble Gas Activity (R-15)	1	D	DVR 13.3.2.2 DVR 13.3.2.5 DVR 13.3.2.6 DVR 13.3.2.7
3. Auxiliary Building Vent			
a. Noble Gas Activity Monitor (R-13 or R-14)	1	D	DVR 13.3.2.2 DVR 13.3.2.5 DVR 13.3.2.6 DVR 13.3.2.7
b. Radioiodine and Particulate Sampler (R-13 or R-14)	1	G	DVR 13.3.2.3
c. Sample Flow-Rate Monitor (R-13 or R-14)	1	F	DVR 13.3.2.2 DVR 13.3.2.6 DVR 13.3.2.7
4. Containment Building Vent			
a. Radioiodine and Particulate Sampler (R-21)	1	G	DVR 13.3.2.3
b. Sample Flow-Rate Monitor (R-21)	1	F	DVR 13.3.2.2 DVR 13.3.2.6 DVR 13.3.2.7
5. Containment Purge 2" line			
a. Noble Gas Activity Monitor (R-13 or R-14)	1	E	DVR 13.3.2.2 DVR 13.3.2.5 DVR 13.3.2.6 DVR 13.3.2.7
6. Containment Purge 36" line			
a. Noble Gas Activity Monitor (R-12 or R-21)	1	E	DVR 13.3.2.2 DVR 13.3.2.4 DVR 13.3.2.6 DVR 13.3.2.7

BASES

The radioactive gaseous effluent instrumentation, required FUNCTIONAL by this DNC, is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The alarm/trip will occur prior to exceeding the dose rate limits of ODCM DNC 13.2.1. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design criteria 60, 63 and 64 in Appendix A to 10 CFR Part 50.

13.4 RADIOACTIVE EFFLUENTS TOTAL DOSE

13.4.1 Radioactive Effluents Total Dose

DNC 13.4.1 The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to ≤ 25 mrem to the total body or any organ, except the thyroid, which shall be limited to ≤ 75 mrem.

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Estimated dose or dose commitment due to direct radiation and the release of radioactive materials in liquid or gaseous effluents exceeds the limits.	A.1 Verify the condition resulting in doses exceeding these limits has been corrected.	Immediately
B. CONTINGENCY MEASURES A.1 and RESTORATION TIME not met.	B.1 --------------NOTE------------- This is the Special Report required by DNC 13.1.2, 13.2.2, or 13.2.3 supplemented with the following. ---------------------------------- Submit a Special Report, pursuant to DNC 15.3, including a request for a variance in accordance with the provisions of 40 CFR 190. This submission is considered a timely request, and a variance is granted until staff ACTION on the request is complete.	30 days

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
DVR 13.4.1.1	Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with VERIFICATION REQUIREMENTS 13.1.2.1, 13.2.2.1, and 13.2.3.1 in accordance with the methodology and parameters in the ODCM.	12 months
DVR 13.4.1.2	Cumulative dose contributions from direct radiation from the reactor unit shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in ODCM DNC 13.4.1.A.	12 months

BASES

This normal condition is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The DNC requires the preparation and submittal of a Special Report whenever the calculated doses from plant generated radioactive effluents and direct radiation exceed 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. It is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the reactor remains within twice the dose design objectives of Appendix I, and if direct radiation doses from the reactor are kept small.

The Special Report will describe a course of ACTION that should result in the limitation of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and 10 CFR 20.2203, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff ACTION is completed. The variance only relates to the limits of 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in ODCM Normal Condition 13.3.1 and 13.4.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

13.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

13.5.1 Monitoring Program

This Kewaunee Program is established by the RADIOLOGICAL ENVIRONMENTAL MONITORING MANUAL (REMM) and implemented by approved station procedures. This program is required by Technical Specification 5.5.1.a, ODCM.

The radiological environmental monitoring program required by this DNC provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring.

13.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

13.5.2 Land Use Census Program

This Kewaunee Land Use Census Program is implemented by the RADIOLOGICAL ENVIRONMENTAL MONITORING MANUAL (REMM) and Land Use Census Program procedure.

BASES

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

13.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

13.5.3 Interlaboratory Comparison Program

This Kewaunee Interlaboratory Comparison Program is implemented by the RADIOLOGICAL ENVIRONMENTAL MONITORING MANUAL (REMM) and approved station procedures.

BASES

The requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring (developed using the guidance in Regulatory Guide 1.21, Revision 1, April 1974 and Regulatory Guide 4.1, Revision 1, April 1975) in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

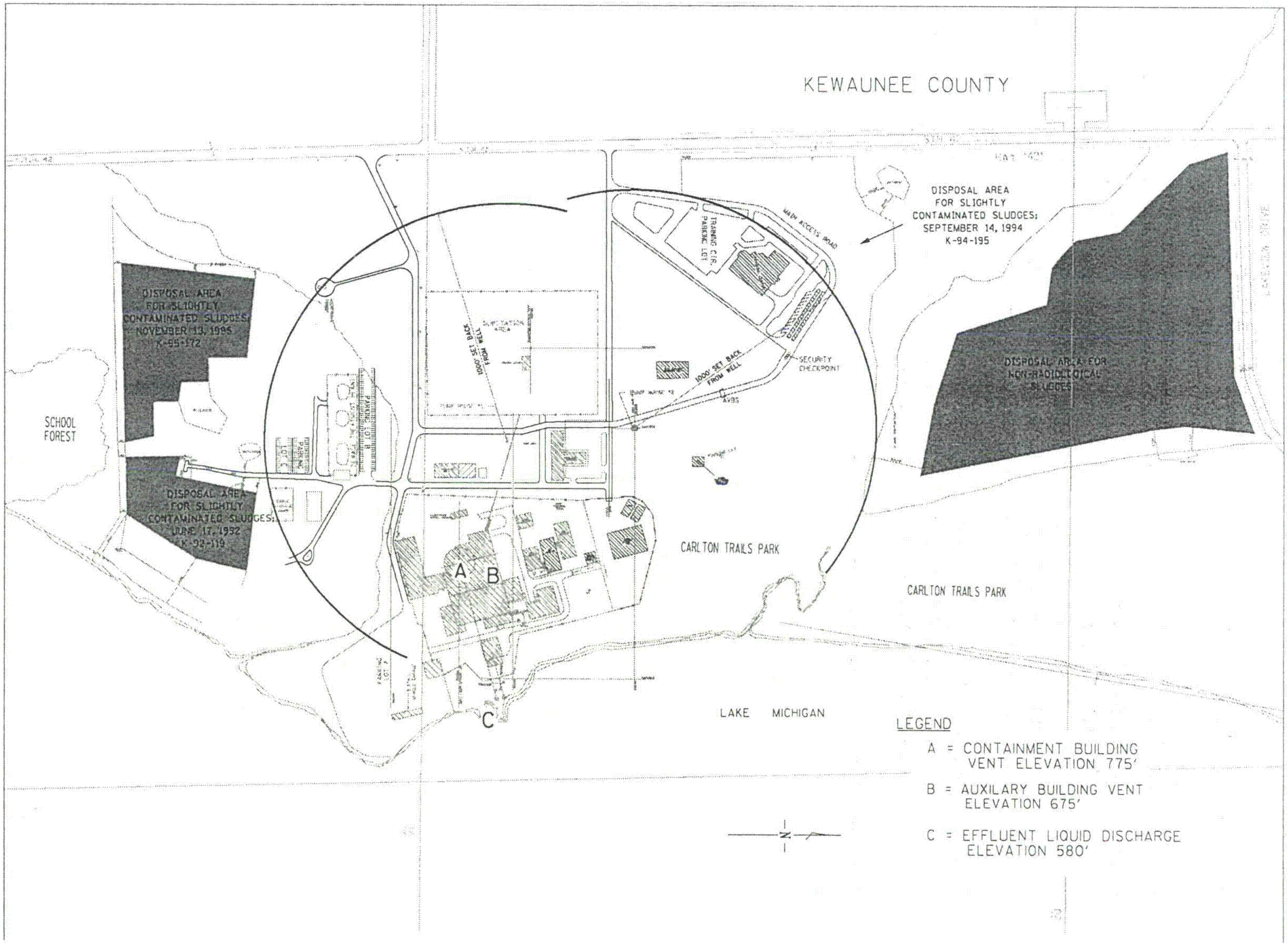
14.0 DESIGN FEATURES

14.1 GASEOUS AND LIQUID EFFLUENT RELEASE POINTS

14.1.1 Plant drawing A-408, "Radiological Survey Site Map" depicts the site area by illustrating the SITE BOUNDARY and the restricted areas. Plant drawing A-449, "Plan of Plant Area, Fence, Lighting, and CCTV Support Structure" shows the layout of the site buildings. MEMBERS OF THE PUBLIC are restricted from access to all areas of the Owner Controlled Area (OCA).

14.1.2 Figure 14.1-1 presents the locations 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.

FIGURE 14.1-1


KEWAUNEE COUNTY
DISPOSAL AREA
FOR SLIGHTLY
CONTAMINATED SLUDGES:
SEPTEMBER 14, 1994
K-94-195
DISPOSAL AREA FOR
NON-RADIOLOGICAL
SLUDGES
SCHOOL
FOREST
SECURITY
CHECKPOINT
CARLTON TRAILS PARK
CARLTON TRAILS PARK
A
B
C
LAKE MICHIGAN
LEGEND
A = CONTAINMENT BUILDING
VENT ELEVATION 775'
B = AUXILARY BUILDING VENT
ELEVATION 675'
C = EFFLUENT LIQUID DISCHARGE
ELEVATION 580'
N

15.0 ADMINISTRATIVE CONTROLS

15.1 Major Changes to Radioactive Waste Systems[(1)]

Licensee initiated major changes to the radioactive waste systems (liquid, gaseous and solid) shall be reported to the Commission in the Radioactive Effluent Release Report for the period in which the evaluation was reviewed by FSRC. The discussion of each change shall contain:

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

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

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

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

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

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

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

h. Documentation of the fact that the change was reviewed and found acceptable by the FSRC.

Changes shall become effective upon review and acceptance by the FSRC.

[(1)]Licensees may choose to submit the information called for in this requirement as part of the periodic USAR update.

15.0 ADMINISTRATIVE CONTROLS

15.2 Radioactive Effluent Release Report

The Radioactive Effluent Release Report to be submitted by May 1 of each year shall include:

a. A summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit following the format of Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974.

b. An annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distribution of wind speed, wind direction, and atmospheric stability. In lieu of submission with the Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data onsite in a file that shall be provided to the NRC upon request.

c. An assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the previous calendar year.

d. An assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, the previous calendar year to show conformance with 40 CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operation.

All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in these reports. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

e. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The material provided shall be consistent with the objectives outlined in the ODCM and the PCP, and in conformance with 10 CFR 50.36a and Section IV.B.1 of Appendix I to 10 CFR Part 50.

f. A list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

g. Any changes made during the reporting period to the PROCESS CONTROL PROGRAM (PCP) and to the OFFSITE DOSE CALCULATION MANUAL (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the land use census pursuant to DNC 13.5.2.

15.0 ADMINISTRATIVE CONTROLS

15.3 Special Reports

Special reports may be required covering inspections, tests, and maintenance activities. These special reports are determined on an individual basis. Their preparation and submittal are designated in the ODCM Contingency Measures for each Normal Condition.

Special reports shall be submitted to the Director of the NRC Regional Office listed in Appendix D, 10 CFR Part 20, with a copy to the Director, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington D.C. 20555 within the time period specified for each report.

These Special Report(s) are in lieu of a Licensee Event Report

Kewaunee Power Station

Offsite Dose Calculation Manual

PART II - CALCULATIONAL METHODOLOGIES

1.0 LIQUID EFFLUENTS METHODOLOGY

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, Sr-90, and Fe-55 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, Sr-90, and Fe-55 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 5.5.3.b and ODCM Normal Condition 13.3.1, alarm setpoints shall be established for the liquid effluent monitoring instrumentation to ensure that the release concentration limits of ODCM Normal Condition 13.1.1 are met (i.e., the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREA shall be limited to ten times the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2, for radionuclides and 2.0E-04 μCi/ml for dissolved or entrained noble gases). The following equation[1] must be satisified to meet the liquid effluent restrictions:

$$c \leq \frac{10 \times C(F+f)}{f} \qquad (1.1)$$

[1] Adapted from NUREG-0133 to include the application of 10 times the Effluent Concentration (EC) of 10 CFR 20, Appendix B, Table 2, Column 2.

where:

$10 \times C$ = ten times the effluent concentration limit of 10 CFR 20, Appendix B, Table 2, Column 2, in µCi/ml. For dissolved and entrained noble gases equals 2×10^{-4} 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 ODCM Normal Condition 13.1.1.

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 ≤ C. Also, note that when (F) is large compared to (f), then (F + f) ≈ F.]

1.2.1 Liquid Effluent Monitors (Radwaste, Steam Generator Blowdown and Service Water)

The setpoints for the liquid effluent monitors at the Kewaunee Power Station are determined by the following equations:

$$SP \le \frac{CW \times \sum (C_i \times SEN_i)}{\sum \frac{C_i}{10 \times EC_i} \times RR} + bkg \qquad (1.2)$$

where:

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

Ci = the concentration of radionuclide "i" in the liquid effluent (µCi), to include gamma emitters only

10×ECi = ten times the EC value corresponding to radionuclide "i" from 10 CFR 20, Appendix B, Table 2, Column 2 (µCi/ml)

SENi	=	the sensitivity value to which the monitor is calibrated for radionuclide "i" (cpm per µCi/ml). The default calibration value from Table 1.1 may be used for gamma emitting radionuclides in lieu of nuclide specific values.
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:

$$SP \leq \frac{\sum (C_i \times SEN_i)}{\sum \frac{C_i}{(10 \times EC_i)}} + bkg \qquad (1.3)$$

1.2.2 Conservative Default Values

Non-gamma emitting radionuclides (H-3, Fe-55, Sr-89/90) are not detected by the effluent monitor and, therefore, are not directly included in the above setpoint equation. These non-gamma radionuclides can, however, contribute a sizable fraction of the total EC limit (refer to Appendix C). The method specified below for establishing default setpoints provides conservatism to account for these non-gamma emitters and ensures that the setpoint meets the requirements of ODCM Normal Condition 13.3.1 including all radionuclides. Refer to Appendix C for further discussion.

Conservative alarm setpoints have been determined through the use of generic, default parameters. Table 1.1 summarizes all current default values in use for Kewaunee. They are based upon the following:

a) substitution of the default effective EC (EC_e) value of 1.0E-06 µCi/ml (refer to Appendix C for justification),

where:

$$EC_e = \frac{\sum C_i}{\sum \frac{C_i}{(EC_i)}} \qquad (1.4)$$

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

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

d) substitution of the default monitor sensitivity.

The default setpoint equation is provided below:

$$SP \leq \frac{EC_e \times 10 \times SEN \times CW}{RR} + bkg \tag{1.5}$$

1.3 Liquid Effluent Concentration Limits – 10 CFR 20

ODCM Normal Condition 13.1.1 limits the concentration of radioactive material in liquid effluents (after dilution in the Circulating Water System) to less than ten times the concentrations as specified in 10 CFR 20, Appendix B, Table 2, 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 ODCM Normal Condition 13.1.1 may be performed using the following equation:

where:

$$\sum[(C_i \div (10 \times EC_i)) \times (RR \div CW)] \leq 1 \tag{1.6}$$

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

10×ECi = ten times the EC value corresponding to radionuclide "i" from 10 CFR 20, Appendix B, Table 2, 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

ODCM Normal Condition 13.1.2 limits the dose or dose commitment to MEMBERS OF THE PUBLIC from radioactive materials in liquid effluents from the Kewaunee Power Station 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 Verification Requirement 13.1.2.1, the following calculational methods may be used for determining the dose or dose commitment due to the liquid radioactive effluents from Kewaunee.

$$D_o = \frac{1.67E-02 \times VOL}{CW} \times \sum (C_i \times A_{io}) \qquad (1.7)$$

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 1.2)
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 doses/dose commitment factors (A_{io}) are presented in Table 1.2 and have been derived in accordance with guidance of NUREG-0133 by the equation:

$$A_{io} = 1.14E+05[(U_w \div D_w) + (U_F \times BF_i)]DF_i \qquad (1.8)$$

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 × ml/kg ÷hr/yr)
U_w	=	adult water consumption (730 kg/yr)
D_w	=	dilution factor from the near field area within ¼ mile of the release point to the nearest potable water intake for the adult water consumption (84[2], unitless)
U_F	=	adult fish consumption (21 kg/yr)
BF_i	=	bioaccumulation factor for radionuclide "i" in fish from Table 1.3 (pCi/kg per pCi/1)
DF_i	=	dose conversion factor for radionuclide "i" for adults in pre-selected 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 ODCM Normal Condition 13.1.2 and Verification Requirement 13.1.2.1 are those as identified by gamma spectral analysis of the liquid waste samples collected and analyzed per Verification Requirement 13.1.1.1, Table 13.1.1-1.

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 13.1.1-1.

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 ODCM Normal Condition 13.1.2. (Refer to Appendix A for the derivation and justification for this simplified method.)

[2] Adapted from the Kewaunee Final Environmental Statement, Section V.

Total Body

$$D_{tb} = \frac{9.67E+03 \times VOL}{CW} \times \sum C_i \tag{1.9}$$

Maximum Organ

$$D_{max} = \frac{1.18E+04 \times VOL}{CW} \times \sum C_i \tag{1.10}$$

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/min)
D_{tb}	=	conservatively evaluated total body dose (mrem)
D_{max}	=	conservatively evaluated maximum organ dose (mrem)
9.67E+03	=	product of the hour-to-minute 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	=	product of the hour-to-minute 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

ODCM Normal Condition 13.1.3 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 31 day projected doses exceed:

- 0.06 mrem to the total body, or
- 0.2 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:

$$D_{tbp} = D_{tb}(31 \div d) \qquad (1.11)$$

$$D_{maxp} = D_{max}(31 \div d) \qquad (1.12)$$

where:

D_{tbp}	=	the total body dose projection for current 31 day period (mrem)
D_{tb}	=	the total body dose to date for current 31 day period as determined by equation (1.7) or (1.9) (mrem)
D_{maxp}	=	the maximum organ dose projection for current 31 day period (mrem)
D_{max}	=	the maximum organ dose to date for current 31 day period as determined by equation (1.7) or (1.10) (mrem)
d	=	the number of days to date for current 31 day period
31	=	the number of days in a 31 day period

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 operation 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 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.

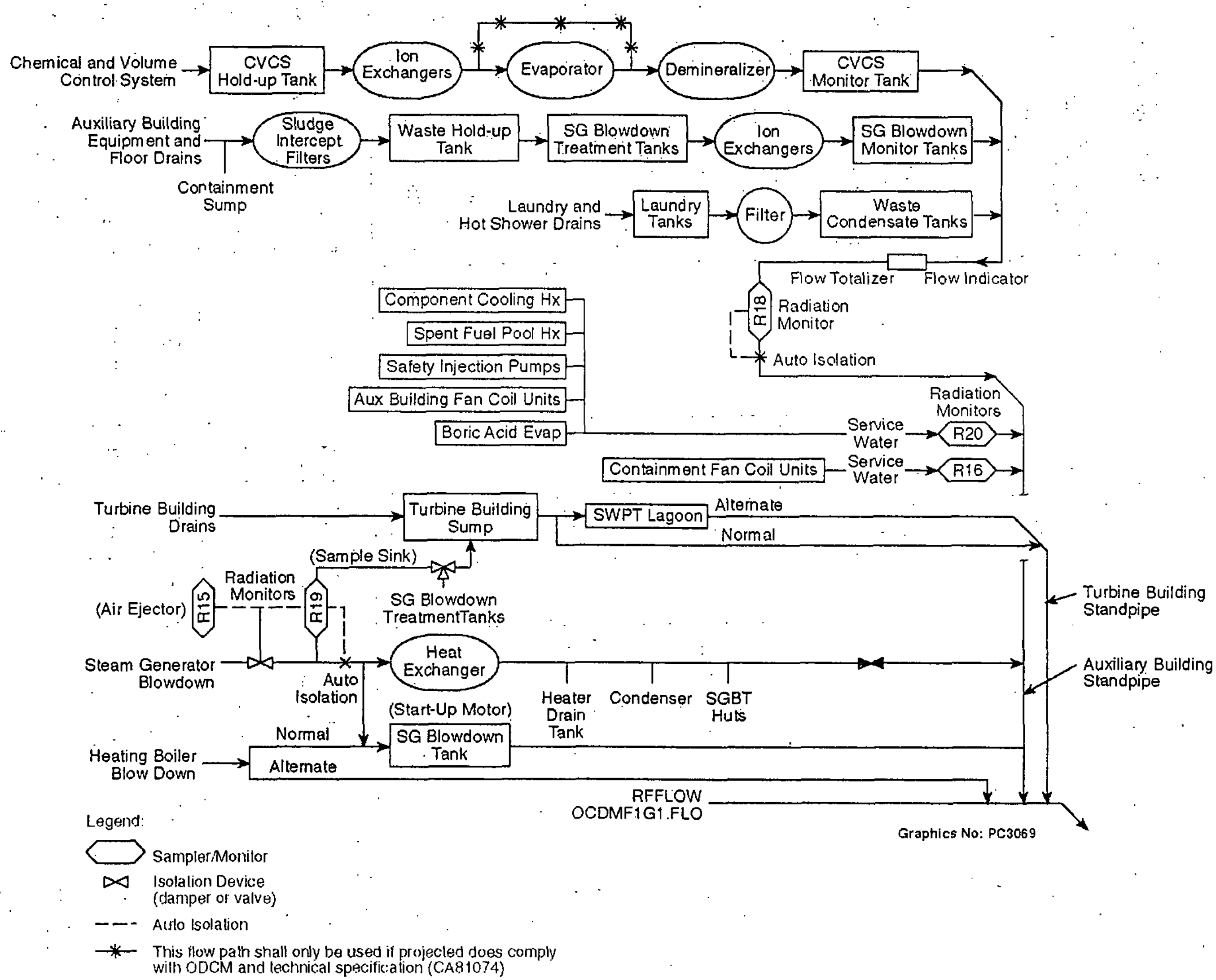
This waste material will be monitored and evaluated prior to disposal to ensure its radioactive material content is negligible. It shall then be disposed of in a normal conventional manner with records being maintained of all materials disposed of using these methods.

Approvals for specific alternate disposal methods are listed in Appendix D. Currently, only service water pretreatment (SWPT) facility lagoon sludge and sewage treatment plant sludge have been approved for disposal by land spreading.

1.7 Heating Boiler Blowdown Operation with Primary-to-Secondary Leak

During operation with a primary-to-secondary leak, the potential exists for non-radioactive systems to become contaminated. One such system is the heating system. Activity is transferred from the reactor coolant system into the secondary main steam system through the leak and then into the heating system. Heating boiler operation following operation with a primary-to-secondary leak will result in the heating boiler becoming contaminated.

When the heating boiler is operated, it must be periodically blown down to remove impurities, which collect in the system. This blowdown is normally directed to the steam generator blowdown tank but can be diverted to the circulating water discharge. Either way, the blowdown becomes a release path for radioactivity to the environment. The heating boiler blowdown is sampled, using current plant procedures, whenever the primary-to-secondary leakage exceeds 10 gallons per day and the gross gamma activity exceeds 1.0E-06 μCi/ml or tritium activity exceeds 1.0E-05 μCi/ml. The results of these samples allow for the activity being released to the environment to be quantified. This is similar to the method used for the turbine building sump release path. The radioactive effluent limits of 10 CFR Part 20, 40 CFR 190, and Technical Specifications can therefore be maintained.



LIQUID RADIOACTIVE EFFLUENT FLOW DIAGRAM

Table 1.1
Parameters for Liquid Alarm Setpoint Determinations

Parameter	Actual Value	Default Value*	Units	Comments
EC_e	calculated	1.0E-06**	µCi/ml	Calculate for each batch to be released
C_i	measured	N/A	µCi/ml	Taken from gamma spectral analysis of liquid effluent
EC_i	as determined	N/A	µCi/ml	Taken from 10 CFR 20, Appendix B, Table 2, Col. 2
Sensitivity (SEN)				
R-18	as determined	1.0E+08	cpm per µCi/ml	Radwaste effluent
R-19	as determined	1.0E+08	cpm per µCi/ml	Steam Generator blowdown
R-20	as determined	1.0E+08	cpm per µCi/ml	Service Water – component cooling
R-16	as determined	9.8E+07	cpm per µCi/ml	Service Water – containment fan cooling
CW	as determined	2.58E+05	gpm	Circulating Water System default = winter, single CW pump
Release Rate (RR)				
R-18	as determined	8.0E+01	gpm	Determined prior to release; release rate can be adjusted for requirement compliance
R-19	as determined	2.0E+02	gpm	Steam Generator A and B combined
R-20	as determined	5.0E+03	gpm	Service Water – component cooling
R-16	as determined	1.5E+03	gpm	Service Water – Containment fan cooling
Background (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	as determined	8.0E+01	cpm	
R-20	as determined	6.0E+01	cpm	
R-16	as determined	8.0E+01	cpm	
Setpoint* (SP)				
R-18****	calculated	5.00E+05+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	5.00E+05+bkg	cpm	
R-20	calculated	5.16E+04+bkg	cpm	
R-16	calculated	1.68E+05+bkg	cpm	
Setpoint* (SP) with no Circulating Water System flow, CW=0				
R-18	calculated	6.25E+04+bkg	cpm	For outages with no Circulating Water System flow (CW=0) and a dilution flow as provided by the Service Water system of 5,000 gpm total.***
R-19	calculated	2.50E+04+bkg	cpm	
R-20	calculated	1.00E+03+bkg	cpm	
R-16	calculated	3.26E+03+bkg	cpm	

* Refer to Calculation # C10690 for the default setpoint calculation.
** Refer to Appendix C for derivation
*** SW flow is based on N-SW-02 Operating Parameters and Service Water Pump Flow Curves.
**** The default alarm setpoints for R-18 and R-19 are based upon the linear calibration range of those radiation monitors in accordance with CAP 37265 and DCR 26981.

Table 1.2 (Page 1 of 2)
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	-
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	-	-	-	-	-	-	-

Table 1.2 (Page 2 of 2)
Site Related Ingestion Dose Commitment Factors
(mrem/hr per µCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
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 1.3
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.

2.0 Gaseous Effluents Methodology

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:

2.1.1 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.

2.1.2 Condenser Evacuation System

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

2.1.3 Containment Purge

Containment purge and ventilation is via the containment stack for the 36-inch RBV system but via the auxiliary building stack for the 2-inch vent and mini-purge blower system. The stack radiation monitoring system consists of:

- a noble gas activity monitor providing alarm and automatic termination of release (R-12 and R-21),
- an iodine sampler, and
- a particulate sampler.

Effluent flow rates are determined empirically as a function of fan operation (fan curves). Sampler flow rates are determined by flow rate instrumentation.

2.1.4 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, 2-inch containment pressure relief purge/vent system, and Auxiliary Building general area. All effluents pass through the R-13 and/or R-14 channels which contain:

- a noble gas monitor
- an iodine sampler, and
- a particulate sampler.

The noble gas monitor provides auto isolation of any waste gas decay tank release 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.

2.1.5 Containment Mini-Purge/Vent System

Slight pressure buildup in containment is a recurring event resulting from normal operation of the plant. Prior to exceeding 2 psig in containment, this excess pressure is vented off. Air from containment is routed to the Auxiliary Building ventilation system, via the post-LOCA hydrogen recombiner piping and then out through the Auxiliary Building vent stack. The system is also designed to allow a continuous supply of fresh air to be introduced into containment via a mini-blower to purge gases. An alarm of the Auxiliary Building vent stack monitor (R-13 or R-14) or the containment building airborne radioactivity monitors (R-11, R-12) provides automatic isolation.

2.1.6 Steam Generator PORV Release With Primary-to-Secondary Leakage

IF the plant is operating with Steam Generator leakage from the primary side to the secondary, THEN release of steam through the Steam Generator PORVs will constitute a radiological release. There are no monitors on this release path, so accurate data collection is important. The appropriate procedures provide directions for release permit preparations.

2.1.7 Non-routine Discharge Locations

Periodically, non-routine breaches are made in the Auxiliary and Containment buildings that might allow the release of the atmosphere, which contains some levels of radioactivity. These breaches include, but are not limited to, opening the Containment equipment hatch during outages, holes cut in walls or ceilings to allow for moving equipment in or out of the Radiologically Controlled Areas (RCAs). All efforts to maintain these areas at negative pressure will be made. IF negative pressure cannot be maintained (i.e., more exhaust than supply fan volume), THEN supply ventilation to the area must be secured. Criteria for determining if and when a release occurs from these areas is provided in implementing procedures. As possible, the effects of these possible releases shall be evaluated beforehand. Any actual releases shall be documented and included in the monthly, quarterly and annual reports as appropriate.

2.1.8 Miscellaneous Releases

IF the plant is experiencing primary-to-secondary leaks in the steam generators, THEN the secondary steam side will become contaminated. Any release of steam will constitute an effluent, gaseous release, which will need to be accounted for in the effluent release program. Historically, if this condition had existed, the affects were considered to be minimal, and therefore were NOT included in the ODCM. The potential sources are too numerous to specifically call out here. However, in the event conditions arise that such releases occur, the methods outlined in the ODCM for dose calculation of the releases will be applied, and the results included in the annual effluent release report.

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 ODCM Normal Condition 13.3.2, 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:

$$FRAC_{tb} = \left[4.72E+02 \times \chi/Q \times VF \times \sum \left(C_i \times K_i\right)\right] \div 500 \qquad (2.1)$$

$$FRAC_{skin} = \left[4.72E+02 \times \chi/Q \times VF \times \sum \left(C_i \times \left(L_i + 1.1 M_i\right)\right)\right] \div 3000 \qquad (2.2)$$

where:

$FRAC_{tb}$	=	fraction of the allowable release rate for the total body based on the identified radionuclide concentrations and the release flow rate
$FRAC_{skin}$	=	fraction of the allowable release rate for skin based on the identified radionuclide concentrations and the release flow rate
χ/Q	=	annual average meteorological dispersion for direct exposure to noble gas at the controlling SITE BOUNDARY location (sec/m^3, from Table 2.3)
VF	=	ventilation system flow rate for the applicable release point and monitor (ft^3/min, from Table 2.2)
C_i	=	concentration of noble gas radionuclide "i" as determined by radioanalysis of grab sample (μCi/cm^3)
K_i	=	total body dose conversion factor for noble gas radionuclide "i" (mrem/yr per μCi/m^3, from Table 2.1)
L_i	=	beta skin dose conversion factor for noble gas radionuclide "i" (mrem/yr per μCi/m^3, from Table 2.1)
M_i	=	gamma air dose conversion factor for noble gas radionuclide "i" (mrad/yr per μCi/m^3, from Table 2.1)
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:

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

where:

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

SEN_i = the sensitivity value to which the monitor is calibrated for radionuclide "i" (cpm per μCi/cm³), use the default value from Table 2.2 if radionuclide specific sensitivities are not available

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 2.2. These values are based upon:

a) substitution of the maximum ventilation flow rate,

b) substitution of a radionuclide distribution[1] comprised of 95% Xe-133, 2% Xe-135, 1% Xe-133m, 1% Kr-88 and 1% Kr-85; and,

c) application of 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 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 2.2.

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

2.3 Gaseous Effluent Instantaneous Dose Rate Calculations - 10 CFR 20

2.3.1 SITE BOUNDARY Dose Rate - Noble Gases.

ODCM Normal Condition 13.2.1.a limits the dose rate at the SITE BOUNDARY due to noble gas releases to ≤ 500 mrem/yr to the total body, and ≤ 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:

$$\dot{D}_{tb} = \chi/Q \times \sum\left(K_i \times \dot{Q}_i\right) \quad (2.4)$$

and

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

where:

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

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

χ/Q = atmospheric dispersion for direct exposure to noble gas at the controlling SITE BOUNDARY (sec/m³, from Table 2.3)

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

K_i = total body dose conversion factor for noble gas radionuclide "i" (mrem/yr per μCi/m³, from Table 2.1)

L_i = beta skin dose conversion factor for noble gas radionuclide "i" (mrem/yr per μCi/m³, from Table 2.1)

M_i = gamma air dose conversion factor for noble gas radionuclide "i" (mrad/yr per μCi/m³, from Table 2.1)

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 2.3 may be used for evaluating the gaseous effluent dose rate.

2.3.2 SITE BOUNDARY Dose Rate - Radioiodine and Particulates

ODCM Normal Condition 13.2.1.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:

$$\dot{D}_o = \chi/Q \times \sum\left(R_i \times \dot{Q}_i\right) \quad (2.6)$$

where:

$\dot{D}_o$	=	average organ dose rate over the sampling time period (mrem/yr)
χ/Q	=	atmospheric dispersion to the controlling SITE BOUNDARY for the inhalation pathway (sec/m³, from Table 2.3)
R_i	=	dose parameter for radionuclide "i", (mrem/yr per μCi/m³) for the child inhalation pathway from Table 2.6
$\dot{Q}_i$	=	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 (μCi/sec)

By substituting 1500 mrem/yr for $\dot{D}_o$ solving for $\dot{Q}_i$, an allowable release rate for I-131 can be determined. Based on the annual average meteorological dispersion (see Table 2.3) and the most limiting potential pathway, age group and organ (inhalation pathway, child thyroid – R_i = 1.62E+07 mrem/yr per μCi/m³) the allowable release rate for I-131 is 6.43 μCi/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 ODCM Normal Condition 13.2.1.b limits on allowable release rate.

2.4 Gaseous Effluent Dose Calculations - 10 CFR 50

2.4.1 UNRESTRICTED AREA Dose - Noble Gases

ODCM Normal Condition 13.2.2 requires a periodic assessment of releases of noble gases to evaluate compliance with the quarterly dose limits of (≤ 5 mrad, gamma-air and ≤ 10 mrad, beta-air) and the calendar year limits (≤ 10 mrad, gamma-air and ≤ 20 mrad, beta-air). The following equations may be used to calculate the gamma-air and beta-air doses:

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

and

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

where:

D_γ	=	air dose due to gamma emissions for noble gas radionuclides (mrad)
D_β	=	air dose due to beta emissions for noble gas radionuclides (mrad)
χ/Q	=	atmospheric dispersion to the controlling SITE BOUNDARY (sec/m³, from Table 2.3)
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 μCi/m³ from Table 2.1)
N_i	=	air dose factor due to beta emissions from noble gas radionuclide "i" (mrad/yr per μCi/m³, Table 2.1)
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 ODCM Normal Condition 13.2.2. (Refer to Appendix B for the derivation and justification for this simplified method.)

$$D_\gamma = \frac{3.17E\text{-}08}{0.50} \times \chi/Q \times M_{eff} \times \sum Q_i \quad (2.9)$$

and

$$D_\beta = \frac{3.17E\text{-}08}{0.50} \times \chi/Q \times N_{eff} \times \sum Q_i \quad (2.10)$$

where:

M_{eff} = 5.3E+02 effective gamma-air dose factor (mrad/yr per μCi/m³)

N_{eff} = 1.1E+03 effective beta-air dose factor (mrad/yr per μCi/m³)

0.50 = conservatism factor

Actual meteorological conditions concurrent with the release period or the default, annual average dispersion parameters as presented in Table 2.3, 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 ODCM Normal Condition 13.2.3, a periodic assessment shall be performed to evaluate compliance with the quarterly dose limit (≤ 7.5 mrem) and calendar year limit (≤ 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:

$$D_{aop} = 3.17E-08 \times W \times SF_p \times \sum (R_i \times Q_i) \qquad (2.11)$$

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 2.3

χ/Q = atmospheric dispersion for inhalation pathway and H-3 dose contribution via other pathways (sec/m³)

D/Q = atmospheric deposition for vegetation, milk and ground plane exposure pathways (l/m²)

R_i = dose factor for radionuclide "i", (mrem/yr per μCi/m³) or (m² - mrem/yr per μCi/sec) from Table 2.4 through 2.15 for each age group "a" and the applicable pathway "p" as identified in Table 2.3. 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 half-life greater than 8 days (μCi).

SF_p = seasonal correction factor to account for the fraction of the period that the applicable exposure pathway does exist.

1) For milk and vegetation exposure pathways:

$$= \frac{\#\ of\ months\ in\ the\ period\ that\ grazing\ occurs}{total\ \#\ of\ months\ in\ period}$$

= 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 ODCM Normal Condition 13.2.3.

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

where:

D_{max} = maximum organ dose (mrem)

R_{I-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. Otherwise, the dose will be evaluated based on the predetermined controlling pathways as identified in Table 2.3.

2.5 Gaseous Effluent Dose Projection

ODCM Normal Condition 13.2.4 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 31 days, i.e., exceeding:

- 0.2 mrad, gamma air,
- 0.4 mrad, beta air, or
- 0.3 mrem, maximum organ.

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

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

$$D_{\gamma p} = D_{\gamma} \times (31 \div d) \qquad (2.13)$$

$$D_{\beta p} = D_{\beta} \times (31 \div d) \qquad (2.14)$$

$$D_{maxp} = D_{max} \times (31 \div d) \qquad (2.15)$$

where:

$D_{\gamma p}$ = gamma air dose projection for current 31 day period (mrad)

D_{γ} = gamma air dose to date for current 31 day period as determined by equation (2.7) or (2.9) (mrad)

$D_{\beta p}$ = beta air dose projection for current 31 day period (mrad)

D_{β} = beta air dose to date for current 31 day period as determined by equation (2.8) or (2.10) (mrad)

D_{maxp} = maximum organ dose projection for current 31 day period (mrem)

D_{max} = maximum organ dose to date for current 31 day period as determined by equation (2.11) or (2.12) (mrem)

d = number of days to date in current 31 day period

31 = number of days in a 31 day period

2.6 Environmental Radiation Protection Standards 40 CFR 190

For the purpose of implementing ODCM Normal Condition 13.4.1 on the EPA environmental radiation protection standard and Technical Specification 5.6.2 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.

2.7 Incineration of Radioactively Contaminated Oil

During plant operation, radioactively contaminated oils are generated from various pieces of equipment operating in the plant. The largest source of contaminated oil is the reactor coolant pump lubricating oil, which is periodically changed for preventive maintenance reasons. 10 CFR Part 20 allows licensees to incinerate radioactively contaminated oils on site provided that the total radioactive effluents from the facility conform to the requirements of 10 CFR Part 50, Appendix I.

Radioactively contaminated oil, which is designated for incineration, will be collected in containers, which are uniquely serialized such that the contents can be identified and tracked. Each container will be sampled and analyzed for radioactivity. The isotopic concentrations will be recorded for each container.

The heating boiler will be utilized to incinerate the radioactively contaminated oil collected on site. A gaseous radwaste effluent dose calculation, as prescribed in Section 2.3 of the ODCM, will be performed to insure that the limits established by ODCM Normal Condition 13.2.1, 13.2.2 and 13.2.3 are not exceeded. Release of the activity is assumed to occur at the time the contaminated oil is transferred into the heating boiler fuel oil storage tank and will be accounted for using established plant procedures. This will be valid for an assumed release from the fuel oil storage tank vent, fill piping, or from the boiler exhaust stack. See Figure 3 for a description of the heating boiler fuel oil system.

2.8 Total Dose

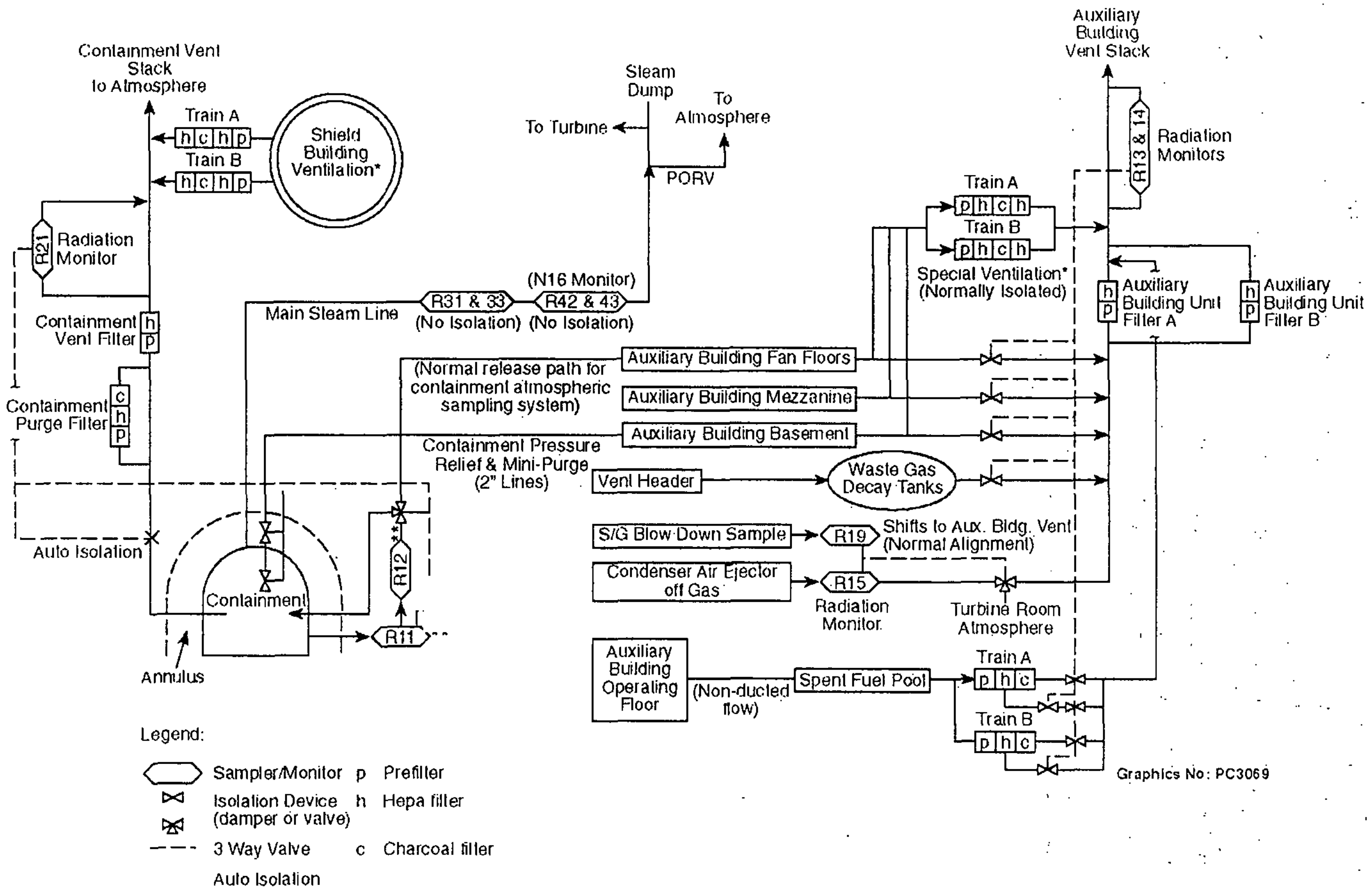
The purpose of this section is to describe the method used to calculate the cumulative dose contributions from liquid and gaseous effluents in accordance with KPS Technical Specifications for total dose. This method can also be used to demonstrate compliance with the Environmental Protection Agency (EPA) 40CFR190, “Environmental Standards for the Uranium Fuel Cycle”.

Compliance with the KPS Technical Specification dose objectives for the maximum individual demonstrates compliance with the EPA limits to any MEMBER OF THE PUBLIC, since the design dose objectives from 10CFR50, Appendix I are much lower than the 40CFR190 dose limits to the general public. With the calculated doses from the releases of radioactive materials in liquid or gaseous effluents exceeding twice the limits outlined in ODCM DNC 13.1.2, 13.2.2, and 13.2.3, a special analysis shall be performed. The purpose of this analysis is to demonstrate if the total dose to any MEMBER OF THE PUBLIC (real individual) from all uranium fuel cycle sources (including direct radiation contributions from the reactor unit, from outside storage areas and from all real pathways) is limited to less than or equal to 25 mrem per year to the total body or any organ, except the thyroid, which is limited to 75 mrem per year.

If required, the total dose to a MEMBER OF THE PUBLIC will be calculated for all significant effluent release points for all real pathways including direct radiation. Effluent releases from Point Beach Nuclear Plant must also be considered due to its proximity. Calculations will be based on the equations in Sections 1.4, 2.4.1, and 2.4.2, with the exception that usage factors and other site specific parameters may be modified using more realistic assumptions, where appropriate.

The direct radiation component from the facility can be determined using environmental TLD results. These results will be corrected for natural background and for actual occupancy time of any areas accessible to the general public at the location of maximum direct radiation. It is recognized that by including the results from the environmental TLDs into the sum of total dose component, the direct radiation dose may be overestimated. The TLD measurements may include the exposure from noble gases, ground plane deposition, and shoreline deposition, which have already been included in the summation of the significant dose pathways to the general public. However, this conservative method can be used, if required, as well as any other method for estimating the direct radiation dose from contained radioactive sources within the facility. The methodology used to incorporate the direct radiation component into total dose estimates will be outlined whenever total doses are reported.

Therefore, the total dose will be determined based on the most realistic site specific data and parameters to assess the real dose to any MEMBER OF THE PUBLIC.



* 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 (R11) and radiation monitor (R12) can also be aligned as needed for sampling containment vent.

GASEOUS RADIOACTIVE EFFLUENT FLOW DIAGRAM

Figure 3
Simplified Heating Boiler Fuel Oil Piping System

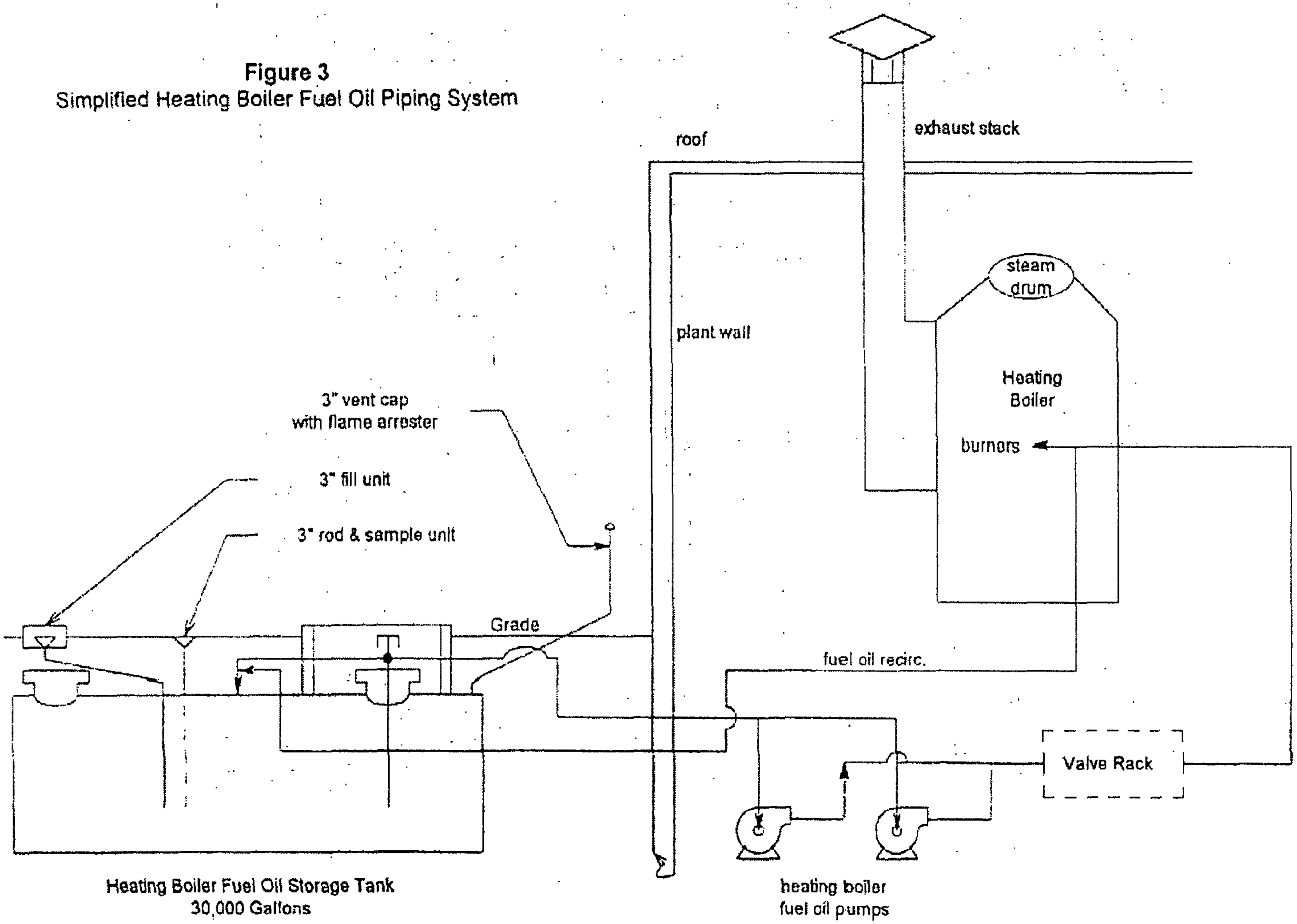


Table 2.1

Dose Factors for Noble Gases

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

Table 2.2

Parameters for Gaseous Alarm Setpoint Determinations

Parameter	Actual Value	Default Value*	Units	Comments
χ/Q	calculated	3.6E-06	sec/m^3	Licensing technical specification value
VF	fan curves	26,000 54,000	cfm	Containment – normal plus purge modes Auxiliary Building – normal operation
C_i	measured	N/A	µCi/m^3	
K_i	nuclide specific	N/A	mrem/yr per µCi/m^3	Values from Table 2.1
L_i	nuclide specific	N/A	mrem/yr per µCi/m^3	Values from Table 2.1
M_i	nuclide specific	N/A	mrem/yr per µCi/m^3	Values from Table 2.1
Sensitivity** (SEN) R-12 R-21 R-13 R-14	as determined	2.32E+07 2.32E+07 2.32E+07 2.32E+07	cpm per µCi/cm^3	Containment Containment Auxiliary Building Auxiliary Building
Background (bkg) R-12 R-21 R-13 R-14	as determined	4.0E+02 4.0E+01 6.0E+02 9.0E+02	cpm	Nominal values only; actual values may be used in lieu of these reference values.
Setpoint* (SP) R-12 R-21 R-13 R-14	calculated calculated calculated calculated	2.8E+05+bkg 2.8E+05+bkg 1.3E+05+bkg 1.3E+05+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.

* Refer to Calculation # C10690 for the default setpoint calculation.
** Conservatively based on Xe-133 sensitivity.

Table 2.3

Controlling Locations, Pathways and

Atmospheric Dispersion for Dose Calculations

ODCM Normal Condition	Location	Pathways	Atmospheric Dispersion	
			χ/Q (sec/m^3)	D/Q (1/m^2)
13.2.1.a	Site Boundary (0.81 mile, NNW)	Noble gases Direct exposure	7.44E-07	N/A
13.2.1.b	Site Boundary (0.81 mile, NNW)	Inhalation, Ground Plane	7.44E-07	N/A
13.2.2	Site Boundary (0.81 mile, NNW)	Gamma Air Beta Air	7.44E-07	N/A
13.2.3	Residence/dairy (1.3 mile SW)	Inhalation, Vegetation, Milk and Ground Plane	3.95E-08	1.86E-09

Table 2.4 (Page 1 of 2)

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 2.4 (Page 2 of 2)

R_i Inhalation Pathway Dose Factors – ADULT

(mrem/yr per μCi/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 2.5 (Page 1 of 2)

R_i Inhalation Pathway Dose Factors – TEEN

(mrem/yr per µCi/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 2.5 (Page 2 of 2)

R_i Inhalation Pathway Dose Factors – TEEN

(mrem/yr per μCi/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 2.6 (Page 1 of 2)
R_i Inhalation Pathway Dose Factors - CHILD
(mrem/yr per $\mu Ci/m^3$)

Nuclide	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 2.6 (Page 2 of 2)

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 2.7 (Page 1 of 2)

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 2.7 (Page 2 of 2)

R_i Inhalation Pathway Dose Factors - INFANT

(mrem/yr per μCi/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 2.8 (Page 1 of 2)

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 $\mu Ci/sec$) 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	-	-	-	2.97E+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 2.8 (Page 2 of 2)

R_i Vegetation Pathway Dose Factors - ADULT

(mrem/yr per µCi/m³) for H-3 and C-14 (m² x mrem/yr 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+1 0	-	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 2.9 (Page 1 of 2)

R_i Vegetation Pathway Dose Factors - TEEN

(mrem/yr per μCi/m³) for H-3 and C-14 (m² x mrem/yr 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 2.9 (Page 2 of 2)

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 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 2.10 (Page 1 of 2)

R_i Vegetation Pathway Dose Factors - CHILD

(mrem/yr per µCi/m^3) for H-3 and C-14 (m² x mrem/yr 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	-	-	-	2.45E+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 2.10 (Page 2 of 2)

R_i Vegetation Pathway Dose Factors - CHILD

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

Nuclide	Bone	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 2.11 (Page 1 of 2)

R_i Grass-Cow-Milk Pathway Dose Factors - ADULT

(mrem/yr per μCi/m³) for H-3 and C-14 (m² x mrem/yr μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	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 2.11 (Page 2 of 2)

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 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 2.12 (Page 1 of 2)

R_i Grass-Cow-Milk Pathway Dose Factors - TEEN

(mrem/yr per μCi/m³) for H-3 and C-14 (m² x mrem/yr 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 2.12 (Page 2 of 2)

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 μCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	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 2.13 (Page 1 of 2)

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 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 2.13 (Page 2 of 2)

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 μCi/sec) for others

Nuclide	Bone	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 2.14 (Page 1 of 2)

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 µCi/sec) for others

Nuclide	Bone	Liver	Thyroid	Kidney	Lung	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 2.14 (Page 2 of 2)

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 $\mu Ci/sec$) 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 2.15 (Page 1 of 2)

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

Table 2.15 (Page 2 of 2)

R_i Ground Plane Pathway Dose Factors

(m^2 x mrem/yr per μCi/sec)

Nuclide	Any Organ
Ru-105	6.36E+5
Ru-106	4.21E+8
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

Technical Basis for Effective Dose Factors - Liquid Effluent Releases

To verify that the current approach to determining environmental doses using a simplified method has remained consistent since the previous analysis (performed using effluent data from 1981-1983), a similar evaluation was performed using the liquid effluent release data from 2000-2002. From the effluent data, the dose contribution of the radionuclide mixture can be obtained to provide a simplified method of determining compliance with the dose limits of ODCM Normal Condition 13.1.2. For the radionuclide distribution of effluents from the Kewaunee Power Station, 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 Fe-55 releases. The radionuclides, Fe-55, Co-58, Co-60, Sr-90, and Cs-137 contribute essentially all of the calculated total body dose. The results of this evaluation are presented in Table A-1. The individual nuclide doses used in the dose comparisons of Table A-1 were calculated using the total curies released via batch and continuous releases as reported in the Annual Radioactive Effluent Release Report, weighted by the appropriate dose factors.

Tritium is not included in the limited analysis dose assessment for liquid releases, because the potential dose resulting from normal reactor releases is negligible. From 2000-2002, the maximum tritium release from the Kewaunee Power Station to Lake Michigan was 270 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 0.07% 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.

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.

While not present in the 2000-2002 liquid effluent releases, it still remains conservative to use the Cs-134 dose conversion factor (7.09E+05 mrem/hr per μCi/ml, liver) to evaluate the maximum organ dose. 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 2000, using this simplified conservative method (CW value of 2.00E+05 gpm) would overestimate the maximum organ dose as reported in the Annual Radioactive Effluent Release Report by a factor of 234; for 2001, the conservatism is a factor of 109; and for 2002, a factor of 730. This comparison is shown in Table A-2.

For the total body calculation, the Cs-134 dose factor (5.79E+05 mrem/hr per µCi/ml, total body) is again used since it is higher than the identified dominant nuclides. For 2000, using this simplified conservative dose calculational method would overestimate the total body dose by a factor of 253; for 2001, the conservatism is a factor of 105; and for 2002, a factor of 601.

For evaluating compliance with the dose limits of ODCM Normal Condition 13.1.2 the following simplified equations may be used:

Total Body

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

where:

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

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

VOL = volume of liquid effluent released (gal)

ΣC_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

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

where:

D_{max} = maximum organ dose (mrem)

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

Substituting the value for $A_{Cs\text{-}134,Liver}$ 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 ODCM Normal Condition 13.1.2.

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

	2000				2001				2002			
Radio-nuclide	**Release (Ci)**	**TB Dose Frac.**	**GI-LLI Dose Frac.**	**Liver Dose Frac.**	**Release (Ci)**	**TB Dose Frac.**	**GI-LLI Dose Frac.**	**Liver Dose Frac.**	**Release (Ci)**	**TB Dose Frac.**	**GI-LLI Dose Frac.**	**Liver Dose Frac.**
Fe-55	4.81E-02	0.03	0.02	0.10	4.85E-02	0.04	0.03	0.13	3.69E-02	0.19	0.02	0.84
Co-58	8.07E-03	0.01	0.03	*	4.09E-03	0.01	0.02	*	4.94E-03	0.05	0.02	0.02
Fe-59	2.77E-04	*	*	*	2.44E-04	*	*	*	1.65E-04	0.01	*	0.02
Co-60	4.71E-03	0.02	0.04	0.01	4.31E-03	0.02	0.05	0.01	2.07E-03	0.06	0.02	0.03
Br-82	4.94E-04	0.01	*	*	1.44E-04	*	*	*	N/D	*	*	*
Sr-90	2.25E-04	0.18	0.01	*	2.50E-04	0.25	0.01	*	9.76E-05	0.63	*	*
Nb-95	3.41E-04	*	0.89	*	2.39E-04	*	0.86	*	2.45E-04	*	0.91	*
Cs-137	3.70E-04	0.75	0.01	0.88	2.74E-04	0.68	0.01	0.85	3.04E-06	0.05	*	0.08

* Less than 0.01
N/D = not detected

Table A-2
Adult Liver and Total Body Dose Assessment

Dose Via the Simplified Method Versus the Actual Calculated Dose

	2000	2001	2002
Simplified Liver Dose (mRem)*	1.16E+00	9.87E-01	7.88E-01
Actual Liver Dose (mRem)**	4.97E-03	9.02E-03	1.08E-03
Simplified divided by Actual	**234**	**109**	**730**
Simplified Total Body Dose (mRem) *	9.53E-01	8.09E-01	6.46E-01
Actual Total Body Dose (mRem) **	3.77E-03	7.73E-03	1.07E-03
Simplified divided by Actual	**253**	**105**	**601**

* Assuming 2.00E+05 gpm circulating water flow
** From the Annual Radioactive Effluent Release Report

APPENDIX B

TECHNICAL BASIS FOR EFFECTIVE DOSE FACTORS -

GASEOUS RADIOACTIVE EFFLUENTS

APPENDIX B

Technical Basis 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

$$(L + 1.1M)_{eff} = \sum \left[(L_i + 1.1M_i) \times f_i\right] \qquad \text{(B.2)}$$

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

$$M_{eff} = \sum (M_i \times f_i) \qquad \text{(B.3)}$$

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

$$N_{eff} = \sum (N_i \times f_i) \quad \text{(B.4)}$$

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 2000, 2001 and 2002, the total noble gas releases have been limited to 2.54E-04 Ci for 2000, 1.37E-01 Ci for 2001, and 1.91E-02 Ci for 2002. 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 ODCM Normal Condition 13.2.2, the following simplified equations may be used:

$$D_\gamma = \frac{3.17E-08}{0.50} \times \chi/Q \times M_{eff} \times \sum Q_i \quad \text{(B.5)}$$

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

where:

D_γ = 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)

χ/Q = atmospheric dispersion to the controlling SITE BOUNDARY (sec/m^3)

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

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

ΣQ_i = 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:

$$D_\gamma = 3.5E-05 \times \chi/Q \times \sum Q_i \qquad (B.7)$$

and

$$D_\beta = 7.0E-05 \times \chi/Q \times \sum Q_i \qquad (B.8)$$

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 annually for preparation of the 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.

Table B-1
Effective Dose Factors - Noble Gases

Radionuclide	f_i	Total Body Effective Dose Factor K_{eff} (mrem/yr per μCi/m^3)	Skin Effective Dose Factor $(L+1.1\ M)_{eff}$ (mrem/yr per μCi/m^3)
Noble Gases - Total Body and Skin			
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	0.9	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 μCi/m^3)**	**Beta Air Effective Dose Factor N_{eff} (mrad/yr per μCi/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 EFFECTIVE EC VALUE FOR LIQUID EFFLUENTS

Appendix C

Evaluation of Conservative, Default Effective EC Value for Liquid Effluents

In accordance with the requirements of ODCM Normal Condition 13.3.1 the radioactive liquid effluent monitors shall be FUNCTIONAL with alarm setpoints established to ensure that the concentration of radioactive material at the discharge point does not exceed 10 times the value of 10 CFR 20, Appendix B, Table 2, Column 2 for all radionuclides other than noble gases and a value of $2X10^{-4}$ µCi/ml for noble gases. The determination of allowable radionuclide concentration and corresponding alarm setpoint is a function of the individual radionuclide distribution and corresponding EC 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 EC_e value for this distribution.

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

$$EC_e = \frac{\sum C_i}{\sum \frac{C_i}{EC_i}} \qquad (C.1)$$

where:

EC_e = an effective EC value for a mixture of radionuclide (µCi/ml)

C_i = concentration of radionuclide "i" in the mixture

EC_i = the 10 CFR 20, Appendix B, Table 2, Column 2 EC value for radionuclide "i" (µCi/ml)

Based on the above equation and the radionuclide distribution in the effluents for past years from Kewaunee, an EC_e value can be determined. Effluent release data from 2000-2002 was used to generate the results presented in Table C-1. The most limiting effective EC (for gamma emitting radionuclides) was for the calendar year 2001, with a calculated value of 5.98E-06 µCi/ml. For conservatism in establishing the alarm setpoints, a default effective EC value of 1.0E-06 µCi/ml was selected. The overall conservatism of this value is reaffirmed for future releases considering that 1.0E-06 µCi/ml is as or more restrictive than the individual EC values for the principal fission and activation products of Co-58, Co-60 and Cs-137. Overall, use of this effective EC value provides a factor of six (6) conservatism based on the 2000-2002 radionuclide distribution for gamma emitters.

Being a non-gamma emitter, tritium is not detected by the effluent monitor. While tritium accounts for nearly all of the activity, it is not a significant contributor when determining the alarm setpoint for release rate evaluations. Examining releases over the years 2000-2002, the average, diluted H-3 contribution to its limiting concentration (i.e., fraction of concentration limit - 10 x EC) in liquid effluents was 0.004%. This contribution is not expected to change significantly over time, since the concentration of H-3 in effluents can be expected to remain fairly consistent in effluent releases regardless of fuel conditions, activation product releases, and waste processing.

Based on relative abundances, other non-gamma emitting radionuclides (Fe-55 and Sr-89/90) contributed up to 30% of the concentration limit (30% for CY 2001). It is reasonable to assume that the abundances of these non-gammas will remain the same relative to other fission and/or activation products under varying conditions. Therefore, under conditions of elevated effluent radionuclide levels, the gamma-emitting radionuclides can be expected to be the main contributors to limiting conditions on liquid effluent concentrations, as established in Technical Specification 5.5.3.b and ODCM Normal Condition 13.1.1. Note that including the non-gammas (excluding tritium) in the evaluation results in a higher effective EC value.

Therefore, under conditions of elevated effluent levels, the main contributor to the limiting conditions of the liquid effluent concentration would be the gamma-emitting radionuclides. The factor of six (6) conservatism in the effective EC determination (discussed above) provides adequate consideration for the contribution from non-gamma emitting radionuclides, and provides a conservative basis for establishing an alarm setpoint consistent with the requirements of Technical Specification 5.5.3.b and ODCM Normal Condition 13.1.1.

The Heating Boiler Blow Down and Turbine Building Sump are discharged to the lake with no installed radiation monitor. Using the default effective EC value of 1.0E-06 μCi/ml for increased monitoring is consistent with the ODCM methodology if an installed radiation monitor was available.

Table C-1
Calculation of Effective EC (EC_e)

Nuclide	EC (µCi/ml)	2000			2001			2002		
		Release (C_i)	C_i/EC_i	Frac.	Release (C_i)	C_i/EC_i	Frac.	Release (C_i)	C_i/EC_i	Frac.
Na-24	5.00E-05	1.03E-03	2.06E+01	4.89E-03	2.18E-04	4.35E+00	1.27E-03	0.00E+00	0.00E+00	0.00E+00
Cr-51	5.00E-04	1.44E-03	2.89E+00	6.85E-04	8.26E-04	1.65E+00	4.83E-04	0.00E+00	0.00E+00	0.00E+00
Mn-54	3.00E-05	1.49E-04	4.97E+00	1.18E-03	3.30E-04	1.10E+01	3.22E-03	6.41E-05	2.14E+00	9.83E-04
Fe-55	1.00E-04	4.81E-02	4.81E+02	1.14E-01	4.85E-02	4.85E+02	1.42E-01	3.69E-02	3.69E+02	1.70E-01
Co-57	6.00E-05	0.00E+00	0.00E+00	0.00E+00	2.42E-05	4.03E-01	1.18E-04	0.00E+00	0.00E+00	0.00E+00
Co-58	2.00E-05	8.07E-03	4.04E+02	9.59E-02	4.09E-03	2.05E+02	5.99E-02	4.94E-03	2.47E+02	1.14E-01
Fe-59	1.00E-05	2.77E-04	2.77E+01	6.57E-03	2.44E-04	2.44E+01	7.14E-03	1.65E-04	1.65E+01	7.61E-03
Co-60	3.00E-06	4.71E-03	1.57E+03	3.73E-01	4.31E-03	1.44E+03	4.21E-01	2.07E-03	6.89E+02	3.17E-01
Br-82	4.00E-05	4.94E-04	1.23E+01	2.93E-03	1.44E-04	3.59E+00	1.05E-03	0.00E+00	0.00E+00	0.00E+00
Sr-89	8.00E-06	3.42E-04	4.27E+01	1.01E-02	2.59E-04	3.24E+01	9.48E-03	5.98E-04	7.48E+01	3.44E-02
Sr-90	5.00E-07	2.25E-04	4.50E+02	1.07E-01	2.50E-04	5.00E+02	1.46E-01	9.76E-05	1.95E+02	8.98E-02
Zr-95	2.00E-05	1.16E-04	5.79E+00	1.38E-03	7.18E-05	3.59E+00	1.05E-03	5.24E-05	2.62E+00	1.20E-03
Nb-95	3.00E-05	3.41E-04	1.14E+01	2.70E-03	2.39E-04	7.95E+00	2.33E-03	2.45E-04	8.17E+00	3.76E-03
Ag-110m	6.00E-06	2.85E-03	4.74E+02	1.13E-01	1.63E-03	2.72E+02	7.97E-02	2.86E-03	4.76E+02	2.19E-01
Sn-113	3.00E-05	9.65E-05	3.22E+00	7.64E-04	5.08E-05	1.69E+00	4.95E-04	7.06E-05	2.35E+00	1.08E-03
Sb-124	7.00E-06	5.61E-04	8.01E+01	1.90E-02	1.81E-04	2.59E+01	7.59E-03	4.34E-05	6.20E+00	2.85E-03
Sb-125	3.00E-05	4.86E-03	1.62E+02	3.85E-02	1.02E-03	3.41E+01	9.99E-03	2.46E-03	8.18E+01	3.76E-02
I-132	1.00E-04	0.00E+00	0.00E+00	0.00E+00	7.75E-08	7.75E-04	2.27E-07	0.00E+00	0.00E+00	0.00E+00
I-133	7.00E-06	6.16E-04	8.80E+01	2.09E-02	6.32E-04	9.03E+01	2.65E-02	0.00E+00	0.00E+00	0.00E+00
I-135	3.00E-05	0.00E+00	0.00E+00	0.00E+00	4.61E-05	1.54E+00	4.50E-04	0.00E+00	0.00E+00	0.00E+00
Cs-137	1.00E-06	3.70E-04	3.70E+02	8.78E-02	2.74E-04	2.74E+02	8.02E-02	3.04E-06	3.04E+00	1.40E-03
	Total	7.46E-02	4.21E+03	1.00E+00	6.34E-02	3.42E+03	1.00E+00	5.06E-02	2.17E+03	1.00E+00
Non-Gamma Fraction				0.23			0.30			0.29
Gamma Fraction				0.77			0.70			0.71
EC_e (µCi/ml, total)		1.77E-05			1.86E-05			2.33E-05		
EC_e (µCi/ml, gammas)		8.03E-06			5.98E-06			8.44E-06		

APPENDIX D

On-site Disposal of Low-Level Radioactively

Contaminated Waste Streams

Appendix D consists of hard copies of the following reference documents:

DESCRIPTION	DATE	DOCKET NUMBER
Operating License DPR-43 Kewaunee Nuclear Power Plant Disposal of Low Level Radioactive Material	October 17, 1991	NRC-91-148 50-305
Proposed Disposal of Low Level Radioactive Waste Sludge Onsite at the Kewaunee Nuclear Power Plant (TAC No. M75047)	June 17, 1992	K92-119 50-305
Safety Evaluation For An Amendment To An Approved 10 CFR 20.302 Application For The Kewaunee Nuclear Plant (TAC No. M89719)	September 14, 1994	K-94-195 50-305
Alternate Disposal Of Contaminated Sewage Treatment Plant Sludge In Accordance With 10 CFR 20.2002 (TAC No. M93844)	November 13, 1995	K-95-172 50-305
Onsite Disposal Of Contaminated Sludge Pursuant To 10 CFR 20.2002 (TAC No. M97411)	April 9, 1997	K-97-64 50-305

Adapted from N

WPSC (414) 433-1598
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NRC 91-148

EASYLINK 62891993

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D A Bollom G6
R E Draheim KNP
K H Evers D2
M L Marchi KNP
D L Masarik KNP
J N Morrison D2
J R Mueller D2
D S Nalepka KNP
L A Nuthals D2 (NSRAC)
R P Pulec D2
J S Richmond D2
D J Ristau D2
D J Ropson KNP
DT Brown KNP
A J Ruege D2
C A Schrock KNP
C S Smoker KNP
C R Steinhardt D2
J J Wallace KNP
K H Weinhauer KNP
S F Wozniak D2
QA Vault KNP
TJ Webb KNP

File

October 17, 1991

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Disposal of Low Level Radioactive Material

References: 1) Letter from K.H.Evers to Document Control Desk dated September 12, 1989

2) Letter from M.J.Davis to K.H.Evers dated February 13, 1990

3) Letter from L.Sridharon (WDNR) to M.Vandenbusch dated June 13, 1991

In reference 1, pursuant to the regulation of 10 CFR 20.302, Wisconsin Public Service Corporation (WPSC) requested authorization for the alternative disposal of very-low-level radioactive materials from the Kewaunee Nuclear Power Plant. In reference 2, the US NRC identified additional questions that needed to be addressed in order to complete their review. Attachment 1 provides our response to the questions.

WPSC requested the State of Wisconsin Department of Natural Resources (WDNR) to review the disposal options for the service water pretreatment lagoon sludges. In reference 3, the WDNR completed a review of the most appropriate on site disposal methods for the slightly contaminated service water pretreatment lagoon sludges. The two proposed methods that the WDNR evaluated included in-situ capping of the sludge in the wastewater treatment lagoon and on site landspreading. In Attachment 1, Appendix A, WPSC evaluated the on site landspreading

Document Control Desk
October 17, 1991
Page 2

application which is our preferred disposal method. WPSC does not intend to utilize the in-situ capping of the sludge in the lagoon at this time. However, in the letter the WDNR agreed that either disposal method was acceptable provided:

- if the material is to be left in the lagoon, it would be capped in accordance with Wisconsin State statutes.

- if the on site landspreading option is utilized, the material would be spread by either disking into the soil or by spiking into the ground.

WPSC will abide by the WDNR landspreading requirements which include locational and performance standards. Should there be any additional questions please feel free to contact a member of my staff.

Sincerely,

C A Schrock

C. A. Schrock
Manager - Nuclear Engineering

DJM/jms

Attach.

cc - US NRC - Region III
Mr. Patrick Castleman, US NRC

LIC\DJM\N492

ATTACHMENT 1

To

Letter from K. H. Evers (WPSC) to Document Control Desk (NRC)

Dated

October 17, 1991

Document Control Desk
October 17, 1991
Attachment 1, Page 1

References 1) Letter from K. H. Evers to Document Control Desk dated September 1, 1989.

NRC Question #1

On page 4 of your submittal, the average input to the Sewage Treatment System is approximately 11,000 gallons per day. In the Final Environmental Statement, this system is to be operated below its design capacity of 9,000 gallons per day. Discuss this deviation from the design capacity, and provide information to justify the higher output for this system.

WPSC Response

The original Sewage Treatment System installed at the Kewaunee Nuclear Power Plant (KNPP) was replaced in 1986 with a higher capacity system. The original system was designed for an onsite work force of around 150 people. It was a limited capacity aerobic treatment system which included the onsite lagoon for additional retention. Because of this limited capacity and more stringent conditions on system effluent to Lake Michigan, an aerobic digester system was installed, which has a higher capacity, and uses current technology.

The estimated input volume to the Sewage Treatment System used in the September 12, 1989 application was 11,000 gallons per day. This value was based on past operating data. The increase in influent from the original design basis included in the Final Environmental Statement is due mainly to an increase in the number of individuals and facilities (e.g., training and simulator building) located onsite. Design changes to the system were required to accommodate these new facilities.

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October 17, 1991
Attachment 1, Page 2

The current volumes of sewage sludge were used as the basis for the potential dose analysis and corresponding radionuclide concentration limits. This increase has no significant effect on the dose modeling. (Refer to the response to NRC Question #2, below.)

NRC Question #2

Provide information regarding how the disposal plan assures that the annual dose to any exposed individual will be kept below 1 mrem per year.

WPSC Response

The dose pathway modeling used for determining the radioactive material concentration limits was based on NRC modeling. The computer code IMPACTS-BRC was used as the basis for calculating the potential doses from the alternative disposal methods. This modeling includes reasonable conservative exposure pathway scenarios for the various disposal methods.

Administrative controls will be established to ensure that the actual disposal of any slightly contaminated materials from KNPP are within the bounds of the evaluation. Samples from each of the waste streams will be collected and analyzed by gamma spectroscopy prior to release for disposal. A system lower limit of detection (LLD) of 5E-07 μCi/ml for the principal gamma emitting radionuclides will be required. This LLD ensures the identification of any contaminated materials at a fraction of the allowable concentration limits for the alternative disposal.

The results of these analyses will be used to ensure that any detectable levels of radioactive material are within the limits for alternative disposal. Any materials with levels of radioactive material above the concentration limits (and of plant origin) will be treated as a radioactive waste and appropriately controlled.

Records will be maintained to ensure that the cumulative disposal of any contaminated materials are maintained within the bounds of the evaluation. In addition to a comparison of the individual radionuclide concentration limits, a record of the total amount of radioactive material disposed of will be maintained. Cumulative totals will be maintained to ensure that the total activity does not exceed the quantity assumed in the derivation of the limits.

In developing the concentration limits presented in Table 1 of reference 1, it was assumed the total annual design basis volume of 27,000 ft^3 would be contaminated at the derived limit. The dose commitment from each radionuclide was individually evaluated as if it were the only radioactive material present. To determine if a mixture of radionuclides meets the limit, the sum-of-the-fractions rule should be applied (i.e., the sum of each radionuclide's concentration divided by its limiting concentration must be less than one).

The concentration limits of Table 1 of reference 1 also have an implied total activity limit. This limit is determined by multiplying the individual radionuclide concentration limit by the total estimated waste volume of 27,000 ft^3. These total activity limits are presented in Table A of this response, for each radionuclide individually. For a mixture of radionuclides, a total annual activity limit may be determined by normalizing the concentrations so that the sum-of-the-fractions for the mixture equals one (1). These resultant adjusted concentrations may be multiplied by the 27,000 ft^3 waste volume to determine the corresponding total activity limit of the mixture.

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Attachment 1, Page 4

A Disposal Log will be maintained on a calendar year basis for all disposals of any very-low-level radioactive materials. The log will contain as a minimum the following information:

- Disposal location
- Description of waste
- Shipment/disposal date
- Waste volume
- Radionuclide concentrations (gamma emitters)
- Year-to-date radionuclide activity
- Year-to-date waste volume

In addition to the above Disposal Log, a record file will be kept for each individual disposal. This file will contain, as a minimum, the following information:

- Waste identification
- Sample gamma spectroscopy results
- Identified radionuclide concentrations and total activity

NRC Question #3

Revise Appendix B, Section A of your submittal, "Radiation Exposure During Transport," by adding the cumulative dose to the exposed population per reactor year for both the transportation worker and the general public (onlookers along route).

WPSC Response

The potential exposure to the general public (onlookers along route) is modeled by the IMPACTS-BRC code. As addressed in NUREG/CR-3585, this modeling is based on an integration of the source strength, an assumed

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Attachment 1, Page 5

population density along route and vehicular speed. For a conservative evaluation of the potential exposure to the general public from the transport of the KNPP waste, a population density of 610 persons/mi^2 was assumed. This value is conservative for the KNPP site area where the average population density is less than 53 persons/mi^2. A transport distance of 45 miles was assumed. The IMPACTS-BRC modeling assumes five (5) tons of material are transported per shipment. For the assumed KNPP waste volume, this shipment weight translates into a total of 167 shipments per year. With a vehicular speed of 20 miles per hour, the resultant total population exposure time is 375 person-hours per year. At the concentration limits established for the alternative disposal, the potential onlooker doses during transport will be less than 0.01 person-rem per year. For the modeling of the exposure to the transport worker, the IMPACTS-BRC model assumes two drivers per vehicle. As presented in the September 12, 1989 submittal, the maximum dose to the driver is less than 1 mrem per year (<0.001 rem/yr). Therefore, the total collective dose to the transport workers will be twice the individual dose, i.e., less than 0.002 person-rem. Including the population dose of <0.01 person-rem per year, the total collective dose to both the transport workers and the population is less than 0.02 person-rem (0.002 person-rem + 0.01 person-rem < 0.02 person-rem).

For the disposal of the existing 15,000 ft^3 of contaminated sludges, the population dose due to the transportation of the waste is calculated to be 0.0002 person-rem. The estimated collective exposure to the transport worker is 0.00007 person-rem. The total collective dose due to transport of the waste is 0.00027 person-rem.

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Attachment 1, Page 6

Additional Potential Disposal Method

The Wisconsin Department of Natural Resources has requested Wisconsin Public Service to examine the feasibility of land application of the lagoon sludges in lieu of disposal in the Kewaunee County Landfill. Land application is also an option for the disposal of the sewage sludges. Therefore, WPS requests that the option for onsite disposal at the KNPP site by land application be included in the alternative disposal methods which was determined to be acceptable in our September 12, 1989 submittal.

The potential pathways of exposure as evaluated in the September 12, 1989 submittal conservatively bound any additional pathways of exposure that would result from onsite land spreading of the waste. Attachment A to this response provides an overview of the land spreading disposal method. Also, the pathways of exposure applicable to the onsite land application are evaluated; and a comparison to the controlling pathways and radionuclide concentrations as presented in the September 12, 1989 submittal are discussed. From a modeling standpoint, the two exposure scenarios , "Radiation Exposure During Transport" and "Radiation Exposure to Landfill Operator," appropriately characterize any potential exposure to workers involved with the land spreading of the waste. The other post-disposal exposure scenarios, "Intruder Scenario", "Intruder Well", and "Exposed Waste Scenario," as described in NUREG/CR-3585 (and as discussed in Appendix C of the submittal) reasonably bound any potential exposures from either ground waste migration or post-release from the Kewaunee site. In no case is there a higher potential for exposure from land application than the pathways and potential exposures that were used for the derivation of the limits for alternative disposal. Therefore, no revisions are needed to the radionuclide concentration limits proposed in the September 12, 1989 submittal to include the option for disposal by onsite land spreading of the waste.

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Table A

Radionuclide Quantity Limits for Alternative Disposal

Nuclide	Limiting Concentration (μCi/ml)	Limiting Annual Quantity (Ci)
H-3	9.65E-04	0.7382
C-14	4.55E-05	0.0348
Cr-51	3.13E-04	0.2394
Mn-54	1.14E-05	0.0087
Fe-55	1.00E-02	7.6500
Fe-59	7.90E-06	0.0060
Co-58	1.16E-05	0.0089
Co-60	3.74E-06	0.0029
Ni-63	1.00E-02	7.6500
Sr-90	3.45E-03	2.6393
Zr-95	6.28E-06	0.0048
Nb-95	1.23E-05	0.0094
Mo-99	6.73E-05	0.0515
Tc-99	2.70E-04	0.2066
I-129	2.50E-06	0.0019
I-131	2.68E-05	0.0205
Cs-134	6.16E-06	0.0047
Cs-137	1.71E-05	0.0131
Ba-140	5.52E-05	0.0422
La-140	4.17E-06	0.0032
Transuranics		
TRU (T½ > 5 yrs)	8.91E-05	0.0682
Pu-241	2.85E-03	2.1803
Cm-242	1.00E-02	7.6500

Assumes annual quantity of KNPP wastes is 27,000 ft^3 or 7.65E8 mls.

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Appendix A

Evaluation of Onsite Land Application for Alternative Disposal of Very-Low-Level Contaminated Materials

Overview

Land spreading of lagoon sludges onsite at the Kewaunee Nuclear Power Plant has been recommended by personnel from the Wisconsin Department of Natural Resources (DNR) as a desirable alternative to the use of the Kewaunee County Landfill for disposal. This method of disposal is also a recommended practice for disposing of sewage treatment facility sludges. Therefore, WPS requests that this disposal method be included in the options available for the alternative disposal of very-low-level radioactively contaminated materials from KNPP.

Description of Disposal Method

The disposal of KNPP sludges will be performed by beneficial land application to a dedicated disposal area located onsite at the Kewaunee Nuclear Power Plant. Typical methods of land spreading will be employed. KNPP sludges will be loaded onto appropriate vehicles (e.g., tanker truck, sludge spreader, etc.) and applied to the dedicated disposal area. The dedicated disposal area will be periodically plowed to a depth of 6 inches.

Onsite disposal of water treatment and sewage sludges are allowed by EPA and State of Wisconsin Department of Natural Resources with the criteria and limits for land spreading being specified by the potential use of the land. The two land use criteria are 1) Agricultural land that covers any lands upon which food crops are grown or animals are grazed for human consumption, and 2) Non-Agricultural land that covers lands which do not represent ingestion pathways to man. To be conservative, the Agricultural Land Application limits of sludge contaminants will be applied to the KNPP wastes even though the less restrictive Non-Agricultural Land Application sludge contamination limits are allowed. Therefore, no more than 50 metric tons of sludge per hectare will be applied to the dedicated disposal site. This limit will ensure that any land application will not exceed the bounds of the dose analysis as

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October 17, 1991
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performed previously. In addition, other limitations as applied to land application by the State of Wisconsin Department of Natural Resources will be followed (e.g., control of runoff/erosion, proximity to wells/residences/surface water, etc.).

Applicable Pathways of Exposure

The pathways of exposure applicable for land spreading are not appreciably different from the pathways evaluated for the disposal methods at the Kewaunee County Landfill or the Green Bay Metropolitan Sewerage District facilities. The major exposure pathways are discussed below:

Direct Exposure to Workers

Any potential exposures to workers involved in the removal, transport and land spreading of the sludges are reasonably bound by the evaluation of the exposure to the transport worker in the September 12, 1989 submittal. The transport worker has been assumed to be exposed for 460 hours per year at one (1) meter from unshielded waste. For the land spreading of these wastes, it is estimated that the total exposure time for the removal and disposal of the lagoon sludges will require no longer than a three week period per year (i.e., 120 hours).

The potential exposure to a worker onsite after land spreading, has been estimated at no more that 100 hours per year. Such an individual would be involved in land maintenance activities, such as plowing and mowing. As modeled in the September 12, 1989 submittal, an exposure of 2000 hours per year to the landfill operator has been assumed. For this exposure, the KNPP materials are mixed with other landfill waste: a 1:13 mixing of KNPP materials to other waste is assumed. This mixing is not significantly different from the type of mixing that will occur in the field with the sludges being

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October 17, 1991
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plowed into the soil to a depth of six (6) inches. With a land spreading of 50 metric tons per hectare per year, a mixing ratio of 1:30 will be achieved. Therefore, the resultant dose to the exposed worker would be less than the 1 mrem per year dose to the transport worker as evaluated in the September 12, 1989 submittal.

Post Disposal Exposure - Intruder Scenario

The IMPACTS-BRC model, as applied to the disposal of the KNPP waste, assumes a loss of institutional controls 10 years after closure of the site (See Appendix B of the September 12, 1989 submittal). An individual is assumed to reside in a house built on the disposal area. This individual receives a direct exposure (from the uncovered waste), an inhalation exposure (from resuspension), and an ingestion exposure (from growing ½ of his food crops). For modeling purposes, it is assumed that the waste is mixed at a ratio of 1:13 with other soils during the resident's construction process.

The onsite land application of KNPP waste will be limited by the Agricultural Land Application sludge concentrations even though the less restrictive Non-Agricultural Land Application sludge concentrations are applicable since a "dedicated land disposal" site will be used (i.e., no crops will be grown on the disposal site). Therefore, provided the KNPP waste does not exceed the Non-Agricultural maximum sludge concentrations for heavy metal or organic chemicals, unlimited application of waste to the dedicated land disposal site is allowed. However, to be conservative, the land application of KNPP wastes will be limited to 5 metric tons per hectare per year. The intruder scenario as evaluated in the September 12, 1989 submittal conservatively bounds this exposure pathway for the on-site land spreading.

Post Disposal - Intruder Well

The intruder well pathway for onsite land disposal is essentially the same as the intruder well pathway as evaluated by the IMPACTS-BRC model. It is conservatively assumed that the well is located at the edge of the disposal site. As modeled, locating the well at the disposal site edge in "downstream flow" direction maximizes the calculated hypothetical dose. (Additional discussion of this modeling is presented in NUREG/CR-3585, Volume 2).

The potential dose for the intruder well scenario for the land spreading disposal would be less than 0.001 mrem per year. The modeling as presented in the September 12, 1989 submittal reasonably bounds any hypothetical well water exposure pathway.

In summary, the modeling of the exposure scenarios, as presented in the September 12, 1989 submittal, conservatively bounds the hypothetically exposures for the on-site land spreading. In no case is it likely that any individual, either on-site or off-site, will receive a dose in excess of 1 mrem per year from the disposal of the slightly contaminated materials.

K 92-114
Received
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,

[signature]

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. Sridharan 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).

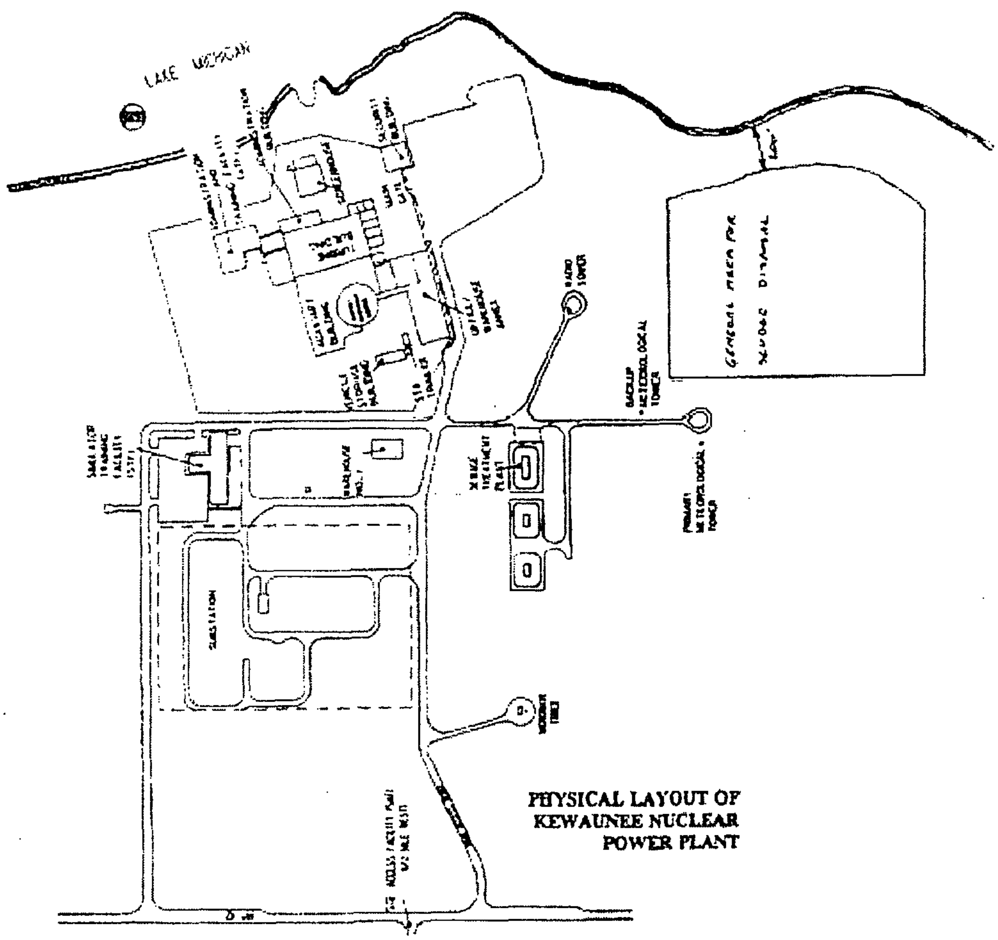
Principal Contributor: J. Minns

Date: June 17, 1992

- 6 -

Figure 1

Kewaunee Nuclear Power Plant Site Area Map



K-94-195
9/21/94

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 14, 1994

Mr. C. A. Schrock
Manager - Nuclear Engineering
Wisconsin Public Service Corporation
Post Office Box 19002
Green Bay, WI 54307-9002

SUBJECT: SAFETY EVALUATION FOR AN AMENDMENT TO AN APPROVED 10 CFR 20.302 APPLICATION FOR THE KEWAUNEE NUCLEAR PLANT (TAC NO. M89719)

Dear Mr. Schrock:

By letter dated June 23, 1994, as supplemented June 29, 1994, you requested approval to use another onsite area for the disposal of contaminated waste sludge in addition to the location approved by the NRC on June 17, 1992. The staff has completed its review of your request and finds that your proposal meets the radiological boundary conditions approved in the June 17, 1992, Safety Evaluation, and is therefore acceptable. The staff also finds that your proposal is in accordance with 10 CFR 20.2002 which replaced 20.302 on January 1, 1994.

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.

Sincerely,

Richard J. Laufer

Richard J. Laufer, Acting Project Manager
Project Directorate III-3
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-305

Enclosure:
Safety Evaluation

cc w/enclosure:
see next page

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D E Cole KNP
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C A Schrock D2

C S Smoker KNP
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Wisconsin Public Service Corporation   Kewaunee Nuclear Power Plant

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

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

By letter dated June 23, 1994, and as supplemented on June 29, 1994, Wisconsin Public Service Corporation (the licensee) requested approval to use another onsite area for the disposal of contaminated waste sludge in addition to the location approved by the NRC on June 17, 1992.

2.0 EVALUATION

A Safety Evaluation (SE) dated June 17, 1992, approved the licensee's request pursuant to 10 CFR 20.302 for the disposal of 15,000 cubic feet of contaminated waste sludge by land application at the Kewaunee Nuclear Power Plant (KNPP) at a specific onsite location. The SE imposed 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.
3. The disposal must be the same site.

The site designated in the SE was an unused area adjacent to the onsite lagoon at the KNPP sewage treatment facility. In 1993, approximately 7500 cubic feet of the original 15,000 cubic feet of contaminated sludge was spread on that location. The licensee has now proposed to dispose of the remaining contaminated sludge at another onsite location northwest of the plant (see Attachment). The licensee has committed that the new disposal location will meet all the radiological boundary conditions contained in the SE for the 10 CFR 20.302 application approved on June 17, 1992. Additionally, the licensee has stated that this additional disposal site will meet all applicable Wisconsin Department of Natural Resources (WDNR) application requirements (i.e., sludge application rate and frequency of spreading rate), in addition to WDNR landspreading requirements regarding location and performance standards that were required at the original disposal site.

3.0 CONCLUSION

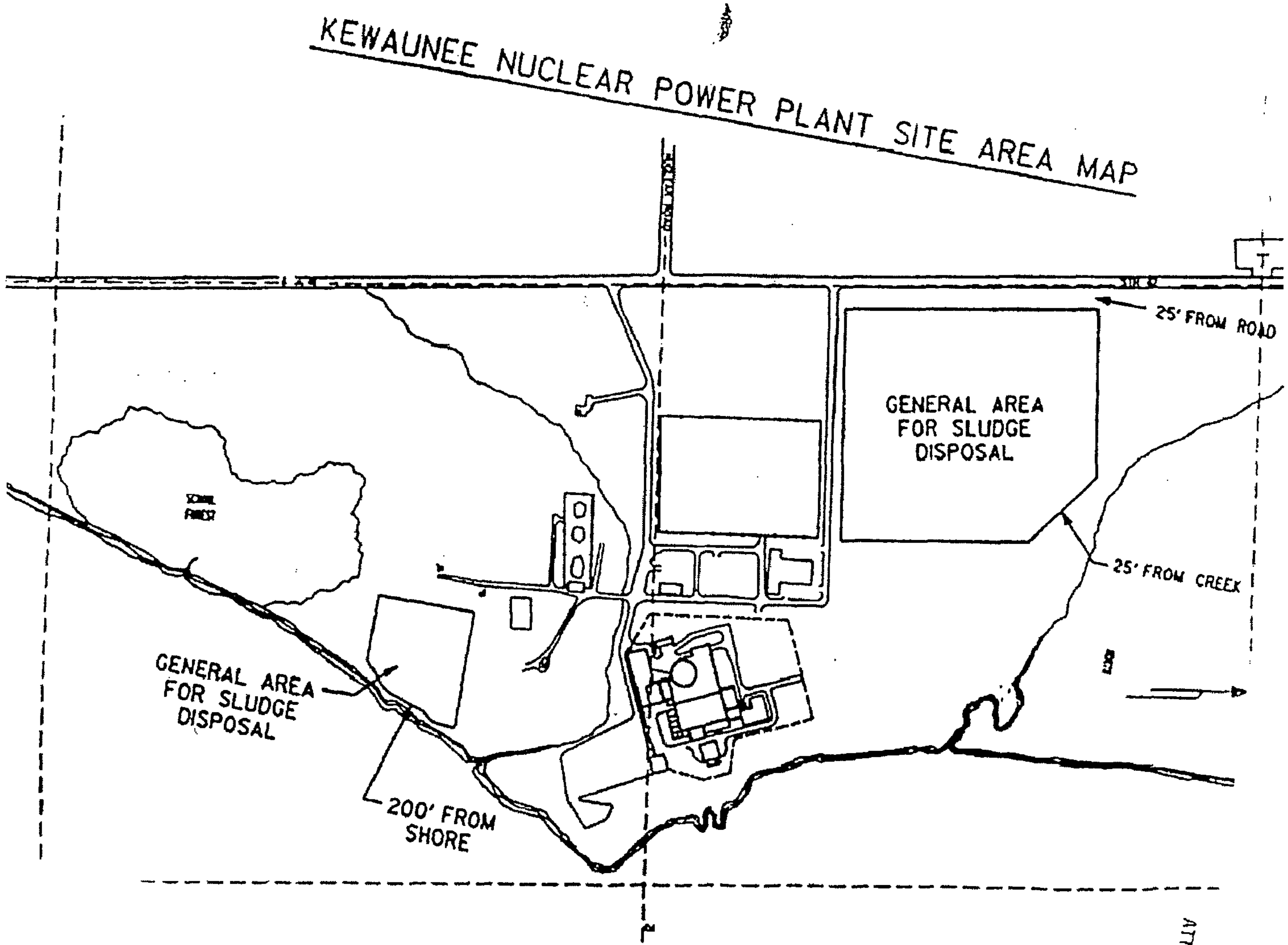
The staff finds the licensee's proposal to dispose of the low-level radioactive waste sludge in the additional onsite location to be within the radiological boundary conditions approved in the June 17, 1992, SE and is therefore acceptable. The staff also finds that your proposal is in accordance with 10 CFR 20.2002 which replaced 20.302 on January 1, 1994.

As stated in the NRC's June 17, 1992, approval of the licensee's 10 CFR 20.302 application, the licensee is required to permanently incorporate this modification into the Offsite Dose Calculation Manual as an Appendix, and that future modification of this commitment be reported to the NRC.

Principal Contributor: S. Klementowicz

Date: September 14, 1994

Attachment: KNPP Site Area Map


KEWAUNEE NUCLEAR POWER PLANT SITE AREA MAP
25' FROM ROAD
GENERAL AREA
FOR SLUDGE
DISPOSAL
25' FROM CREEK
GENERAL AREA
FOR SLUDGE
DISPOSAL
200' FROM
SHORE
ATTACHMENT

K-95-172
Rec'd. 11-20-95

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 13, 1995

Mr. M. L. Marchi
Manager - Nuclear Business Group
Wisconsin Public Service Corporation
Post Office Box 19002
Green Bay, WI 54307-9002

SUBJECT: ALTERNATE DISPOSAL OF CONTAMINATED SEWAGE TREATMENT PLANT SLUDGE IN ACCORDANCE WITH 10 CFR 20.2002 (TAC NO. M93844)

Dear Mr. Marchi:

By letter dated October 17, 1995, as supplemented on November 3, 1995, you requested approval for the onsite disposal of contaminated sewage treatment sludge in accordance with 10 CFR 20.2002. This request was similar to a previous disposal request that was approved by the NRC on June 17, 1992.

The staff has completed its review of your request and finds that your proposal meets the radiological boundary conditions approved in the June 17, 1992, Safety Evaluation, and is therefore acceptable.

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

Sincerely,

Richard J. Laufer, Project Manager
Project Directorate III-3
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-305

Enclosure: Safety Evaluation

cc: See next page

NRC to WPSC LETTER DISTRIBUTION

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO ONSITE DISPOSAL OF LOW-LEVEL RADIOACTIVELY

CONTAMINATED SEWAGE TREATMENT 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

By letter dated October 17, 1995, as supplemented on November 3, 1995, Wisconsin Public Service Corporation (the licensee) requested approval for the onsite disposal of contaminated sewage sludge similar to a previous disposal request that was approved by the NRC on June 17, 1992.

2.0 BACKGROUND

In a letter dated September 12, 1989, the licensee requested authorization for the alternate disposal of very-low-level radioactive material. In a Safety Evaluation (SE) dated June 17, 1992, the NRC approved the licensee's request pursuant to 10 CFR 20.302 (new 10 CFR 20.2002) for the disposal of 15,000 cubic feet of contaminated waste sludge by land application at the Kewaunee Nuclear Power Plant (KNPP) location. The SE imposed 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.
3. The disposal must be at the same site.

The licensee completed the disposal of the contaminated waste sludge discussed in the SE dated June 17, 1992. The licensee is now requesting authorization to dispose of additional contaminated waste sludge within the boundary conditions of the previously approved disposal.

3.0 EVALUATION

The licensee has proposed to dispose of approximately 6000 gallons (800 cubic feet) of sewage sludge similar to the material approved for disposal in the SE dated June 17, 1992. The principal radionuclides identified in the waste sludge and their activity based on measurements in May 1995 are: Co-58, 0.0009 mCi; Co-60, 0.0008 mCi; and Cr-51, 0.0006 mCi. The total combined activity is 0.0023 mCi. This activity is well below the boundary value of 0.2 mCi. Additionally, Cr-51 with it short half-life (27.7 day) will have undergone significant decay from its initial value of 0.0006 mCi.

The licensee has committed that the new disposal will meet all the radiological boundary conditions, on a cumulative basis, contained in the SE for the 10 CFR 20.302 application approved on June 17, 1992. Additionally, the licensee has stated that all applicable permits for this disposal have been obtained from the Wisconsin Department of Natural Resources.

4.0 CONCLUSION

The staff finds the licensee's proposal to dispose of the low-level radioactive waste sludge pursuant to 10 CFR 20.2002, on the licensee's site (see Attachment), is within the radiological boundary conditions approved in the June 17, 1992, SER and is therefore acceptable.

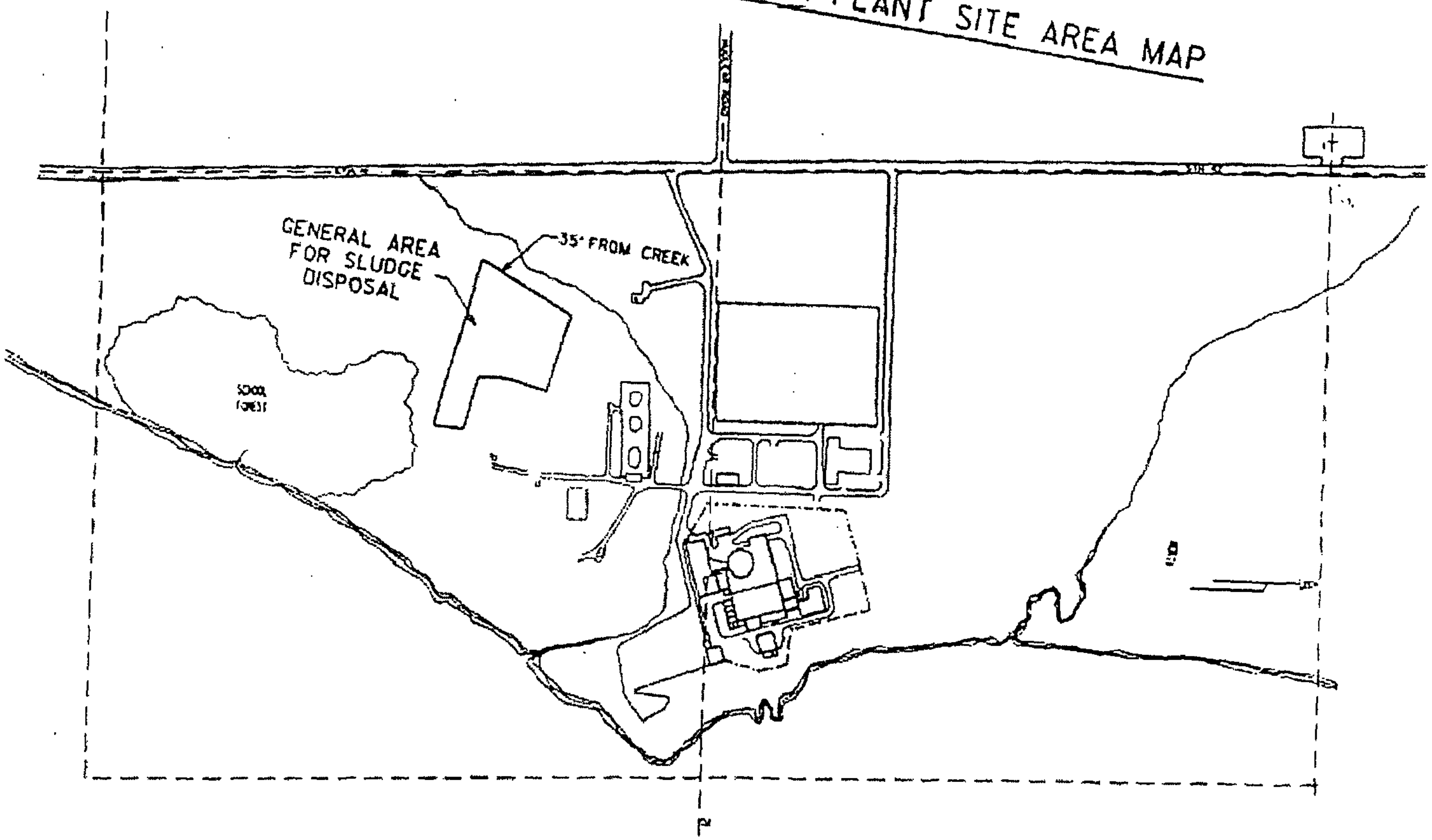
The licensee is required to permanently incorporate this modification into the Offsite Dose Calculation Manual as an Appendix, and to ensure that future modifications of these commitments are reported to the NRC.

Principal Contributor: S. Klementowicz

Date: November 13, 1995

Attachment: KNPP Site Area Map

KEWAUNEE NUCLEAR POWER PLANT SITE AREA MAP



K-97-64
Rec'd 4-14-9

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 9, 1997

Mr. M. L. Marchi
Manager - Nuclear Business Group
Wisconsin Public Service Corporation
Post Office Box 19002
Green Bay, WI 54307-9002

SUBJECT: ONSITE DISPOSAL OF CONTAMINATED SLUDGE PURSUANT TO 10 CFR 20.2002 (TAC NO. M97411)

Dear Mr. Marchi:

By letter dated December 10, 1996, you requested that the U.S. Nuclear Regulatory Commission (NRC) review the applicability of a 10 CFR 20.203 (now 20.2002) application approved on June 17, 1992, for additional disposals of a similar nature.

The staff has completed its review of your request and agrees with your determination that the 10 CFR 20.203 application for onsite disposal of sludge contaminated with licensed radioactive material, which was approved on June 17, 1992, contains bounding conditions that are applicable for additional onsite disposals of a similar nature. A copy of the Safety Evaluation is enclosed.

Sincerely,

Richard J. Laufer

Richard J. Laufer, Project Manager
Project Directorate III-3
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-305

Enclosure: Safety Evaluation

cc: See next page

NRC to WPSC LETTER DISTRIBUTION

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M W Seitz (WPL)	M L Marchi D2	C R Steinhardt D2
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D E Day D1	C A Schrock KNP	BJDomnick/PRReschesko KNP (Com/USAR)

Mr. M. L. Marchi
Wisconsin Public Service Corporation

Kewaunee Nuclear Power Plant

cc:

Foley & Lardner
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Madison, Wisconsin 53701-1497

Chairman
Town of Carlton
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Kewaunee, Wisconsin 54216

Mr. Harold Reckelberg, Chairman
Kewaunee County Board
Kewaunee County Courthouse
Kewaunee, Wisconsin 54216

Chairman
Wisconsin Public Service Commission
610 N. Whitney Way
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Attorney General
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Madison, Wisconsin 53702

U. S. Nuclear Regulatory Commission
Resident Inspectors Office
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Regional Administrator - Region III
U. S. Nuclear Regulatory Commission
801 Warrenville Road
Lisle, Illinois 60532-4531

Mr. Robert S. Cullen
Chief Engineer
Wisconsin Public Service Commission
610 N. Whitney Way
Madison, Wisconsin 53705-2829

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO ONSITE DISPOSAL OF CONTAMINATED 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

By letter dated December 10, 1996, Wisconsin Public Service Corporation (the licensee) requested that the U.S. Nuclear Regulatory Commission (NRC) review its determination that NRC approval, pursuant to 10 CFR 20.2002, for the onsite disposal of contaminated sludge at the Kewaunee Nuclear Power Plant (KNPP) is not required, provided such disposals are conducted within the limits and bounding conditions approved by the NRC in its June 17, 1992, Safety Evaluation (SE).

2.0 BACKGROUND

In a letter dated September 12, 1989, the licensee requested authorization for the alternate disposal of sludge contaminated with licensed radioactive material. In an SE dated June 17, 1992, the NRC approved the licensee's request pursuant to 10 CFR 20.302 (new 10 CFR 20.2002) for the disposal of 15,000 cubic feet of contaminated waste sludge by land application at the KNPP location. The SE imposed boundary conditions as follows:

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.

The SE also stated that for any repetitive disposals, the licensee must reapply to the NRC when a particular disposal would exceed the boundary conditions.

3.0 EVALUATION

The licensee has determined that NRC approval for future onsite disposals of sludge contaminated with licensed radioactive material is not required provided the disposals comply with the limits and conditions of the SE issued on June 17, 1992. The licensee has also developed a sludge sampling and analysis procedure that implements the guidance contained in NRC Information

Notice 88-22. Specifically, the licensee's procedure will require the analysis of sludge samples using a detection system design and operating characteristics that yield a lower limit of detection for Co-58, Co-60, Cs-134, and Cs-137 consistent with measurements of environmental samples. The licensee has provided a site map (attached) that specifies the acceptable onsite disposal areas for the contaminated sludge.

4.0 CONCLUSION

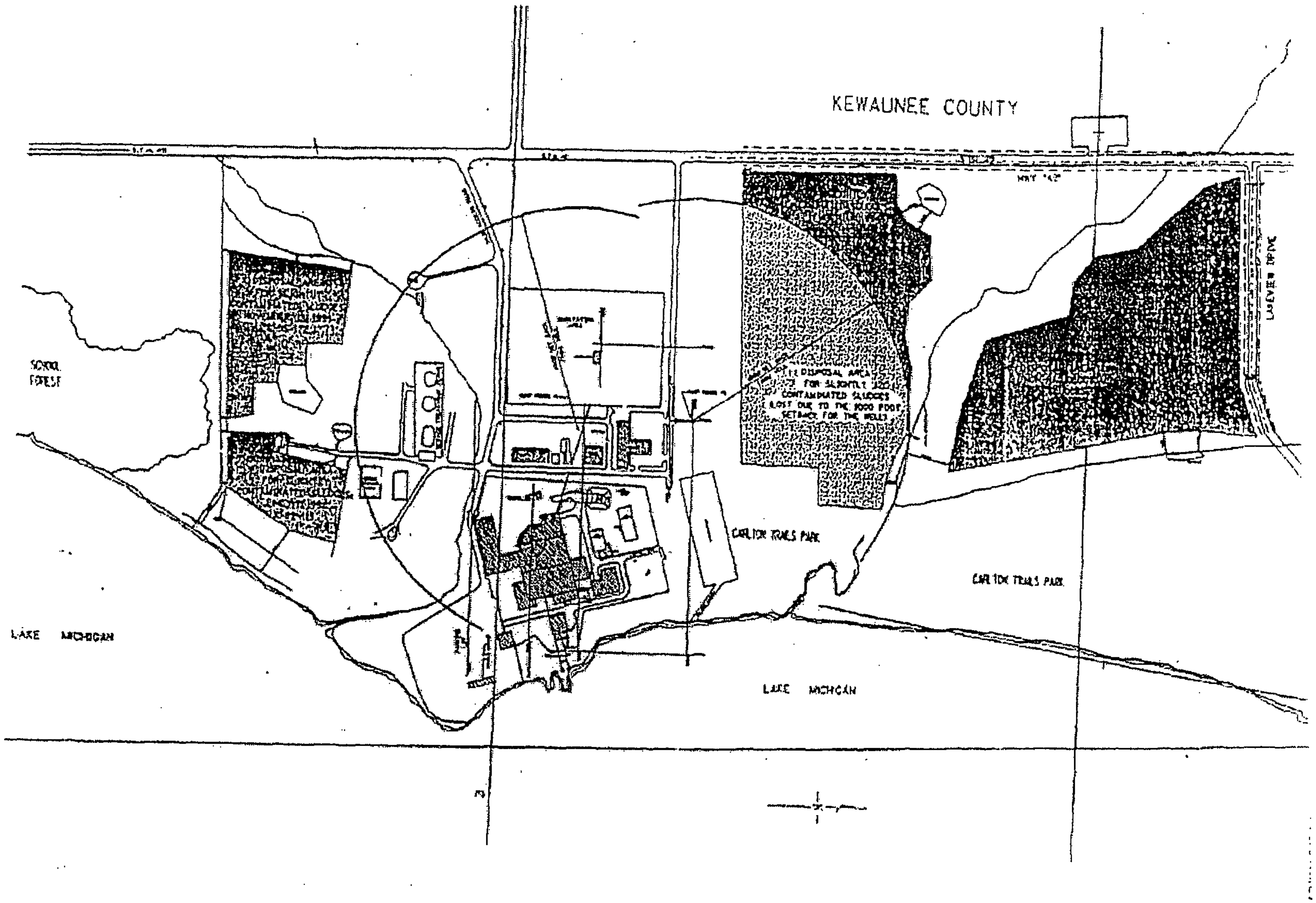
The staff agrees with the licensee's determination that additional onsite disposals of contaminated sludge, which are conducted within the bounding limits and conditions contained in the June 17, 1992, SE and within the areas specified in the attached site map, do not require specific NRC approval.

The licensee should permanently incorporate this Safety Evaluation into the Offsite Dose Calculation Manual as an Appendix.

Principal Contributor: S. Klementowicz

Date: April 9, 1997

Attachment: KNPP Site Map


KEWAUNEE COUNTY
SCHOOL FOREST
LAKE MICHIGAN
LAKE MICHIGAN

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Appendix C

Kewaunee Power Station

Radiological Environmental Monitoring Manual (REMM)

Revision 19
September 6, 2012

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Dominion Energy Kewaunee, Inc.

Kewaunee Power Station

RADIOLOGICAL ENVIRONMENTAL MONITORING MANUAL (REMM)

Revision 19
DATE: September 6, 2012

Approved By:	JM Hale	08/21/2012
	Manager - Radiological Protection and Chemistry	Date
Approved By:	RP Repshas	08/27/2012
	Licensing Supervisor	Date
Reviewed By:	Jeffrey T. Stafford	09/04/2012
	Facility Safety Review Committee	Date
Approved By:	AJ Jordan	09/06/2012
	Site Vice-President	Date

Table of Contents

Tables & Figures

1.0 Introduction

1.1 Purpose

The purpose of this document is to define the Radiological Environmental Monitoring Program (REMP) for the Kewaunee Power Station (KPS). The REMP is required by ODCM, 13.5

This document is known as the Radiological Environmental Monitoring Manual (REMM) and is intended to serve as a tool for program administration and as a guidance document for contractors which implement the monitoring program.

1.2 Scope

This program defines the sampling and analysis schedule which was developed to provide representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the high potential radiation exposures of MEMBERS OF THE PUBLIC resulting from plant operation. This monitoring program implements Section IV.B.2 of Appendix I to 10CFR Part 50 and thereby verifies that the measurable concentrations of radioactivity and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for the development of this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring. This program has been developed in accordance with NUREG 0472.

The program will provide field and analytical data on the air, aquatic, and terrestrial radioecology of the area near the Kewaunee Power Station so as to:

1. Determine the effects of the operation of the Kewaunee Power Station on the environment;
2. Serve as a gauge of the operating effectiveness of in-plant control of waste discharges; and
3. Provide data on the radiation dose to the public by direct or indirect pathways of exposure.

1.3 Implementation

This document is considered, by reference, to be part of the Offsite Dose Calculation Manual. This is as required by KPS TS 5.5.1. The REMM is controlled as a separate document for ease of revision, use in the field and use by contractors. This format was approved by the NRC as part of TS Amendment No. 64, which provided Radiological Effluent Technical Specifications (RETS) for KPS.

The REMP is setup to be implemented by a vendor and controlled by KPS in accordance with Nuclear Administrative Directive NAD-01.20, "Radiological Environmental Monitoring Program." Monthly reviews of the vendor's progress report are checked and approved by KPS in accordance with Surveillance Procedure SP-63-276. Annual reviews and submittals of the vendor's report and raw data are checked and approved by KPS in accordance with Surveillance Procedure SP-63-280. All sample collection, preparation, and analysis are performed by the vendor except where noted. Surveillance Procedure SP-63-164 outlines the environmental sample collection performed by KPS. Current vendor Quality Control Program Manuals and implementing procedures shall be kept on file at KPS.

Periodic reviews of monitoring data and an annual land use census will be used to develop modifications to the existing monitoring program. Upon approval, these modifications will be incorporated into this document so that it will accurately reflect the current radiological environmental monitoring program in effect for KPS.

The remainder of this document is divided into two sections. The first section, 2.0 REMP Requirements, describes the different TS and REMM requirements associated with the REMP. The second section, 3.0 REMP Implementation, describes the specific requirements used to implement the REMP.

2.0 REMP Requirements

KPS TS Amendment No. 104 implemented the guidance provided in Generic Letter 89-01, "Implementation of Programmatic Controls for Radiological Effluent Technical Specifications (RETS)." These changes included:

1. Incorporation of *programmatic controls* in the Administrative Controls section of the TS to satisfy existing regulatory requirements for RETS, and

2. Relocation of the *procedural details* on radioactive effluents monitoring, radiological environmental monitoring, reporting details, and other related specifications from the TS to the ODCM.

Relocating the procedural details to the ODCM allows for revising these requirements using the 10CFR50.59 process instead of requiring prior NRC approval using the TS Amendment process.

The RETS requirements were incorporated verbatim into the ODCM, Revision 6. Several of these requirements pertain only to the environmental monitoring program and therefore have been relocated into this document (REMM, Revision 3 and 4) and are identified as REMM requirements.

2.1 ODCM 13.5 Requirements

ODCM 13.5 provides the programmatic control, which requires a program to monitor the radiation and radionuclides in the environs of the plant. This is the reason for the existence of the REMP. ODCM 13.5, also provides the programmatic control which requires:

a. The program to perform the monitoring, sampling, analysis, and reporting in accordance with the methodology and parameters in the ODCM,

b. A land use census to be performed, and

c. Participation in an Interlaboratory Comparison Program.

The details of each requirement are described in the REMM requirements stated below.

Technical Specification 5.6.1 requires an "Annual Radiological Environmental Operating Report," be submitted to the NRC each year. The specific contents of this report are detailed in REMM 2.4.1. Additional specific reporting requirements are listed in the other REMM requirements.

2.2 REMM Requirements

The following REMM requirements include the procedural details that were originally located in the KPS RETS section and then relocated into Revision 6 of the ODCM, as discussed above. These requirements are specific to the radiological environmental monitoring program and have been relocated into this document for ease of use and completeness.

The REMM requirements for the Monitoring Program, Land Use Census, and the Interlaboratory Comparison Program include a detailed operating requirement (numbered 2.2.1, 2.2.2, and 2.2.3 respectively) and an associated verification requirement (numbered 2.3.1, 2.3.2, and 2.3.3 respectively), along with the basis for the requirement. Reporting requirements are listed in requirement REMM 2.4.1.

ODCM 13.0, USE AND APPLICATION apply to both the ODCM and REMM.

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

REMM 2.2.1 The radiological environmental monitoring program shall be conducted as specified in Table 2.2.1-A.

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Radiological Environmental Monitoring Program not conducted as specified in REMM Table 2.2.1-A.	A.1 Prepare and submit to the NRC in the Annual Radiological Environmental Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.	In accordance with the Annual Radiological Environmental Operating Report frequency.
B. Level of radioactivity in an environmental sampling medium at a specified location exceeds the reporting levels of REMM Table 2.2.1-D when averaged over any calendar quarter. <u>OR</u>	B.1 -------------NOTES------------- 1. Only applicable if the radioactivity/radionuclides are the result of plant effluents. 2. For radionuclides other than those in REMM Table 2.2.1-D, this report shall indicate the methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC. -----------------------------------	

ACTIONS (continued)

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
More than one of the radionuclides in REMM Table 2.2.1-D are detected in the environmental sampling medium and $\frac{\text{Concentration 1}}{\text{Reporting level 1}} + \frac{\text{Concentration 2}}{\text{Reporting level 2}} + \ldots \geq 1.0.$ OR Radionuclides other than those in REMM Table 2.2.1-D are detected in an environmental sampling medium at a specified location which are the result of plant effluents and the potential annual dose to a MEMBER OF THE PUBLIC from all radionuclides is ≥ the calendar year limits of DNC 13.1.2, DNC 13.2.2, DNC 13.2.3	Prepare and submit to the NRC, a Special Report, pursuant to DNC 15.3, that (1) Identifies the cause(s) for exceeding the limit(s) and (2) Defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose to a MEMBER OF THE PUBLIC is less than the calendar year limits of DNC 13.1.2, DNC 13.2.2, DNC 13.2.3	30 days
	OR	
	B.2 -------------NOTES------------ 1. Only applicable if the radioactivity/radionuclides are not the result of plant effluents. 2. For radionuclides other than those in REMM Table 2.2.1-D, this report shall indicate the methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC. ------------------------------------- Report and describe the condition in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report frequency.

ACTIONS (continued)

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
C. Milk or fresh leafy vegetation samples unavailable from one or more of the sample locations required by REMM Table 2.2.1-A.	C.1 Identify specific alternative locations for obtaining replacement samples and add them to the Radiological Environmental Operating Program. AND C.2 When changes in sampling locations are permanent, then the sampling schedule in the REMM will be updated to reflect the new routine and alternative sampling locations. This revision will be submitted in the next Annual Radiological Environmental Operating Report.	30 days

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
REMM 2.3.1	Collect and analyze radiological environmental monitoring samples pursuant to the requirements of REMM Table 2.2.1-A and the detection capabilities required by Table 2.2.1-A	In accordance with REMM Table 2.2.1-A

BASES

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

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 2.3.1-A are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

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

RADIOLOGICAL ENVIRONMENTAL MONITORING LAND USE CENSUS

REMM 2.2.2 A land use census shall:

a. Be conducted,

b. Identify within a distance of 8 km (5 miles) the location, in each of the 10 meteorological sectors, of the nearest milk animal and the nearest residence, and the nearest garden > 50 m^2 (500 ft^2) producing broad leaf vegetation, sampling of leaf vegetation may be performed at the site boundary in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Requirements for broad leaf vegetation sampling in REMM Table 2.2.1-A item 4c shall be followed, including analysis of control samples.

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Land use census identifies location(s) that yields a calculated dose, dose commitment greater than the values currently being calculated in ODCM 13.2.3.1	A.1 Identify the new location(s) in the next Radiological Environmental Operating Program.	In accordance with the Radiological Environmental Operating Report.

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
B. Land use census identifies location(s) that yields a calculated dose, or dose commitment (via the same exposure pathway) greater than 20% at a location from which samples are currently being obtained in accordance with REMM 2.2.1.	B.1 Add the new location(s) to the Radiological Environmental Operating Program.	30 days
	AND	
	B.2 Delete the sampling locations(s), excluding the control station location, having the lowest calculated dose, dose commitment(s) or D/Q value, via the same exposure pathway, from the Radiological Environmental Operating Program.	In accordance with Radiological Environmental Operating Report.
	AND	
	B.3 Submit in the next Radiological Environmental Operating Report documentation for a change which includes revised figures(s) and table(s) reflecting the new location(s) with information supporting the change in sampling locations.	

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
REMM 2.3.2	Conduct the land use census during the growing season using that information that will provide the best results, such as by a door-to-door survey, aerial survey, reporting the results of the land use census in the Annual Radiological Environmental Operating Report, or by consulting local agriculture authorities.	12 months

BASES

This requirement is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the radiological environmental monitoring program are made if required by the door-to-door survey, from aerial survey or from consulting with local agricultural authorities. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10CFR Part 50. Restricting the census to gardens of greater than 50 m^2 provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/yr) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made:

1. 20% of the garden was used for growing leafy vegetation (i.e., similar to lettuce and cabbage), and
2. A vegetation yield of 2 kg/m^2.

RADIOLOGICAL ENVIRONMENTAL MONITORING INTERLABORATORY COMPARISON PROGRAM

REMM 2.2.3 Analyses shall be performed on all radioactive materials, supplied as part of an Interlaboratory Comparison Program that has been approved by the Commission.

APPLICABILITY: At all times.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Analyses not performed as required.	A.1 Report the corrective actions taken to prevent a recurrence to the NRC in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report.

VERIFICATION REQUIREMENTS

VERIFICATION		FREQUENCY
REMM 2.3.3	Report a summary of the results obtained as part of the Interlaboratory Comparison Program in the Annual Radiological Environmental Operating Report.	In accordance with the Annual Radiological Environmental Operating Report.

BASES

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

REMM 2.4.1 Reporting Requirements

2.4.1 The Annual Radiological Environmental Operating Report shall include:

a. Summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with pre-operational studies, with operational controls as appropriate, and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use censuses required by REMM 2.2.2.

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

c. A summary description of the radiological environmental monitoring program; legible maps covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor; the results of licensee participation in the Interlaboratory Comparison Program, required by REMM 2.2.3; discussion of all deviations from the sampling schedule of Table 2.2.1-A; and discussion of all analyses in which the LLD required by Table 2.3.1-A was not achievable.

Discussion

KPS TS 5.6.1 provides the programmatic control, which requires that an Annual Radiological Environmental Operating Report be submitted to the NRC. It also states that this report shall include summaries, interpretations, and analysis of trends of the results of the REMP for the reporting period.

The procedural details of this report are included in this requirement. REMM 2.2.1/2.3.1, 2.2.2/2.3.2, and 2.2.3/2.3.3 also include specific reporting requirements. These requirements reference this REMM, along with TS 5.6.1, as the method for reporting deviations from the current program during the reporting period, and require that this information be included in the Annual Radiological Environmental Operating Report.

3.0 REMP Implementation

The Radiological Environmental Monitoring Program for KPS is under the direction of a Contracted Vendor (CV). This section describes this program, as required by REMM 2.2.1 and the process the CV uses to perform it.

3.1 Sampling Requirements

Table 2.2.1-A identifies the various samples required by the REMP. Identified in the "available sample locations" column in Table 2.2.1-A are the sample locations selected, in conjunction with the vendor, to meet or exceed the REMP requirements. Table 2.2.1-B includes the same requirements as in Table 2.2.1-A but presents the information in a different format by identifying the type of samples required at each location and the collection frequency. Table 2.2.1-C identifies the location and description of each sample location. Figure 1 shows the physical location of each sample point on an area map.

3.2 Analysis Methodology

Analytical procedures and counting methods employed by the CV will follow those recommended by the U.S. Public Health Service publication, Radioassay Procedures for Environmental Samples, January 1967; and the U.S. Atomic Energy Commission Health and Safety Laboratory, HASL Procedures Manual (HASL-300), 1972. The manual is also available on-line at www.eml.st.dhs.gov/publications/procman.

Updated copies will be maintained in KPS's vault.

3.3 Detection Capability (LLD) Requirements

The required detection capabilities for environmental sample and analysis are tabulated in terms of lower limits of detection (LLDs) in Table 2.3.1-A. The LLDs required by Table 2.3.1-A are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

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

3.4 Contracted Vendor Reporting Requirements

Monthly Progress Reports

Monthly progress reports will include a tabulation of completed analytical data on samples obtained during the previous 30 day period together with graphic representations where trends are evident, and the status of field collections. One copy of the reports will be submitted within 30 to 60 days of the reporting month.

Annual Reports

Annual reports will be submitted in two parts. Part I, to be submitted to the NRC, will be prepared in accordance with NRC Regulatory Guide 4.8. It will contain an introductory statement, a summary of results, description of the program, discussion of the results, and summary table. Part II of the annual report will include tables of analytical data for all samples collected during the reporting period, together with graphic presentation where trends are evident and statistical evaluation of the results. Gamma scan data will be complemented by figures of representative spectra if requested by KPS. Draft copies of each annual report will be due 60 days after completion of the annual period. After final review of the draft document, one photoready copy of the revised annual report will be sent to KPS for printing.

Non-Routine Reports

If analyses of any samples collected show abnormally high levels of radioactivity, KPS will be notified by telephone immediately after data becomes available.

Action Limits

The CV will report any radioactive concentrations found in the environmental samples which exceed the reporting levels shown in Table 2.2.1-D, CV to KPS column. These levels are set below the NRC required reporting levels (KPS to NRC column) so actions can be initiated to prevent exceeding the NRC concentration limits.

3.5 Quality Control Program

To insure the validity of the data, the CV maintains a quality control (QC) program, which employs quality control checks, with documentation, of the analytical phase of its environmental monitoring studies. The program is defined in the CV's QC Program Manual, and procedures are presented in the CV QC Procedures Manual. The program shall be reviewed and meet the requirements of Regulatory Guide 4.15 and 10CFR21. All data related to quality control will be available for review by Dominion Energy Kewaunee upon reasonable prior notification. Proprietary information will be identified so that it may be treated accordingly.

Updated copies of the Quality Control Program Manual and the Quality Assurance Program Manual will be maintained in KPS's vault.

3.6 Sample Descriptions

A description of each of the samples required by this program follows:

Airborne Particulates

Airborne particulates are collected at six locations (K-1f, K-2, K-8, K-31, K-41, and K-43) on a continuous basis on a 47 mm diameter membrane filter of 0.8 micron porosity at a volumetric rate of approximately one cubic foot per minute (CFM). The filters are changed weekly, placed in glassine protective envelopes, and dispatched by U.S. Mail to the CV for Gamma Isotopic Analysis. Filter samples are analyzed weekly for gross beta activity after sufficient time (usually 3 to 5 days) has elapsed to allow decay of Radon and Thoron daughters. If gross beta concentration in air particulate samples are greater than ten (10) times the yearly mean of the control samples, gamma isotopic analysis shall be performed on the individual samples. Quarterly composites from each location receive Gamma Isotopic Analysis using a Germanium detector. All identifiable gamma-emitters are quantified. Reporting units are pCi/m^3.

Airborne Iodine

All air samplers are equipped with charcoal traps installed behind the particulate filters for collection of airborne I-131. The traps are changed once every week. Iodine-131 is measured by Gamma Isotopic Analysis.

Periphyton (Slime) or Aquatic Vegetation

Periphyton (slime) or aquatic plant samples are collected at or near locations used for surface water sampling. They are collected twice during the year (2nd and 3rd quarter), if available. The samples are analyzed for gross beta activity and, if available in sufficient quantity, for Sr-89, Sr-90, and by Gamma Isotopic Analysis. Reporting units are pCi/g wet weight.

Fish

Fish are collected three times per year (second, third, and fourth quarters) near the discharge area (K-1d). Flesh is separated from the bones and analyzed for gross beta activity and by Gamma Isotopic Analysis. The bones are analyzed for gross beta activity and Sr-89 and Sr-90. Reporting units are pCi/g wet weight.

Domestic Meat

Domestic meat (chickens) may be collected once a year during the 3rd quarter, from three locations in the vicinity of the plant (K-24, K-29, and K-32). Samples may not be available every year at every location due to farmer preference. At least one control and one indicator should be collected. The flesh is analyzed for gross alpha, gross beta, and by Gamma Isotopic Analysis to identify and quantify gamma-emitting radionuclides. Reporting units are pCi/g wet weight.

Ambient Radiation

Two packets of thermoluminescent dosimeters ($CaSO_4$: Dy cards) are placed at twenty-two locations, six of which are air sampling locations (K-1f, K-2, K-8, K-31, K-41, and K-43), three of which are milk sampling locations (K-3, K-5, and K-39), eight of which are ISFSI area locations (K-1l through K-1s), and the remaining four locations are K -15, K-17, K-27, and K-30. One packet is changed quarterly and one annually. Annual TLDs will serve as an emergency set to be read when needed. They will be exchanged annually (without reading) if not read during the year. To insure the precision of the measurement, each packet will contain two cards with four dosimeters each (four sensitive areas each for a total of eight). For protection against moisture each set of cards is sealed in a plastic bag and placed in a plastic container.

Each card is individually calibrated for self-irradiation and light response. Fading is guaranteed by the manufacturer (Teledyne Isotopes) not to exceed 20% in one year. Minimum sensitivity for the multi-area dosimeter is 0.5 mR defined as 3 times the standard deviation of the background. Maximum Error (1 standard deviation) - ^{60}Co Gamma +/-0.2 mR or +/-3%, whichever is greater. The maximum spread between areas on the same dosimeter is 3.5% at 1 standard deviation.

Reporting units for TLDs are mR/91 days for quarterly TLDs and mR/exposure period for annual TLDs.

Tests for uniformity and reproducibility of TLDs as specified in ANSI N545-1981 and NRC Regulatory Guide 4.13, are performed annually.

Well Water

One gallon water samples are taken once every three months from four off-site wells, (K-10, K-11, K-13, and K-38) and two on-site wells (K-1h and K-1g). All samples are analyzed for gross beta in the total residue, K-40, tritium, and by Gamma Isotopic Analysis. Samples from one on-site well are analyzed for Sr-89, and Sr-90. Samples from K-1h and K-1g are also analyzed for gross alpha. Reporting units are pCi/l.

Precipitation

A monthly cumulative sample of precipitation is taken at Location K-11. This sample is analyzed for tritium. Reporting units are pCi/l.

Milk

Milk samples are collected from three herds that graze within three miles of the reactor site (K-38, K-44, and K-34); from four herds that graze between 3-7 miles of the reactor site (K-3, K-5, K-35, and K-39); and one from a dairy in Green Bay (K-42), 28.1 miles from the reactor site.

The samples are collected twice per month during the grazing period (May through October) and monthly for the rest of the year. To prevent spoilage the samples are treated with preservative. All samples are analyzed by Gamma Isotopic Analysis and for iodine -131 immediately after they are received at the laboratory. To achieve required minimum sensitivity of 0.5 pCi/l, iodine is separated on an ion exchange column, precipitated as palladium iodide and beta counted. Monthly samples and monthly composites of semimonthly samples are then analyzed for Sr-89 and Sr-90. Potassium and calcium are determined and the ^{137}Cs/gK and ^{90}Sr/gCa ratios are calculated. Reporting units are pCi/l except for stable potassium and calcium, which are reported in g/l.

If milk samples are not available, green leafy vegetables will be collected on a monthly basis (when available) from Locations K-23A, K-23B, and K-26.

Grass

Grass is collected three times per year (2nd, 3rd, and 4th quarters) from the six dairy farms (K-3, K-5, K-35, K-34, K-38, and K-39) and from two on-site locations (K-1b and K-1f). The samples are analyzed for gross beta activity, for Sr-89 and Sr-90, and Gamma Isotopic Analysis to identify and quantify gamma-emitting radionuclides. Reporting units are pCi/g wet weight.

Cattle feed

Once per year, during the first quarter when grass is not available, cattle feed (such as hay or silage) is collected from the six dairy farms. The analyses performed are the same as for grass. Reporting units are pCi/g wet weight.

Vegetables and Grain

Annually, during the 3rd quarter, samples of five varieties of vegetables grown and marketed for human consumption are collected from K-26, depending upon the availability of samples. If samples are not available from this location, samples may be obtained from any local source so there is some sample of record. The location will be documented. In addition, two varieties of grain or leafy vegetables from the highest predicted X/Q and D/Q, if available, are collected annually from the farmland owned by Dominion Energy Kewaunee (K-23 a and b) and rented to a private individual for growing crops. The analyses performed are the same as for grass. Reporting units are pCi/g wet weight.

Eggs

Quarterly samples of eggs can be taken from K-24 and K-32. At least one control and one indicator should be collected. The samples are analyzed for gross beta activity, for Sr-89 and Sr-90, and Gamma Isotopic Analysis to identify and quantify gamma-emitting radionuclides. Reporting units are pCi/g wet weight.

Soil

Twice during the growing season samples of the top two inches of soil are collected from the six dairy farms and from an on-site location (K-1f). The soil is analyzed for gross alpha and gross beta activities, for Sr-89 and Sr-90, and Gamma Isotopic Analysis to identify and quantify gamma-emitting manmade radionuclides. Reporting units are pCi/g dry weight.

Surface Water

Surface water is sampled monthly from Lake Michigan at the KPS discharge (K-1d), two samples (north and south ends), of Two Creeks Park, 2.5 miles south of the reactor site (K-14a, K-14b). Samples are collected monthly at the Green Bay Municipal Pumping station between Kewaunee and Green Bay (K-9). Raw and treated water is collected. Monthly samples are also taken, when available, from each of the three creeks (K-1a, K-1b, K-1e) that pass through the reactor site and from the drainage pond (K-1k) south of the plant. The samples are taken at a point near the mouth of each creek and at the shore of the drainage pond. The water is analyzed for gross beta activity in:

a. The total residue,
b. The dissolved solids, and
c. The suspended solids.

The samples are also analyzed for K-40 and by Gamma Isotopic Analysis. Quarterly composites from all locations are analyzed for tritium, Sr-89 and Sr-90. Reporting units are pCi/l.

Bottom Sediments

Five samples of Lake Michigan bottom sediments, one at the discharge (K-1d), one from 500 feet north of the discharge (K-1c), one from 500 feet south of the discharge (K-1j), and one at the Two Creeks Park (K-14), one at the Green Bay Municipal Pumping Station (K-9) are collected semi-annually (May and November). The samples are collected at the beach in about 2-3 feet of water. All samples are analyzed for gross beta activity, for Sr-89 and Sr-90 and by Gamma isotopic Analysis. Since it is known that the specific activity of the sediments (i.e., the amount of radioactivity per unit mass of sediment) increases with decreasing particle size, the sampling procedure will assure collection of very fine particles. Reporting units are pCi/g dry weight.

Ground Monitoring Wells

Figure 2 shows the location of 14 installed groundwater monitoring wells. The wells and location are identified with a diamond shape in Figure 2. The wells are labeled MW (Monitoring Well) and AB (Auxiliary Building).

The Groundwater Protection Program consists of the 14 wells in addition to the two on-site wells already in the REMM (K-1g and K-1h).

Results of analyses and a description of any event above Reporting Levels will be included in the Annual Radiological Environmental Operating Report for K-1g, K-1h and in the annual Radioactive Effluent Release Report for the other 14 wells.

Table 2.2.1-A ***Radiological Environmental Monitoring Program***				
Exposure Pathway And/Or Sample	Minimum Required Samples [a]	Available Sample Locations [b]	Sampling, Collection and Analysis Frequency	Type of Analysis
1. Direct Radiation[c]	13 Inner Ring locations	**K-5, K-25, K-27, K-43, K-1f, K-30, K-1l, K-1m, K-1n, K-1o, K-1p, K-1q, K-1r, K-1s**	See Table 2.2.1-B	Gamma dose
	6 Outer Ring locations	**K-2, K-3, K-15, K-17, K-8, K-31, K-39**		
	1 Control location	**K-41**		
	1 Population center	**K-43**		
	1 Special interest location	**K-8**		
	1 Nearby resident	**K-27**		
2. Airborne Radioiodine and Particulates	3 samples close to the site boundary in highest average X/Q	**K-1f, K-2, K-43, K-8, K-31**	See Table 2.2.1.B Continuous sampler operation Iodine; charcoal	Iodine (I-131) by Gamma Isotopic[f]
	1 sample from the closest community having the highest X/Q	**K-43**	Particulates See Table 2.2.1-B	Particulates; gross beta analysis[e] Gamma isotopic of composite (by location) [f]
	1 sample from a control location	**K-41**[d]	See Table 2.2.1-B	
3. Waterborne a. Surface[g]	1 Upstream sample 1 Downstream sample	**K-1a, K-9**[j]**, K-1d** **K-1e, K-14a, K-14b, K-1k, K-1b**	Grab sample See Table 2.2.1-B	Gross Beta, Gamma isotopic K-40 [f] Composite of grab samples for tritium, K-40 and Sr 89/90
b. Ground	1-2 location likely to be affected [d]	**K-1g, K-1h**[h]	Grab sample See Table 2.2.1-B	Gamma isotopic [f], tritium and K-40 analysis Gross Beta, one well for Sr 89/90

Table 2.2.1-A ***Radiological Environmental Monitoring Program***				
Exposure Pathway And/Or Sample	Minimum Required Samples [a]	Available Sample Locations [b]	Sampling, Collection and Analysis Frequency	Type of Analysis
c. Drinking	1-3 samples of nearest water supply	**K-10, K-11, K-13, K-38**	Grab sample See Table 2.2.1-B	Gross beta and gamma isotopic [f] analysis. Tritium and K-40 analysis of the composite of monthly grab samples. [i]
d. Sediment from shoreline	1 sample from downstream area with potential for recreational value	**K-14, K-1c, K-1d, K-1j, K-9**	Grab sample See Table 2.2.1-B	Gamma isotopic [f] analysis Gross Beta, Sr 89/90
4. Ingestion a. Milk	Samples from milking animals in 4 locations within 5 km having the highest dose potential. 1 alternate location 1 control location	**K-5**[k]**, K-38, K-34, K-44** **K-3, K-39** **K-35, K-42**	See Table 2.2.1-B	I-131 Gamma Isotopic [f] SR 89/90
b. Fish	3 random samplings of commercially and recreationally important species in the vicinity of the discharge.	**K-1d**	See Table 2.2.1-B	Gamma isotopic [f] and Gross Beta on edible portions, Gross Beta and Sr 89/90 on bones
c. Food Products	Samples of grain or leafy vegetables grown nearest each of two different offsite locations within 5 miles of the plant if milk sampling is not performed.	2 samples **K-23a, K-23b** – and one more location if available 1 sample 15-30 km distant if milk sampling is not performed. **K-26**	See Table 2.2.1-B	Gamma isotopic [f] and I-131 Analysis.

Table 2.2.1-A *Radiological Environmental Monitoring Program*				
Exposure Pathway And/Or Sample	Minimum Required Samples [a]	Available Sample Locations [b]	Sampling, Collection and Analysis Frequency	Type of Analysis
5. Miscellaneous samples not identified in NUREG-0472				
a. Aquatic Slime	None required	**K-1k** **K-1a, K-1b, K-1e** **K-14, K-1d** **K-9** (control)	See Table 2.2.1-B	Gross Beta activity and if available Sr-89, Sr-90 and Gamma Isotopic[f]
b. Soil	None required	**K-1f, K-5, K-35, K-39** **K-34, K-38** **K-3**, (control)	See Table 2.2.1-B	Gross Alpha/Beta Sr-89 and Sr-90 Gamma Isotopic[f]
c. Cattle feed	None required	**K-5, K-35, K-39** **K-34, K-38** **K-3**,(control)	See Table 2.2.1-B	Gross Beta Sr-89 and Sr-90 Gamma Isotopic[f]
d. Grass	None required	**K-1b, K-1f, K-35, K-39** **K-5, K-34, K-38** **K-3**,(control)	See Table 2.2.1-B	Gross Beta Sr-89 and Sr-90 Gamma Isotopic[f]
e. Domestic Meat	None required	**K-24, K-29** **K-32** (control)	See Table 2.2.1-B	Gross Alpha/Beta Gamma Isotopic[f]
f. Eggs	None required	**K-32** **K-24**	See Table 2.2.1-B	Gross Beta Sr-89/90 Gamma Isotopic[f]
g. Precipitation	None required	**K-11**	See Table 2.2.1-B	Tritium

Table 2.2.1-A				
Radiological Environmental Monitoring Program				
Exposure Pathway And/Or Sample	Minimum Required Samples [a]	Available Sample Locations [b]	Sampling, Collection and Analysis Frequency	Type of Analysis

Table Notations	
a.	The samples listed in this column describe the minimum sampling required to meet REMP requirements.
b.	Additional details of sample locations are provided in Table 2.2.1-C and Figure 1. The REMP requires that samples to be taken from each of the "available sample locations" listed (see section 3.1). Deviations from the required sampling schedule will occur if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, reasonable efforts shall be made to complete corrective actions prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented, as required by REMM 2.4.1.c, in the Annual Radiological Environmental Operating Report. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the REMM. The cause of the unavailability of samples for that pathway and the new location(s) for obtaining replacement samples will be identified in the Annual Radiological Environmental Operating Report.
c.	For the purposes of this table, each location will have 2 packets of thermoluminescent dosimeters (TLDs). The TLDs are CaSO4: Dy cards with 2 cards/packet and 4 dosimeters/card (four sensitive areas each for a total of eight dosimeters/packet). The NRC guidance of 40 stations is not an absolute number. The number of direct radiation monitoring stations has been reduced according to geographical limitations; e.g., Lake Michigan. The frequency of analysis or readout for TLD systems depends upon the characteristics of the specific system used and selection is made to obtain optimum dose information with minimal fading.
d.	The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that provide valid background data may be substituted.
e.	Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.
f.	Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.
g.	The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area near the mixing zone.
h.	Ground water samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.
i.	In the event elevated analysis are reported by CV for gamma isotopic or tritium, a review will be conducted with the option to retest additional analysis for hard to detect isotopes or alpha emitters. The additional test may include Fe-55, Ni-63, or alpha emitters anticipated on current plant conditions.
j.	Two samples to be collected, Raw and Treated
k.	K-5 is about 5.1 km, closest Milk Location available.

Table 2.2.1-B ***Type and Frequency of Collection***						
Location	Weekly	Monthly	Quarterly	Semi-Annually		Annually
K-1a		SW			SL[f]	
K-1b		SW	GR[a]		SL[f]	
K-1c				BS[b]		
K-1d		SW	FI[a]	BS[b]	SL[f]	
K-1e		SW			SL[f]	
K-1f	AP[g], AI		GR[a] TLD	SO		
K-1g			WW			
K-1h			WW			
K-1j				BS[b]		
K-1k		SW			SL[f]	
K-1l			TLD			
K-1m			TLD			
K-1n			TLD			
K-1o			TLD			
K-1p			TLD			
K-1q			TLD			
K-1r			TLD			
K-1s			TLD			
K-2	AP[g], AI		TLD			
K-3		MI[c]	GR[a] TLD	SO		CF[d]
K-5		MI[c]	GR[a] TLD	SO		CF[d]
K-8	AP[g], AI		TLD			
K-9		SW[i]		BS[b]	SL[f]	
K-10			WW			
K-11		PR	WW			
K-13			WW			
K-14		SW[h]		BS[b]	SL[f]	
K-15			TLD			
K-17			TLD			
K-23a						GRN/GLV[e]
K-23b						GRN/GLV[e]
K-24			EG			DM
K-25			TLD			
K-26						VE/GLV[e]
K-27			TLD			
K-29						DM

Table 2.2.1-B *Type and Frequency of Collection*						
Location	Weekly	Monthly	Quarterly	Semi-Annually		Annually
K-30			TLD			
K-31	AP[g], AI		TLD			
K-32			EG			DM
K-34		MI[c]	GR[a]	SO		CF[d]
K-35		MI[c]	GR[a]	SO		CF[d]
K-38		MI[c]	GR[a] WW	SO		CF[d]
K-39		MI[c]	TLD GR[a]	SO		CF[d]
K-41	AP[g], AI		TLD			
K-42		MI[c]				
K-43	AP[g], AI		TLD			
K-44		MI[c]				

a. Three times a year, second (April, May, June), third (July, August, September), and fourth (October, November, December) quarters
b. To be collected in May and November
c. Monthly from November through April; semimonthly from May through October
d. First (January, February, March) quarter only
e. Alternate if milk is not available
f. Second and third quarters
g. The frequency may be increased dependent on the dust loading.
h. Two water samples are collected, North (K-14a) and South (K-14b) of Two Creeks Rd.
i. Two samples, raw and treated

Code	Description	Code	Description	Code	Description
AI	Airborne Iodine	FI	Fish	SO	Soil
AP	Airborne Particulate	GR	Grass	SW	Surface Water
BS	Bottom Sediment	GRN	Grain	TLD	Thermoluminescent Dosimeter
CF	Cattle feed	MI	Milk	VE	Vegetables
DM	Domestic Meat	PR	Precipitation	WW	Well Water
EG	Eggs	SL	Slime	GLV	Green Leafy Vegetables

Table 2.2.1-C *Sampling Locations, Kewaunee Power Station*			
Code	**Type[a]**	**Distance (Miles)[b] and Sector**	**Location**
K-1			Onsite
K-1a	I	0.62 N	North Creek
K-1b	I	0.12 N	Middle Creek
K-1c	I	0.10 N	500′ North of Condenser Discharge
K-1d	I	0.10 E	Condenser Discharge
K-1e	I	0.12 S	South Creek
K-1f	I	0.12 S	Meteorological Tower
K-1g	I	0.06 W	South Well
K-1h	I	0.12 NW	North Well
K-1j	I	0.10 S	500′ south of Condenser Discharge
K-1k	I	0.60 SW	Drainage Pond, south of plant
K-1l	I	0.13 N	ISFSI Southeast
K-1m	I	0.15 N	ISFSI East
K-1n	I	0.16 N	ISFSI Northwest
K-1o	I	0.16 N	ISFSI North
K-1p	I	0.17 N	ISFSI Northwest
K-1q	I	0.16 N	ISFSI West
K-1r	I	0.13 N	ISFSI West
K-1s	I	0.12 N	ISFSI Southwest
K-2	C	8.91 NNE	WPS Operations Building in Kewaunee
K-3	C	5.9 N	Lyle and John Siegmund Farm, N2815 Hy 42, Kewaunee
K-5	I	3.2 NNW	Ed Paplham Farm, E4160 Old Settlers Rd, Kewaunee
K-8	C	4.85 WSW	Saint Isadore the Farmer Church, 18424 Tisch Mills Rd, Tisch Mills
K-9	C	11.5 NNE	Green Bay Municipal Pumping Station, six miles east of Green Bay (sample source is Lake Michigan from Rostok Intake 2 miles north of Kewaunee)
K-10	I	1.35 NNE	Turner Farm, Kewaunee Site
K-11	I	0.96 NW	Harlan Ihlenfeldt Farm, N879 Hy 42, Kewaunee
K-13	C	3.0 SSW	Rand's General Store, Two Creeks
K-14	I	2.6 S	Two Creeks Park, 2.5 miles south of site
K-15	C	9.25 NW	Gas Substation, 1.5 miles north of Stangelville
K-17	I	4.0 W	Jansky's Farm, N885 Cty Tk B, Kewaunee
K-20(c)	I	2.5 N	Carl Struck Farm, N1596 Lakeshore Dr., Kewaunee

Table 2.2.1-C *Sampling Locations, Kewaunee Power Station*			
Code	**Type**[a]	**Distance (Miles)**[b] **and Sector**	**Location**
K-23a	I	0.5 W	0.5 miles west of plant, Kewaunee site
K-23b	I	0.6N	0.6 miles north of plant, Kewaunee site
K-24	I	5.4 N	Fictum Farm, N2653 Hy 42, Kewaunee
K-25	I	1.9 SW	Wotachek Farm, E3968 Cty Tk BB, Two Rivers
K-26(d)	C	9.1 SSW	Sandy's Vegetable Stand (8.0 miles south of "BB")
K-27	I	1.53 NW	Schleis Farm, E4298 Sandy Bay Rd
K-29	I	5.34 W	Kunesh Farm, E3873 Cty Tk G, Kewaunee
K-30	I	0.8 N	End of site boundary
K-31	I	6.35 NNW	E. Krok Substation, Krok Road
K-32	C	7.8 N	Piggly Wiggly, 931 Marquette Dr., Kewaunee
K-34	I	2.7 N	Leon and Vicky Struck Farm, N1549 Lakeshore Drive, Kewaunee
K-35(e)	C	6.71 WNW	Duane Ducat Farm, N1215 Sleepy Hollow, Kewaunee
K-36(f)	I		Fiala's Fish Market, 216 Milwaukee, Kewaunee
K-38	I	2.45 WNW	Dave Sinkula Farm, N890 Town Hall Road, Kewaunee
K-39	I	3.46 N	Francis Wotja Farm, N1859 Lakeshore Road, Kewaunee
K-41 (g)	C	22 NW	KPS-EOF, 3060 Voyager Drive, Green Bay
K-42 (h)	C	28.1 W	Lamers Dairy Products obtain from Green Bay Markets (i)
K-43 (j)	I	2.71 SSW	Gary Maigatter Property, 17333 Highway 42, Two Rivers
K-44	I	2.63 SW	Gerald and Betty Schleis, 4728 Schleis Rd., Two Rivers

a. I = indicator; C = control.
b. Distances are measured from reactor stack.
c. Location removed from program in 2007
d. Location K-18 was changed because Schmidt's Food Stand went out of business. It was replaced by Bertler's Fruit Stand (K-26). Replaced with Sandy's Vegetable in 2007.
e. Removed from the program in Fall of 2001, back to program in August 2008.
f. Removed from the program in Fall of 2001, back to program in August 2008.
g. Location replaces K-16, January of 2007
h. Location replaces K-28 as of March 2010
i. Lamers Dairy is actually located in Appleton. The herds providing milk to Lamers are located nearer to Appleton than the plant to provide adequate distance for purposes of a control location.
j. K-7 moved to a nearby location and relabeled K-43, within 0-2 miles of original, August/September 2010.

Table 2.2.1-D Reporting Levels for Radioactivity Concentrations in Environmental Samples			
Medium	**Radionuclide**	**Reporting Levels**	
		CV to KPS[a]	**KPS to NRC[b]**
Airborne Particulate or Gases (pCi/m3)	Gross Beta	1	--
	I-131 (Charcoal)	0.1	0.9
	Cs-134	1	10
	Cs-137	1	20
Precipitation (pCi/l)	H-3	1,000	--
Water (pCi/l)	Gross Alpha	10	--
	Gross Beta	30	--
	H-3	10,000	20,000[c]
	Mn-54	100	1,000
	Fe-59	40	400
	Co-58	100	1,000
	Co-60	30	300
	Zr-Nb-95	40	400
	Cs-134	10	30
	Cs-137	20	50
	Ba-La-140	100	200
	Sr-89	8[d]	- -
	Sr-90	8[d]	- -
	Zn-65	30	300
Milk (pCi/l)	I-131	1.0	3
	Cs-134	20	60
	Cs-137	20	70
	Ba-La-140	100	300
	Sr-89	10	- -
Grass, Cattle Feed, and Vegetables (pCi/g wet)	Gross Beta	30	- -
	I-131	0.1	0.1
	Cs-134	0.2	1
	Cs-137	0.2	2
	Sr-89	1	- -
	Sr-90	1	- -

Table 2.2.1-D *Reporting Levels for Radioactivity Concentrations in Environmental Samples*			
Medium	**Radionuclide**	**Reporting Levels**	
		CV to KPS[a]	**KPS to NRC[b]**
Eggs (pCi/g wet)	Gross Beta	30	- -
	Cs-134	0.2	1
	Cs-137	0.2	2
	Sr-89	1	- -
	Sr-90	1	- -
Soil, Bottom Sediments (pCi/g)	Gross Beta	50	- -
	Cs-134	5	- -
	Cs-137	5	- -
	Sr-89	5	- -
	Sr-90	5	- -
Meat (pCi/g wet)	Gross Beta (Flesh, Bones)	10	- -
	Cs-134 (Flesh)	1.0	1.0
	Cs-137 (Flesh)	2	2.0
	Sr-89 (Bones)	2	- -
	Sr-90 (Bones)	2	- -
Fish (pCi/g wet)	Gross Beta (Flesh, Bones)	10	--
	Mn-54	--	30.0
	Fe-59	--	10.0
	Co-58	--	30.0
	Co-60	--	10.0
	Cs-134 (Flesh)	1	1.0
	Cs-137 (Flesh)	2	2.0
	Sr-89 (Bones)	2	--
	Sr-90 (Bones)	2	--
	Zn-65 (Bones)	--	20

a. Radionuclides will be monitored by the CV and concentrations above the listed limits will be reported to KPS.
b. Concentrations above the listed limits will be reported to NRC as required by REMM 2.2.1.b.
c. For drinking water samples, this is 40CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/l may be used.
d. The Sr-89/90 values are based on the EPA drinking water standards. See note "f." of Table 2.3.1-A for further information

Table 2.3.1-A
Detection Capabilities for Environmental Sample Analysis[a]
Lower Limit of Detection (LLD)[b,c]

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross Beta	4	0.01				
H-3	2000[d]					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zr-Nb-95	15					
I-131	1[e]	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		
Zn-65	30		260			
Sr-89/90[f]	5					

Table Notations for Table 2.3.1-A

a. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environment Operating Report.

b. Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

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

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

$$LLD = \frac{4.66 s_b}{E \times V \times 2.22 \times Y \times \exp(-\gamma \Delta t)}$$

Where:

LLD is the a priori lower limit of detection as defined above, as picocuries per unit mass or volume,

S_b is the standard deviation of the background counting rate or of the counting rate of blank sample as appropriate, as counts per minute,

E is the counting efficiency, as counts per disintegration,

V is the sample size in units of mass or volume,

2.22 is the number of disintegrations per minute per picocurie,

Y is the fractional radiochemical yield, when applicable,

γ is the radioactive decay constant for the particular radionuclide, and

Δt for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting,

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

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

d. If no drinking water pathway exists, a value of 3,000 pCi/l may be used.

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

f. This is NOT a NUREG-0472 required value. It is based on EPA drinking water standards, which tie into the NEI Groundwater Protection Initiative that was implemented at KPS on August 4, 2006.

FIGURE1

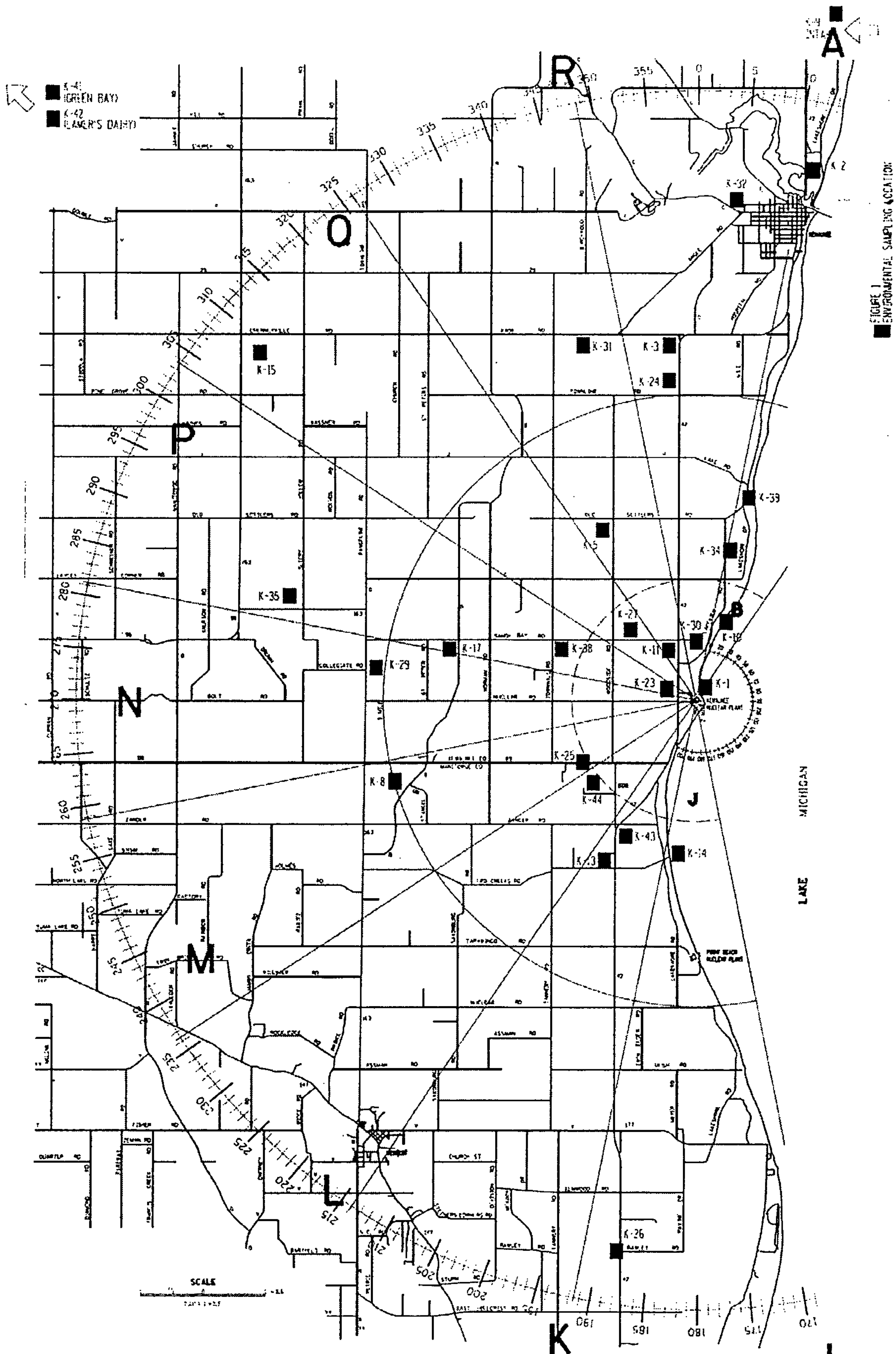

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FIGURE 2

NOTES:

1. LOCATIONS OF MONITORING WELLS SURVEYED BY STS ON JUNE 21, 2007.
2. LOCATIONS OF WATER SUPPLY WELLS ARE ESTIMATED.

LOCATION	NORTHING	EASTING	ELEVATION
MW-0701 GROUND	195859.5	2644681	605.828
MW-0701 TPVC	195859	2644681	605.672
MW-0702 GROUND	195372.1	2644096	607.897
MW-0702 TPVC	195371.5	2644097	607.386
MW-0703 TPVC	194762.3	2644838	602.485
MW-0703 GROUND	194761.4	2644838	603.112
MW-0704 GROUND	194938.2	2645268	606.916
MW-0704 TPVC	194938.7	2645268	606.502
MW-0705 TPVC	195264.4	2644927	604.912
MW-0705 GROUND	195264.4	2644927	605.339
MW-0706 GROUND	195491.2	2644865	606.402
MW-0705 TPVC	195491.2	2644865	605.997
AB 0707 GROUND	195461	2644563	606.0153
AB 0707 TPVC	195460.4	2644563	605.6723
AB 0708 GROUND	195451.3	2644530	606.0615
AB 0708 TPVC	195451	2644529	605.5165
AB 0709 GROUND	195448.3	2644493	606.1195
AB 0709 TPVC	195448	2644493	605.8593
AB 0710 GROUND	195429.7	2644450	606.1495
AB 0710 TPVC	195429.2	2644450	605.8672
AB 0711 GROUND	195421.1	2644417	605.8849
AB 0711 TPVC	195420.8	2644417	605.4903
AB 0712 GROUND	195412.4	2644367	605.5062
AB 0712 TPVC	195413	2644366	605.1851
AB 0715 GROUND	195196.2	2644512	605.7393
AB 0715 TPVC	195195.4	2644512	605.4299
AB 0717 GROUND	195509.4	2644690	605.4798
AB 0717 TPVC	195508.7	2644690	605.2917

NOTE: COORDINATES ARE IN NAD 1927 WISCONSIN STATE PLANE CENTRAL

LEGEND:

- 8' HIGH FENCE
- SUPPLY WELL
- MONITORING WELL