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DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION
2013 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Enclosed is the Kewaunee Power Station (KPS) 2013 Annual Radioactive Effluent Release Report for January through December 2013. 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

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2013 Annual Radioactive Effluent Release Report

Kewaunee Power Station

Dominion Energy Kewaunee, Inc.

DOCKET 50-305

KEWAUNEE POWER STATION

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

January 1 - December 31, 2013

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0.0 SUMMARY

On October 22, 2012, Dominion made known the decision to permanently shut down the Kewaunee Power Station (KPS). On February 25, 2013, Dominion Energy Kewaunee (DEK) submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. On May 15, 2013 the NRC docketed the certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii). Therefore the 10 CFR Part 50 license no longer authorizes KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2).

During 2013 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	Total Body	
	Quarterly Limit (mRem)	7.5	
	Actual Dose (mRem)	5.42E-04	(2nd Quarter)
	% of Specification	7.23E-03	
LIQUID:	Ingestion Pathway-Organ	GI-LLI	
	Quarterly Limit (mRem)	5.0	
	Actual Dose (mRem)	5.03E-03	(2nd Quarter)
	% of Limit	1.01E-01	
SOLID:	No upper limit for solid radioactive waste applies.		
	Cubic Meters Shipped	3.19E+01 m^3 (1.31E+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, 2013. 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 radio-analyses, 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 2013.

Number of batch releases.....................................27

Total time for all batch releases (min)...............2490.0

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

Average time for a batch release (min)..................92.1

Minimum time for a batch release (min)................16.0

2.3 Gaseous Effluent Data

Table 2.1 presents a quarterly summation of the total activity released and average release rates of gaseous effluents. Table 2.2 lists the quarterly sums of individual gaseous radionuclide released by continuous mode. Table 2.3 lists the quarterly sums of individual gaseous radionuclide released by batch mode. Table 2.4 presents the dose limits for gaseous effluents, and the calculated doses this year from gaseous effluents.

Table 2.1
Gaseous Effluents - Summation of all Releases

Fission and Activation Gases	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
Total Activity Released (Ci)	0.00E+00	1.79E-02	0.00E+00	0.00E+00	1.79E-02
Average Release Rate (µCi/sec)	0.00E+00	2.27E-03	0.00E+00	0.00E+00	5.67E-04
Iodines					
Total Activity Released (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Average Release Rate (µCi/sec)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulates					
Total Activity Released (Ci)	0.00E+00	6.84E-06	0.00E+00	2.81E-05	3.49E-05
Average Release Rate (µCi/sec)	0.00E+00	8.68E-07	0.00E+00	3.564E-06	1.11E-06
Tritium					
Total Activity Released (Ci)	8.54E+00	2.05E+01	1.32E+01	7.95E+00	5.02E+01
Average Release Rate (µCi/sec)	1.08E+00	2.60E+00	1.67E+00	1.01E+00	1.59E+00
Gross Alpha Released (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon-14					
Total Annual Activity Released (Ci)					2.41E+00

Table 2.2
Gaseous Effluents - Ground Level - Nuclides Released (Ci)
Continuous Mode

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
Fission Gases					
Total	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iodines					
Total	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulates					
Co-58	0.00E+00	5.84E-06	0.00E+00	0.00E+00	5.84E-06
Nb-95	0.00E+00	1.00E-06	0.00E+00	0.00E+00	1.00E-06
Cs-137 (1)	0.00E+00	0.00E+00	0.00E+00	2.81E-05	2.81E-05
Total	0.00E+00	6.84E-06	0.00E+00	2.81E-05	3.49E-05
Gross Alpha	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	8.54E+00	5.57E+00	1.32E+01	7.95E+00	3.52E+01

(1) Cs-137 isotope was in contaminated oil that was transferred to the heating boiler for disposal as part of the continuous release process.

Table 2.3
Gaseous Effluents - Ground Level - Nuclides Released (Ci)
Batch Mode

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total
Fission Gases					
Xe-133	0.00E+00	1.78E-02	0.00E+00	0.00E+00	1.78E-02
Xe-133m	0.00E+00	3.77E-05	0.00E+00	0.00E+00	3.77E-05
Total	0.00E+00	1.78E-02	0.00E+00	0.00E+00	1.78E-02
Iodines					
Total	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulates					
Total	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	3.68E-03	1.49E+01	2.83E-03	0.00E+00	1.49E+01
Gross Alpha	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2.4
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 releases of gaseous effluents during 2013 for each quarter and for the year were 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 and annual limits are shown below:

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Annual
1. Gamma- Air Dose					
Specification (mrad)	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
Actual Dose (mrad)	0.00E+00	1.49E-07	0.00E+00	0.00E+00	1.49E-07
% of Specification	0.00E+00	2.98E-06	0.00E+00	0.00E+00	1.49E-06
2. Beta- Air Dose					
Specification (mrad)	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
Actual Dose (mrad)	0.00E+00	4.43E-07	0.00E+00	0.00E+00	4.43E-07
% of Specification	0.00E+00	4.43E-06	0.00E+00	0.00E+00	2.22E-06
3. Organ Dose					
Specification (mrem)	7.50E+00	7.50E+00	7.50E+00	7.50E+00	1.50E+01
Total Body					
Actual Dose (mrem)	2.26E-04	5.42E-04	3.48E-04	2.10E-04	1.33E-03
% of Specification	3.01E-03	7.23E-03	4.64E-03	2.81E-03	8.85E-03
Bone					
Actual Dose (mrem)	0.00E+00	1.40E-07	0.00E+00	5.99E-05	6.01E-05
% of Specification	0.00E+00	1.86E-06	0.00E+00	7.99E-04	4.01E-04

Table 2.4 (continued)
Dose from Gaseous Effluents

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Annual
Liver					
Actual Dose (mrem)	2.26E-04	5.42E-04	3.48E-04	2.11E-04	1.33E-03
% of Specification	3.01E-03	7.23E-03	4.64E-03	2.81E-03	8.85E-03
Thyroid					
Actual Dose (mrem)	2.26E-04	5.42E-04	3.48E-04	2.10E-04	1.33E-03
% of Specification	3.01E-03	7.23E-03	4.64E-03	2.81E-03	8.85E-03
Kidney					
Actual Dose (mrem)	2.26E-04	5.42E-04	3.48E-04	2.11E-04	1.33E-03
% of Specification	3.01E-03	7.23E-03	4.64E-03	2.81E-03	8.85E-03
Lung					
Actual Dose (mrem)	2.26E-04	5.42E-04	3.48E-04	2.10E-04	1.33E-03
% of Specification	3.01E-03	7.23E-03	4.64E-03	2.81E-03	8.85E-03
GI-LLI					
Actual Dose (mrem)	2.26E-04	5.42E-04	3.48E-04	2.10E-04	1.33E-03
% of Specification	3.01E-03	7.23E-03	4.64E-03	2.81E-03	8.85E-03

2.4 Estimation of Carbon-14 in Gaseous Releases

Per Nuclear Engineering in Innsbrook the Cycle 31 flux values are bounding and conservative and can be used for all future cycles (reference KW-CALC-000-C11988).

Based on 127 days on line in 2013 and 331 days on line in 2012 (34 day refueling shutdown in 2012) the following ratio was determined - 127/331 = 0.3837.

The total estimated C-14 released is 6.29 Ci (2012 value) x 0.3837 = 2.41 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 (2012 value) x 0.3837 = 7.44E-02 mrem as Child Bone Dose

3.88E-02 mrem (2012 value) x 0.3837 = 1.49E-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 radio-analyses, 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	1.33E-07	1.33E-07	1.75E-08	9.53E-08	9.47E-08
Fe-59	2.22E-07	3.92E-08	2.22E-07	3.78E-08	1.30E-07
Co-58	1.31E-07	1.31E-07	9.73E-08	1.65E-08	9.40E-08
Co-60	1.33E-07	2.34E-08	2.34E-08	2.05E-07	9.62E-08
Zn-65	4.42E-08	4.42E-08	4.42E-08	4.26E-08	4.38E-08
Mo-99	9.40E-07	6.98E-07	1.23E-07	8.99E-07	6.65E-07
Cs-134	1.03E-07	1.35E-08	1.03E-07	1.18E-07	8.44E-08
Cs-137	9.51E-08	9.51E-08	9.51E-08	1.22E-07	1.02E-07
Ce-141	1.04E-07	9.42E-08	1.04E-07	1.24E-07	1.07E-07
Ce-144	3.09E-07	5.43E-07	5.43E-07	3.54E-07	4.37E-07
I-131	9.29E-08	9.28E-08	9.28E-08	7.42E-08	8.82E-08
H-3	2.69E-06	3.16E-06	3.10E-06	3.00E-06	2.99E-06
Sr-89	1.01E-08	3.48E-08	9.57E-09	NA	1.82E-08
Sr-90	7.36E-09	6.94E-09	7.12E-09	NA	7.14E-09
Gross Alpha	7.84E-09	8.74E-09	1.13E-08	NA	9.29E-09
Fe-55	6.76E-07	7.77E-07	7.87E-07	NA	7.47E-07
Ni-63	1.22E-07	1.36E-07	1.19E-07	NA	1.26E-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	1.38E-08	1.52E-08	1.28E-08	4.39E-09	1.15E-08
Fe-59	1.80E-08	2.47E-08	1.99E-08	2.47E-08	2.18E-08
Co-58	1.08E-08	1.14E-08	1.25E-08	1.20E-08	1.17E-08
Co-60	1.38E-08	1.18E-08	1.55E-08	1.38E-08	1.37E-08
Zn-65	2.94E-08	1.49E-08	2.43E-08	2.61E-08	2.37E-08
Mo-99	9.03E-08	1.05E-07	7.78E-08	8.24E-08	8.89E-08
Cs-134	9.02E-09	9.91E-09	1.22E-08	9.48E-09	1.02E-08
Cs-137	9.94E-09	9.26E-09	1.17E-08	1.33E-08	1.11E-08
Ce-141	1.73E-08	1.77E-08	1.77E-08	1.68E-08	1.74E-08
Ce-144	7.94E-08	8.38E-08	6.76E-08	2.36E-08	6.36E-08
I-131	1.01E-08	8.48E-09	1.13E-08	9.36E-09	9.81E-09
H-3	2.69E-07	3.16E-06	3.10E-06	3.00E-06	2.38E-06
Sr-89	8.70E-09	3.71E-08	6.32E-09	1.08E-08	1.57E-08
Sr-90	5.69E-09	7.83E-09	7.48E-07	6.29E-09	1.92E-07
Gross Alpha	4.37E-09	4.94E-09	1.16E-07	4.71E-09	3.25E-08
Fe-55	6.80E-07	7.91E-07	9.29E-09	6.76E-07	5.39E-07
Ni-63	1.17E-07	1.15E-07	6.50E-09	1.24E-07	9.06E-08

3.2 Liquid Batch Release Statistics

The following is a summation of all liquid batch releases during 2013.

Number of batch releases.......................................46

Total time for all batch releases (min).............33,000

Maximum time for a batch release (min)...........2,020

Minimum time for a batch release (min).................30

Average time for a batch release (min).................718

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. Table 3.2 contains the quantity of the individual isotopes released to the unrestricted area for batch releases. Table 3.3 contains the quantity of the individual isotopes released to the unrestricted area for continuous releases. Table 3.4 presents the doses from liquid effluents for each quarter and the calculated doses this year from liquid effluents.

Table 3.1
Liquid Effluents - Summation of all Releases

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
<u>Fission and Activation Products</u>					
Total Release (Ci)	9.16E-04	1.12E-02	3.80E-03	0.00E+00	1.59E-02
Average Concentration (µCi/ml)	5.71E-12	1.01E-10	3.47E-11	0.00E+00	4.17E-11
<u>Tritium</u>					
Total Release (Ci)	4.62E+01	1.85E+02	5.12E+01	0.00E+00	2.82E+02
Average Concentration (µCi/ml)	2.88E-07	1.67E-06	4.68E-07	0.00E+00	7.39E-07
% of Tech. Spec. Limit(3.0E-3 µCi/ml)	9.60E-03	5.57E-02	1.56E-02	0.00E+00	2.46E-02
<u>Dissolved and Entrained Gases</u>					
Total Release (Ci)	0.00E+00	7.67E-05	0.00E+00	0.00E+00	7.67E-05
Average Concentration (µCi/ml)	0.00E+00	6.92E-13	0.00E+00	0.00E+00	2.00E-13
% of Tech. Spec. Limit(2.0E-4 µCi/ml)	0.00E+00	3.46E-07	0.00E+00	0.00E+00	1.00E-07
<u>Gross Alpha Activity</u>					
Total Release (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
<u>Volume of Waste Released</u>					
Total (liters)	2.49E+07	1.26E+07	6.12E+06	3.39E+06	4.70E+07
<u>Volume of Dilution Water</u>					
Total (liters)	1.60E+11	1.11E+11	1.09E+11	2.14E+09	3.82E+11

Table 3.2
Liquid Effluents – Nuclides Released (Ci)
Batch Mode

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr*	Total
Fission and Activation Products					
Mn-54	0.00E+00	1.77E-04	0.00E+00	NA	1.77E-04
Fe-55	4.81E-04	2.38E-03	2.22E-03	NA	5.08E-03
Co-57	0.00E+00	3.69E-05	0.00E+00	NA	3.69E-05
Co-58	2.72E-05	2.87E-04	1.36E-04	NA	4.50E-04
Co-60	1.58E-05	3.38E-03	7.72E-05	NA	3.47E-03
Ni-63	3.04E-04	4.01E-03	3.64E-04	NA	4.68E-03
Nb-95	0.00E+00	9.62E-05	0.00E+00	NA	9.62E-05
Ag-110m	3.65E-05	5.31E-04	1.60E-04	NA	7.28E-04
Sn-117m	3.81E-06	0.00E+00	0.00E+00	NA	3.81E-06
Sb-124	0.00E+00	1.78E-05	1.19E-04	NA	1.37E-04
Sb-125	4.74E-05	3.19E-04	7.16E-04	NA	1.08E-03
Total Release	9.16E-04	1.12E-02	3.80E-03	NA	1.59E-02
Dissolved and Entrained Gases					
Xe-133	0.00E+00	7.67E-05	0.00E+00	NA	7.67E-05
Total Release	0.00E+00	7.67E-05	0.00E+00	NA	7.67E-05
Tritium					
Total Release	4.62E+01	1.85E+02	5.12E+01	NA	2.82E+2
Gross Alpha Activity					
Total Release	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00

*There were no batch releases in the 4th quarter.

Table 3.3
Liquid Effluents – Nuclides Released (Ci)
Continuous Mode

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
Fission and Activation Products					
Total Release	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dissolved and Entrained Gases					
Total Release	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium					
Total Release	1.51E-02	6.44E-03	0.00E+00	0.00E+00	2.15E-02
Gross Alpha Activity					
Total Release	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3.4
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 mrem to the total body and less than or equal to 5 mrem 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 mrem to the total body and less than or equal to 10 mrem to any organ.

Instantaneous release concentrations are limited by the individual radionuclide concentrations established in 10 CFR 20, Appendix B, for unrestricted areas. During the report period, none of the isotopes released exceed the concentrations specified in Appendix B. The following offsite doses were calculated using equation 1.7 from the Kewaunee ODCM.

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Annual
<u>Total Body</u>					
Specification (mrem)	1.50E+00	1.50E+00	1.50E+00	1.50E+00	3.00E+00
Actual Dose (mrem)	3.44E-04	1.49E-03	3.87E-04	0.00E+00	2.22E-03
% of Specification	2.30E-02	9.95E-02	2.58E-02	0.00E+00	7.41E-02
<u>Organs</u>					
Specification (mrem)	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
Bone					
Actual Dose (mrem)	2.17E-04	2.80E-03	2.83E-04	0.00E+00	3.30E-03
% of Specification	4.35E-03	5.60E-02	5.66E-03	0.00E+00	3.30E-02
Liver					
Actual Dose (mrem)	3.55E-04	1.60E-03	4.12E-04	0.00E+00	2.37E-03
% of Specification	7.11E-03	3.20E-02	8.24E-03	0.00E+00	2.37E-02
Thyroid					
Actual Dose (mrem)	3.36E-04	1.35E-03	3.72E-04	0.00E+00	2.05E-03
% of Specification	6.72E-03	2.69E-02	7.43E-03	0.00E+00	2.05E-02
Kidney					
Actual Dose (mrem)	3.36E-04	1.35E-03	3.72E-04	0.00E+00	2.06E-03
% of Specification	6.72E-03	2.71E-02	7.43E-03	0.00E+00	2.06E-02

Table 3.4 (continued)
Dose from Liquid Effluents

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Annual
Lung					
Actual Dose (mrem)	3.39E-04	1.36E-03	3.84E-04	0.00E+00	2.08E-03
% of Specification	6.77E-03	2.72E-02	7.69E-03	0.00E+00	2.08E-02
GI-LLI					
Actual Dose (mrem)	3.45E-04	5.03E-03	4.05E-04	0.00E+00	5.78E-03
% of Specification	6.90E-03	1.01E-01	8.10E-03	0.00E+00	5.78E-02

3.4 Ground Water Monitoring

Sample Point Sample Date	Tritium pCi/L	Total Gamma Activity µCi/ml
AB-707		
03/26/13	2194	None Detected
04/24/13	1149	(1)
05/29/13	1038	None Detected
07/02/13	1917	None Detected
07/25/13	1802	None Detected
08/29/13	1219	None Detected
09/06/13	1429	None Detected
01/04/14 (2)	1204	None Detected
AB-708		
03/26/13	1181	None Detected
07/02/13	1036	None Detected
09/06/13	953	None Detected
01/04/14 (2)	856	None Detected
AB-709		
03/26/13	575	None Detected
07/03/13	463	None Detected
09/11/13	548	None Detected
01/10/14 (2)	904	None Detected
AB-710		
03/26/13	985	None Detected
07/03/13	966	None Detected
09/06/13	809	None Detected
01/04/14 (2)	877	None Detected
AB-711		
03/25/13	978	None Detected
07/03/13	952	None Detected
09/06/13	805	None Detected
01/04/14 (2)	1060	None Detected
AB-712		
03/25/13	<241	None Detected
07/03/13	251	None Detected
09/11/13	554	None Detected
01/10/14 (2)	419	None Detected
AB-715		
03/25/13	624	None Detected
07/03/13	1623	None Detected
09/11/13	759	None Detected
01/04/14 (2)	553	None Detected

Sample Point Sample Date	Tritium pCi/L	Total Gamma Activity µCi/ml
AB-717		
03/26/13	<241	None Detected
07/03/13	<239	None Detected
09/12/13	<280	None Detected
01/10/14 (2)	<253	None Detected
MW-701		
03/26/13	<241	None Detected
07/03/13	<219	None Detected
09/11/13	<240	None Detected
MW-702		
03/26/13	<241	None Detected
07/02/13	<219	None Detected
09/11/13	<240	None Detected
MW-703		
04/01/13	<241	None Detected
07/02/13	<219	None Detected
09/11/13	<240	None Detected
MW-704		
04/01/13	<241	None Detected
07/02/13	<219	None Detected
09/11/13	<240	None Detected
MW-705		
03/26/13	<241	None Detected
07/03/13	<219	None Detected
09/12/13	<240	None Detected
MW-706		
03/26/13	<241	None Detected
07/03/13	<219	None Detected
09/12/13	<240	None Detected

(1) The sample at location AB-707 on 4/24/13 was an additional sample for tritium – the sample was not analyzed for Total Gamma Activity.

(2) Due to schedule and winter weather conditions wells AB707, AB708, AB709, AB710, AB711, AB712, AB715, and AB717 were sampled for 4th quarter in January 2014. Wells MW701, MW702, MW703, MW704, MW705, and MW706 were not sampled for 4th quarter 2013. Condition Report 538443 was submitted.

4.0 UNPLANNED or ABNORMAL RELEASES or ABNORMAL DISCHARGES

No unplanned or abnormal releases or abnormal discharges 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 for the report period.

6.0 SOLID WASTE DISPOSAL

Table 6.1 is a summation of solid radioactive waste shipped during 2013. Presented are the types of waste, major nuclide composition, disposition of the waste and shipping containers used. Table 6.1 also contains the radionuclide content (curies) and percent abundance for each type of waste.

Table 6.1
Solid Waste and Irradiated Fuel Shipments

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

1. Type of Waste with Estimate of Major Nuclide Composition

Resins, Filters, and Evaporator Bottoms	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	1.94E+02	5.49E+00	1.30E+01
B	1.63E+02	4.62E+00	1.45E+02
C	0.00E+00	0.00E+00	0.00E+00
All	3.57E+02	1.01E+01	1.58E+02

Estimate of Major Nuclides for Resins, Filters, and Evaporator Bottoms:

Class A	Nuclide	% Abundance	Curies
	H-3	0.020	2.56E-03
	C-14	0.069	8.94E-03
	Mn-54	2.420	3.14E-01
	Fe-55	8.150	1.06E+00
	Co-57	0.340	4.42E-02
	Co-58	3.118	4.05E-01
	Co-60	13.253	1.72E+00
	Ni-59	0.789	1.02E-01
	Ni-63	71.013	9.22E+00
	Sr-90	0.003	4.15E-04
	Nb-95	0.024	3.15E-03
	Ag-110m	0.012	1.61E-03
	Sb-125	0.558	7.25E-02
	Cs-137	0.159	2.06E-02
	Ce-144	0.068	8.81E-03
	Pu-238	0.000	5.96E-06
	Pu-239	0.000	1.97E-06
	Pu-241	0.004	4.76E-04

Class B	Nuclide	% Abundance	Curies
	H-3	0.020	2.89E-02
	C-14	0.048	6.96E-02
	Mn-54	0.879	1.28E+00

Table 6.1 (continued)
Solid Waste and Irradiated Fuel Shipments

	Fe-55	5.942	8.62E+00
	Co-57	0.457	6.63E-01
	Co-58	6.442	9.35E+00
	Co-60	7.737	1.12E+01
	Ni-59	0.635	9.21E-01
	Ni-63	77.073	1.12E+02
	Zn-65	0.080	1.16E-01
	Sr-89	0.001	9.06E-04
	Sr-90	0.004	5.29E-03
	Sb-125	0.406	5.89E-01
	Cs-137	0.208	3.02E-01
	Ce-144	0.063	9.14E-02
	Pu-238	0.000	2.67E-05
	Pu-239	0.000	1.79E-05
	Pu-241	0.005	6.82E-03
	Am-241	0.000	8.73E-06
	Cm-243	0.000	8.78E-06

Class All	Nuclide	% Abundance	Curies
	H-3	0.020	3.15E-02
	C-14	0.050	7.85E-02
	Mn-54	1.006	1.59E+00
	Fe-55	6.124	9.68E+00
	Co-57	0.447	7.07E-01
	Co-58	6.169	9.75E+00
	Co-60	8.190	1.29E+01
	Ni-59	0.647	1.02E+00
	Ni-63	76.575	1.21E+02
	Zn-65	0.073	1.16E-01
	Sr-89	0.001	9.06E-04
	Sr-90	0.004	5.70E-03
	Nb-95	0.002	3.15E-03
	Ag-110m	0.001	1.61E-03
	Sb-125	0.419	6.62E-01
	Cs-137	0.204	3.22E-01
	Ce-144	0.063	1.00E-01
	Pu-238	0.000	3.26E-05
	Pu-239	0.000	1.98E-05
	Pu-241	0.005	7.30E-03
	Am-241	0.000	8.73E-06
	Cm-243	0.000	8.78E-06

Table 6.1 (continued)
Solid Waste and Irradiated Fuel Shipments

Dry Active Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	5.00E+02	1.42E+01	1.34E-01
B	0.00E+00	0.00E+00	0.00E+00
C	0.00E+00	0.00E+00	0.00E+00
All	5.00E+02	1.42E+01	1.34E-01

Estimate of Major Nuclides for Dry Active Waste:

Class A	Nuclide	% Abundance	Curies
	H-3	0.477	6.38E-04
	Cr-51	5.063	6.76E-03
	Mn-54	0.823	1.10E-03
	Fe-55	12.306	1.64E-02
	Fe-59	0.384	5.14E-04
	Co-57	0.231	3.08E-04
	Co-58	54.749	7.32E-02
	Co-60	3.087	4.12E-03
	Ni-63	10.045	1.34E-02
	Zn-65	0.089	1.18E-04
	Zr-95	4.043	5.40E-03
	Nb-95	7.488	1.00E-02
	Tc-99	0.579	7.74E-04
	Ag-110m	0.024	3.25E-05
	Sn-113	0.139	1.86E-04
	Sb-125	0.265	3.55E-04
	Cs-137	0.137	1.84E-04
	Ce-144	0.070	9.34E-05

Class All	Nuclide	% Abundance	Curies
	H-3	0.477	6.38E-04
	Cr-51	5.063	6.76E-03
	Mn-54	0.823	1.10E-03
	Fe-55	12.306	1.64E-02
	Fe-59	0.384	5.14E-04
	Co-57	0.231	3.08E-04
	Co-58	54.749	7.32E-02
	Co-60	3.087	4.12E-03
	Ni-63	10.045	1.34E-02
	Zn-65	0.089	1.18E-04

Table 6.1 (continued)
Solid Waste and Irradiated Fuel Shipments

Zr-95	4.043	5.40E-03
Nb-95	7.488	1.00E-02
Tc-99	0.579	7.74E-04
Ag-110m	0.024	3.25E-05
Sn-113	0.139	1.86E-04
Sb-125	0.265	3.55E-04
Cs-137	0.137	1.84E-04
Ce-144	0.070	9.34E-05

Irradiated Components	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	0.00E+00	0.00E+00	0.00E+00
B	0.00E+00	0.00E+00	0.00E+00
C	0.00E+00	0.00E+00	0.00E+00
All	0.00E+00	0.00E+00	0.00E+00

Estimate of Major Nuclides for Irradiated Components:

Nuclide	% Abundance	Curies
None	NA	NA

Other Waste (DAW-Asbestos)	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	2.70E+02	7.65E+00	2.89E-04
B	0.00E+00	0.00E+00	0.00E+00
C	0.00E+00	0.00E+00	0.00E+00
All	2.70E+02	7.65E+00	2.89E-04

Estimate of Major Nuclides for Other Waste:

Class A	Nuclide	% Abundance	Curies
	H-3	0.448	1.30E-06
	Cr-51	5.629	1.63E-05
	Mn-54	0.785	2.27E-06
	Fe-55	11.610	3.36E-05
	Fe-59	0.403	1.16E-06

Table 6.1 (continued)
Solid Waste and Irradiated Fuel Shipments

	Co-57	0.221	6.39E-07
	Co-58	55.173	1.60E-04
	Co-60	2.905	8.40E-06
	Ni-63	9.427	2.73E-05
	Zn-65	0.085	2.46E-07
	Zr-95	4.103	1.19E-05
	Nb-95	8.061	2.33E-05
	Tc-99	0.543	1.57E-06
	Ag-110m	0.023	6.74E-08
	Sn-113	0.137	3.95E-07
	Sb-125	0.250	7.24E-07
	Cs-137	0.129	3.73E-07
	Ce-144	0.067	1.93E-07

Class All	Nuclide	% Abundance	Curies
	H-3	0.448	1.30E-06
	Cr-51	5.629	1.63E-05
	Mn-54	0.785	2.27E-06
	Fe-55	11.610	3.36E-05
	Fe-59	0.403	1.16E-06
	Co-57	0.221	6.39E-07
	Co-58	55.173	1.60E-04
	Co-60	2.905	8.40E-06
	Ni-63	9.427	2.73E-05
	Zn-65	0.085	2.46E-07
	Zr-95	4.103	1.19E-05
	Nb-95	8.061	2.33E-05
	Tc-99	0.543	1.57E-06
	Ag-110m	0.023	6.74E-08
	Sn-113	0.137	3.95E-07
	Sb-125	0.250	7.24E-07
	Cs-137	0.129	3.73E-07
	Ce-144	0.067	1.93E-07

Sum of All Low-Level Waste	Volume		Curies Shipped
Waste Class	ft^3	m^3	Curies
A	9.64E+02	2.73E+01	1.31E+01
B	1.63E+02	4.62E+00	1.45E+02
C	0.00E+00	0.00E+00	0.00E+00
All	1.13E+03	3.19E+01	1.58E+02

Table 6.1 (continued)
Solid Waste and Irradiated Fuel Shipments

Estimate of Major Nuclides for All Low-Level Waste:

Class A	Nuclide	% Abundance	Curies
	H-3	0.024	3.20E-03
	C-14	0.068	8.94E-03
	Cr-51	0.052	6.78E-03
	Mn-54	2.404	3.16E-01
	Fe-55	8.192	1.08E+00
	Fe-59	0.004	5.15E-04
	Co-57	0.339	4.45E-02
	Co-58	3.645	4.78E-01
	Co-60	13.149	1.73E+00
	Ni-59	0.781	1.02E-01
	Ni-63	70.391	9.24E+00
	Zn-65	0.001	1.19E-04
	Sr-90	0.003	4.15E-04
	Zr-95	0.041	5.41E-03
	Nb-95	0.100	1.32E-02
	Tc-99	0.006	7.75E-04
	Ag-110m	0.013	1.64E-03
	Sn-113	0.001	1.86E-04
	Sb-125	0.555	7.28E-02
	Cs-137	0.159	2.08E-02
	Ce-144	0.068	8.91E-03
	Pu-238	0.000	5.96E-06
	Pu-239	0.000	1.97E-06
	Pu-241	0.004	4.76E-04

Class B	Nuclide	% Abundance	Curies
	H-3	0.020	2.89E-02
	C-14	0.048	6.96E-02
	Mn-54	0.879	1.28E+00
	Fe-55	5.942	8.62E+00
	Co-57	0.457	6.63E-01
	Co-58	6.442	9.35E+00
	Co-60	7.737	1.12E+01
	Ni-59	0.635	9.21E-01
	Ni-63	77.073	1.12E+02
	Zn-65	0.080	1.16E-01
	Sr-89	0.001	9.06E-04
	Sr-90	0.004	5.29E-03

Table 6.1 (continued)
Solid Waste and Irradiated Fuel Shipments

	Sb-125	0.406	5.89E-01
	Cs-137	0.208	3.02E-01
	Ce-144	0.063	9.14E-02
	Pu-238	0.000	2.67E-05
	Pu-239	0.000	1.79E-05
	Pu-241	0.005	6.82E-03
	Am-241	0.000	8.73E-06
	Cm-243	0.000	8.78E-06

Class All	Nuclide	% Abundance	Curies
	H-3	0.020	3.21E-02
	C-14	0.050	7.85E-02
	Cr-51	0.004	6.78E-03
	Mn-54	1.006	1.59E+00
	Fe-55	6.129	9.70E+00
	Fe-59	0.000	5.15E-04
	Co-57	0.447	7.08E-01
	Co-58	6.210	9.82E+00
	Co-60	8.186	1.30E+01
	Ni-59	0.647	1.02E+00
	Ni-63	76.519	1.21E+02
	Zn-65	0.073	1.16E-01
	Sr-89	0.001	9.06E-04
	Sr-90	0.004	5.70E-03
	Zr-95	0.003	5.41E-03
	Nb-95	0.008	1.32E-02
	Tc-99	0.000	7.75E-04
	Ag-110m	0.001	1.64E-03
	Sn-113	0.000	1.86E-04
	Sb-125	0.419	6.62E-01
	Cs-137	0.204	3.23E-01
	Ce-144	0.063	1.00E-01
	Pu-238	0.000	3.26E-05
	Pu-239	0.000	1.98E-05
	Pu-241	0.005	7.30E-03
	Am-241	0.000	8.73E-06
	Cm-243	0.000	8.78E-06

Table 6.1 (continued)
Solid Waste and Irradiated Fuel Shipments

2. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
3	Hittman Transport	Energy Solutions, LLC
2	Hittman Transport	Studsvik Processing Facility, LLC

B. Irradiated Fuel Shipments

Number of Shipments	Mode of Transportation	Destination
None	NA	NA

No irradiated fuel shipments were made from the Kewaunee Power Station during 2013.

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 twice during this report period. Appendix B is a copy of the Kewaunee Power Station ODCM Revision 15, June 6, 2013. Appendix C is a copy of the Kewaunee Power Station ODCM Revision 16, December 5, 2013.

7.3 Radiological Environmental Monitoring Manual

The Kewaunee Power Station Radiological Environmental Monitoring Manual (REMM) was revised during this report period. Appendix D is a copy of the Kewaunee Power Station REMM Revision 20, October 31, 2013.

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

The following changes were made to the radioactive waste systems (liquid, gaseous or solids):

a) System abandonment evaluations were performed using procedure OP-KW-DEC-SYC-001, System Evaluation and Categorization, and documented on Attachment B, SSC Category Determination Document. The following is a summary from the applicable Attachment B for the changes made to the following radioactive waste treatment systems:

   - 07-Steam Generator Blowdown Treatment System
   - 18-Reactor Building Ventilation System
   - 32B-Waste Gaseous System
   - 35- Chemical and Volume Control System

   On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. On May 15, 2013 the NRC docketed the certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(10(ii). Therefore, the 10 CFR Part 50 license no longer authorizes KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2).

Steam Generator Blowdown Treatment System

Being that the reactor is defueled, and the Reactor Coolant System (RCS) and Secondary Systems are no longer in operation; the Steam Generator Blowdown Treatment System no longer performs a function or provides support for decommissioning, except as follows: One train is being maintained available to support draining and processing waste water for systems located in the auxiliary building.

Reactor Building Ventilation System

Being that the reactor is defueled, and the RCS and associated systems are no longer in operation; the Reactor Building Ventilation (RBV) System no longer performs prevention or mitigating function or provides support for decommissioning.

Waste Gaseous System

The gas decay tanks contain the gases vented from the RCS, the Volume Control Tank (VCT), and the liquid Chemical and Volume Control (CVCS) holdup tanks. Following the abandonment of the RCS and CVCS systems the waste gas decay tanks and associated piping were discharged and vented to atmosphere. No new gases will be produced as the CVCS was drained and vented and the reactor vessel has been defueled.

Chemical and Volume Control System

Being that the reactor is defueled, and the RCS and associated systems are no longer in operation; there will be no liquid waste created and no releases from the CVCS.

b) Refer to Attachment E, Documentation for Major Changes to Radioactive Waste Treatment Systems in 2013, for information to support the reason for the changes, including a description of the equipment, components, and processes involved and interfaces with other plant systems.

c) The changes described in Attachment E either reduced or eliminated the release paths of radioactive effluents from the specified systems. The Steam Generator Blowdown Treatment system has been reduced to one train to support draining and processing waste water in the auxiliary building. There will no longer be any releases of radioactive material or any further exposures to individuals in the UNRESTRICTED AREA and to the general population from the Reactor Building Ventilation, Waste Gaseous, and Chemical and Volume Control systems.

d) There is no exposure expected by plant personnel as a result of the changes to these waste treatment systems.

e) Refer to Attachment E, Documentation for Major Changes to Radioactive Waste Treatment Systems in 2013, for FSRC review and approval documentation of these changes to the radioactive waste treatment systems.

8.0 REPORTABLE OCCURRENCES

8.1 Condition Report 516118, ODCM Channel Checks Not Performed for R-12 and R-21

On 5/19/2013 it was discovered that the R-12 and R-21 channel checks required by the ODCM per DVR 13.3.2.2 were not being performed per procedure SP-87-149, Shift Instrument Channel Checks – Shutdown. ODCM Table 13.3.2-1 requires one noble gas activity monitor to be functional when the containment building 36" ventilation system is in service. A channel check is required to be performed every 24 hours to verify the monitor is functional. This performance check was not performed as required placing the monitors in a nonconforming condition. Upon discovery of the missed performance checks, in accordance with DVR 13.0.6.3 - Actions should be taken to restore conformance with the DNCs / DVRs in a timely fashion, a partial SP-87-149 procedure was performed. No abnormal conditions were found and conformance was restored to R-12 and R-21.

The plant had been permanently shut down on 5/7/2013 and certified defueled on 5/15/2013. This placed the plant in a NO MODE condition. SP-87-149 lists the plant initial conditions as either MODE 5 or MODE 6. It was determined that this was the reason why the channel checks were not performed. A revision to procedure OSP-MI-002, Daily Instrument Channel Checks, was submitted on the day of discovery and was issued on 5/20/2014 to include the required R-12 and R-21 channel checks. This procedure is not limited to any MODE classification.

8.2 Condition Report 516164, R-15 Condenser Air Ejector Radiation Monitor, Shutdown

Bases statement excerpt from the ODCM related to gaseous effluent instrumentation:

"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 plant had been permanently shut down on 5/7/2013 and certified defueled on 5/15/2013. The Main Steam system was no longer required, which eliminated the effluent release path to the condensers. Therefore, R-15 was no longer required and subsequently shut down.

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Appendix A

Kewaunee Power Station

2013 Meteorological Data

Missing Data

First Quarter: 17.75 hours
Second Quarter: 5.25 hours
Third Quarter: 1.50 hours
Fourth Quarter: 47.50 hours

Note: A total of 72.00 hours of data is missing or otherwise unavailable. This represents the availability of 99.18% of the data for the year.

First Quarter 2013

Stability Class A

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	7.25	13	21.25	0	0	41.5
NNE	0	0	3	9.75	15.75	9.25	0	37.75
NE	0	0	12.25	17.5	10.25	0	0	40
ENE	0	0	2.5	3	5.25	0	0	10.75
E	0	0	6.25	6.75	10.25	3	0.25	26.5
ESE	0	0	1	4	13	0	0.25	18.25
SE	0	0	0	0	20.75	1	0	21.75
SSE	0	0	1.25	8	6.5	0	0	15.75
S	0	0	2.25	7.25	0	0	0	9.5
SSW	0	0	2.25	2.25	0	0	0	4.5
SW	0	0	6	4.75	0	0	0	10.75
WSW	0	0	2.75	16.75	4.25	0.25	0	24
W	0	0	7.5	55.5	21	6.5	0	90.5
WNW	0	0	9.5	39.5	24.75	0	0	73.75
NW	0	0	12	21.25	7.25	1	0	41.5
NNW	0	0	18.5	28.75	9.75	0	0	57
TOTAL	0	0	94.25	238	170	21	0.5	523.75

Stability Class B

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	1.75	5.5	6.75	0	0	14
NNE	0	0	0.5	1	3.25	12.75	3.25	20.75
NE	0	0	3	0	1.5	1	0	5.5
ENE	0	0	0	0.25	2	0	0	2.25
E	0	0	0.5	1	3.5	0	0	5
ESE	0	0	1.25	0	0	0	0	1.25
SE	0	0	0	0	0.5	0.5	0	1
SSE	0	0	0.75	0	0	1.25	0	2
S	0	0	1.5	15.5	6	0.75	0	23.75
SSW	0	0	1.75	7.5	0	0	0	9.25
SW	0	0	1	3.25	0.25	0	0	4.5
WSW	0	0	2.25	1.75	0.5	0	0	4.5
W	0	0.25	4	7.5	9.5	0	0	21.25
WNW	0	0	3.5	10	2.25	0	0	15.75
NW	0	0	1.5	7	2	0	0	10.5
NNW	0	0	1.75	8	2.25	0	0	12
TOTAL	0	0.25	25	68.25	40.25	16.25	3.25	153.25

Stability Class C

Wind Speed

Wind Direction

	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	1.5	6	16.75	0	0	24.25
NNE	0	0	1.25	0.5	5	5.75	1.25	13.75
NE	0	0	1.75	2	1.5	2.5	0	7.75
ENE	0	0	0.25	1.75	0	0	0	2
E	0	0	0.5	0.25	0.5	0	0	1.25
ESE	0	0	0.25	0	0	0	0	0.25
SE	0	0	0	0	0	1	0	1
SSE	0	0	0.25	1	1	0	0	2.25
S	0	0	0.25	1.75	0	2.25	0	4.25
SSW	0	0	1.25	6.5	0	0	0	7.75
SW	0	0	13	3.5	0.75	0	0	17.25
WSW	0	0.75	3.5	4.5	2	0.25	0	11
W	0	0.25	2.25	15	6	0	0	23.5
WNW	0	0	3	24	3.25	1	0	31.25
NW	0	0.75	3.25	6.5	5.25	0	0	15.75
NNW	0	0	4.25	5.5	0	0	0	9.75
TOTAL	0	1.75	36.5	78.75	42	12.75	1.25	173

Stability Class D

Wind Speed

Wind Direction

	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.5	7.25	28.5	27.5	0	0	64.75
NNE	0	0	2.25	4.75	5.25	0	0	12.25
NE	0	0	2.25	0	0	0	0	2.25
ENE	0	0	2.75	0.25	0	0	0	3
E	0	1	0.5	1.25	1.5	0	0	4.25
ESE	0	1.75	1.25	1.75	0	0	0	4.75
SE	0	0.25	3	2	4.5	2.75	0	12.5
SSE	0	0.75	6.25	5.25	17	11.75	0	41
S	0	0.5	12.5	10.25	7.25	2.75	0	33.25
SSW	0	1.5	29	8.75	1.75	0	0	41
SW	0	2.25	9.75	10.5	8	0	0	30.5
WSW	0	2.5	20.25	12.25	8.75	1.25	0	45
W	0	0.75	22.5	22	14.25	2.75	0	62.25
WNW	0	0.5	11.75	56.5	5	4.75	0	78.5
NW	0	1.25	12.25	27	12.75	0.25	0	53.5
NNW	0	1.5	11.75	24.75	11.5	0	0	49.5
TOTAL	0	16	155.25	215.75	125	26.25	0	538.25

APPENDIX A
Kewaunee Power Station 2013 Meteorological Data

Stability Class E

Wind Speed

Wind Direction

	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	5.75	10	2.5	0	0	18.25
NNE	0	0.25	1.75	0.5	0	0	0	2.5
NE	0	0	1	0	0	0	0	1
ENE	0	0	1	0	0	0	0	1
E	0	0.25	1	0.5	0	0	0	1.75
ESE	0	0.25	1	0.5	0	0	0	1.75
SE	0	0.75	2.75	0.25	1.25	0	0	5
SSE	0	0.25	4.5	4.25	3	0.75	0	12.75
S	0	3.5	8.25	6.5	2.25	0	0	20.5
SSW	0	4	26.5	22	0.25	0	0	52.75
SW	0	2.5	19.75	20.5	1.5	0.5	0	44.75
WSW	0	2.75	12	11.25	5.5	1.75	0	33.25
W	0	2	11.75	18.25	9.5	0.25	0	41.75
WNW	0	1	22	23.5	0.25	0.25	0	47
NW	0	0.5	18.75	16	3.5	0	0	38.75
NNW	0	0.25	16	20.25	3.75	0	0	40.25
TOTAL	0	18.25	153.75	154.25	33.25	3.5	0	363

Stability Class F

Wind Speed

Wind Direction

	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	0.75	0.75	0	0	0	1.75
NNE	0	0	0	0	0	0	0	0
NE	0	0.25	0.25	0	0	0	0	0.5
ENE	0	0	0.25	0	0	0	0	0.25
E	0	0.5	0.25	0	0	0	0	0.75
ESE	0	0.25	1.25	1.25	0	0	0	2.75
SE	0	0	2.25	4.75	2	0	0	9
SSE	0	0.25	3.75	4.75	0.5	0	0	9.25
S	0	0.5	5.25	1.5	0	0	0	7.25
SSW	0	3	10.5	1.5	0	0	0	15
SW	0	2.75	16.25	2.25	0.75	0	0	22
WSW	0	3.5	12	5.25	0	0	0	20.75
W	0	5.25	15	10.75	0	0	0	31
WNW	0	1.5	25.5	12.25	0	0	0	39.25
NW	0	1.25	17.5	5.75	0	0	0	24.5
NNW	0	0.75	7.75	1.5	0	0	0	10
TOTAL	0	20	118.5	52.25	3.25	0	0	194

Stability Class G

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.5	4	0	0	0	0	5.5
NNE	0	1	0	0	0	0	0	1
NE	0	0	0	0	0	0	0	0
ENE	0	0.25	0	0	0	0	0	0.25
E	0	0	0	0	0	0	0	0
ESE	0	0.25	0	0	0	0	0	0.25
SE	0	0.25	0	0	0	0	0	0.25
SSE	0	0	0.75	0.25	0	0	0	1
S	0	0	1.5	0	0	0	0	1.5
SSW	0	1.75	5.5	0	0	0	0	7.25
SW	0	3	15.5	0.25	0.75	0	0	19.5
WSW	0	5.75	25.25	0.75	0	0	0	31.75
W	0	4	27	1.5	0	0	0	32.5
WNW	0	1	39.25	0	0	0	0	40.25
NW	0	1.25	32	7.5	0	0	0	40.75
NNW	0	1.5	13.75	0	0	0	0	15.25
TOTAL	0	21.5	164.5	10.25	0.75	0	0	197

Second Quarter 2013

Stability Class A

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	5.75	12.5	14.75	0	0	33
NNE	0	0	9.5	61.25	55.25	18	1.75	145.75
NE	0	0	7.75	25.75	4.25	0.25	0	38
ENE	0	0	7	11.5	12.75	4.5	0	35.75
E	0	0	5.5	7.25	1	0	0	13.75
ESE	0	0	4	3	0	0	0	7
SE	0	0	3.5	6.5	0	0	0	10
SSE	0	0.25	2	8.5	14	9.25	2	36
S	0	0	1	10.25	8	2	0.25	21.5
SSW	0	0	3	6.5	0.25	0	0	9.75
SW	0	0	2.75	2.25	1	0	0	6
WSW	0	0	3.75	4.75	3.25	1.75	0	13.5
W	0	0	1.75	23.25	7.25	2.25	0	34.5
WNW	0	0	6	29.25	5.5	0	0	40.75
NW	0	0	5.5	23	11.5	0	0	40
NNW	0	0	3.75	12.25	7.25	0.5	0	23.75
TOTAL	0	0.25	72.5	247.75	146	38.5	4	509

Stability Class B

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	2.75	3	2.75	0.75	0	9.25
NNE	0	0	4	13.5	11.5	3	2.75	34.75
NE	0	0	3.25	2.5	6	0	0	11.75
ENE	0	0	1.25	1.5	0.5	0	0	3.25
E	0	0	0.5	2.75	2	0	0	5.25
ESE	0	0	1.25	0.25	0	0	0	1.5
SE	0	0	0	0.75	0	0	0	0.75
SSE	0	0	0.5	1.5	4.5	0.25	0	6.75
S	0	0.25	1.25	2.25	3.75	0.25	0	7.75
SSW	0	0	2.5	3	0.25	0	0	5.75
SW	0	0	0	0.5	0	0.75	0	1.25
WSW	0	0	0.25	1	0	0.25	0	1.5
W	0	0	0.5	1.25	0	0	0	1.75
WNW	0	0	0.75	7	1.25	0	0	9
NW	0	0	2.75	2.25	3	0	0	8
NNW	0	0	1.75	0.5	0.5	0	0	2.75
TOTAL	0	0.25	23.25	43.5	36	5.25	2.75	111

Stability Class C

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	2.25	5.5	2	0	0	9.75
NNE	0	0	2.75	11.75	8.5	5	5.75	33.75
NE	0	0.25	6	6.5	0	0	0	12.75
ENE	0	0	3.5	1.5	0	0	0	5
E	0	0	6.25	1	0	0	0	7.25
ESE	0	0	1	0.25	0.5	0	0	1.75
SE	0	0.25	0.25	3.5	0	0	0	4
SSE	0	0	1	0.5	1	1	0	3.5
S	0	0	0.25	3.25	2.75	0.5	0	6.75
SSW	0	0	1.5	1.25	0	0	0	2.75
SW	0	0	0	0.75	0.5	0.5	0	1.75
WSW	0	0	0.25	0.75	0	0	0	1
W	0	0	0.25	2	0.75	0	0	3
WNW	0	0	0.25	6.5	2.25	0	0	9
NW	0	0	4.5	1.25	3.5	0	0	9.25
NNW	0	0	1.5	2	0.25	0	0	3.75
TOTAL	0	0.5	31.5	48.25	22	7	5.75	115

Stability Class D

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	3.75	7	1.75	0	0	12.75
NNE	0	0.25	14.25	39.5	24.25	1	0	79.25
NE	0	0.75	17.25	6	0.25	0	0	24.25
ENE	0	3.5	12.5	3.25	0.25	0	0	19.5
E	0	2	4.5	0	0	0	0	6.5
ESE	0	1	2.25	1.25	0.25	0	0	4.75
SE	0	1	2.5	4.25	3	0.75	0	11.5
SSE	0	0.25	3	10	3.5	2.25	0	19
S	0	0.25	3.25	7.75	6	0	0	17.25
SSW	0	0.25	8.75	8	0.75	0	0	17.75
SW	0	1	2	1.75	5.75	0.5	0	11
WSW	0	1.25	3.25	2	0.5	0	0	7
W	0	0.25	3	4.25	0	0	0	7.5
WNW	0	0.75	4	9.75	2.25	0	0	16.75
NW	0	0	7.75	7.25	7.75	0	0	22.75
NNW	0	0.25	3.25	4	1.75	0	0	9.25
TOTAL	0	13	95.25	116	58	4.5	0	286.75

Stability Class E

Wind Direction	Wind Speed							
	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.75	11	7.5	0.5	0	0	20.75
NNE	0	3.75	33	32.25	17	0	0	86
NE	0	6.25	28.75	4.25	0	0	0	39.25
ENE	0	5.5	10	2.75	0	0	0	18.25
E	0	2.75	6.75	0.75	0	0	0	10.25
ESE	0	3.25	5	0	0	0	0	8.25
SE	0	1.5	4.75	1.5	0.75	0	0	8.5
SSE	0	1.75	11.5	6.5	2.5	0.75	0	23
S	0	3.5	13	16.25	3.5	0	0	36.25
SSW	0	2.25	19.75	11	0.25	0	0	33.25
SW	0	2.75	6.5	1.75	2.25	0	0	13.25
WSW	0	3.5	6.25	1.75	1.75	0	0	13.25
W	0	0.75	8	2.75	0.25	0	0	11.75
WNW	0	2.25	5.25	1.75	0.75	0	0	10
NW	0	1.75	5.75	0	1	0	0	8.5
NNW	0	2.75	7.25	8.25	0.25	0	0	18.5
TOTAL	0	46	182.5	99	30.75	0.75	0	359

Stability Class F

Wind Direction	Wind Speed							
	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.75	15.25	6.5	0	0	0	23.5
NNE	0	1.5	16	13.25	4.25	0	0	35
NE	0	5.75	13.5	3.25	0	0	0	22.5
ENE	0	3.5	4.25	0	0	0	0	7.75
E	0	5.25	3	0	0	0	0	8.25
ESE	0	3	3.25	0	0	0	0	6.25
SE	0	3.5	4.75	0.25	0	0	0	8.5
SSE	0	3.75	15	13.25	1.25	0	0	33.25
S	0	3.75	20	10.5	0.75	0	0	35
SSW	0	7.75	24.75	4.5	0	0	0	37
SW	0	4.5	7.75	2.25	0	0	0	14.5
WSW	0	3.75	6.75	0.5	0	0	0	11
W	0	2	7.75	0	0	0	0	9.75
WNW	0	1.5	7.5	3.5	0.5	0	0	13
NW	0	2.25	2.75	0.5	0	0	0	5.5
NNW	0	0.75	18.5	1.75	0	0	0	21
TOTAL	0	54.25	170.75	60	6.75	0	0	291.75

Stability Class G

Wind Speed

	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0.25	6.75	5.5	0.25	0	0	0	12.75
NNE	0.25	7.75	7	6.75	4.25	0	0	26
NE	0.25	6.5	16	7.25	0	0	0	30
ENE	0	6.25	6.25	0	0	0	0	12.5
E	0	6	2.75	0	0	0	0	8.75
ESE	0.25	4.5	6	1	0	0	0	11.75
SE	0	6.25	14.75	1.25	0.25	0	0	22.5
SSE	0	4.5	64.75	32.75	4.75	0.25	0	107
S	0	9	55.75	39.25	2.25	0	0	106.25
SSW	0.25	12.5	19.25	1	0.25	0	0	33.25
SW	0	13.75	14	1	0	0	0	28.75
WSW	0.25	12	20	0.5	0	0	0	32.75
W	0	5.75	13.25	3.5	0	0	0	22.5
WNW	0	6.25	8.75	3.25	0.25	0	0	18.5
NW	0	11	5.25	0.5	0	0	0	16.75
NNW	0	9.25	6	1	0	0	0	16.25
TOTAL	1.5	128	265.25	99.25	12	0.25	0	506.25

Third Quarter 2013

Stability Class A

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.5	7.75	10.5	2.25	0	0	21
NNE	0	0.25	13.75	39	7	0	0	60
NE	0	0	17.25	5.5	0	0	0	22.75
ENE	0	1.75	8.5	0.5	1.75	0	0	12.5
E	0	0.75	68	22	0	0	0	90.75
ESE	0	0.5	3.5	0.25	0	0	0	4.25
SE	0	1.25	14.5	6	0	0	0	21.75
SSE	0	0.75	8.25	12.25	8.5	0	0	29.75
S	0	0.25	4	9.75	3	0	0	17
SSW	0	0	4.75	5.75	0	0	0	10.5
SW	0	0.25	9	7.25	0	0	0	16.5
WSW	0	1	7.75	9.5	4	0	0	22.25
W	0	0.75	11.25	8.25	0.5	0	0	20.75
WNW	0	1	16.25	13.25	0.25	0	0	30.75
NW	0	0.75	9.75	13.75	0	0	0	24.25
NNW	0	0.25	15.5	11.25	0.25	0	0	27.25
TOTAL	0	10	219.75	174.75	27.5	0	0	432

Stability Class B

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0.5	2.5	0.5	0	0	3.5
NNE	0	1	4	5.25	1.25	0.25	0	11.75
NE	0	0	3.75	0	0	0	0	3.75
ENE	0	0.25	6	0	0	0	0	6.25
E	0	0	19.25	8.25	0	0	0	27.5
ESE	0	1.25	1.25	0	0	0	0	2.5
SE	0	0.25	1.25	0.5	0	0	0	2
SSE	0	1	1.75	1.25	2	0	0	6
S	0	0	0.25	5.75	0.25	0	0	6.25
SSW	0	0	1	2	0	0	0	3
SW	0	0	1.75	0.5	0	0	0	2.25
WSW	0	0	2.25	1	0.5	0	0	3.75
W	0	0	3.25	1	0.25	0	0	4.5
WNW	0	0	5	1.75	0	0	0	6.75
NW	0	0.25	1.75	1.5	0	0	0	3.5
NNW	0	0.25	1.75	1.5	0	0	0	3.5
TOTAL	0	4.25	54.75	32.75	4.75	0.25	0	96.75

Stability Class C

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	0.75	6.25	0.25	0	0	7.5
NNE	0	0.75	3	5.75	0	0	0	9.5
NE	0	0.25	2.25	0	0	0	0	2.5
ENE	0	0	4.25	1.75	0.25	0	0	6.25
E	0	0.75	5	9.75	1.25	0	0	16.75
ESE	0	2.5	3	0.75	0	0	0	6.25
SE	0	1	7.75	1.5	0	0	0	10.25
SSE	0	1	3	7.75	1.75	0	0	13.5
S	0	0.25	1.25	3.75	1.25	0	0	6.5
SSW	0	0.25	2.25	0.25	0	0	0	2.75
SW	0	0	0.75	0.5	0	0	0	1.25
WSW	0	0	0.75	0.75	0.5	0	0	2
W	0	0	1	0	0	0	0	1
WNW	0	0	2.75	1.25	0.25	0.25	0	4.5
NW	0	0.25	2.75	0.25	0	0	0	3.25
NNW	0	0	1.75	2	0	0	0	3.75
TOTAL	0	7.25	42.25	42.25	5.5	0.25	0	97.5

Stability Class D

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.5	6.75	5.5	0.25	0	0	13
NNE	0	0.5	6	11.75	1.5	0	0	19.75
NE	0	1	4.75	0	0	0	0	5.75
ENE	0	2.25	2.75	0.25	0.25	0	0	5.5
E	0	1.25	5.5	2.75	0.25	0	0	9.75
ESE	0	2.25	3.5	40.25	0	0	0	46
SE	0	1.5	14	0.75	0	0	0	16.25
SSE	0	3.25	10.75	17	0.75	0	0	31.75
S	0	1.5	6.5	15	0.5	0	0	23.5
SSW	0	1	11	3	0	0	0	15
SW	0	3.25	3.5	0.5	0	0	0	7.25
WSW	0	3.25	4	0.75	2.25	0	0	10.25
W	0	1.75	3	2	1.25	0	0	8
WNW	0	2.5	5.5	1	0	0	0	9
NW	0	0.5	4.25	1.5	0.5	0	0	6.75
NNW	0	1	7.5	4.25	0	0	0	12.75
TOTAL	0	27.25	99.25	106.25	7.5	0	0	240.25

Stability Class E

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1.75	7	2	0	0	0	10.75
NNE	0	1.5	7.25	5.75	0.25	0	0	14.75
NE	0	2	4.75	0.25	0	0	0	7
ENE	0	2	3.5	0	0	0	0	5.5
E	0	2.5	3	0	0	0	0	5.5
ESE	0	0.5	6	77.25	0	0	0	83.75
SE	0	2	8.5	7.75	0	0	0	18.25
SSE	0	5.75	19.25	25.5	10.5	0	0	61
S	0	5	25.5	21.75	3.75	0.75	0	56.75
SSW	0	4	33.75	8.5	0	0	0	46.25
SW	0	3.5	11.25	2.75	0	0	0	17.5
WSW	0	1.75	6	5.25	0	0	0	13
W	0	1.25	6.75	3.5	0	0	0	11.5
WNW	0	0.75	4.25	1.5	0	0	0	6.5
NW	0	1.25	7.25	0.5	0	0	0	9
NNW	0	1.5	12.5	12.25	0.25	0	0	26.5
TOTAL	0	37	166.5	174.5	14.75	0.75	0	393.5

Stability Class F

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	2.5	6.5	0.25	0	0	0	9.25
NNE	0	1.5	1.25	0	0	0	0	2.75
NE	0	2	4.75	0	0	0	0	6.75
ENE	0	1.5	6	0	0	0	0	7.5
E	0	1.5	1.25	0	0	0	0	2.75
ESE	0	0.5	0.75	0	0	0	0	1.25
SE	0	1.5	2.25	101.25	0	0	0	105
SSE	0	2	10	4.5	6.25	0	0	22.75
S	0	9	26	9	2	0	0	46
SSW	0	11.5	25	0.75	0	0	0	37.25
SW	0	4.5	8.75	0.5	0	0	0	13.75
WSW	0	5	11	3.75	0	0	0	19.75
W	0	2.5	7.25	0.75	0	0	0	10.5
WNW	0	2	10.5	0	0	0	0	12.5
NW	0	1.5	4.75	0	0	0	0	6.25
NNW	0	3	8.25	2.25	0	0	0	13.5
TOTAL	0	52	134.25	123	8.25	0	0	317.5

Stability Class G

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	10.75	3	0	0	0	0	13.75
NNE	0.25	2.5	0.75	0	0	0	0	3.5
NE	0	1.25	0.25	0	0	0	0	1.5
ENE	0.25	1.25	0	0	0	0	0	1.5
E	0.5	0.75	0	0	0	0	0	1.25
ESE	0.25	3.5	1.25	0	0	0	0	5
SE	0	5.5	5	13.25	0	0	0	23.75
SSE	0	7.25	30.25	96	3.25	0	0	136.75
S	0	12.75	46	16.75	0.75	0	0	76.25
SSW	0	13.75	25.25	0.25	0	0	0	39.25
SW	0	21	27.25	0.25	0	0	0	48.5
WSW	0	49	32.5	0	0	0	0	81.5
W	0.25	28	48.25	0	0	0	0	76.5
WNW	0	15	33.5	0	0	0	0	48.5
NW	0.25	13.5	23.25	0	0	0	0	37
NNW	0.5	17	17	0	0	0	0	34.5
TOTAL	2.25	202.75	293.5	126.5	4	0	0	629

Fourth Quarter 2013

Stability Class A

Wind Direction	Wind Speed							
	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	8.75	33.75	8.25	0	0	50.75
NNE	0	0.25	2.5	8.75	13.75	6.25	0	31.5
NE	0	0.25	2	5.5	8.25	0	0	16
ENE	0	0	2	0.75	6.5	0	0	9.25
E	0	0.75	6	7	10.25	0	0	24
ESE	0	1.5	2	10.75	4.5	0	0	18.75
SE	0	0	4.25	3.25	0	0	0	7.5
SSE	0	0	2.75	7	6	13.25	0.5	29.5
S	0	0	6.25	16	10.25	8	0	40.5
SSW	0	0.25	13	5.75	0	0	0	19
SW	0	0.25	13.25	11	13.5	2	0	40
WSW	0	0.5	17.75	15.5	4.5	0	0	38.25
W	0	0.5	21.5	51.5	22.25	0.25	0	96
WNW	0	0.75	9	43.5	9.75	1	0	64
NW	0	1.25	8.75	17	13	0	0	40
NNW	0	0	16	21.5	16	0	0	53.5
TOTAL	0	6.25	135.75	258.5	146.75	30.75	0.5	578.5

Stability Class B

Wind Direction	Wind Speed							
	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0.75	4.25	3	0	0	8
NNE	0	0	0	1.75	1	0.75	0	3.5
NE	0	0	0.25	0.5	0	0	0	0.75
ENE	0	0.25	0	0.25	0	0	0	0.5
E	0	0.75	1	0	1.25	0	0	3
ESE	0	0.25	2	2	0	0	0	4.25
SE	0	0	0.25	0	0	0	0	0.25
SSE	0	0	0	0	0.25	1	0	1.25
S	0	0	1	5	0.25	1	0	7.25
SSW	0	0	1.25	7.75	1	0	0	10
SW	0	0	6.25	5	2	0	0	13.25
WSW	0	0	10.25	10.5	3.75	0	0	24.5
W	0	0	8	16.75	3.5	3.5	0	31.75
WNW	0	0	3.25	16	2	0	0	21.25
NW	0	0.25	3	3	0.75	0.25	0	7.25
NNW	0	0.25	6.5	7	4.25	0	0	18
TOTAL	0	1.75	43.75	79.75	23	6.5	0	154.75

Stability Class C

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0	0.25	6	2.25	0	0	8.5
NNE	0	0	0.25	1.75	0.75	0.25	0	3
NE	0	0	0.5	0	0	0	0	0.5
ENE	0	0	0	0.75	0	0	0	0.75
E	0	0.5	0.25	0.25	0	0	0	1
ESE	0	0.25	2.75	0.75	0.25	0.25	0	4.25
SE	0	0	0.5	1.25	0	0	0	1.75
SSE	0	0	0.75	0.75	0.5	0.75	0	2.75
S	0	0	0.75	2.25	2.75	0	0	5.75
SSW	0	0.5	4	3	0	0	0	7.5
SW	0	0.25	3.5	1.5	4.25	0	0	9.5
WSW	0	1.75	6.5	5.5	2.75	0	0	16.5
W	0	0.75	7.25	8.25	4.5	0.5	0	21.25
WNW	0	0.5	4.25	12	1.25	0	0	18
NW	0	0.75	4.5	4.25	0.5	0	0	10
NNW	0	1	4	8.5	3.5	0	0	17
TOTAL	0	6.25	40	56.75	23.25	1.75	0	128

Stability Class D

Wind Speed

Wind Direction	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.25	3.75	1.5	6	0	0	11.5
NNE	0	0.25	0.5	8.75	4.25	1.5	0.5	15.75
NE	0	0	0.75	0.5	1.25	0	0	2.5
ENE	0	0	2.75	4.75	0	0	0	7.5
E	0	0.25	5	3.25	0	0	0	8.5
ESE	0	1.25	3.5	4	1.5	0.25	0	10.5
SE	0	0	3.25	2.5	6.25	1.25	0	13.25
SSE	0	0	2.5	7.5	6	1.5	0.5	18
S	0	0	4	9.5	12.25	7	1.5	34.25
SSW	0	0	13.75	17	1.25	0	0	32
SW	0	1.25	8.75	4.25	4.25	0.5	0	19
WSW	0	1.75	14.25	10	2	1.25	0	29.25
W	0	1.75	18	38.75	13	0	0	71.5
WNW	0	1.75	27.5	25.25	5.25	0	0	59.75
NW	0	1.5	12.5	12.5	4	0	0	30.5
NNW	0	0.5	15.5	23.25	10	0	0	49.25
TOTAL	0	10.5	136.25	173.25	77.25	13.25	2.5	413

Stability Class E

Wind Direction	Wind Speed							
	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	0.75	6.5	2.75	2	0	0	12
NNE	0	1	1.25	3.5	5.5	1.5	0	12.75
NE	0	0.75	0	0	0	0	0	0.75
ENE	0	0.5	1.75	0.25	0	0	0	2.5
E	0	1	3	3.75	0	0	0	7.75
ESE	0	0.75	0.75	0.5	0	0	0	2
SE	0	0.75	2	1.5	0	0	0	4.25
SSE	0	1.5	11.75	10.25	0.5	0	0	24
S	0	0.25	11.25	15.25	1.75	0	0	28.5
SSW	0	0	23.5	7.25	0	0	0	30.75
SW	0	2	15.75	15.75	5.75	0	0	39.25
WSW	0	4.5	22.5	22.25	4.75	0	0	54
W	0	4.5	33.25	22.75	3	0	0	63.5
WNW	0	3.5	29.25	21.5	3.25	0	0	57.5
NW	0	2.25	7.25	8	0	0	0	17.5
NNW	0	1.75	6.25	9.75	3	0	0	20.75
TOTAL	0	25.75	176	145	29.5	1.5	0	377.75

Stability Class F

Wind Direction	Wind Speed							
	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	3.25	4.75	0	0	0	0	8
NNE	0	2.75	1.75	1.5	1.25	0	0	7.25
NE	0	1.5	3.25	0	0	0	0	4.75
ENE	0	2.25	0.5	0.5	0	0	0	3.25
E	0	1	0.75	1.25	0	0	0	3
ESE	0	1	3.75	1.75	0	0	0	6.5
SE	0	1.5	1.25	1.25	0	0	0	4
SSE	0	0.75	5	11.25	0	0	0	17
S	0	0.75	8.5	4.5	1.25	0	0	15
SSW	0	2	18	0.25	0	0	0	20.25
SW	0	1.75	8.5	0.5	0	0	0	10.75
WSW	0	4	18.5	5.5	0	0	0	28
W	0	1.25	21.75	7.75	0	0	0	30.75
WNW	0	1	21	11.25	0	0	0	33.25
NW	0	7.75	13.25	2.75	0	0	0	23.75
NNW	0	5	12.5	6.5	0	0	0	24
TOTAL	0	37.5	143	56.5	2.5	0	0	239.5

APPENDIX A
Kewaunee Power Station 2013 Meteorological Data

Stability Class G

Wind Direction	Wind Speed							
	CALM	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	5	6.75	0	0	0	0	11.75
NNE	0	3.5	0.75	0	0	0	0	4.25
NE	0	3	4	0	0	0	0	7
ENE	0	1.25	1.75	0.25	0	0	0	3.25
E	0	1.5	0.75	0.75	0	0	0	3
ESE	0	2	2.5	0.75	0	0	0	5.25
SE	0	1.25	1.5	0.5	0	0	0	3.25
SSE	0	3	8.75	2.25	0	0	0	14
S	0	4.5	10	0.25	0	0	0	14.75
SSW	0	6.25	9.75	0	0	0	0	16
SW	0	4	10	0	0	0	0	14
WSW	0	10.5	50.5	0	0	0	0	61
W	0	6.75	33.5	0.5	0	0	0	40.75
WNW	0	4.25	32.75	0.5	0	0	0	37.5
NW	0	3.75	11.75	8.25	0	0	0	23.75
NNW	0	5	3.75	0.75	0	0	0	9.5
TOTAL	0	65.5	188.75	14.75	0	0	0	269

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Appendix B

Kewaunee Power Station

Offsite Dose Calculation Manual (ODCM)

Revision 15
June 6, 2013

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Dominion Energy Kewaunee, Inc.

Kewaunee Power Station

OFFSITE DOSE CALCULATION MANUAL (ODCM)

SUPERSEDED

Revision 15
DATE: June 6, 2013

Approved By:	James M. Hale Manager - Radiological Protection and Chemistry	06-04-2013 Date
Approved By:	Richard P. Repshas Manager - Regulatory Affairs	06-04-2013 Date
Reviewed By:	Jeffrey T. Stafford Facility Safety Review Committee	06-04-2013 Date
Approved By:	A. J. Jordan Site Vice President	06-06-2013 Date

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PART II CALCULATIONAL METHODOLOGIES

Kewaunee Power Station

Offsite Dose Calculation Manual

PART I - RADIOACTIVE EFFLUENT CONTROLS

SUPERSEDED

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.

SUPERSEDED

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 facility. 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

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13.0 USE AND APPLICATION

13.0.5 ODCM Normal Condition (DNC) Applicability

DNC 13.0.5.1 DNCs shall be met during the 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; and
- Conservatism and margins.

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.

SUPERSEDED

13.0 USE AND APPLICATION

13.0.6 ODCM VERIFICATION REQUIREMENTS (DVR) Applicability

DVR 13.0.6.1 DVRs shall be met during the 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 x 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 (g)	Each Batch (g)	1×10^{-6} μCi/ml
	b.	I-131	Grab Sample	Each Batch (g)	Each Batch (g)	1×10^{-6} μCi/ml
	c.	Dissolved and Entrained Gases (gamma emitters)	Grab Sample	Each Batch (g)	31 days	1×10^{-5} μCi/ml
	d.	H-3	Composite (d)	Each Batch (g)	31 days	1×10^{-5} μCi/ml
	e.	Gross Alpha	Composite (d)	Each Batch (g)	31 days	5×10^{-7} μCi/ml
	f.	Sr-89	Composite (d)	Each Batch (g)	92 days	5×10^{-8} μCi/ml
	g.	Sr-90	Composite (d)	Each Batch (g)	92 days	5×10^{-8} μCi/ml
	h.	Fe-55	Composite (d)	Each Batch (g)	92 days	1×10^{-6} μCi/ml
2. Continuous Releases (e) (SG Blowdown) (TB Sump)						
	a.	Principal Gamma Emitters (c)	Grab Sample	7 days	7 days	5×10^{-7} μCi/ml
	b.	I-131	Grab Sample	7 days	7 days	1×10^{-6} μCi/ml
	c.	Dissolved and Entrained Gases (gamma emitters)	Grab Sample	7 days	7 days	1×10^{-5} μCi/ml
	d.	H-3	Grab Sample	7 days	31 days(f)	1×10^{-5} μCi/ml
	e.	Gross Alpha	Composite (f)	7 days	31 days(f)	5×10^{-7} μCi/ml
	f.	Sr-89	Composite (f)	7 days	92 days(f)	5×10^{-8} μCi/ml
	g.	Sr-90	Composite (f)	7 days	92 days(f)	5×10^{-8} μCi/ml
	h.	Fe-55	Composite (f)	7 days	92 days(f)	1×10^{-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:

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

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) Complete prior to each release.

SUPERSEDED

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).

SUPERSEDED

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

SUPERSEDED

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 facility (including outside storage tanks, etc.).	Immediately
	<u>AND</u>	
	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 13.1.2.1	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.

SUPERSEDED

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, except for the parts of the system taken permanently out of service.

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 facility 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.

SUPERSEDED

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
	AND	
	A.2 Initiate measures to reduce content to within the limits.	48 hours
	AND	
	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

SUPERSEDED

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 UNRESTRICTED 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

SUPERSEDED

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

SUPERSEDED

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 and Chemical and Volume Control System Holdup 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

SUPERSEDED

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:

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

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.

SUPERSEDED

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).

SUPERSEDED

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 facility 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 facility (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

SUPERSEDED

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

SUPERSEDED

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

SUPERSEDED

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 facility (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

SUPERSEDED

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, except for the parts of the system taken permanently out of service.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Radioactive gaseous waste is being discharged without treatment. AND Projected doses due to the gaseous effluent, from the facility, 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

SUPERSEDED

VERIFICATION REQUIREMENTS

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

SUPERSEDED

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, except when the tank is taken permanently out of service.

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

SUPERSEDED

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

SUPERSEDED

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
	<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

SUPERSEDED

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 1×10^{-6} µCi/ml.	At least once every 24 hours with identified primary to secondary leakage (with secondary side activity > 1×10^{-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 1×10^{-6} µCi/ml.	Once per 12 hours

SUPERSEDED

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

SUPERSEDED

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

SUPERSEDED

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: During release via the monitored pathway.

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
	OR	
	A.2 Declare the channel non-functional.	Immediately
	OR	
	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 and Chemical and Volume Control System Holdup Tanks 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

SUPERSEDED

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			DVR 13.3.2.1 DVR 13.3.2.4
a. Noble Gas Activity Monitor (R-13 or R-14)	1	C	DVR 13.3.2.6 DVR 13.3.2.7
2. Condenser Evacuation System			DVR 13.3.2.2 DVR 13.3.2.5
a. Noble Gas Activity (R-15)	1	D	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			DVR 13.3.2.2
a. Noble Gas Activity Monitor (R-13 or R-14)	1	E	DVR 13.3.2.5 DVR 13.3.2.6 DVR 13.3.2.7
6. Containment Purge 36" line			DVR 13.3.2.2 DVR 13.3.2.4
a. Noble Gas Activity Monitor (R-12 or R-21)	1	E	DVR 13.3.2.6 DVR 13.3.2.7

SUPERSEDED

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.

SUPERSEDED

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 facility 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 facility remains within twice the dose design objectives of Appendix I, and if direct radiation doses from the facility 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.

SUPERSEDED

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.

SUPERSEDED

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.

SUPERSEDED

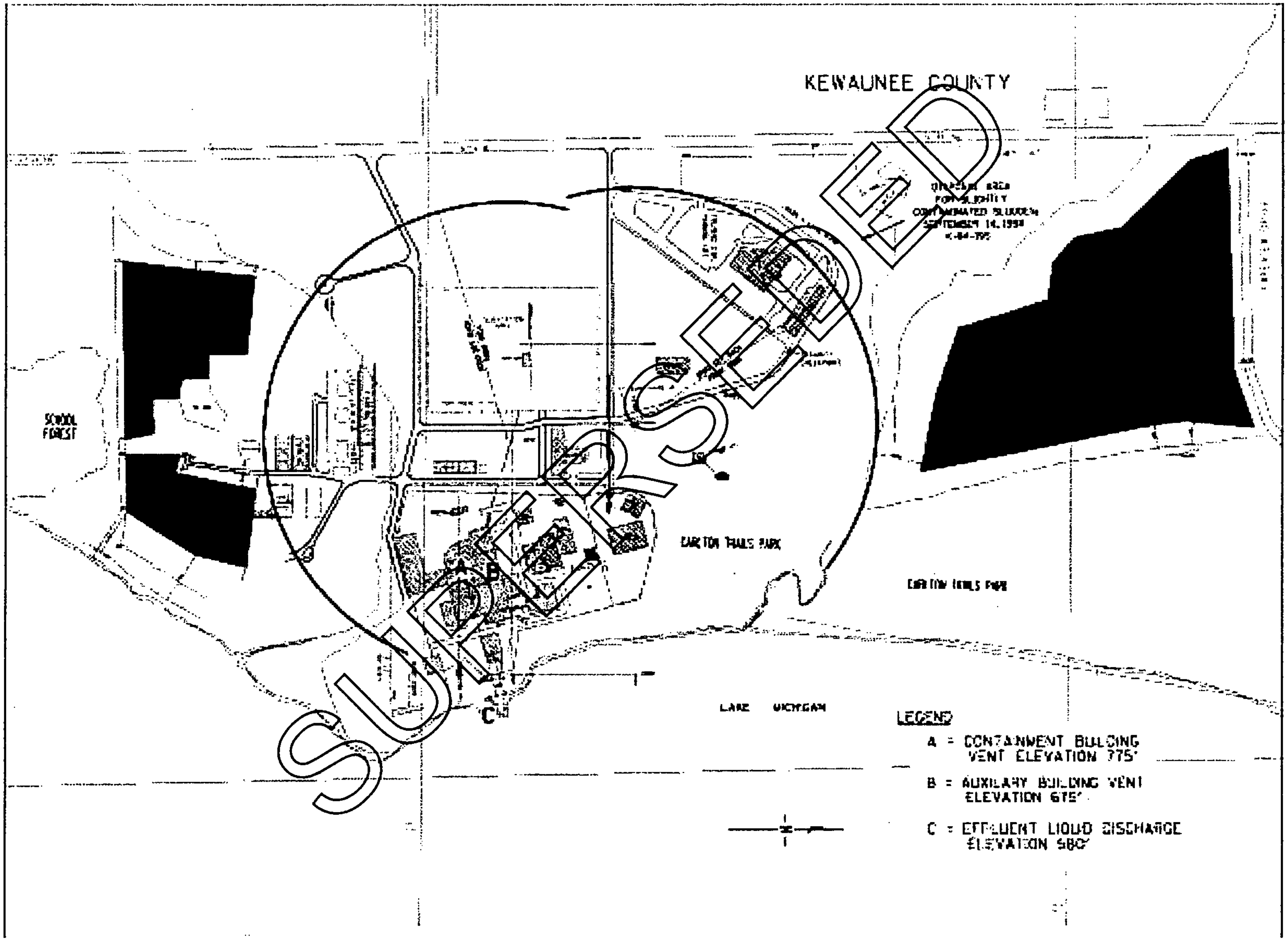
14.0 DESIGN FEATURES

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
SCHOOL FOREST
CARLTON TRAILS PARK
CARLTON TRAILS PARK
LAKE MICHIGAN
A
B
C
LEGEND
A = CONTAINMENT BUILDING VENT ELEVATION 775'
B = AUXILARY BUILDING VENT ELEVATION 675'
C = EFFLUENT LIQUID DISCHARGE ELEVATION 580'
SUPERSEDED

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.

SUPERSEDED

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 facility 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 facility during the previous calendar year.

d. An assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from facility 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).

SUPERSEDED

e. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the facility. 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

SUPERSEDED

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×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:

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

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:

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

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:

$$SP \le \frac{EC_e \times 10 \times SEN \times CW}{RR} + bkg \qquad (1.5)$$

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:

$$\sum[(C_i \div (10 \times EC_i)) \times (RR \div CW)] \le 1 \qquad (1.6)$$

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.

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

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)

SUPERSEDED

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:

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

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/l)
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

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

Maximum Organ

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

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.

SUPERSEDED

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

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

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

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

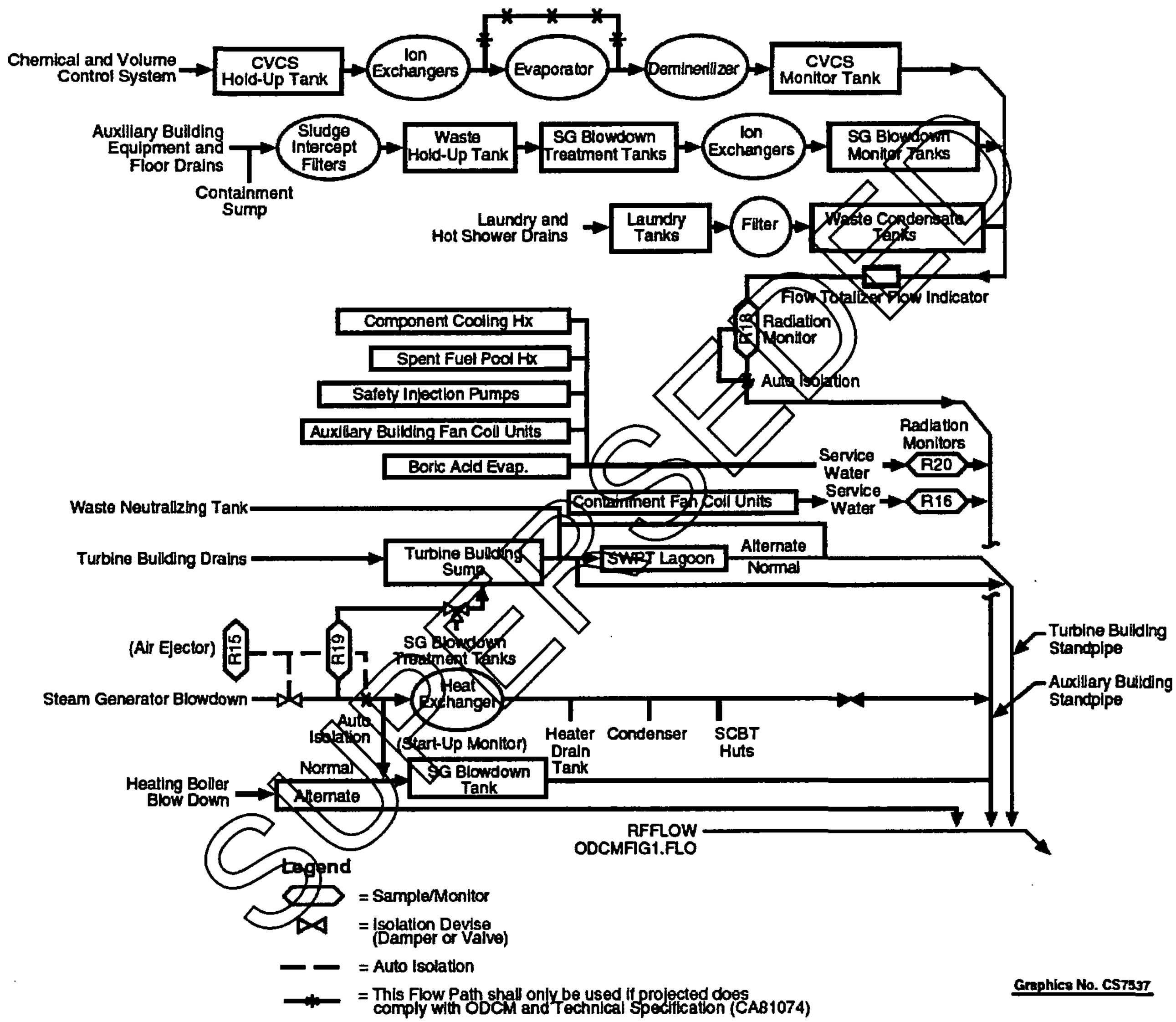
During the normal operation of Kewaunee, the potential exists for in-plant process streams, which are not normally radioactive to become contaminated with very low levels of radioactive materials. These waste streams are normally separated from the radioactive streams. However, due mainly to infrequent, 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.



ODCM FIGURE 1
LIQUID RADIOACTIVE EFFLUENT FLOW DIAGRAM

Table 1.1
Parameters for Liquid Alarm Setpoint Determinations

SUPERSEDED

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 R-19 R-20 R-16	 as determined as determined as determined as determined	 1.0E+08 1.0E+08 1.0E+08 9.8E+07	cpm per µCi/ml	Radwaste effluent Steam Generator blowdown Service Water – component cooling 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 R-19 R-20 R-16	 as determined as determined as determined as determined	 8.0E+01 2.0E+02 5.0E+03 1.5E+03	gpm	Determined prior to release; release rate can be adjusted for requirement compliance Steam Generator A and B combined Service Water – component cooling Service Water – Containment fan cooling
Background (bkg) R-18 R-19 R-20 R-16	 as determined as determined as determined as determined	 2.0E+03 8.0E+01 6.0E+01 8.0E+01	cpm	Nominal values only; actual values may be used in lieu of these reference values
Setpoint* (SP) R-18**** R-19**** R-20 R-16	 calculated calculated calculated calculated	 5.00E+05+bkg 5.00E+05+bkg 5.16E+04+bkg 1.68E+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.
Setpoint* (SP) with no Circulating Water System flow, CW=0				
R-18 R-19 R-20 R-16	calculated calculated calculated calculated	6.25E+04+bkg 2.50E+04+bkg 1.00E+03+bkg 3.26E+03+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.***

* 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	-	-	-	-	-	-	-

SUPERSEDED

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	5.69E-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

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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.

SUPERSEDED

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 Chemical and Volume Control System Hold-Up Tanks (CVCS HUTs) or held in the Waste Gas Decay Tanks (WGDTs) 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.

In some cases, the gas in the CVC HUTs will not be able to be complely depressurized to the WGDTs. CVCs HUTs will be isolated and discharged via the Auxiliary Building Vent. R-13 and/or R-14 provide noble gas monitoring, and additional administrative controls are required in lieu of automatic isolation.

During a planned release, the administrative controls include the presence of an operator in the Aux Building if R-13/R-14 levels are below 5,000 cpm. If levels are above 5,000 but below 10,000 cpm, an operator will be present at the valve MG(R)-519A, B, or C area, in communication with the Control Room, and will be directed to manually shut the valve if levels exceed 10,000 cpm.

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 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.

A gaseous radioactive waste flow diagram with the applicable, associated radiation monitoring instrumentation and controls is presented as Figure 2.

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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:

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

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

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/m³, from Table 2.3)
VF	=	ventilation system flow rate for the applicable release point and monitor (ft³/min, from Table 2.2)
C_i	=	concentration of noble gas radionuclide "i" as determined by radioanalysis of grab sample (µCi/cm³)
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)
4.72E+02	=	conversion factor (cm³/ft³ 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.

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[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

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

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:

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

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:

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

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

SUPERSEDED

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 ensure 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

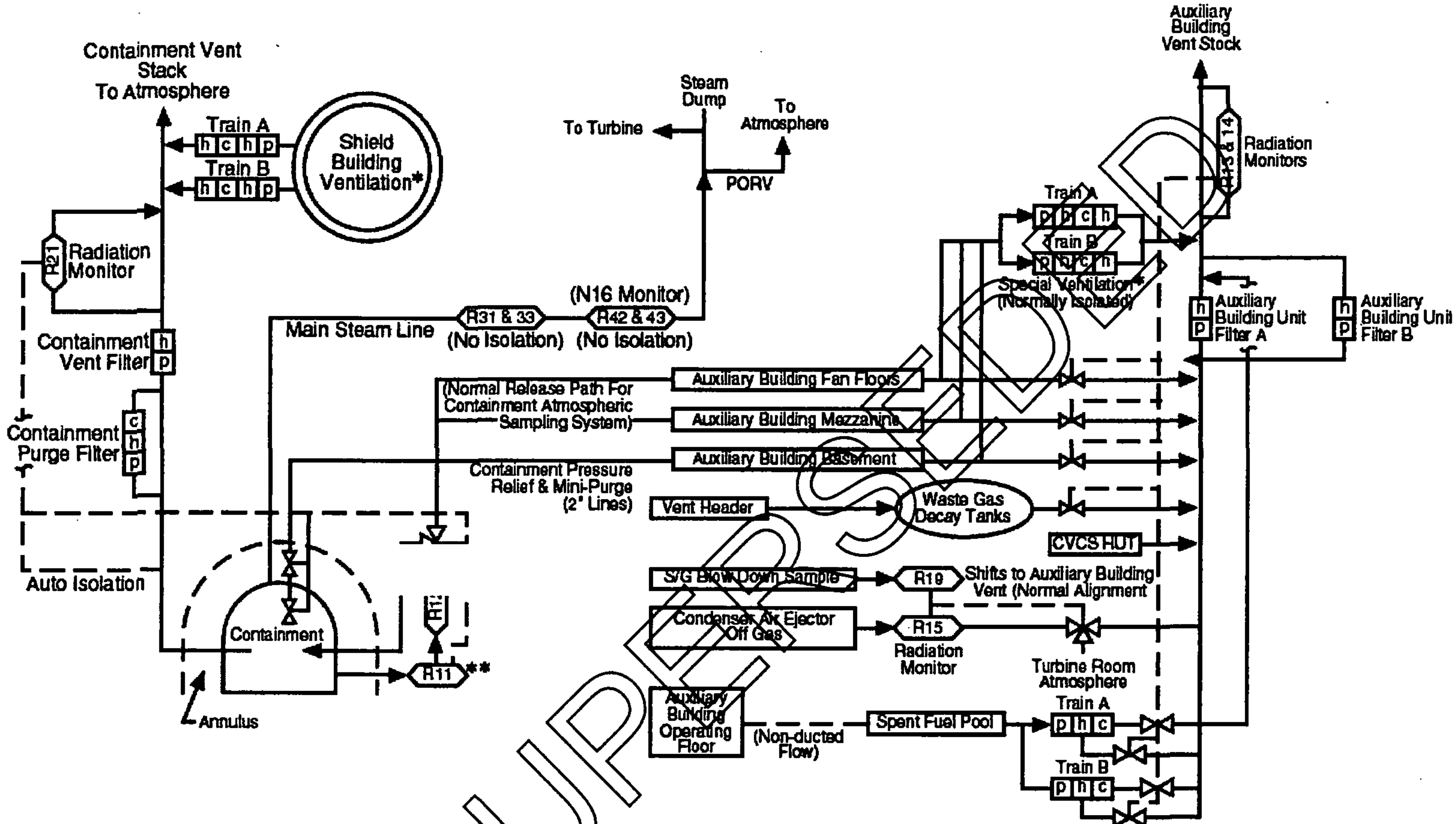
The purpose of this section is to describe the method used to calculate the cumulative dose contributions from liquid and gaseous effluents in accordance with KPS Technical Specifications for total dose. This method can also be used to demonstrate compliance with the Environmental Protection Agency (EPA)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



Legend

- ⬡ = Sample/Monitor
- ⋈ = Isolation Devise (Damper or Valve)
- = 3 Was Valve
- — — = Auto Isolation

p = Prefilter
h = HEPA Filter
c = Charcoal Filter

* 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.

Graphics No. CS7536

ODCM FIGURE 2
GASEOUS RADIOACTIVE EFFLUENT FLOW DIAGRAM

Figure 3
Simplified Heating Boiler Fuel Oil Piping System

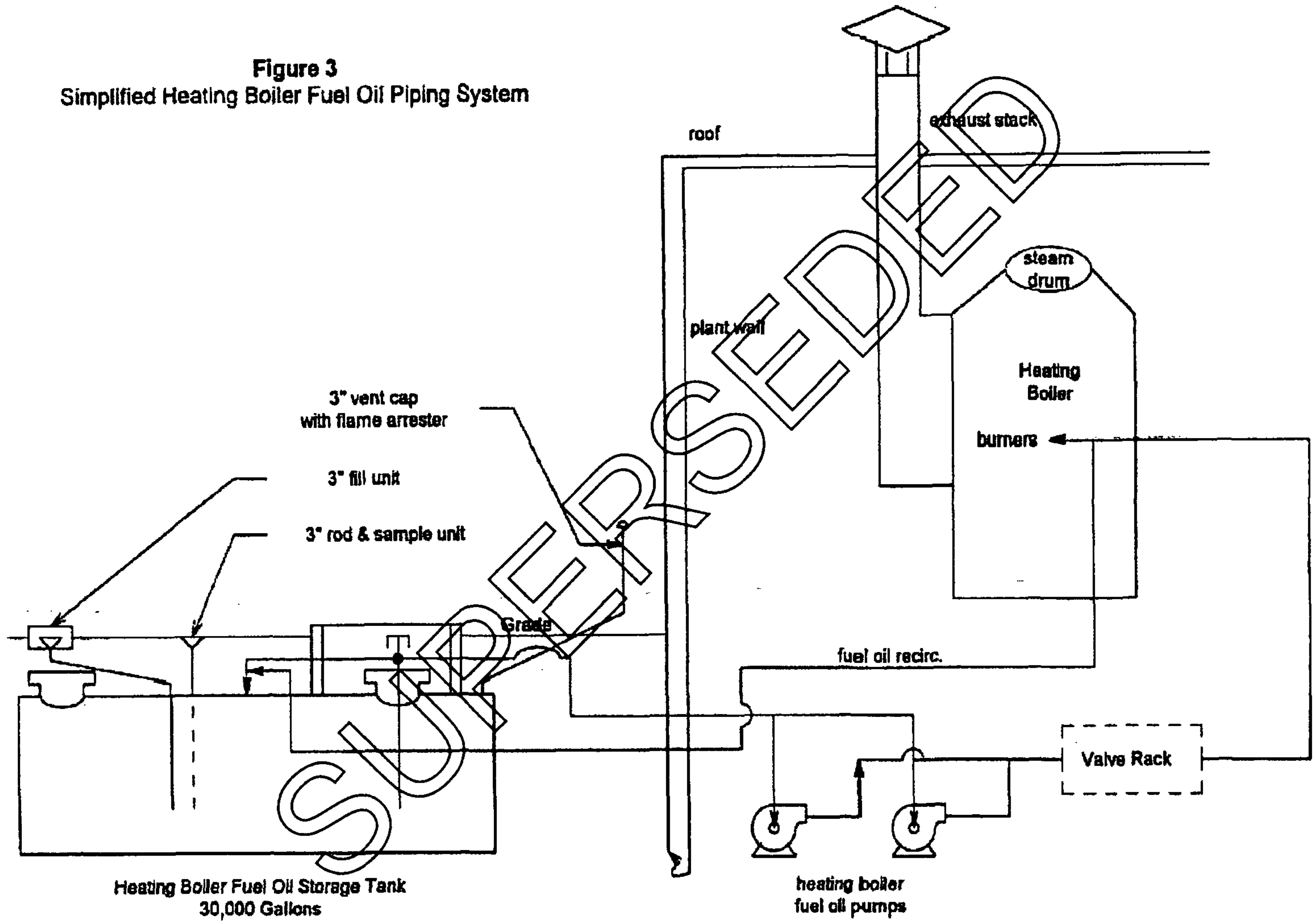


Table 2.1

Dose Factors for Noble Gases

Radionuclide	Total Body Dose Factor K_i (mrem/yr per μCi/m³)	Skin Dose Factor L_i (mrem/yr per μCi/m³)	Gamma Air Dose Factor M_i (mrad/yr per μCi/m³)	Beta Air Dose Factor N_i (mrad/yr per μCi/m³)
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 8.0E+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.

SUPERSEDED

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

SUPERSEDED

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

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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

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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

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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	1.06E+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

SUPERSEDED

Table 2.7 (Page 2 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
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 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	-	2.26E+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	-	-	-	-	-	-	-

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Table 2.8 (Page 2 of 2)

R_i Vegetation 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	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	2.96E-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

SUPERSEDED

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+6	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	-	-	-	-	-	-	-

SUPERSEDED

Table 2.9 (Page 2 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
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/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	-	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	1.81E+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	-	-	-	-	-	-	-

SUPERSEDED

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	2.19E+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

SUPERSEDED

Table 2.11 (Page 1 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
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	1.07E+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 (m² 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

SUPERSEDED

Table 2.12 (Page 1 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
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	-	-	-	-	-	-	-

SUPERSEDED

Table 2.12 (Page 2 of 2)

R_i Grass-Cow-Milk Pathway Dose Factors - TEEN

(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	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	-	-	8.66E+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

SUPERSEDED

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	-	-	-	-	-	-	-

SUPERSEDED

Table 2.13 (Page 2 of 2)

R_i Grass-Cow-Milk Pathway Dose Factors - CHILD

(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	4.29E+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

SUPERSEDED

Table 2.14 (Page 1 of 2)

R_i Grass-Cow-Milk Pathway Dose Factors - INFANT

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

SUPERSEDED

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

SUPERSEDED

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

SUPERSEDED

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 facility 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:

<u>Total Body</u>

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

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:

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

<u>Maximum Organ</u>

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

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 dose (compared with the maximum organ dose) for demonstrating compliance with ODCM Normal Condition 13.1.2.

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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

SUPERSEDED

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.

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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.

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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/m³)
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)
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:

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

and

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

The effective dose factors are used on a very limited basis for the purpose of facilitating the timely assessment of radioactive effluent releases, particularly during periods of computer malfunction where a detailed dose assessment may be unavailable. Dose assessments using the detailed, radionuclide dependent calculation are performed at least 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.

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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

SUPERSEDED

APPENDIX C

EVALUATION OF CONSERVATIVE, DEFAULT EFFECTIVE EC VALUE FOR LIQUID EFFLUENTS

SUPERSEDED

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 $2E10^{-4}$ 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

NRC 91-148

WPSC (414) 433-1598
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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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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

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(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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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

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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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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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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

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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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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.

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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.

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K 92-119
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.

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Sincerely,

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

Enclosure:
As stated

cc w/enclosure:
See next page

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Wisconsin Public Service Corporation   Kewaunee Nuclear Power Plant

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Chief Engineer
Wisconsin Public Service Commission
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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.

- 3 -

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).

SUPERSEDED

- 4 -

TABLE 3

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

REFERENCES

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

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

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

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

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

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

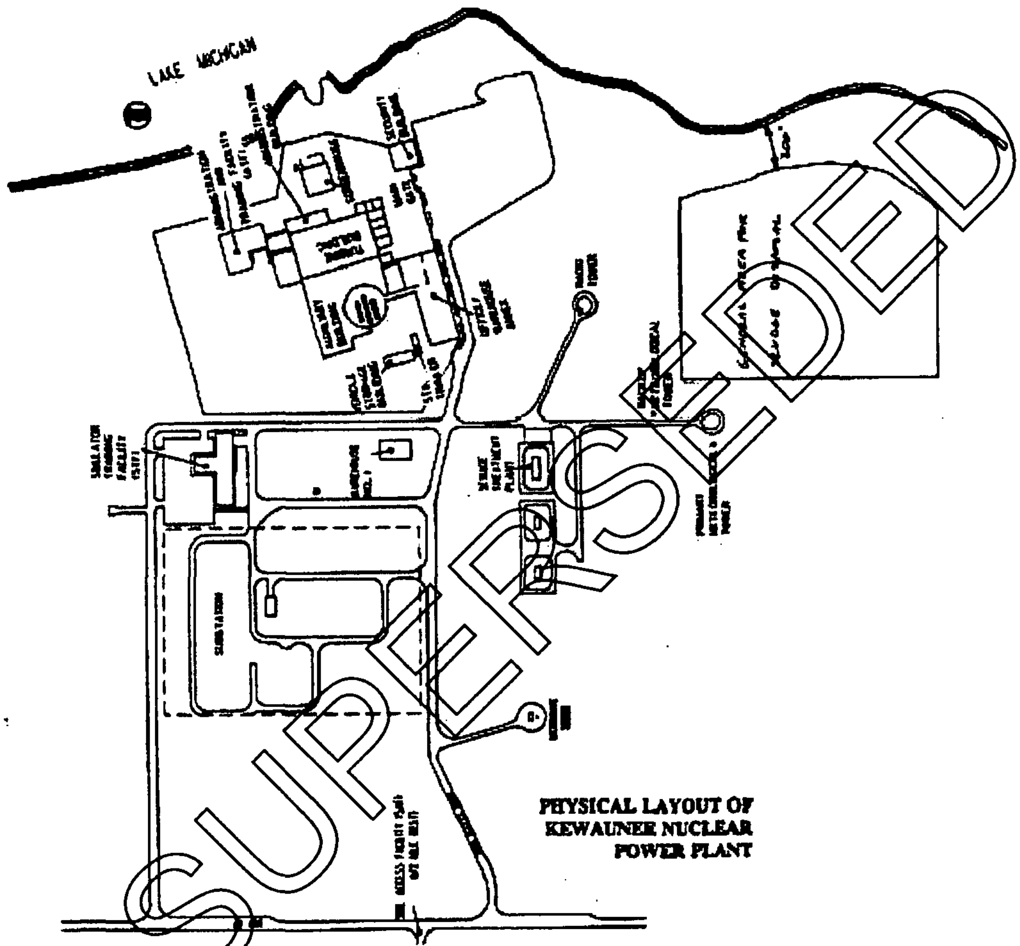
Principal Contributor: J. Minns

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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M W Seitz (WPL)
Larry Nielsen (ANFC)
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D E Cole KNP
K H Evers KNP
J P Gieseler KNP

K A [illegible] KNP
M L Marchi KNP
D L Masarik KNP
J N Morrison D1
L A Nuthals (NSRAC)
R P Pulec D2 (2)
C A Schrock D2

C S Smoker KNP
C R Steinhardt D2
C A Sternitzky KNP
T J Webb KNP
S F Wozniak D2
QA Vault KNP

Wisconsin Public Service Corporation Kewaunee Nuclear Power Plant

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P. O. Box 7854
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SUPERSEDED

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.

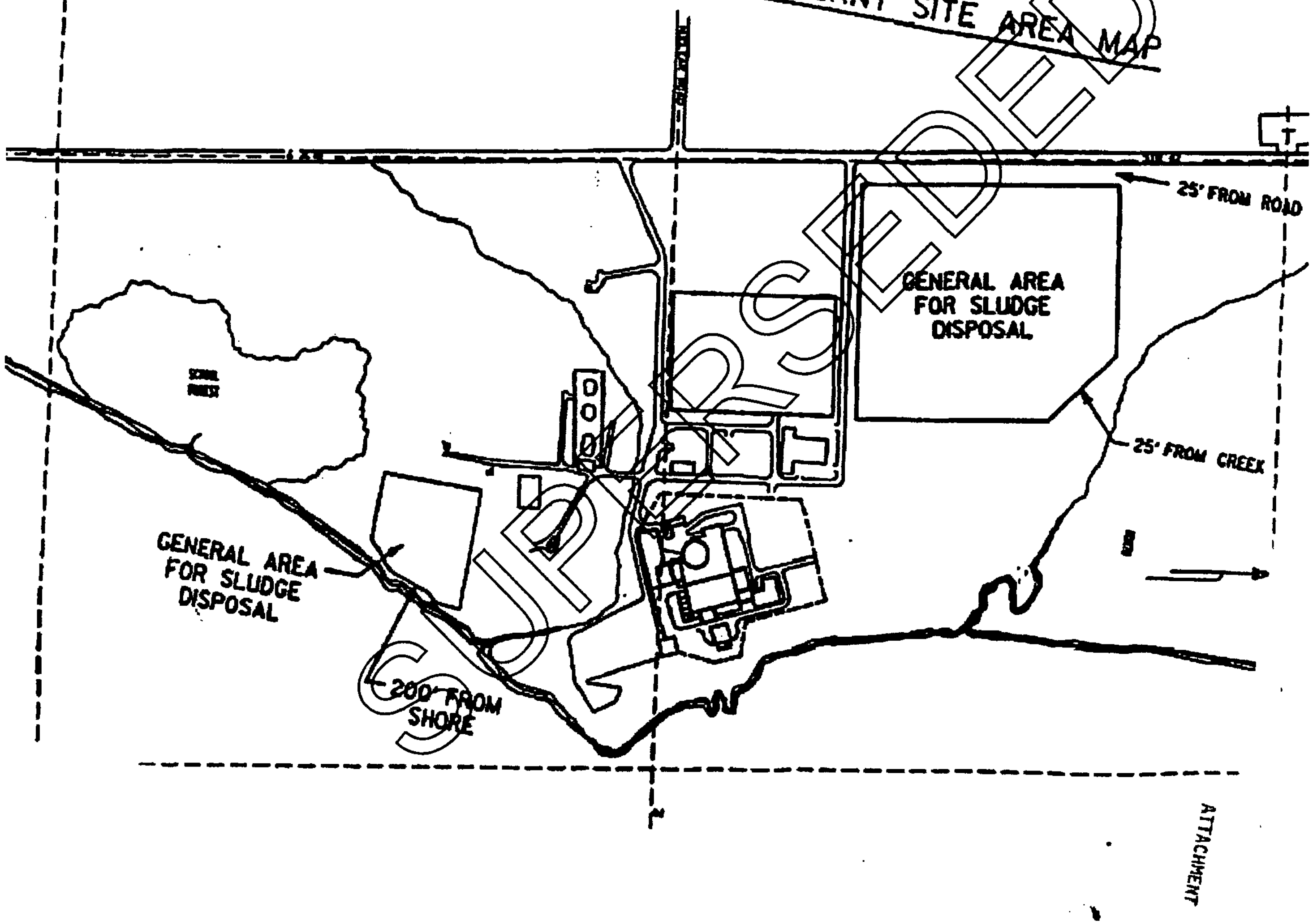
As stated in the NRC's June 17, 1992, approval of the licensee's 10 CFR 20.302 application, the licensee is required to permanently incorporate this modification into the Offsite Dose Calculation Manual as an Appendix, and that future modification of this commitment be reported to the NRC.

Principal Contributor: S. Klementowicz

Date: September 14, 1994

Attachment: KNPP Site Area Map

KEWAUNEE NUCLEAR POWER PLANT SITE AREA MAP



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

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

SUPERSEDED

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
Larry Nielsen (ANFC)	J K Jubin (NSRAC)	CA Sternitzky KNP(Lic)
D A Bollom G6	R P Pulec KNP (3)	S F Wozniak D2
D E Day D1	C A Schrock KNP	BJ Domnick KNP (Com)

Mr. M. L. Marchi
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 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

SUPERSEDED

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 (now 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.

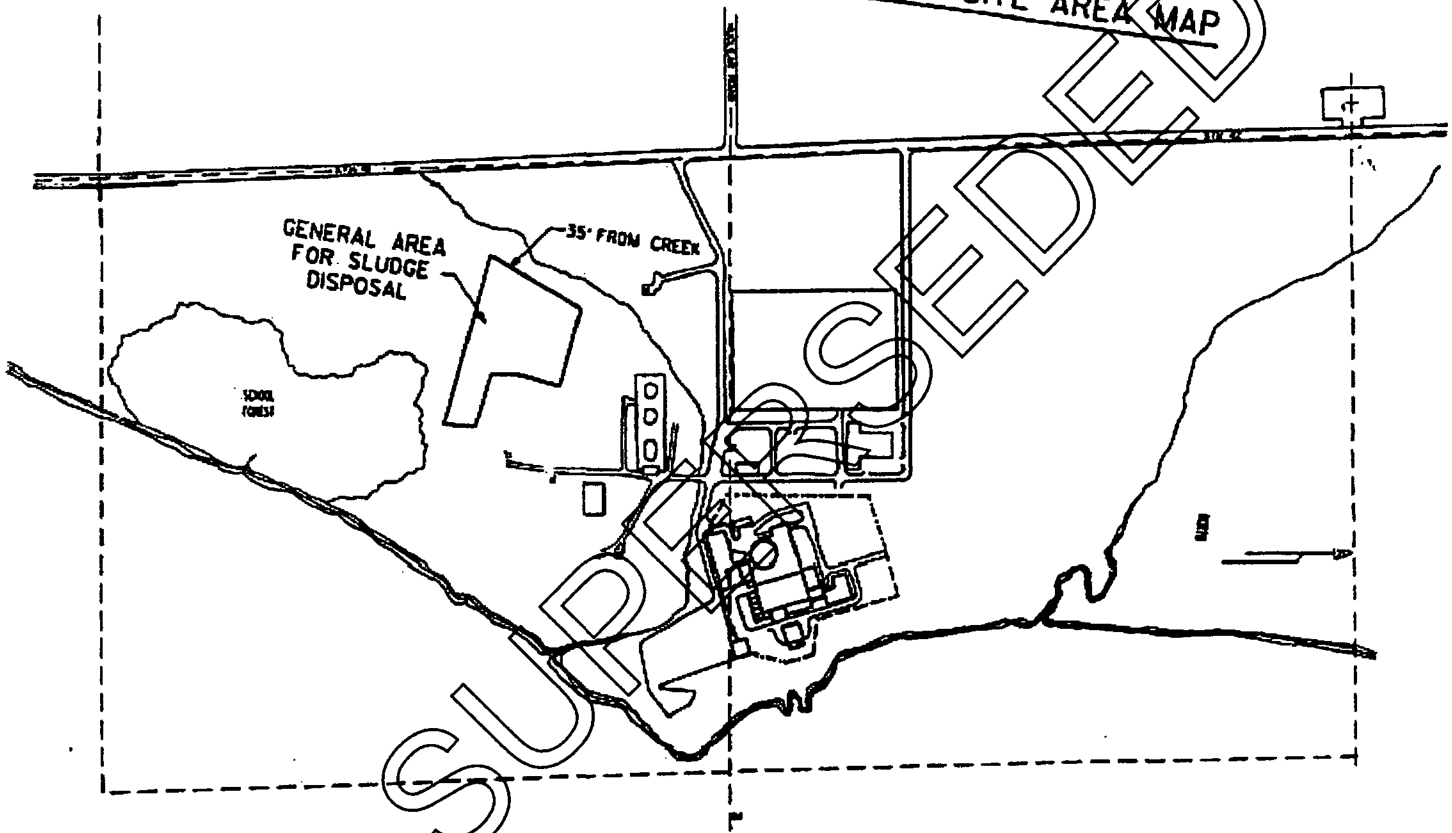
The licensee is required to permanently incorporate this modification into the Offsite Dose Calculation Manual as an Appendix, and to ensure that future modifications of these commitments are reported to the NRC.

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.

SUPERSEDED

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 L Marchi D2
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Wisconsin Public Service Corporation

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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

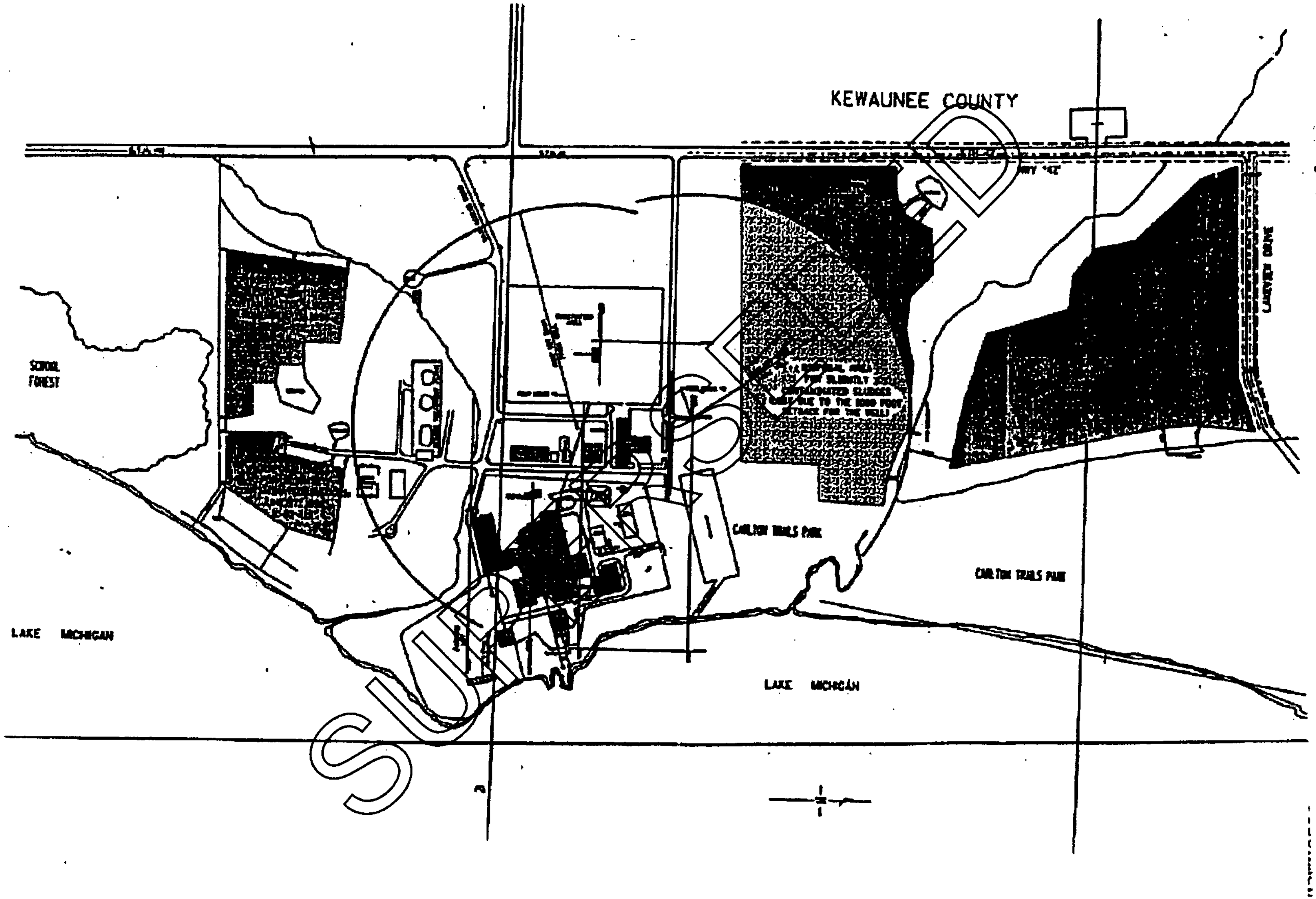
The staff agrees with the licensee's determination that additional onsite disposals of contaminated sludge, which are conducted within the bounding limits and conditions contained in the June 17, 1992, SE and within the areas specified in the attached site map, do not require specific NRC approval.

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
CARLTON TRAILS PARK
CARLTON TRAILS PARK
LAKE MICHIGAN
LAKE MICHIGAN
LAKEVIEW DRIVE

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Appendix C

Kewaunee Power Station

Offsite Dose Calculation Manual (ODCM)

Revision 16
December 5, 2013

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Dominion Energy Kewaunee, Inc.

Kewaunee Power Station

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Revision 16
DATE: December 5, 2013

Approved By:	James M. Hale Manager - Radiological Protection and Chemistry	12/04/2013 Date
Approved By:	Richard P. Repshas Manager - Regulatory Affairs	12/04/2013 Date
Reviewed By:	Jeffrey T. Stafford Facility Safety Review Committee	12/05/2013 Date
Approved By:	A. J. Jordan Site Vice President	12/05/2013 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 facility. 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 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; and
- Conservatism and margins.

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 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 (g)	Each Batch (g)	1×10^{-6} µCi/ml
	b.	I-131	Grab Sample	Each Batch (g)	Each Batch (g)	1×10^{-6} µCi/ml
	c.	Dissolved and Entrained Gases (gamma emitters)	Grab Sample	Each Batch (g)	31 days	1×10^{-5} µCi/ml
	d.	H-3	Composite (d)	Each Batch (g)	31 days	1×10^{-5} µCi/ml
	e.	Gross Alpha	Composite (d)	Each Batch (g)	31 days	5×10^{-7} µCi/ml
	f.	Sr-89	Composite (d)	Each Batch (g)	92 days	5×10^{-8} µCi/ml
	g.	Sr-90	Composite (d)	Each Batch (g)	92 days	5×10^{-8} µCi/ml
	h.	Fe-55	Composite (d)	Each Batch (g)	92 days	1×10^{-6} µCi/ml
2. Continuous Releases (e) (TB Sump)						
	a.	Principal Gamma Emitters (c)	Grab Sample	7 days	7 days	5×10^{-7} µCi/ml
	b.	I-131	Grab Sample	7 days	7 days	1×10^{-6} µCi/ml
	c.	Dissolved and Entrained Gases (gamma emitters)	Grab Sample	7 days	7 days	1×10^{-5} µCi/ml
	d.	H-3	Grab Sample	7 days	31 days(f)	1×10^{-5} µCi/ml
	e.	Gross Alpha	Composite (f)	7 days	31 days(f)	5×10^{-7} µCi/ml
	f.	Sr-89	Composite (f)	7 days	92 days(f)	5×10^{-8} µCi/ml
	g.	Sr-90	Composite (f)	7 days	92 days(f)	5×10^{-8} µCi/ml
	h.	Fe-55	Composite (f)	7 days	92 days(f)	1×10^{-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) 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 facility (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, except for the parts of the system taken permanently out of service.

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 facility 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
	AND	
	A.2 Initiate measures to reduce content to within the limits.	48 hours
	AND	
	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 and Chemical and Volume Control System Holdup Tank		Principal Gamma Emitters (b)	Grab Sample	Each Tank (d)	Each Tank (d)	1×10^{-4} µCi/ml
2. Containment Purge		Principal Gamma Emitters (b)	Grab Sample	Each Purge (d)	Each Purge (d)	1×10^{-4} µCi/ml
3. Auxiliary Building and Containment Building Vent		Principal Gamma Emitters (b)	Grab Sample	31 days	31 days	1×10^{-4} µCi/ml
	a.	H-3	Silica Gel, Grab Sample	31 days	31 days	1×10^{-6} µCi/ml
	b.	I-131	Charcoal Sample	Continuous (c)	7 days	3×10^{-12} µCi/ml
	c.	Principal Gamma Emitters (b) (I-131, Others)	Particulate Sample	Continuous (c)	7 days	1×10^{-11} µCi/ml
	d.	Gross Alpha	Composite Particulate Sample	Continuous (c)	31 days	1×10^{-11} µCi/ml
	e.	Sr-89, Sr-90	Composite Particulate Sample	Continuous (c)	92 days	1×10^{-11} µCi/ml
	f.	Noble Gases Gross Beta or Gamma	Noble Gas Monitor	Continuous (c)	Continuous (c)	1×10^{-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:

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

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 facility 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 facility (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 13.2.2.1	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 facility (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 13.2.3.1	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, except for the parts of the system taken permanently out of service.

ACTIONS

NON-CONFORMANCE	CONTINGENCY MEASURES	RESTORATION TIME
A. Radioactive gaseous waste is being discharged without treatment. AND Projected doses due to the gaseous effluent, from the facility, 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 facility 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, except when the tank is taken permanently out of service.

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
	<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

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. Service Water System Effluent Line (R-20) 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. ------------------------------------ D.1 Collect and analyze grab samples for gross radioactivity (beta or gamma) at a lower limit of detection of at least 1×10^{-6} µCi/ml.	Once per 12 hours
E. CONTINGENCY MEASURES <u>OR</u> RESTORATION TIME of A, B, C, or D not met.	E.1 Initiate a CR <u>AND</u> E.2 Explain in the next Radioactive Effluent Release Report why the CONTINGENY MEASURE was not met in a timely manner.	In accordance with Corrective Action Program 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
2. Gross Beta or Gamma Radioactivity Monitors Providing Alarm but not Providing Automatic Termination of Release		
a. Service Water System Effluent Line (R-20)	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: During release via the monitored pathway.

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 and Chemical and Volume Control System Holdup Tanks 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 AND 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 OR RESTORATION TIME A, B, C, D, E, F, or G not met.	H.1 Initiate a CR AND 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			DVR 13.3.2.1 DVR 13.3.2.4
a. Noble Gas Activity Monitor (R-13 or R-14)	1	C	DVR 13.3.2.6 DVR 13.3.2.7
2. Condenser Evacuation System			DVR 13.3.2.2 DVR 13.3.2.5
a. Noble Gas Activity (R-15)	1	D	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			DVR 13.3.2.2 DVR 13.3.2.4
a. Noble Gas Activity Monitor (R-12 or R-21)	1	E	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 facility 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 facility remains within twice the dose design objectives of Appendix I, and if direct radiation doses from the facility 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.

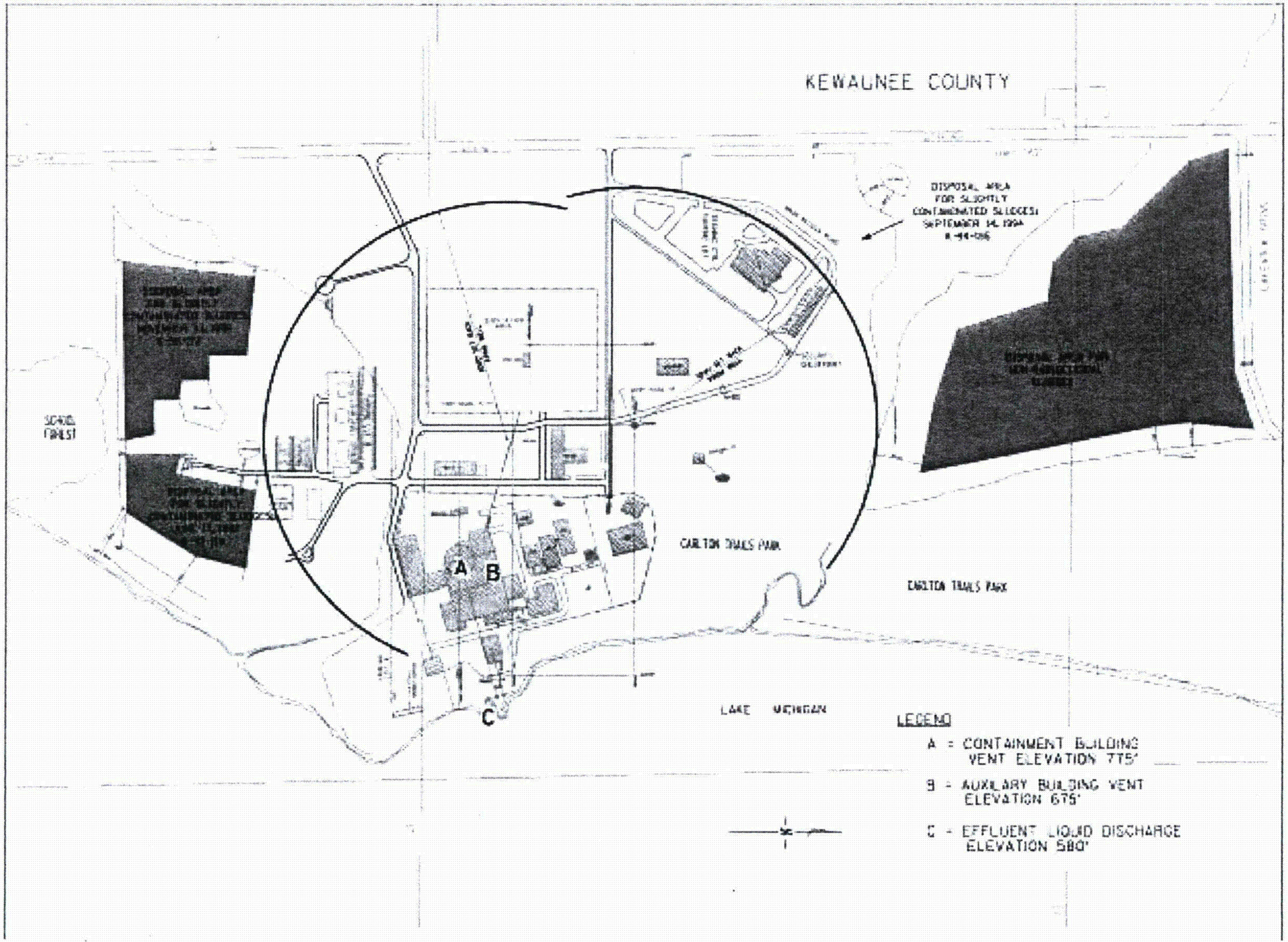
14.0 DESIGN FEATURES

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
CARLTON TRAILS PARK
CARLTON TRAILS PARK
LAKE MICHIGAN
A
B
C
LEGEND
A = CONTAINMENT BUILDING VENT ELEVATION 775'
B = AUXILARY BUILDING VENT ELEVATION 675'
C = EFFLUENT LIQUID DISCHARGE ELEVATION 580'

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 facility 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 facility during the previous calendar year.

d. An assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from facility 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 facility. 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.

2) Alarm (only) – R-20 provides this function for the Service Water discharges.

3) Composite Samples – 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.

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×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 and Service Water)

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

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

where:

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

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

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

SEN_i = 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.

SW = the service 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 periods when the service 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, SW 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 service 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:

$$SP \le \frac{EC_e \times 10 \times SEN \times SW}{RR} + bkg \qquad (1.5)$$

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 Service 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:

$$\sum[(C_i \div (10 \times EC_i)) \times (RR \div SW)] \le 1 \qquad (1.6)$$

C_i	=	concentration of radionuclide "i" in the undiluted liquid effluent (µCi/ml)
$10 \times EC_i$	=	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)
SW	=	the service 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.

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

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)
SW	=	average service 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.

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

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:

$$D_{tbp} = D_{tb}(31 \div d) \quad (1.9)$$

$$D_{maxp} = D_{max}(31 \div d) \quad (1.10)$$

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) (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) (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

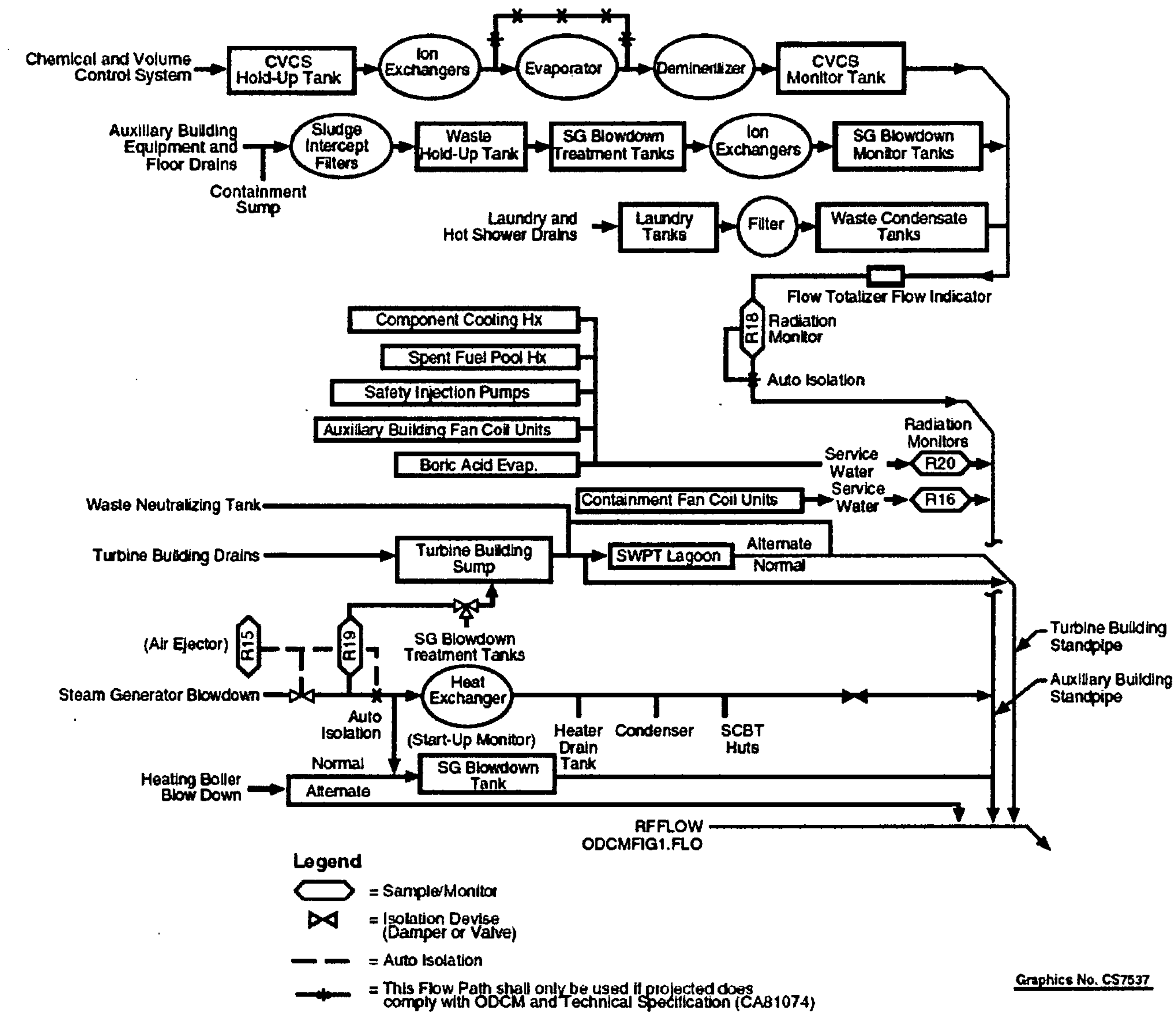
During the normal operation of Kewaunee, the potential exists for in-plant process streams, which are not normally radioactive to become contaminated with very low levels of radioactive materials. These waste streams are normally separated from the radioactive streams. However, due mainly to infrequent, 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.



ODCM FIGURE 1
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 R-20	 as determined as determined	 1.0E+08 1.0E+08	cpm per µCi/ml	 Radwaste effluent Service Water
Release Rate (RR) R-18 R-20***	 as determined as determined	 8.0E+01 8.0E+02	gpm	Determined prior to release; release rate can be adjusted for ODCM limit compliance Service Water
Background (bkg) R-18 R-20	 as determined as determined	 2.0E+03 6.0E+01	cpm	Nominal values only; actual values may be used in lieu of these reference values
Setpoint* (SP) R-18**** R-20	 calculated calculated	 6.25E+04+bkg 1.00E+03+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.

* Refer to Calculation # C10690 Rev. 2 Addendum B for the default setpoint calculation.
** Refer to Appendix C for derivation.
*** Actual SW flow is determined using OP-KW-NOP-SW-001, Service Water System, Attachment B, Service Water Pump Curves.
**** The alarm setpoint for R-18 cannot exceed the linear calibration range of the radiation monitor in accordance with CAP 37265 and DCR 26981 (5.00E+05+bkg cpm).

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 Chemical and Volume Control System Hold-Up Tanks (CVCS HUTs) or held in the Waste Gas Decay Tanks (WGDTs) 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.

In some cases, the gas in the CVC HUTs will not be able to be completely depressurized to the WGDTs. CVCs HUTs will be isolated and discharged via the Auxiliary Building Vent. R-13 and/or R-14 provide noble gas monitoring, and additional administrative controls are required in lieu of automatic isolation.

During a planned release, the administrative controls include the presence of an operator in the Aux Building if R-13/R-14 levels are below 5,000 cpm. If levels are above 5,000 but below 10,000 cpm, an operator will be present at the valve MG(R)-519A, B, or C area, in communication with the Control Room, and will be directed to manually shut the valve if levels exceed 10,000 cpm.

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 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.

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:

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

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

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/m³, from Table 2.3)
VF	=	ventilation system flow rate for the applicable release point and monitor (ft³/min, from Table 2.2)
C_i	=	concentration of noble gas radionuclide "i" as determined by radioanalysis of grab sample (μCi/cm³)
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)
4.72E+02	=	conversion factor (cm³/ft³ 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 $\mu Ci/cm^3$), 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:

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

and

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

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:

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

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:

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

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

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

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 ensure 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

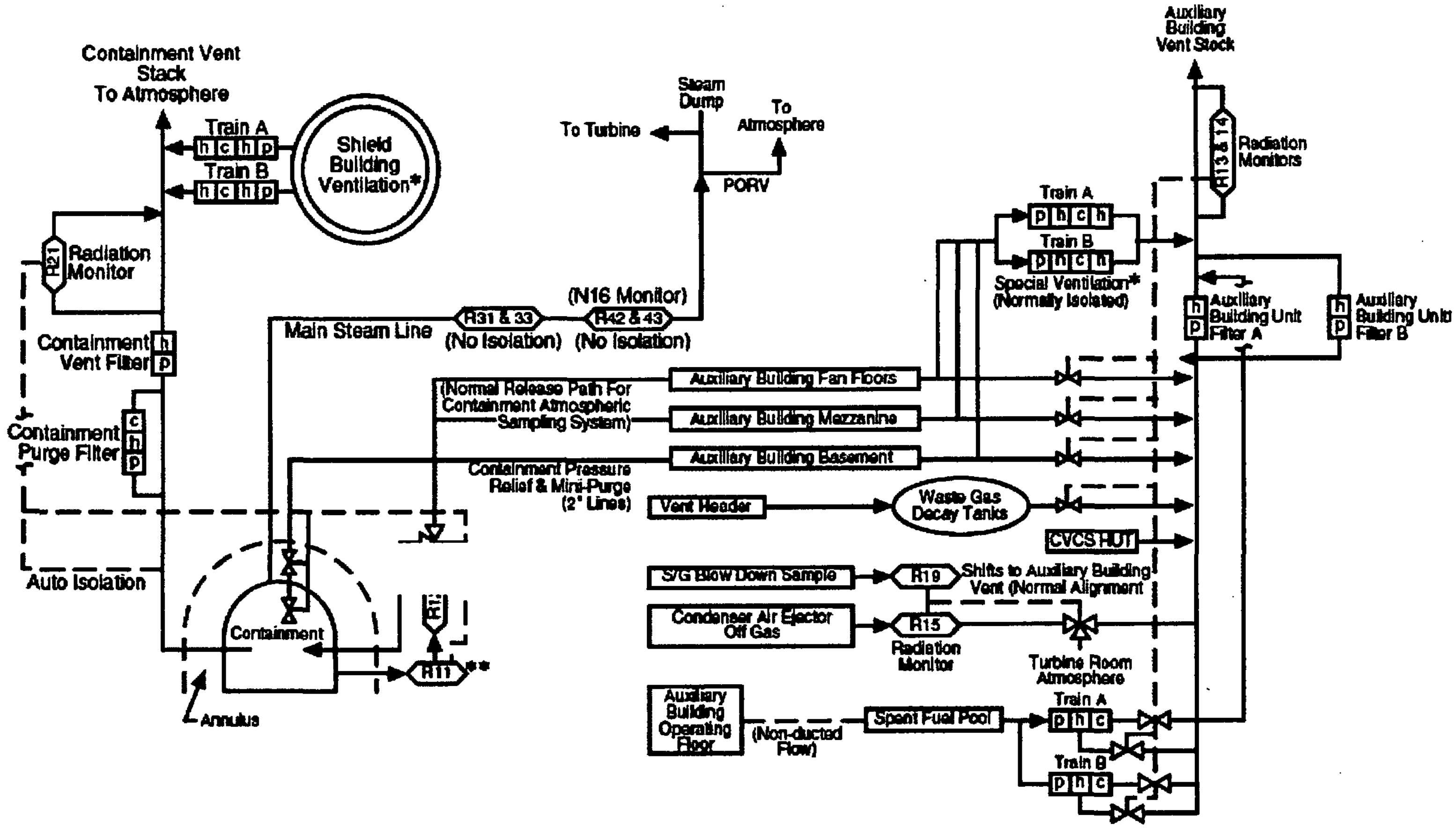
The purpose of this section is to describe the method used to calculate the cumulative dose contributions from liquid and gaseous effluents in accordance with KPS Technical Specifications for total dose. This method can also be used to demonstrate compliance with the Environmental Protection Agency (EPA)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



Legend

= Sample/Monitor
= Isolation Devise (Damper or Valve)
= 3 Was Valve
= Auto Isolation

p = Prefilter
h = HEPA Filter
c = Charcoal Filter

* 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.

Graphics No. CS7536

ODCM FIGURE 2
GASEOUS RADIOACTIVE EFFLUENT FLOW DIAGRAM

Figure 3
Simplified Heating Boiler Fuel Oil Piping System

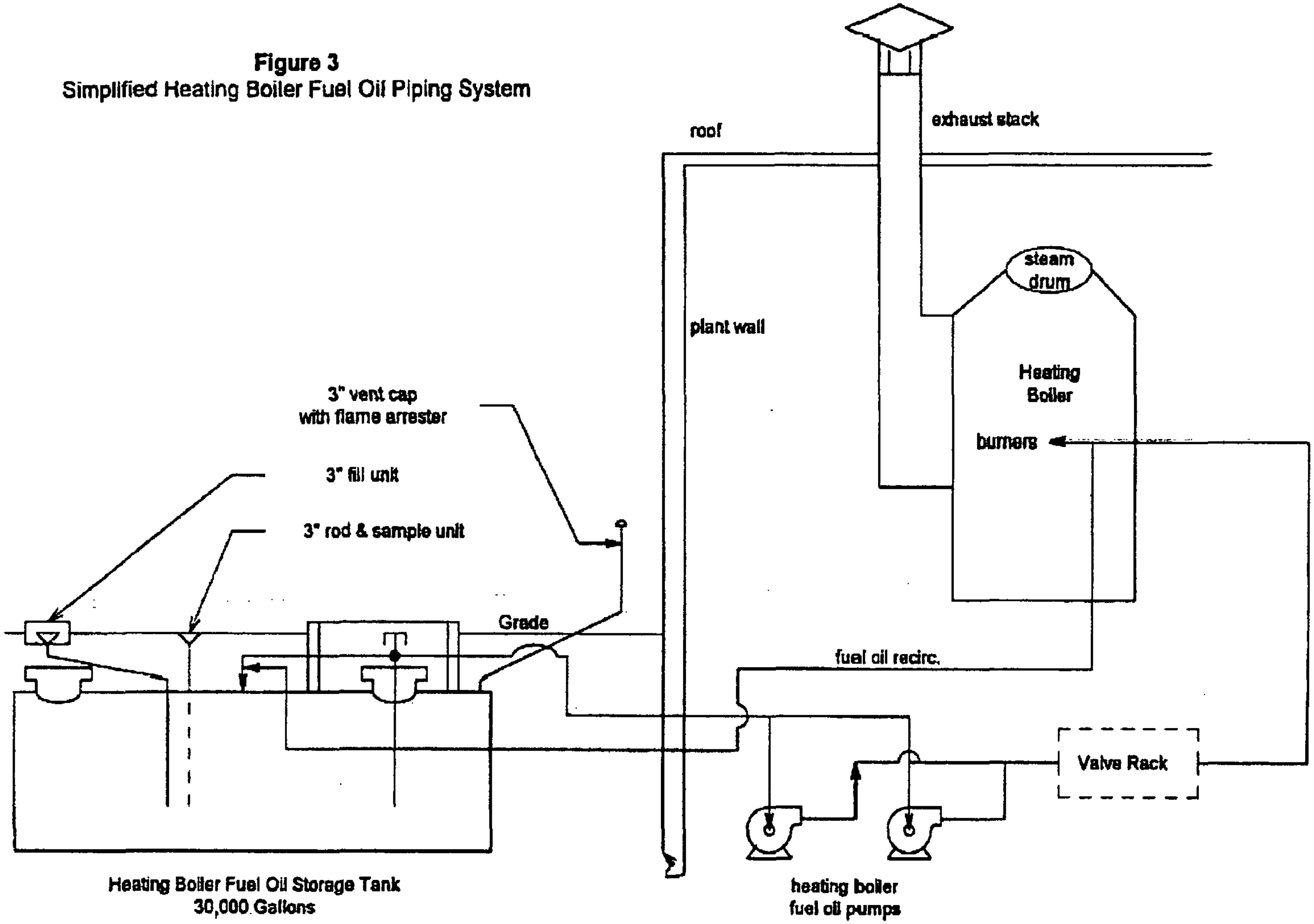


Table 2.1

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/m³)

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/m³)

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 μCi/m³)

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 µCi/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 μCi/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 $\mu Ci/m^3$)

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

Table 2.8 (Page 1 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
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/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	4.80E+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/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	-	2.59E+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 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	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 (m^2 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/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	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/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	-	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 (m² 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 $\mu Ci/m^3$) 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	-	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 (m² 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 (m² 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/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	4.29E+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 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
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

Content deleted. No longer being used.

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:

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

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

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

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

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

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

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

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:

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

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

where:

$D\gamma$ = air dose due to gamma emissions for the cumulative release of all noble gases (mrad)

D_β = air dose due to beta emissions for the cumulative release of all noble gases (mrad)

χ/Q = atmospheric dispersion to the controlling SITE BOUNDARY (sec/m³)

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)

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:

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

and

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

The effective dose factors are used on a very limited basis for the purpose of facilitating the timely assessment of radioactive effluent releases, particularly during periods of computer malfunction where a detailed dose assessment may be unavailable. Dose assessments using the detailed, radionuclide dependent calculation are performed at least 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/m³)	Skin Effective Dose Factor $(L+1.1\ M)_{eff}$ (mrem/yr per μCi/m³)
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/m³)**	**Beta Air Effective Dose Factor N_{eff} (mrad/yr per μCi/m³)**
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 $2E10^{-4}$ 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

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NRC 91-148

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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
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K H Weinhauer KNP
S F Wozniak D2
QA Vault KNP
TJ Webb KNP

October 17, 1991

File

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

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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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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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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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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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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
Attachment 1, Page 9

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

Document Control Desk
October 17, 1991
Attachment 1, Page 10

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.

Document Control Desk
October 17, 1991
Attachment 1, Page 11

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 92-119
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,

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

NRC LETTER DISTRIBUTION

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Wisconsin Public Service Corporation   Kewaunee Nuclear Power Plant

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Chief Engineer
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P.O. Box 7854
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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).

- 4 -

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.

- 5 -

REFERENCES

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

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

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

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

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

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

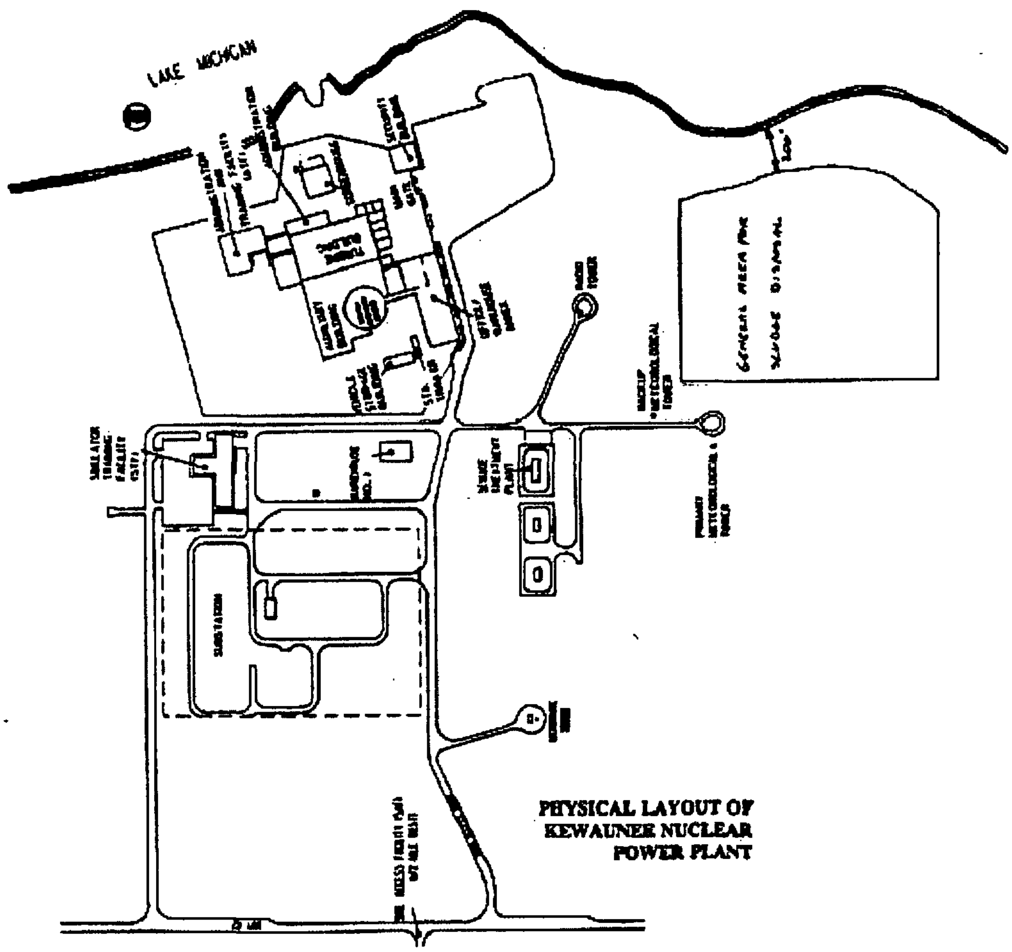
Principal Contributor: J. Minns

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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Larry Nielsen (ANFC)
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D B Cole KNP
K H Evers KNP
J P Giesler KNP

K A [illegible] KNP
M L [illegible] KNP
D L Masarik KNP
J N Morrison D1
L A Nuthals (NSRAC)
R P Puleo D2 (2)
C A Schrock D2

C S Smoker KNP
C R Steinhardt D2
C A Starnitzky KNP
T J Webb KNP
S F Wozniak D2
QA Vault KNP

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

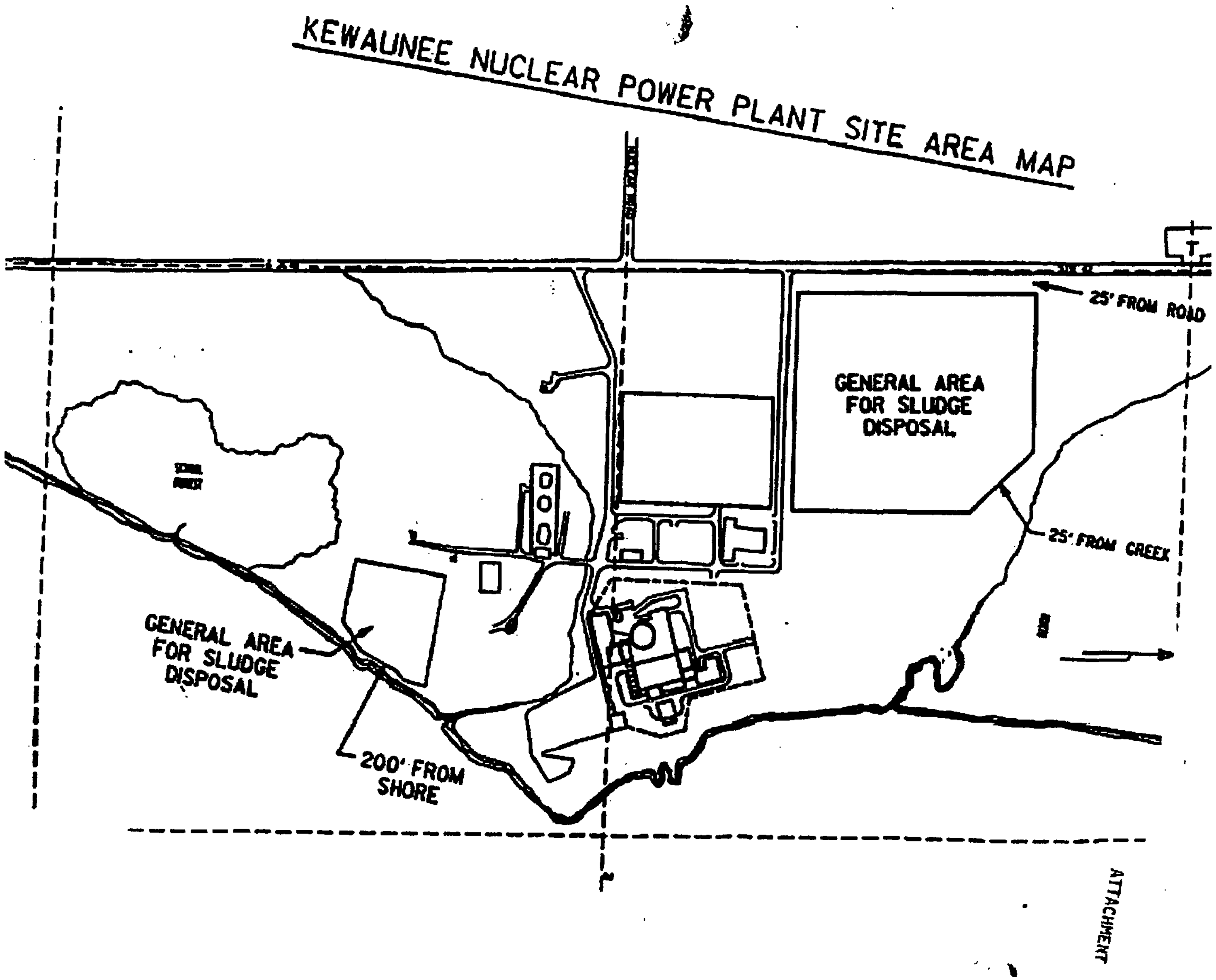
The staff finds the licensee's proposal to dispose of the low-level radioactive waste sludge in the additional onsite location to be within the radiological boundary conditions approved in the June 17, 1992, SE and is therefore acceptable. The staff also finds that your proposal is in accordance with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

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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Mr. M. L. Marchi
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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

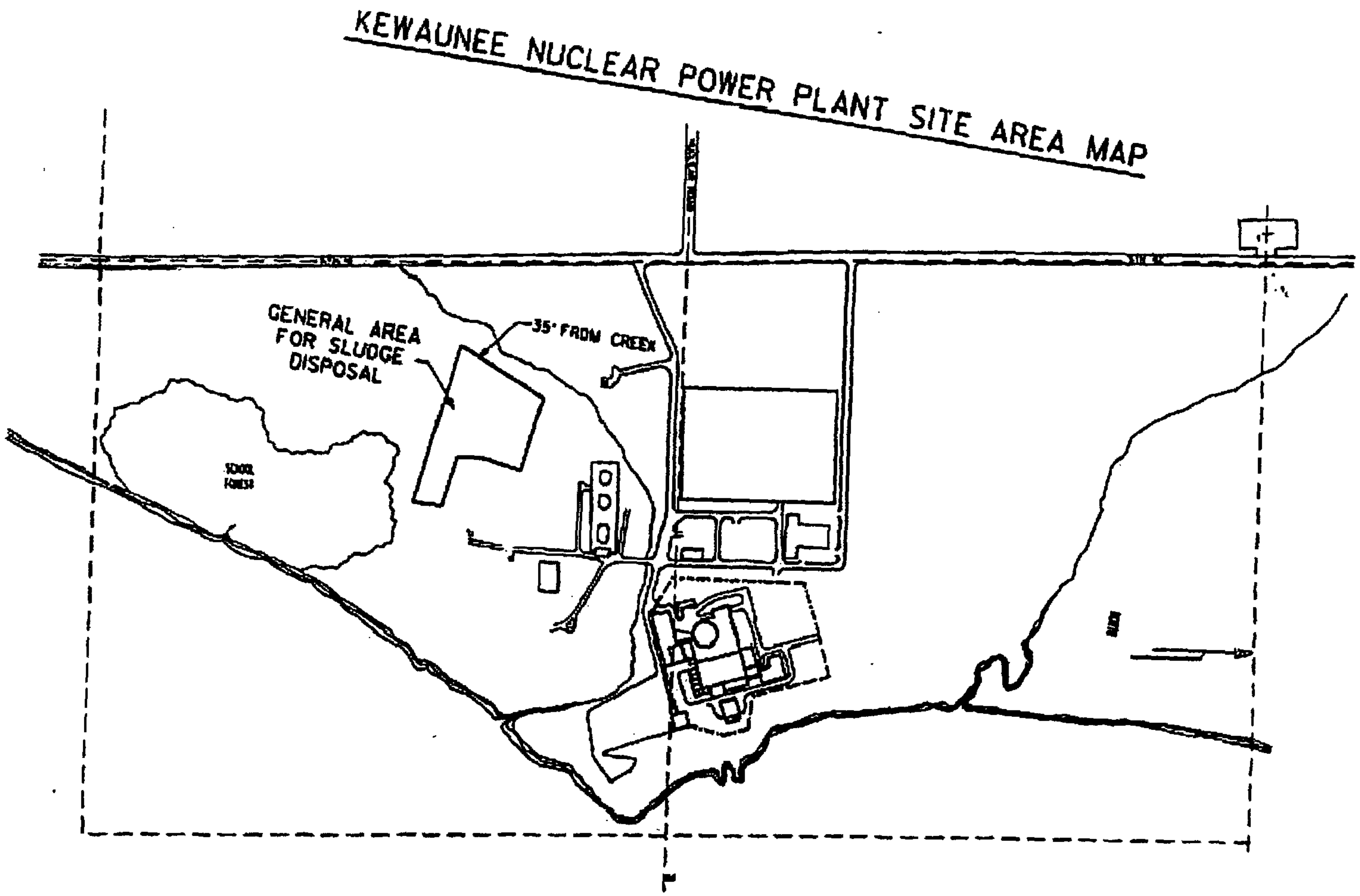
The staff finds the licensee's proposal to dispose of the low-level radioactive waste sludge pursuant to 10 CFR 20.2002, on the licensee's site (see Attachment), is within the radiological boundary conditions approved in the June 17, 1992, SER and is therefore acceptable.

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
GENERAL AREA FOR SLUDGE DISPOSAL
35' FROM CREEK

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

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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 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

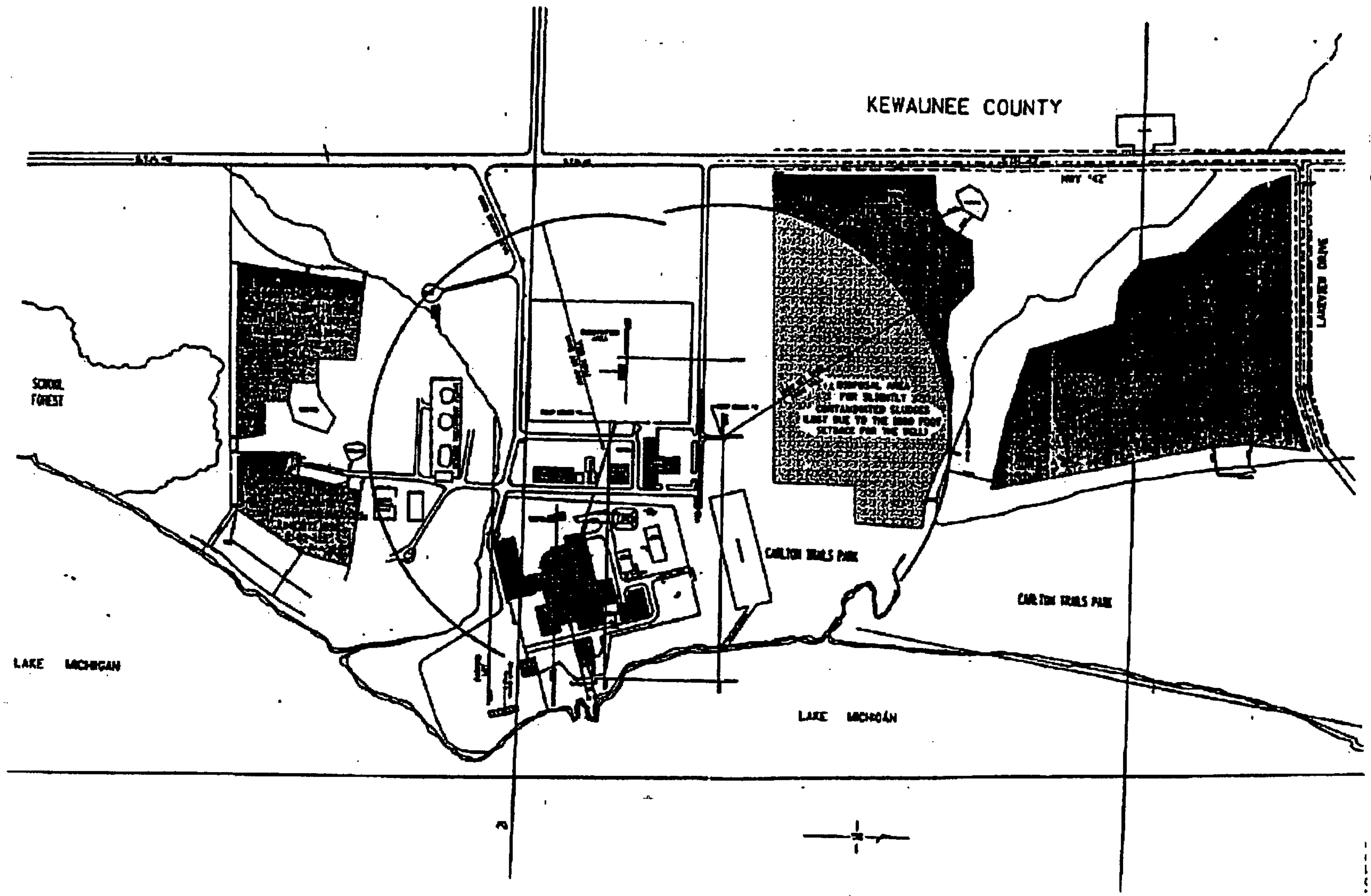
The staff agrees with the licensee's determination that additional onsite disposals of contaminated sludge, which are conducted within the bounding limits and conditions contained in the June 17, 1992, SE and within the areas specified in the attached site map, do not require specific NRC approval.

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
CARLTON TRAILS PARK
CARLTON TRAILS PARK
LAKE MICHIGAN
LAKE MICHIGAN

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Appendix D

Kewaunee Power Station

Radiological Environmental Monitoring Manual (REMM)

Revision 20
October 31, 2013

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Dominion Energy Kewaunee, Inc.

Kewaunee Power Station

RADIOLOGICAL ENVIRONMENTAL MONITORING MANUAL (REMM)

Revision 20

DATE: October 15 , 2013

Approved By:	JM Hale / Manager – Radiological Protection and Chemistry	Date:	9/30/13
Approved By:	RP Repshas / Licensing Supervisor	Date:	10/7/13
Reviewed By:	Jeffrey T. Stafford / Facility Safety Review Committee	Date:	10/10/13
Reviewed By:	AJ Jordan / Site Vice President	Date:	10/15/13

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 set up 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. OR	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 usinga 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 two herds that graze within three miles of the reactor site (K-38 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 3 locations within 5 km (if none, then 3 locations between 5 to 8 km) having the highest dose potential. 1 alternate location 1 control location	**K-5[k], K-38, K-34** **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]

Table 2.2.1-B *Type and Frequency of Collection*						
Location	Weekly	Monthly	Quarterly	Semi-Annually		Annually
K-27			TLD			
K-29						DM
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			

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

Table 2.2.1-C *Sampling Locations, Kewaunee Power Station*			
Code	**Type**[a]	**Distance (Miles)**[b] **and Sector**	**Location**
K-20(c)	I	2.5 N	Carl Struck Farm, N1596 Lakeshore Dr., Kewaunee
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

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.

Table Notations for Table 2.3.1-A (con't)

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

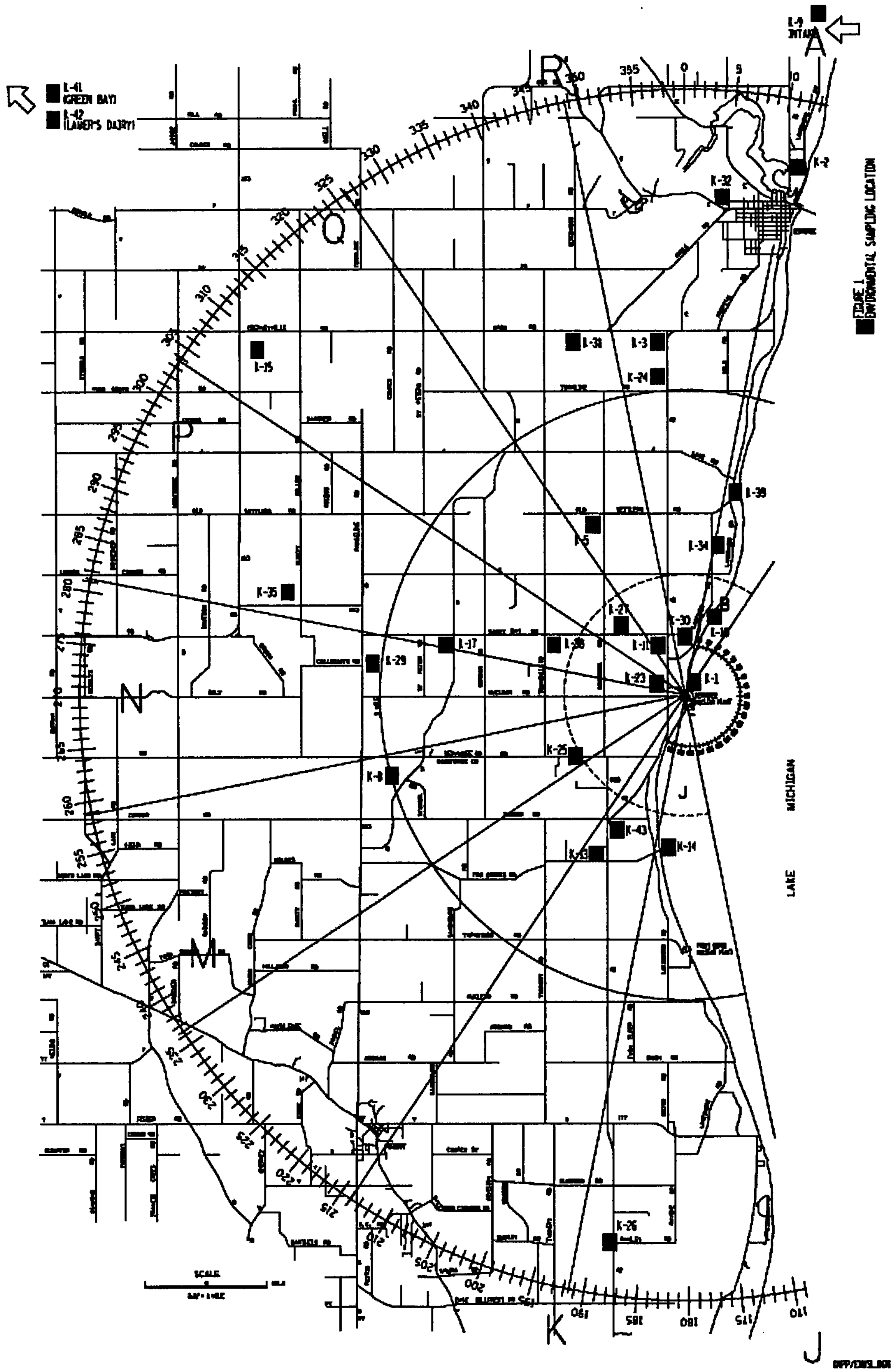
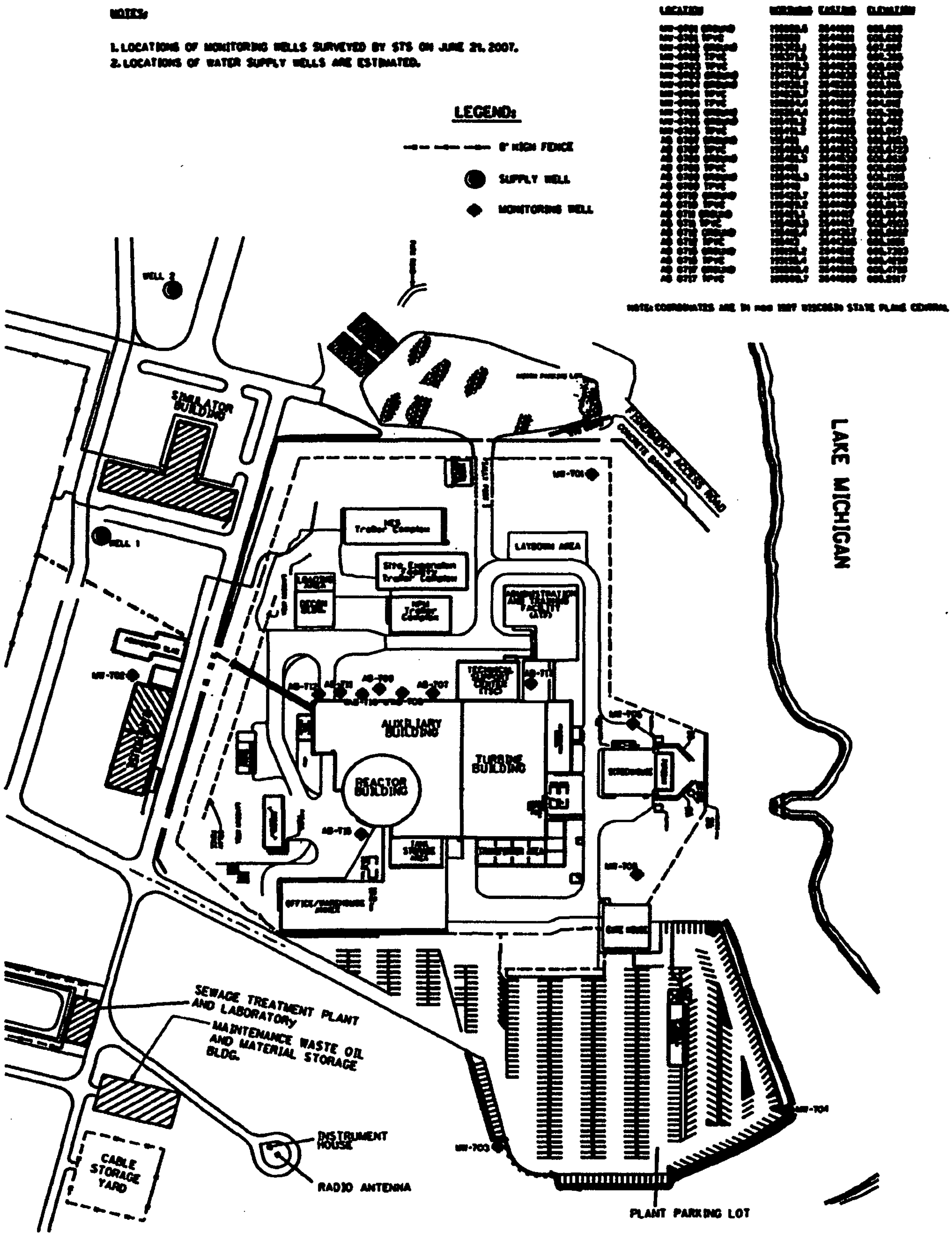

K-41 (GREEN BAY)
K-42 (LAUER'S DAIRY)
FIGURE 1 ENVIRONMENTAL SAMPLING LOCATION
LAKE MICHIGAN
SCALE
K-1
K-2
K-3
K-8
K-14
K-15
K-17
K-23
K-24
K-25
K-26
K-29
K-30
K-32
K-34
K-35
K-38
K-39
K-43

FIGURE 2


NOTES:
1. LOCATIONS OF MONITORING WELLS SURVEYED BY STS ON JUNE 21, 2007.
2. LOCATIONS OF WATER SUPPLY WELLS ARE ESTIMATED.
LEGEND:
8' HIGH FENCE
SUPPLY WELL
MONITORING WELL
LOCATION
NORTHING
EASTING
ELEVATION
LAKE MICHIGAN
WELL 2
WELL 1
SIMULATOR BUILDING
LAYDOWN AREA
AUXILIARY BUILDING
TURBINE BUILDING
REACTOR BUILDING
SEWAGE TREATMENT PLANT AND LABORATORY
MAINTENANCE WASTE OIL AND MATERIAL STORAGE BLDG.
INSTRUMENT HOUSE
RADIO ANTENNA
CABLE STORAGE YARD
PLANT PARKING LOT

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Appendix E

Kewaunee Power Station

Documentation for Major Changes to Radioactive Waste Treatment Systems in 2013

System abandonment evaluations per procedure OP-KW-DEC-SYC-001, System Evaluation and Categorization Attachment B - SSC Category Determination Document

And

FSRC Review and Approval Documentation

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1.0 Doc Type: Report Revision No.: 0 Date: 10/09/2013
Sub Type: DEC
Document Number (ID): SYS-07-DSERT
Title: Blowdown Treatment & Steam Generator Blowdown
1.1 Brief description or reason for revision: Not applicable for Rev 0

2.0 System Category (Check Appropriate):

NOTE:	*A SSC may be divided and have more than one category determination depending upon its functional requirements.*

☒ Available (Category A) ☒ Abandoned (Category X)

Describe the assessed boundaries:

This is a partial functional abandonment of the Steam Generator Blowdown Treatment system. Parts of the system remaining available include:

- Steam Generator Blowdown Tank to support Heating Boiler operation
- One train of Steam Generator Blowdown Treatment Holdup/Monitor tanks/pumps will be maintained to provide the ability to treat future waste water
- SGBT Ion Exchange Pre-Filter
- SGBT Ion Exchanger Post Filter B

The following instrument boundaries will be abandoned along with their respective sensing lines:

PI-11172, TI-12142, TI-12143, PI-11173, TS-16232, TS-16218, DPI-11318, DPI-11325, DPI-11347, ES-19519, PI-11327, DPI-11349, ES-19521, PI-11329, T-22015, TIS-73518, TIS-73526, PI-11898, FI-73524, F-23070, T-22019, TIS-73519, TIS-73527, PI-11899, FI-73525, F-23071, LC-26801, DPI-11890, DPI-11892, DPI-11889, DPI-11891, FI-18354, DPI-11748, DPI-11749, PI-11887, DPI-11750, DPI-11751, PI-11888

3.0 Mark up the affected drawings using color coding to identify system category type and boundaries. These drawings are to include system, electrical one-line and distribution, and select building and isometric drawings. Related system drawings NOT incorporated in the system category require an explanation. REFER to Step 2.7 for a list of drawings.

OPERM-203, Flow Diagram Main Aux Steam And Steam Dump
Abandon:
Blowdown lines from Steam Generator A, B to the Blowdown Heat Exchangers
Blowdown drain lines from the MSIV's to the Steam Generator Blowdown Tank

OPERM-204-1, Flow Diagram Condensate & Gland Seal Systems
Abandon:
Three inch recovered condensate from the SGBT Ion Exchanger to MU-6

OPERM-219, Flow Diagram Secondary Sampling System
Abandon:
Blowdown sample lines from Steam Generator A, B to secondary sampling system instrumentation including piping to the Sample Room

OPERM-368, Flow Diagram Steam Generator Blowdown Treatment System
Abandon:
SGBT Hold-up Tank 1A including SGBT Hold-Up Tank 1A Transfer Pump and piping
SGBT Monitor Tank 1A including SGBT Monitor Tank 1A Transfer Pump and piping
SGBT Ion Exchanger 1A
SGBT Ion Exchanger Post Filter 1A
SGBT Heat Exchanger and filter

Available:
SGBT Hold-up Tank 1B including SGBT Hold-Up Tank 1B Transfer Pump and piping.
Boundary valves:
BT-303A, 1.5 IN. VALVE-MANUAL-SGBT MONITOR TANK 1A DISCHARGE PUMP-DISCH
BT-310, 2 IN. VALVE-MANUAL-CROSSOVER FOR SGBT HOLD-UP TANK TRANSFER PUMPS
MD-410B, 1.5 IN. VALVE-MANUAL-ANAL INST PANEL TO SGBT HOLD UP TK 1B
BT-131A, 2 IN. VALVE-MANUAL-SGBT HOLD-UP TANK 1A BLOWDOWN INLET
BT-337A, 2 IN. VALVE-MANUAL-HOLD-UP TANK 1A MONITOR TANK RETURN
BT-130, 2 IN. VALVE-MANUAL-FLASH TANK FILTER BLOWDOWN TO HOLD-UP TANKS
BT-108, 2 IN. VALVE-MANUAL-SGBT FLASH TANK FILTER TO SGBT ION EXCHANGERS

SGBT Monitor Tank 1B including SGBT Monitor Tank 1B Transfer Pump and piping.
Boundary valves:
BT-115A, 2 IN. VALVE-MANUAL-SGBT MONITOR TANK 1A BLOWDOWN INLET
BT-210, 2 IN. VALVE-MANUAL-CROSSOVER FOR SGBT MONITOR TANK DISCHARGE PUMPS
BT-203A, 1.5 IN. VALVE-MANUAL-SGBT MONITOR TANK 1A DISCHARGE PUMP-DISCH
BT-230, 2 IN. VALVE-MANUAL-SGBT TO CVC MONITOR TANKS

SGBT Ion Exchange Pre-Filter

SGBT Ion Exchanger 1B
Boundary valves:
BT-117B, 1.5 IN. VALVE-MANUAL-SGBT 10N EXCHANGE 1B TO 1A
BT-111A, 1.5 IN. VALVE-MANUAL-SGBT ION EXCHANGER 1A INLET
BT-117A, 1.5 IN. VALVE-MANUAL-SGBT 10N EXCHANGE 1A TO 1B
DW-273, 1.5 IN. VALVE-MANUAL-DEMIN. WTR. TO SGBT ION EXCH RESIN SLUICE LINE

SGBT Ion Exchange Post Filter 1B
Boundary valves:
BT-114A, 1.5 IN. VALVE-MANUAL-SGBT ION EXCHANGER POST FILTER 1A-BYPASS
BT-113A, 1.5 IN. VALVE-MANUAL-SGBT ION EXCHANGER POST FILTER 1A-OUTLET

Steam Generator Blowdown Tank to support Heating Boiler operation
Boundary valves:
BT-100A, 3 IN. VALVE-MANUAL-BLOWDOWN TANK DRAIN TO WASTE HOLD-UP TANK
BT-100B, 2 IN. VALVE-MANUAL-BLOWDOWN TANK DRAIN TO WASTE HOLD-UP TANK
BT-62, 6 IN. VALVE-MANUAL-STEAM GEN BLOWDOWN TANK STEAM TO COND. 1B

OPERM-436, Flow Diagram Steam Generator Blowdown System
Abandon:
Steam Generator Blowdown piping from Steam Generators A, B through SGB Heat Exchangers to the 3"drain to 24"Auxiliary Building Standpipe.
SGBT Pre Filter 1A, 1B
SGBT Polishing Filter 1A, 1B
SGBT Recovery Ion Exchangers 1A, 1B

Available:
Steam Generator Blowdown Tank to support Heating Boiler operation
Boundary valves:
BT-4A, 1 IN. VALVE-MANUAL-STM GEN 1A BLOWDOWN AT BLOWDOWN TNK
BT-4B, 1 IN. VALVE-MANUAL-STM GEN 1B BLOWDOWN AT BLOWDOWN TNK
BT-100A, 3 IN. VALVE-MANUAL-BLOWDOWN TANK DRAIN TO WASTE HOLD-UP TANK
BT-100B, 2 IN. VALVE-MANUAL-BLOWDOWN TANK DRAIN TO WASTE HOLD-UP TANK
BT-50-1, 0 IN. VALVE-MANUAL-SGBT RECOVERY ION EXCHANGER
BT-56-1, 0 IN. VALVE-MANUAL-SGBT RECOVERY ION EXCHANGER
BT-1006, 3 IN. VALVE-MANUAL-SGBT DISCHARGE TO AUX BLDG STANDPIPE

OPERM-605-2, Flow Diagram Heating System
Available:
Heating Boiler Mud Drum Continuous Blowdown to Blowdown Tank

E-256, Circuit Diagram 480V MCC 1-32D, 1-35C, 1-35F, 1-42D, 1-45C, & 1-45F
Abandoned from the electrical breaker out:
MCC 1-32D (C3) SGBT Hold-Up Tank 1A Transfer Pump
MCC 1-32D (C4) SGBT Monitor Tank 1A Discharge Pump
Available:
MCC 1-42D (C3) SGBT Hold-Up Tank 1B Transfer Pump
MCC 1-42D (C4) SGBT Monitor Tank 1B Discharge Pump

E-258, Circuit Diagram 480V MCC 1-52A, 1-52F, & 1-52B
Abandoned from the electrical breaker out:
MCC 1-52B (D4) Steam Generator 1A Blowdown Isolation MV 1A1 BT-2A/32077

E-3075, Circuit Diagram 480V MCC 1-62J
Abandoned from the electrical breaker out:
MCC 1-62J (2JM) Steam Generator 1B Blowdown Iso MV 1B1 BT-2B/32079

E-844, Wiring Diagram DC Auxiliary & Emergency AC
Abandoned from the electrical breaker out:
BRA-104 Circuit 21, To Local Mtr Str 1-428 BT-3B/MV32080 S/G B Blowdown Isolation Valve B2
BRB-104 Circuit 21, To Local Mtr Str 1-427 BT-3A/MV32078 S/G A Blowdown Isolation Valve A2

4.0 Evaluation (Basis for choosing category type):

Purpose/Function

The Steam Generator Blowdown System assists in maintaining secondary chemistry of the Steam Generators and the Main Steam System by removing contaminants. Also, the SGB System provides the means to monitor SG tube integrity and has the ability to transfer radioactive contaminated water from the SGs to the Steam Generator Blowdown Treatment System following a Steam Generator tube rupture.

The SGB System operates in three Modes:

Mode I

Normal operation is from plant startup to 50% power and 50% power to plant shutdown. The water removed from the steam generators is discharged to Lake Michigan via the Auxiliary Building standpipe.

Mode II

Normal operation is from 50% to 100% power. The water removed from the SGs is processed through heat exchangers and filters before returning to the condenser.

Mode III

Emergency operation, following a Steam Generator tube rupture, is to transfer the radioactive contaminated water to the SGBT System.

The Steam Generator Blowdown Treatment System processes radioactive contaminated water. During normal plant operation, radioactive water from the Waste Disposal System is periodically transferred to the SGBT System for processing. In an emergency, Steam Generator tube rupture, SGB System is aligned to Mode III. SGBT System pumps the radioactive water through filters and ion exchangers to remove contaminants. When the water is processed sufficiently, it is discharged to Lake Michigan via the Auxiliary Building Standpipe.

Basis for Category

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. On May 15, 2013 the NRC docketed the certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii). Therefore the 10 CFR Part 50 license no longer authorizes KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2).

With irradiated fuel being stored in the SFP and the ISFSI, the reactor, RCS and secondary system are no longer in operation and have no function related to the storage of the irradiated fuel. Therefore, the postulated accidents involving failure or malfunction of the reactor, RCS or secondary system are no longer applicable. The analyzed accident and operational event applicable to KPS in the permanently shut down and defueled condition is a fuel handling accident (FHA) in the auxiliary building.

The Steam Generator Blowdown Treatment system does perform a function or provide support for some of the following items (they are annotated for the ones that apply):

1. To prevent or mitigate the consequences of a design basis accident of a permanently defueled plant.

2. Fuel Handling Accident as defined in Updated Safety Analysis Report (USAR).

3. For safe storage and handling of radioactive waste or spent fuel.
   Supports draining and processing of systems in the Auxiliary building. One train is being maintained available to support draining.

4. To support Technical Specifications, License Requirements, Design Basis, permits, regulatory requirements, insurance requirements, or other commitments. Provide support of the Spent Fuel Safety Management Program.

5. To support the execution of plans and programs of Kewaunee Power Station.

6. Support day to day operations in the decommissioning plant.
   Supports Heating Boiler operations and processing of waste water. These portions are being maintained to support these.

7. Support plant decommissioning efforts.
   Supports draining of systems in the Auxiliary building. One train is being maintained available to support draining.

Regulatory Impact

Updated Safety Analysis Report (USAR)

The Steam Generator Blowdown Treatment system is mentioned in the following chapters/sections:

Section 5.3.1.1 Containment Isolation Valves
There are two SGB System Containment vessel penetrations denoted as "tube barrier and pressurized system:" 8N and 8S. The associated SGB valves are:
Inside of Containment: BT-2A(B), BT-2A(B)-1
Outside of Containment: BT-3A(B)

Chapter 6.5 Leakage Detection And Provisions For The Primary and Auxiliary Coolant Loops
R-19 monitors the liquid phase of the secondary side of the steam generator for radiation, which would indicate a primary-to-secondary system leak, providing backup information to that of the condenser air ejector gas radiation monitor. Samples from the bottom of each of the two steam generators are mixed to a common header and the common sample is continuously monitored by a scintillation counter and holdup tank assembly. Upon indication of a high-radiation level, each steam generator is individually sampled in order to determine the source. This sampling sequence is achieved by manually selecting the desired steam generator to be monitored and allotting sufficient time for sample equilibrium to be established (approximately 1 minute). At the alarm setpoint for high radiation level, steam generator blowdown is automatically isolated.

A high radiation alarm actuated by R-19 (the steam generator blowdown monitor) or R-15 (the air ejector activity monitor) initiates closure of the isolation valves in the blowdown lines and sample lines.

Chapter 9.4 Sampling System
Steam generator blowdown samples can be taken either in the sample room or at the secondary system analytical and sampling panel. Leakage and drainage resulting from the sampling operations are collected and drained to tanks in the Waste Disposal System.

Section 10A.6.5 Steam Generator Blowdown

Table 10A.4-5 Needed Equipment List For Blowdown Line Break

Chapter 11: Waste Disposal and Radiation Protection System
Waste from the sludge interceptor tank is pumped by the sludge interceptor pump through sludge interceptor filters (4) into the waste holdup tank. Waste from the hot sample station and hot chemical laboratory is also drained to the waste holdup tank. The tank's contents are pumped by the waste evaporator feed pump to the Blowdown Treatment System for processing and eventual release to the environment.

Section 11.1.2.2 Steam Generator Blowdown System

Section 11.1.2.18 SGB Heat Exchangers
Four SGB heliflow heat exchangers are used to cool normal flow blowdown from each steam generator to 100°F. Blowdown then is directed through a high pressure drop flow control valve and then a pressure regulating valve that reduces the pressure to 40 psig prior to discharge to the Auxiliary Building Standpipe.

Section 11.1.2.19 SGBT Heat Exchanger
The SGBT heat exchanger is used to cool liquid from the blowdown tank to below 120°F to allow processing through the SGBT ion exchanger.

Section 11.1.2.20 SGBT Flash Tank Filters
The SGBT filters remove particulate matter from the fluid being pumped, prior to its passing to the SGBT holdup tanks or ion exchangers. The filter is constructed of stainless steel materials.

Section 11.1.2.21 SGBT Monitor Tanks
The SGBT monitor tanks serve as a collection point for liquids processed through the SGBT ion exchanger. The contents are sampled at this point for an activity record before discharge through the Waste Disposal System radiation monitor to the circulating water discharge. The tanks are all-welded stainless steel construction.

Section 11.1.2.22 SGBT Holdup Tank
The SGBT holdup tanks serve as a collection point for cooled and filtered blowdown liquid from the SGB tank before processing through the SGBT ion exchanger or for storage of liquid wastes transferred from the waste holdup tank prior to being processed through the SGBT ion exchangers. The tanks are of all welded stainless steel construction.

Section 11.1.2.23 SGBT Ion Exchanger Pre-Filter
The SGBT ion exchanger pre-filter reduces the amount of ion exchanger resin fouling. The filter housing is constructed of stainless steel.

Section 11.1.2.24 SGBT Ion Exchangers
Two flushable ion exchangers, capable of being operated in series or parallel, are provided. Each vessel is of all-welded stainless steel construction with a stainless steel resin retention element.

Section 11.1.2.25 SGBT Ion Exchanger Post Filters
The SGBT ion exchanger post filters remove resin fines from the treated blowdown stream. The filter housings are constructed of stainless steel.

Section 11.1.2.26 Pumps
The wetted surfaces of all pumps are stainless steel or other materials of equivalent corrosion resistance.

Section 11.1.2.27 Piping
Piping carrying liquid wastes is stainless steel, while all gas piping is carbon steel. Steam generator blowdown piping is carbon steel to the point where this system joins the liquid wastes transferred from the waste holdup tank. Piping connections are welded, except where flanged connections are necessary to facilitate equipment maintenance.

Section 11.1.2.28 Valves
All valves exposed to gases are carbon steel. Those exposed to liquids are stainless steel. All valves have stem leakage control. Globe valves are installed with flow over the seats when such an arrangement reduces the possibility of leakage.
Isolation valves are provided to isolate each piece of equipment for maintenance, to direct the flow of waste through the system, and to isolate storage tanks for radioactive decay. Relief valves are provided for tanks containing radioactive wastes to prevent overpressurization by improper operation or component malfunction. Tanks containing wastes, which are normally free of gaseous activity, are vented locally.

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. On May 15, 2013 the NRC docketed the certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii). Therefore the 10 CFR Part 50 license no longer authorizes KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). The USAR will be revised to address to keep functions associated with the available equipment above.

Technical Specifications

Reviewed all sections for applicability to Steam Generator Blowdown Treatment. The following sections were applicable:

Section 3.4.17 Steam Generator (SG) Tube Integrity
Applicability: Modes, 1, 2, 3, and 4.

Section 3.6.3 Containment Isolation Valves
Applicability: Modes, 1, 2, 3, and 4.

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. On May 15, 2013 the NRC docketed the certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii). Therefore the 10 CFR Part 50 license no longer authorizes KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Therefore, the LCOs (and associated Surveillance Requirements (SRs)) that only apply in Modes 1 thru 6, are no longer applicable.

Offsite Dose Calculation Manual (ODCM):
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.

The USAR and ODCM revisions will be revised to address requirements following cessation of power operation.

Other Related documents
The EAL Technical Bases Document discusses SGB sampling, etc. in a number of places and will require revision.

Plant Impact
No changes are required to SSCs, procedures, programs, processes, etc.

There is no impact on any temporary changes that are active as of 12-19-2013.

The Drawing Control Team did not identify any outstanding drawing changes that required disposition as a result of system abandonment.

EAL, USAR, and ODCM will require changes as listed above in Regulatory Impact.

5.0 Special conditions to support categorization(s): None

6.0 Assumptions/Open Items to be validated or dispositioned:

OPEN ITEMS: EAL, USAR, and ODCM will require changes as listed above in Regulatory Impact.

7.0 Expected duration for SSC category if <u>NOT</u> ABANDONED:
Available SSCs in the Steam Generator Blowdown Treatment system are expected to remain available until plant demolition.

8.0 **PREPARE** and **ATTACH** the following documents:

- Completed 10 CFR 50.59 Screening or Evaluation, if required
- Proposed DUs for appropriate drawings

9.0 Technical Concurrence:

Type Of Review	Name (Print)	Approval Signature	Date
Engineering	DAVID DEGRAVE	[signature]	12-12-13
Type Of Review Fire Protection	Name (Print) Michael Townsend	Approval Signature [signature]	Date 12/9/13
Type Of Review Security	Name (Print) David Falk	Approval Signature [signature]	Date 12-12-13
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review Radiation Protection	Name (Print) Daniel J. Shannon	Approval Signature [signature]	Date 12-11-13
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date

10.0 Review and Approval:

Rick Stenhardt / [signature]	12/3/13
Prepared By (Print/Sign)	Date
DAVID DEGRAVE / [signature]	12-12-13
Reviewed By (Screen Qual.) (Print/Sign)	Date
G S SMOKER / [signature]	12/4/13
Nuclear Licensing (Print/Sign)	Date
BILL SWANSON / [signature]	12/12/13
Concurrence by DSERT Coordinator (Print/Sign)	Date
JEFFREY T. STAFFORD / [signature]	12-19-13
FSRC (Print/Sign), if required	Date

FSRC Meeting Number: 13-048

1.0 Doc Type: Report Revision No.: 0 Date: 5-14-2013
Sub Type: DEC
Document Number (ID): SYS-18-DSERT
Title: Reactor Building Ventilation

1.1 Brief description or reason for revision: Not applicable for Revision 0.

2.0 System Category (Check Appropriate):

NOTE:	*A SSC may be divided and have more than one category determination depending upon its functional requirements.*

X Available (Category A) X Abandoned (Category X)

Describe the assessed boundaries:
This is a partial functional abandonment of System 18 Reactor Building Ventilation System (RBV) including the 1B, 1C, 1D Containment Fan Coil Units (CFCU), charcoal filter units, fans, heating coils, associated ductwork, dampers and instrumentation except as indicated below. The following system functions shall be maintained available.

The ability to vent pressure from containment through the 2" vent to Aux Building exhaust.

The service water system supports the Reactor Building Ventilation System CFCUs and Charcoal Filter Units fire suppression spray manifolds. The service water system shall be isolated and drained to the RBV System including 1A CFCU though this unit could be refilled and operated as desired.

Service Water supports the RBV system and shall be isolated from the containment Fan Coil Units as indicated in Section 3.

Service water piping to fire spray manifolds in Containment Purge Exhaust Filter housing downstream of SW-1051 shall be isolated. **After the charcoal is removed from the filters.**

Heating Steam supports the RBV System and shall be isolated from the Containment Purge Vent Supply fan housing as indicated in Section 3.

The 480 volt system supports the RBV system and shall be isolated as indicated in Section 3.

The instrument air system supports the RBV system. The instrument air system shall be isolated from the RBV system to individual components as indicated on in Section 3.

The following instrument boundaries were abandoned along with their respective sensing lines, thermo wells etc:
FE-27083, PI-11405, FI-18237, PI-11403, FE-27084, FI-18238, PI-11404, PI-11406, TE-13070, TE-15128, TE-15188, TE-13071, TE-15129, TE-15130, TE13072, TE-13074, TE-15184, TE-13168, TE13169, TE-13170, TE-13171, TE-13172, TE-13173, TE13073, TE-15185, TE-15186, TE-15190, TE15191, TE-19192, TE-15080, TE-15081, DPI-11712, DPI-11713, DPI-11714, DPI-11715, DPI-11716, DPI-11717, DPS-16403, P-21100, P-21101, P-21102, P-21105, P-21117, P-21118, P-21119, P-21122, P-21132, P-21133, T-22051, T-22052, T61203, T61205, F-23061, F-23063, F-23065, F-23067 FE-27050, FE-27051, FE-27052, FE-27053, FE-27054, FE-27055, FE-27056, FE-27057, PS-16145, PS-16146, PS-16149, DPI-11407, FI-18239, FI-18240 and PI-11012

The following dampers act as boundary dampers:

TAV-11 Turbine Building Air Damper to RBV System
CD-34187 Containment Fan Coil Unit B to Reactor Coolant Pump Vault Damper

3.0 Mark up the affected drawings using color coding to identify system category type and boundaries. These drawings are to include system, electrical one-line and distribution, and select building and isometric drawings. Related system drawings NOT incorporated in the system category require an explanation. **REFER** to Step 2.7 for a list of drawings.

OPERM-601
Abandon:
Containment Purge and Vent Air Supply fan
Containment Supply Fan Preheat Coil
Containment Supply Fan Reheat Coil
Containment Purge and Vent Air Supply Ductwork up to TAV-11

OPERM-602 Reactor and Shield Building Ventilation
Abandon:
Containment Purge exhaust System including all ductwork and dampers
Containment Vent Exhaust fan
Containment Purge exhaust fan
Containment Purge Exhaust Filter Assembly
Containment Exhaust Filter Assembly

Containment Purge and Vent Air Supply from OPERM-601 through RBV-2 including all ductwork and dampers upstream and downstream

Containment Isolation Valves RBV-1, RBV-2, RBV-3, and RBV-4

Containment Vacuum Breakers VB-10A, VB-10B, VB-11A, and VB-11B

Reactor Gab & Neutron Detector Cooling Fan A
Reactor Gab & Neutron Detector Cooling Fan B
Reactor Gab & Neutron Detector Cooling ductwork and dampers

Containment Fan Coil Unit B
Containment Fan Coil Unit C
Containment Fan Coil Unit D
Containment Fan Coil Unit ductwork and dampers up to damper CD-34187.

Control Rod Drive Cooling Fan A
Control Rod Drive Cooling fan B
Control Rod Drive Cooling ductwork and dampers

Reactor Support Cooling Fan A
Reactor Support Cooling Fan B
Reactor Support Cooling Electric Heater A
Reactor Support Cooling Electric Heater B
Reactor Support Cooling ductwork and dampers

Containment Dome Fan 1B
Containment dome fan ductwork and heaters

Available:
Containment Fan Coil Unit A shall remain available along with its associated ductwork to the reactor coolant pump vault 1B, reactor building 606' and 592' elevations, CD-34187 and RBV-150A. CD-34187 shall be available to open as a check damper but the open assist shall be abandon.
Containment Dome Vent Fan A will be maintained available.

OPERM-605-1 Flow Diagram Heating Steam
Abandon:
Containment Purge and Vent Unit Preheat and Reheat coils
HS-320 Manual Isolation to Containment Purge and Vent Unit Preheat and Reheat coils to HS-5325A, HS-5325B, HS-5321A, HS-5321B, preheat and reheat trap outlet valves, and HS-6326 Manual vacuum breaker valve.

OPERM-606 Flow Diagram Air Conditioning Cooling Water piping

Abandon:
Service water piping to fire spray manifolds in Containment Purge Exhaust Filter housing downstream of SW-1051. **After the charcoal is removed from the filters**

OPERM-403 Flow Diagram Reactor Building Vent. System Post LOCA Hydrogen Control
Abandon:
2" Containment Supply Blower
Reactor Building Vent System Post LOCA Hydrogen Control piping and valves
Available:
Vent flow path through LOCA-2B, LOCA-100B to Aux Building Exhaust up to LOCA-3B and LOCA-10B.

OPERM-213-2 Flow Diagram Station and Instrument Air System
Abandon:
IA-31120 to CV31120, SW-0904B, including positioner air to S/CV-35007 and Pos 37075 on drawing OPERM-213-5

OPERM-213-5 Flow Diagram Station and Instrument Air System
Abandon:
IA-31386-1 Manual valve to LOCA-3A
IA-31386-2 Manual valve to LOCA-3A/AS-19579
IA-31387 Manual Isolation to LOCA-10A
IA-31388-1 Manual Isolation to LOCA-3B
IA-31388-2 Manual Isolation to LOCA-3B/AS-19583
IA-31389 Manual Isolation to LOCA-10B
IA-31119 Manual Isolation to CV-31119, SW904D, including positioner air to S/CV-35007 and Pos 37031 on drawing OPERM-213-2
IA-35007 manual isolation to S/CV-35007

OPERM-213-8 Flow Diagram Station and Instrument Air System
Abandon:
IA-156 downstream to CD-34189, CD-34188, CD34132/RBV150C, CD34133/RBV150D including IA piping, valves, regulators and associated accumulators.
IA-108 downstream to CD-34130/RBV150A, CD-34131/RBV150B, CD34186, CD34187, SW-901A-1, SW-901B-1, SW-910A, SW-910B, SW-911AB, SW-914A, SW-914B including IA piping, valves, regulators and associated accumulators.
IA-131 downstream to SW-901C-1, SW-901D-1, SW-910C, SW-910D, SW-911CD, SW-914C, SW-914D
IA-155 Manual Isolation to LOCA-201A
IA-153 Manual Isolation to RBV-2
IA-152 Manual Isolation to RBV-3
IA-167 Manual Isolation to LOCA-201B

OPERM-213-6 Flow Diagram Station and Instrument Air System

Abandon:
IA-31340 Manual Isolation of VB-11B
IA-31339 Manual Isolation of VB-11A
IA-31724 Manual isolation to LOCA-100A
IA-31125 Manual Isolation of RBV-1
IA-31123 Manual Isolation of RBV-4
IA-1505 Manual Isolation to RBV-5, RBV-6, RBV-7, RBV-10, RBV-20, RBV-21, TAV-12
IA-1522 Manual Isolation to VB10A, VB10B and associated accumulators and valves
IA-1550 Manual Instrument air header Isolation to manual dilution to containment
IA-1630 Manual Instrument Air Isolation to Post LOCA H2 Control

OPERM-213-7 Flow Diagram Station and Instrument Air System

Abandon:
IA-34030 Manual Isolation to TAV10
IA-34034 Manual Isolation to TAV-11
IA-1339 Manual Isolation to Purge Supply Unit Temperature Control

OPERM-547 Flow Diagram Service water System Containment Cooling

Available:
Service Water piping for CFCU A through Shroud Cooling Bypass valve SW-901A-1
Abandon:
1B, 1C, 1D Containment Fan Coil Unit coils
1A, 1B,1C,1D Shroud Cooling coils
CFCU B Service Water piping and components up to but not including SW-900B, SW-910A, SW-914A, SW-903B, SW-904B and SW-905B.
CFCU C Service Water piping and components up to but not including SW-900C, SW-903C and SW-905C.
CFCU D Service Water piping and components up to but not including SW-900D, SW-903D, SW-904D and SW-905D.

E-257 Circuit Diagram 480 Volt MCC 1-35E & 1-45E

Abandon:
Breaker MCC45E-D4 to 1-105 Containment Purge and Vent Supply Fan Motor
Breaker MCC35E-C5 to 1-313 Containment Purge Exhaust fan
Breaker MCC35E-A3 to 1-587 Containment vent Exhaust fan

E-889 Lighting panels RPB1, RPB2, RPB3, RPB4, RPB5, RPB6

Abandon:
Breaker RPB6-18 to 1-1079 Containment 2" Blower Motor

E-235 Circuit Diagram 480V Switchgear Safeguard Buses

Abandon:
Breaker 15104 to 1-156 Containment FCU B Motor

Breaker 16105 to 1-121 Containment FCU C Motor
Breaker 16104 to 1-157 Containment FCU D Motor
Available:
Breaker 15105 to 1-120 Containment FCU A Motor

E-251 Circuit Diagram 480V MCC 1-32E
Abandon:
Breaker MCC32E-D5 to 1-327 Reactor Vessel Support Cooling Fan A
Breaker MCC32E-D4 to 1-329 Reactor Vessel Gap and Neutron Detector Cooling Fan A
Breaker MCC32E-C5 to 1-337 Control Rod Drive Cooling Fan A
Breaker MCC32E-B5 to 1-588 Reactor Vessel Support Heater A

E-252 Circuit Diagram 480V MCC 1-42E
Abandon:
Breaker MCC42E-A2 to 1-328 Reactor Vessel Support Cooling Fan B
Breaker MCC42E-B1 to 1-330 Reactor Vessel Gap and Neutron Detector Cooling Fan B
Breaker MCC42E-E5 to 1-338 Control Rod Drive Cooling Fan B
Breaker MCC42E-A5 to 1-589 Reactor Vessel Support Heater B

E-258 Circuit Diagram 480V 1-52A, 1-52F, 1-52B
Abandon:
Breaker MCC52B-G5 to 1-672, SA-7003A Hydrogen Dilution to Containment
Breaker MCC52B-C2 to 1-670, LOCA 2A Post LOCA Containment Vent
Maintain:
Breaker MCC52B-A3 to 1-583 Containment dome Fan A

E-261 Circuit Diagram 480V 1-62A, 1-52D, 1-5262, 1-62B
Abandon:
Breaker MCC62B-C5 to 1-673, SA-7003B Hydrogen Dilution to Containment,
Breaker MCC62B-C4 to 1-671, LOCA-2B Post LOCA Containment Vent **Note: The power is to be abandoned with the valve in the open position to maintain a containment vent flow path.**
Breaker MCC62B-A2 to 1-584 Containment Dome Fan B

E-259 Circuit Diagram 480V MCC1-62D, 1-62E
Abandon
Breaker MCC62E-B1 to 1-396 , SW-903C MOV
Breaker MCC62E-B2 to 1-397, SW-903D MOV

E-260 Circuit Diagram 480V MCC 1-52C, 1-52E, 1-62C
Abandon:
Breaker MCC52E-G1 to 1-395, SW-903B MOV
Breaker MCC52E-F5 to 1-394, SW-903A MOV **Note: The power is to be abandoned with**

the valve in the open position to maintain a Service Water flow path to CFCU A.

4.0 Evaluation (Basis for choosing category type):

Purpose/Function

The RBV System shall provide cooling and ventilation to the Containment to ensure that temperature, pressure, and air quality are maintained within acceptable limits to support operability of equipment and safety and comfort of personnel during refueling and maintenance activities.

The RBV CFCU Subsystem shall provide Post-LOCA cooling to the Containment to control temperature and pressure within design basis requirements.

The RBV CFCU Emergency Discharge Dampers shall automatically open when containment pressure exceeds 3.85 psig.

The RBV Purge and Vent Subsystem four CIVs shall automatically close upon receipt of a containment isolation signal.

The Containment Vacuum Relief Subsystem shall prevent damage to the Containment vessel from negative pressure inside the Containment.

The Reactor Gap and Neutron Detector Cooling Subsystem shall provide a pressure boundary function for the Incore Support Column and Reactor Cavity.

RBV CFCUs A and B support safe shutdown following an Appendix R Fire Event in the Dedicated Zone. CFCUs C and D support safe shutdown following a fire in the Alternate Zone.

The RBV Post-LOCA Hydrogen Control Subsystem shall provide a means of preventing hydrogen concentration in containment from exceeding 3.5 percent.

The RBV CFCU Subsystem shall provide cooling to the Containment general space and the RC Pump Vaults so that the Containment environment is maintained within the limits of acceptability to support operability of equipment required to control reactor operation.

The CRD Shroud Cooling Subsystem shall provide sufficient cooling to the CRDM during normal operations to support proper functioning of the components.

The Reactor Gap and Neutron Detector Cooling Subsystem shall provide sufficient cooling to limit the maximum temperature of the concrete surrounding the reactor vessel and keep the neutron detectors cool during normal operations.

The Reactor Support Cooling Subsystem shall provide sufficient cooling to maintain the proper temperature profile in the reactor vessel steel at the supports, shims, shoes and supporting steel.

The Purge and Vent Subsystem shall provide comfort cooling and protection from airborne radiation for personnel entering the Containment, as well as a controlled containment exhaust air flow path.

The SG Channel Head
Ventilation Subsystem shall provide an air flow path and filtration to prevent condensation inside the SG heads and to control the spread of airborne contaminants.

Basis for Category

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2).

The basis for the abandoned category for the Reactor Building Ventilation (RBV) is determined by the following criteria:
The RBV is not required:

1. To prevent or mitigate the consequences of a design basis accident of a permanently defueled plant.
2. To prevent or mitigate the consequences of a Fuel Handling Accident or Gas Decay Tank rupture.
3. For safe storage and handling of radioactive waste or spent fuel.
4. To support Technical Specifications, License Requirements, Design Basis, permits, regulatory requirements, insurance requirements, or other commitments. Provide support of the Spent Fuel Safety Management Program, or radiological effluent monitoring.
5. To support the execution of plans and programs of Kewaunee Power Station.
6. Support day to day operations in the decommissioning plant.
7. Support plant decommissioning efforts.

Regulatory Impact

TECHNICAL SPECIFICATIONS

3.6 CONTAINMENT SYSTEMS

3.6.6 Containment Spray and Cooling Systems
LCO 3.6.6 Two containment spray trains and two containment cooling trains shall be OPERABLE.
APPLICABILITY: MODES 1, 2, 3, and 4.
SR 3.6.6.2 Operate each containment cooling train fan unit for ≥ 15 minutes.
SR 3.6.6.3 Verify each containment cooling train cooling water flow rate is sufficient to remove the assumed heat load.
SR 3.6.6.7 Verify each containment cooling train starts automatically on an actual or simulated actuation signal.

B 3.6 CONTAINMENT SYSTEMS
B 3.6.6 Containment Spray and Cooling Systems
The Containment Spray and Containment Cooling systems provide containment atmosphere cooling to limit post accident pressure and temperature in containment to less than the design values. Reduction of containment pressure and the iodine removal capability of the spray reduces the release of fission product radioactivity from containment to the environment, in the event of a Design Basis Accident (DBA), to within limits. The Containment Spray and Containment Cooling systems are designed to meet the requirements of USAR, General Design Criteria (GDC) 52, "Containment Heat Removal Systems," GDC 58, "Inspection of Containment Pressure-Reducing Systems," GDC 59, "Testing of Containment Pressure-Reducing Systems Components," GDC 60, "Testing of Internal Containment Spray System," and GDC 61, "Testing of Operational Sequence of Containment Pressure-Reducing Systems" (Ref. 1)
Containment Cooling System
Two trains of containment cooling, each of sufficient capacity to supply 100% of the design cooling requirement, are provided. Each train of two fan-coil units is supplied with cooling water from a separate train of service water. Each pair is connected to ductwork which distributes the cool air to the reactor coolant pump vaults, the ring duct above the refueling floor, the intake of the Reactor Gap and Neutron Detector Cooling Subsystem, and Various other floor levels in the Reactor Containment Vessel.
The Containment Spray System and Containment Cooling System limit the temperature and pressure that could be experienced following a DBA. The limiting DBAs considered are the loss of coolant accident (LOCA) and the main steam line break (MSLB).
In MODES 1, 2, 3, and 4, a release of radioactive material to containment and an increase in containment pressure and temperature could occur requiring the operation of the containment spray trains and containment cooling trains.

In MODES 5 and 6, the probability and consequences of a release are reduced due to the pressure and temperature limitations of these MODES. Thus, the Containment Spray System and the Containment Cooling System are not required to be OPERABLE in MODES 5 and 6.

3.6.9 Vacuum Relief Valves

LCO 3.6.9 Two vacuum relief lines shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

SR 3.6.9.1 Perform a functional test of each vacuum relief valve and verify the valve opens at a simulated containment vacuum of ≤ 0.5 psig vacuum. 18 months

SR 3.6.9.2 Perform a CHANNEL CALIBRATION on the containment vacuum breaker differential pressure channels. 18 months

B 3.6.9 Vacuum Relief Valves

The purpose of the vacuum relief lines is to protect the containment vessel against negative pressure (i.e., a lower pressure inside than outside). Excessive negative pressure inside containment can occur if there is an inadvertent actuation of containment cooling features, such as the Containment Spray System. Multiple equipment failures or human errors are necessary to cause inadvertent actuation of these systems. The containment pressure vessel contains two 100% vacuum relief lines that protect the containment from excessive external loading.

The containment was designed for an external pressure load equivalent to 0.8 psig. The inadvertent actuation of the containment cooling features was analyzed to determine the resulting reduction in containment pressure. The initial pressure condition used in this analysis was 14.7 psia (0.0 psig). This resulted in a minimum pressure inside containment of 13.917 psia (-0.783 psig), which is less than the design load.

The vacuum relief valves must also perform the containment isolation function in a containment high pressure event. For this reason, the system is designed to take the full containment positive design pressure and the environmental conditions

In MODES 1, 2, 3, and 4, the containment cooling features, such as the Containment Spray System, are required to be OPERABLE. Excessive negative pressure inside containment could occur whenever these systems are required to be OPERABLE due to inadvertent actuation of these systems. Therefore, the vacuum relief lines are required to be OPERABLE in MODES 1, 2, 3, and 4 to mitigate the effects of inadvertent actuation of the Containment Spray System or Containment Cooling System.

The Containment Spray System and Containment Cooling System are not required to be OPERABLE in MODES 5 and 6. Therefore, maintaining OPERABLE vacuum relief valves is not required in MODE 5 or 6.

3.3 INSTRUMENTATION

3.3.6 Containment Purge and Vent Isolation Instrumentation

LCO 3.3.6 The Containment Purge and Vent Isolation Instrumentation for each Function in Table 3.3.6-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.6-1.

B 3.3.6 Containment Purge and Vent Isolation Instrumentation

Containment purge and vent isolation instrumentation closes the containment isolation valves in the Containment Vessel Air Handling System, consisting of the Containment Air Cooling and Containment Purge and Vent Systems. This action isolates the containment atmosphere from the environment to minimize releases of radioactivity in the event of an accident. The Containment Air Cooling System may be in use during reactor operation and the Containment Purge and Vent System will be in use with the reactor shutdown

3.6.3 Containment Isolation Valves

LCO 3.6.3 Each containment isolation valve shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

SR 3.6.3.1 Verify each 36 inch purge and vent isolation valve is sealed closed. 31 days

SR 3.6.3.2 Verify each 2 inch containment vent isolation valve is closed, except when the 2 inch containment vent isolation valves are open for pressure control,

ALARA or air quality considerations for personnel entry, or for Surveillances that require the valves to be open. 31 days

3.6.4 Containment Pressure

LCO 3.6.4 Containment pressure shall be ≥ 0.0 psig and ≤ 2.0 psig.

APPLICABILITY: MODES 1, 2, 3, and 4.

SR 3.6.4.1 Verify containment pressure is within limits. Every 12 hours

B 3.6.4 Containment Pressure

The containment pressure is limited during normal operation to preserve the initial conditions assumed in the accident analyses for a loss of coolant accident (LOCA) or main steam line break (MSLB).

3.6.5 Containment Air Temperature

LCO 3.6.5 Containment average air temperature shall be ≤ 120°F.

APPLICABILITY: MODES 1, 2, 3, and 4.

SR 3.6.5.1 Verify containment average air temperature is within limit.

B3.6.5 Containment Air Temperature

The containment average air temperature is limited during normal operation to preserve the initial conditions assumed in the accident analyses for a loss of coolant accident (LOCA) or main steam line break (MSLB).

3.9 REFUELING OPERATIONS

Verify each penetration providing direct access from the containment atmosphere to the outside atmosphere is either closed with a manual or automatic isolation valve, blind flange, or equivalent; or is capable of being closed by an OPERABLE Containment Purge and Vent Isolation System.

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Therefore, the LCOs (and associated Surveillance Requirements (SRs)) that only apply in Modes 1 thru 6 are no longer applicable.

TECHNICAL REQUIREMENTS MANUAL (TRM)

8.6 CONTAINMENT SYSTEMS
8.6.1 Containment Hydrogen Monitoring System
TNC 8.6.1 Containment Hydrogen Monitoring System, consisting of two trains and associated containment dome fans, shall be FUNCTIONAL.

Note:
A change in operational MODES or conditions is acceptable with one or both trains of the Containment Hydrogen Monitoring System and its associated Containment Dome Vent Fan Non-Functional.

APPLICABILITY: MODE 1 and 2.

Bases:
Even though the requirements for Hydrogen Monitors were taken out of TS, the system still needs to be available for beyond design-basis accident monitoring of containment hydrogen levels. In the event CONTINGENCY MEASURES A or B are not met, the condition will be entered into the corrective action program immediately to address why the hydrogen monitors were not restored to FUNCTIONAL status within the allotted time.

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Therefore, the TNC's (and associated Technical Verification Requirements (TVR's)) that only apply in Modes 1 thru 6, are no longer applicable.

Offsite Dose Calculation Manual (ODCM)

15.1 Major Changes to Radioactive Waste Systems
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.

This is a partial abandonment of RBV. The 36" Containment Purge and Vent fans will be completely abandoned with the 36" RBV isolation valves failed closed. On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. On May 15, 2013 the NRC docketed the certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii). Therefore the 10 CFR Part 50 license no longer authorizes KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). With the 36" Containment Purge and Vent fans be completely abandoned with the 36" RBV isolation valves failed closed there will be no release through this path. This change results in no increase in maximum exposures in the UNRESTRICTED AREA, to the general population and to plant operating personnel. Detailed information concerning the predicted releases and exposure estimates will be included in the annual Radioactive Effluent Release Report.

USAR

5.4 CONTAINMENT VESSEL AIR HANDLING SYSTEM

The Containment Air Cooling System is sized such that any three of the four fan-coil units will provide adequate heat removal capacity from the Reactor Containment Vessel during operation, to maintain interior air temperatures below the maximum temperature allowable for any component and to obtain temperatures below 104°F in accessible areas during hot standby operation. The fan-coil units and their associated emergency discharge dampers will also be utilized for emergency cooling under post-accident conditions. Their use for that purpose is described in Section 6.3.

The fan-coil units of the Containment Air Cooling System are utilized to distribute air adequately over equipment and around occupied spaces for ventilation service. Operation of motors and other electrical equipment in the containment will provide heating within the Reactor Containment Vessel when required during shutdown. The Containment Vent Supply unit will also furnish heated makeup air under shutdown conditions.

The Purge and Ventilation System is designed to provide a reduction in the radioactivity in the Reactor Containment Vessel air following normal full-power operation, if necessary. Provision is made in the design of the Purge and Ventilation System for 1½ air changes per hour during refueling and maintenance operations.

When high airborne radioactivity levels within containment preclude a normal shutdown entry to the Reactor Containment Vessel, the initial purge will be directed to the purge filter (particulate-absolute-carbon). A deluge system is installed in the carbon filter assembly. The water spray is provided from the Service Water System.

When the Reactor Containment Vessel air activity has decreased sufficiently for release to the atmosphere with particulate filtration only, the Vent and Purge Systems operating mode may be changed from purge to ventilate. Should some incident occur to cause the air activity to increase above the setpoint of the Containment System Vent Monitor, the vent and purge line valves would both be automatically closed.

The Reactor Gap and Neutron Detector Cooling Subsystem limits the maximum temperature of the concrete surrounding the reactor vessel and keeps the neutron detectors cool.

The Containment Dome Ventilation Subsystem pulls air from the Reactor Containment Vessel dome through separate fan inlet ducts and discharges the air in the area above the operating level of containment. The containment fan coil units then cool the dome air and return it to the containment. This process mixes the dome air and assists in the control of the Reactor Containment Vessel temperature during normal operation and the control of post-LOCA hydrogen concentration following a design basis accident.

The Reactor Support Cooling Subsystem maintains the proper temperature profile in the reactor vessel supports, shoes, shims, and supporting steel. Two 100% capacity fans draw air from the refueling floor and force the air through ductwork to each of three pairs of reactor support plenums.

The Control Rod Drive Mechanisms (CRDM) Cooling Subsystem provides CRDM cooling by drawing air from the refueling pool area up through the CRDM enclosing shroud and up through three ducts connected to the CRDM shroud plenum mounted on top of the missile shield above the CRDMs.

The Post-LOCA Hydrogen Control Subsystem controls the hydrogen concentration in the post-accident containment atmosphere. Venting and replacement of the containment atmosphere, dilution by pressurization, or a combination of both methods can be used. If required, hydrogen recombiners are brought on site

5.4.2.1 Isolation Valves

The ventilation isolation valves are included as part of the containment isolation systems listed in Table 5.2-3. The valves immediately outside the Reactor Containment Vessel are conventional butterfly valves, specified to be adequately leak-tight with maximum internal pressure on the Reactor Containment Vessel side of the valve disc. The valves inside the Reactor Containment Vessel are also conventional butterfly valves, which are specified to be adequately leak-tight with maximum internal pressure on either side of the valve disc

5.4.3 Vacuum Relief System

Vacuum relief devices or systems are provided to protect the Reactor Containment Vessel against excess differential pressures. Such differential pressure conditions (vacuum) may exist inside the containment vessel if the containment air cooling systems are operated with a heat removal capability in excess of the heat inputs at any time during normal or post-accident operations.

5.8.2.6.3 Provisions for Sampling

Monitoring of the containment hydrogen concentration is accomplished by two Comsip Model K-111 hydrogen analyzers. As stated in Reference 7, the analyzers fulfill the requirements of Item II.F.1.6 of NUREG-0737. The hydrogen monitors have indication in the control room and a range of 0 percent to 10 percent by volume under positive or negative containment pressure. The monitors are normally kept in standby mode, but indication is available on demand. The system is operated from its remote control panel located outside the high radiation sampling room. A hydrogen sample is drawn from the post-LOCA hydrogen control system sample ports in containment. These ports are located near the discharge of the containment dome fans, which permits rapid detection of hydrogen escaping from the reactor. The fans draw suction from the upper areas of containment, which prevents the formation of a stratified atmosphere. The fans are powered from safeguard buses and are designed to operate in a post-LOCA environment

6.0 Engineered Safety Features

6.1.1

With the failure of an active component in either system, the Containment Air Cooling (CAC) System and the Internal Containment Spray (ICS) System are designed and sized so that the remaining combined CAC and ICS equipment is able to supply the necessary post-accident cooling capacity to rapidly reduce the containment pressure following blowdown and cooling of the core by safety injection. Assuming the loss of off-site power and the single active failure of one Emergency Diesel Generator, one containment spray pump in tandum with two containment fan coil-units on the same train, is sufficient for containment heat removal and depressurization.

6.3.2.2 Actuation Provisions

During normal operation up to four fan coil units are operating and the emergency discharge dampers are closed. Each unit has a flow rate capacity of 44,000 cfm under normal conditions. During accident conditions, actuation of all four fan-coil units is by the automatic starting sequence initiated by the Safety Injection Signal.

6.3.2.6.4 Fan-Coil Emergency Discharge Dampers

The dampers are parallel blade, pneumatically operated (air open, spring close) type. Isolation dampers are provided to prevent back flow through an inactive unit.
All ductwork, damper blades, and seating surfaces are constructed of, or coated with corrosion-resistant materials. To ensure the integrity of the ductwork in a post LOCA environment, the Containment Fan Coil Unit emergency discharge dampers and back draft dampers are tested once every operating cycle, or every 18 months.

6.5.1.2.13 Service Water System
The containment fan-coil service water discharge radiation monitor checks the containment fan coils for radiation indicative of a leak from the containment atmosphere into the service water. A small bypass flow from the common return of the fan coil units is monitored by a scintillation detector mounted in a holdup tank assembly. Upon indication of a high radiation level each fan coil is individually sampled to determine which unit is leaking.

14 Safety Analysis

14.3.5.2.2 Input Parameters and Assumptions
A series of analyses, using different break sizes and locations, was performed for the LOCA containment response. Section 14.3.5.1 documents the mass and energy releases for the DEPS and DEHL breaks. The DEPS break cases were run with both minimum and maximum safeguards. The three minimum safeguards cases assume a diesel train failure. This assumption leaves one of two containment spray pumps and two of four containment fan-coil units (CFCUs) available for containment heat removal.

Table B Classification of Systems and Components

- Safeguards Fan Coil Units I

Reactor Building Ventilation System

- Containment Purge and Vent System (Containment Isolation Valves are Class I) III
- Containment Dome Fans I
- Post-LOCA Hydrogen Control System (Containment Isolation Valves are Class I) III
- Containment Vacuum Relief System I
- Containment Fan Coil Units (includes fans, coils, and housings) I
- CRDM Shroud Cooling System II
- Reactor Gap and Neutron Detector Cooling System (excluding Class I piping segment in the reactor cavity) II
- Reactor Support Cooling System II

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR

50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Since KPS will no longer be authorized to operate or place fuel in the reactor the functions credited in the USAR are no longer required. The USAR will be revised to address requirements following cessation of power operation.

LICENSING COMMITMENTS

Commitment Number: 80-001
Title: Containment Purge and Vent Valve Modifications Improvement Initiative
While above hot shutdown Kewaunee will seal the 36 diameter purge and vent valves closed and will verify the valves closed by monthly surveillance of control board indication. This commitment will take effect upon startup from the next refueling outage and will continue until such time that valve operability is shown.

Commitment Number: 83-005
Title: CONT. PURGE AND VENT SYSTEM OPERABILITY
Installation of a 2" containment vent system

Commitment Number: 83-012
Title: CONT. PURGE AND VENT SYSTEM OPERABILITY
Need a procedure for Containment venting.

Commitment Number: 90-143
Title: GENERIC LETTER 89-13: SW BIOFOULING
Commitment change evaluation was in initiated and approved to provide an alternate method for verifying continued heat exchanger performance for the CFCUs.

Commitment Number: 84-009
Title: RESOLUTION OF SER FOR EQ
Replacement of containment vacuum breakers with qualified solenoid valves.

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Since the KPS license will be modified to a possession only license, the regulatory commitments associated with the Reactor Building Ventilation System will not be maintained. These commitments will be dispositioned per LI-AA-110, Commitment Management.

EMERGENCY PLAN

Reviewed the Emergency Plan and the Emergency Action Level (EAL) Technical Basis Document for classification criteria that apply in Mode DEF-Defueled. The Emergency Plan defines Defueled as 'All reactor fuel removed from Reactor Vessel (full core off load during refueling or extended outage)' Abandonment of the RBV System will not impact the Emergency Plan as this equipment is not listed in the EAL tables that apply to a defueled plant. None of the radiation monitoring equipment is being abandon as part of the RBV system categorization.

FIRE PROTECTION PROGRAM PLAN

> **11.0 DESCRIPTION OF FIRE PROTECTION SYSTEMS AND FEATURES**
> Fire protection systems and components are designed using the guidelines of the National Fire Protection Association (NFPA) standards (see Appendix B). The water spray systems for the charcoal filters, boiler fuel oil pumps and the hydrogen seal oil unit are unique and do not meet the NFPA standards.
>
> **11.4.1 Water Spray Systems**
> The water spray systems for the Auxiliary Building charcoal filters (shield building, the containment purge, containment cleanup and the Control Room air conditioning ventilation units) are nonstandard; however, they are adequate for their intended purpose. The water supply is the service water system. These systems have detectors that operate solenoid valves that feed water to the spray nozzles.
> The Fire Plan requires that if the filter fire detector is out of service a hourly fire watch is to be established.
> Use of combustible material, e.g., HEPA and charcoal filters, dry ion exchange resins or other combustible supplies, in safety-related areas should he controlled.

Abandonment of the RBV system will not impact the Fire Plan. The charcoal shall be removed from the charcoal filter unit prior to disabling the fire protection spray system to the filters.

Plant Impact

The abandonment of the RBV system shall eliminate all installed heating from containment. One containment fan coil unit shall remain availble for cooling and dehumidifcation if needed.

Portable heaters are to be placed in containment plugged into weld receptables to maintain containment above 40F so freezing does not occur. The following instrument loops are required to remain available to monitor containment temperture.

TE-15189 Containment elevation 592' ambient air temperature
TE-15187 Containment elevation 626' ambient air temperature

New or existing procedures will need to be created or revised to provide direction for monitoring and controlling containment temperature, including the control of setpoints for the portable heaters and operation of a dome fan to prevent stratification.
A portable dehumidifier is to be placed in containment to control humidity and reduce the potential of mold growth. The portable dehumidifier will be used to reduce or eliminate the need to run CFCU A. The following instrument loop is to be maintained to monitor containment humidity.

41517 Containment humidity indicator

New or exisitng procedures will need to be created or revised to control humididy in containmet and operation of the dehumidifier. Althoug it is expected to be rarely if ever used this should include use of the A CFCU unit as needed.
There is no impact on any temporary changes that are active as of 5-9-2013.
The Drawing Control Team did not identify any outstanding drawing changes that required disposition as a result of system abandonment.
This DSERT package does not impact Spent Fuel Pool Cooling therefore does not require FSRC approval.

5.0 Special conditions to support categorization(s):

None

6.0 Assumptions/Open Items to be validated or dispositioned:

None

7.0 Expected duration for SSC category if <u>NOT</u> ABANDONED:

The CFCU A is expected to remain available indefinitely to provide cooling to containment during decommissioning activities in containment.
The Containment Vent path to the aux building ventilation is expected to remain open indefinitely to avoid pressure increases and decreases as containment heats up and cools down based on ambient conditions.

The A Dome Fan shall be evaluated to determine if it is needed to limit stratification in containment. If deemed it is not required this Categorization plan will be revised to abandon the A Dome Fan.

8.0 **PREPARE** and **ATTACH** the following documents:

- Completed 10 CFR 50.59 Screening or Evaluation, if required
- Proposed DUs for appropriate drawings

9.0 Technical Concurrence:

Type Of Review Engineering	Name (Print) BRIAN O'CONNELL	Approval Signature [signature]	Date 5/20/13
Type Of Review Fire Protection	Name (Print) [signature]	Approval Signature [signature]	Date 5/21/13
Type Of Review Security	Name (Print) Brian Presl	Approval Signature [signature]	Date 05-16-13
Type Of Review Radiation Protection	Name (Print) Daniel J. Shannon	Approval Signature [signature]	Date 5-20-13
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date

10.0 Review and Approval:

BRIAN O'CONNELL / [signature]	5/20/13
Prepared By (Print/Sign)	Date
SCOTT CIESLEWICZ / [signature]	5/20/13
Reviewed By (Screen Qual.) (Print/Sign)	Date
C J SMOKER / [signature]	5/20/13
Nuclear Licensing (Print/Sign)	Date
D DYKSTRA [signature]	5-21-13
Concurrence by DSERT Coordinator (Print/Sign)	Date
Stewart Yuen / [signature]	6-20-13
FSRC (Print/Sign), if required	Date

FSRC Meeting Number: 13-031

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1.0 Doc Type: Report Revision No.: 0 Date: 06/07/2013
Sub Type: DEC
Document Number (ID): SYS-32B-DSERT
Title: Gaseous Radioactive Waste Disposal

1.1 Brief description or reason for revision: Not applicable for Revision 0.

2.0 System Category (Check Appropriate):

NOTE:	*A SSC may be divided and have more than one category determination depending upon its functional requirements.*

☐ Available (Category A) ☒ Abandoned (Category X)

Describe the assessed boundaries:

The WG system consists of:
- Two waste gas compressor packages,
- Four gas decay tanks,
- One nitrogen supply package,
- One hydrogen supply package,
- One multipoint gas analyzer,
- Associated piping, valves, and instrumentation.

Gases processed by the WG System during normal plant operation are collected from the following sources:
- Cover gas from the Chemical and Volume Control System (CVCS),
- Cover gases vented to the closed cover gas system,
- Equipment purging (vents and reliefs),
- Sampling operations,
- Automatic gas analysis for hydrogen and oxygen in cover gases.

The system will be isolated from the CVCS at MG(R)-520, Hold Up Tank to Vent Header 1 WG-17, Gas Decay Tanks to Holdup Tanks, and the CVCS Holdup Tank to Gas analyzer valves.

The gas decay tanks and waste gas compressors will be isolated from the plant vent at WG-36, Gas Decay Tanks to Plant Vent. The tanks will also be isolated from various other tanks and

system Interconnections at the following valves:
BEF-4-1, Isolation on Vent Header Side of BEF4/CV-31277
MD(R)-401, Gas Decay Tank to Drain Header
MG(R)-507, Reactor Coolant Drain Tank to Vent Header
MG(R)-520 Combined Holdup Tanks to Vent Header
ISOL
MG(R)-537, VCT Vent to WDS Isolation
MG(R)-544, VCT Gas Space to Vent Header
MG(R)-549 Przr Relief Tank Vent
Isolation
MG(R)-550, Vent Header #2 to Waste Gas Analyzer Filter Inlet Isolation
WG-16, Gas Decay Valve Gallery to Holdup Tanks
WG-200-1, Gas Decay Tank to Gas ANZR Filter Inlet Isolation
WG-300, Deareated Drain Tank Vent Line to WG Manual Isolation
NG-721, Nitrogen Manifold to Gas Decay Tanks

The Waste Gas Analyzer will be isolated from interconnecting systems at the following valves:
NG-731, Misc Gas Systems to Auto Gas Analyzer
MG(R)-561, Train B Inlet/Outlet Isolation Valves MG(R)561/MG(R)563
MG(R)-562, Train A Inlet/Outlet Isolation Valves MG(R)560/MG(R)562
MG(R)-564, WGA Cal Gas Vent
MG(R)-566 Grab Sample to Bottle Inlet
MG(R)-567 Grab Sample from Bottle Outlet

The system will be isolated from the electrical distribution system at the 480V Waste Gas Compressor 1A and 1B supply breakers.

The system wil be isolated from 120V AC at the supply breaker for the Waste Gas Analyzer Panel.

3.0 Mark up the affected drawings using color coding to identify system category type and boundaries. These drawings are to include system, electrical one-line and distribution, and select building and isometric drawings. Related system drawings <u>NOT</u> incorporated in the system category require an explanation. REFER to Step 2.7 for a list of drawings.

Flow Diagram Chemical & Volume Control System, OPERXK-100-37
Following valves serve as isolation boundaries:
MG(R)-516A, Hold Up Tank 1A to Gas Analyzer
MG(R)-516B, Hold Up Tank 1B to Gas Analyzer
MG(R)-516C, Hold Up Tank 1C to Gas Analyzer
MG(R)-520, Hold Up Tank to Vent Header 1
WG-17, Gas Decay Tanks to Holdup Tanks

Flow Diagram Waste Disposal System, OPERXK-100-131
Abandon the Waste Gas Analyzer with the following valves serving as isolation boundaries:
NG-731, Misc Gas Systems to Auto Gas Analyzer
MG(R)-561, Train B Inlet/Outlet Isolation Valves MG(R)561/MG(R)563
MG(R)-562, Train A Inlet/Outlet Isolation Valves MG(R)560/MG(R)562
MG(R)-564, WGA Cal Gas Vent
MG(R)-566 Grab Sample to Bottle Inlet
MG(R)-567 Grab Sample from Bottle Outlet

Flow Diagram Waste Disposal System, OPERXK-100-132
Abandon the entire drawing with the following valves serving as boundaries:
BEF-4-1, Isolation on Vent Header Side of BEF4/CV-31277
MD(R)-401, Gas Decay Tank to Drain Header
MG(R)-507, Reactor Coolant Drain Tank to Vent Header
MG(R)-520 Combined Holdup Tanks to Vent Header
ISOL
MG(R)-537, VCT Vent to WDS Isolation
MG(R)-544, VCT Gas Space to Vent Header
MG(R)-549 Przr Relief Tank Vent Isolation
MG(R)-550, Vent Header #2 to Waste Gas Analyzer Filter Inlet Isolation
WG-13A, Gas Decay Tank 1A to Plant Vent (Relief valve)
WG-13B, Gas Decay Tank 1B to Plant Vent (Relief valve)
WG-13C, Gas Decay Tank 1C to Plant Vent (Relief valve)
WG-13D, Gas Decay Tank 1D to Plant Vent (Relief valve)
WG-16, Gas Decay valve Gallery to Holdup Tanks
WG-36, Gas Decay Tanks to Plant Vent
WG-200-1, Gas Decay Tank to Gas ANZR Filter Inlet Isolation
WG-300, Deareated Drain Tank Vent Line to WG Manual Isolation
NG-721, Nitrogen Manifold to Gas Decay Tanks

Flow Diagram H2/O2 Automatic Gas Analyzer, M-1725
Abandon the entire drawing with the following valves serving as boundaries:
MG(R)-561, Train B Inlet/Outlet Isolation Valves MG(R)561/MG(R)563
MG(R)-562, Train A Inlet/Outlet Isolation Valves MG(R)560/MG(R)562
MG(R)-564, WGA Cal Gas Vent
V36
SV14
SV15
SV16
SV17
SV24

Circuit Diagram 480V MCC 1-35A, 1-35D, 1-45A & 1-45D, E-254
Abandon: Bus 1-35A, B6, Waste Gas Compressor 1A Motor Feed

Circuit Diagram 480V MCC 1-62A, 1-52D, 1-5262 & 1-62B, E-261
Abandon: Bus 1-5262, A-6, Waste Gas Compressor 1B Motor Feed

Lighting Panels RPA7, RPA8, RPA9, RPA10, RPA11, RPA12, E-885
Abandon: RPA8 circuit 21, Waste Gas Analyzer

The following instrument boundaries will be abandoned along with their respective sensing lines: PI-8131, PI-8132, PI-8133, PC-16108, TI-12151, PS-16173, LT-1030, LC-1030A/F, PC-16109, TI-12152, PS-16044, LT-1032, LC-1032A/F, PT-1025, PC-1025, PC-1025A, PT-1036, PC-1036B, PT-1037, PC-1037B, PT-1038, PC-1038B, PT-1039, PC-1039B, PI-1036, PI-1037, PI-1038, PI-1025, LI-1030, LI-1032, PI-11057J

4.0 Evaluation (Basis for choosing category type):

Purpose/Function

The purposes of the WG System are to:

• Collect gaseous radioactive waste (WG) produced by the operation of the Kewaunee Power Station (KPS).
• Process the WG as required to permit disposal within the limits established by the applicable regulatory guidelines.
• Provide the ability to reuse waste gases as cover gases in the CVCS Holdup Tanks and DDT.

Based on the above, the WG System is capable of processing all gaseous wastes generated during the continuous operation of the Reactor Coolant System (RCS) assuming cladding defects in one percent (1 %) of the fuel rods. The WG System is capable of handling gaseous waste from two units.

Basis for Category

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. On May 15, 2013 the NRC docketed the certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii). Therefore the 10 CFR Part 50 license no longer authorizes KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2).

The gas decay tanks contain the gases vented from the RCS, the Volume Control Tank, and the liquid CVC Holdup Tanks. Following abandonment of the RCS and CVCS systems the Waste Gas Decay Tanks and associated piping will be discharged and vented to atmosphere. No new gasses will be produced as the CVCS will be drained/vented and the reactor vessel has been defueled.

Based on the above, the Waste Gas System does not perform a function or provide support for any of the following items:

1. To prevent or mitigate the consequences of a design basis accident of a permanently defueled plant.
2. Fuel Handling Accident as defined in Updated Safety Analysis Report (USAR).
3. For safe storage and handling of radioactive waste or spent fuel.
4. To support Technical Specifications, License Requirements, Design Basis, permits, regulatory requirements, insurance requirements, or other commitments. Provide support of the Spent Fuel Safety Management Program, or radiological effluent monitoring.
5. To support the execution of plans and programs of Kewaunee Power Station.
6. Support day to day operations in the decommissioning plant.
7. Support plant decommissioning efforts.

Regulatory Impact

This DSERT package does not impact Spent Fuel Pool Cooling. This DSERT package is associated with the accident analysis for a gas decay tank rupture per USAR section 14.2.3 Accidental Release-Waste Gas. Therefore this document requires FSRC review and approval.

Commitments:

A search of licensing commitments using the following file path S:\KEWAUNEE\4\DATA1\LICENSING\Commitments\COMTRAKS\TRUECOMMITMENTS\ALL TRUE Commitments by Number, did not identify any open commitments related to the Waste Gas System. Additionally the license renewal commitments in table 15.7-1 of the USAR were reviewed and no commitments related to the Waste Gase System were identified.

Commitment numbers 85-05 and 85-052 to analyze for explosive gas mixtures were closed to commitment number 94-132, which was subsequently closed to commitment number 96-122. Commitment 96-122 was closed on 2/15/2001 following completion of the waste gas analyzer modification and issuance of the required operating and maintenance procedures.

Technical Specifications:

The Waste Gas System is not explicitly identified in technical specifications.

Technical Specification 5.5.3, Radioactive Effluent Controls Program, refers to the Waste Gas System. The program is required to be maintained until the issuance of the PDTS. This program provides controls for gaseous effluents. Following abandonment of the RCS and CVCS systems the Waste Gas Decay Tanks and associated piping will be discharged and vented to atmosphere. No new gasses will be produced as the CVC System will be drained/vented and the reactor vessel has been defueled. The requirement to maintain the program does not prevent the abandonment of the Waste Gas System as the system will be purged and vented of any radioactive gasses prior to abandonment.

The Waste Gas System is not explicitly identified in technical specifications. Technical Specification 5.5.10, Explosive Gas and Storage Tank Radioactivity Monitoring Program, refers to the waste gas system. The program is required to be maintained until the issuance of the PDTS. This program provides controls for potentially explosive gas mixtures contained in the Gaseous Radioactive Waste Disposal System, the quantity of radioactivity contained in gas storage tanks or fed into the offgas treatment system, and the quantity of radioactivity contained in unprotected outdoor liquid storage tanks. The requirement to maintain the program does not prevent the abandonment of the waste gas system as the system will be purged and vented of any radioactive gasses prior to abandonment.

USAR:
The USAR will require revision to reflect abandonment of Waste Gas System. The system is mentioned in the following chapters/sections:

2.7.1, Meteorological Program
8.2.2.4, 480V System
9.3.2.1, System Design and Operation, Component Cooling System
9.6.5.1, Auxiliary Building Special Ventilation System Design Basis
11.1.1.1 Control of Releases of Radioactivity to the Environment
11.1.2.3, Gas Processing
11.1.2.10, Gas Decay Tanks
11.1.2.11, Waste Gas Compressors
Table 11.1-2, Waste Disposal Components Codes
Table 11.1-3, Component Summary Data
Figure 11.1-8, Waste Gas Processing
11.2.3.5, Auxiliary Building Vent Monitors
14.2 Standby Safety Features Analysis
14.2.3, Accidental Release Waste Gas
Table B.2-1, Classification of Systems and Components
H.2, Containment System evaluation, Leak Paths

Offsite Dose Calculation Manual (ODCM):
The ODCM will require revision to reflect abandonment of Waste Gas System. The system is mentioned in the following chapters/sections:

2.1.1 Waste Gas Holdup System
2.1.4 Auxiliary Building Vent
Table 13.2.1-1, Radioactive Gaseous Waste Sampling and Analysis
13.2 Gaseous Effluents - 13.2.5 Gas Storage Tanks
13.3 Instrumentation - 13.3.2 Radioactive Gaseous Effluent Monitoring Instrumentation
Table 13.3.2-1, Radioactive Gaseous Effluent Monitoring Instrumentation

The USAR and ODCM revisions will be revised to address requirements following cessation of power operation.

Technical Requirements Manual (TRM):
Abandonment of the Waste Gas system would abandon the Waste Gas Analyzer which is identified in the Technical Requirements Manual section 8.3.7. The requirements of this section are applicable whenever a Waste gas Decay Tank is inservice. This requirement does not prevent the abandonment of the waste gas system as the system will be purged and vented of any radioactive gasses prior to abandonment. Additionally, no new gasses will be produced as the CVCS will be drained/vented and the reactor vessel has been defueled.

Plant Impact
The FPPA will be revised to reflect the complete abandonment of the Waste Gas System following abandonment. In addition, the Fire Zone Summaries in the FPPA and the Fire Fighting Strategies books will be revised to CVC HUTs, WGDTs, and VCT as a combustible hazard. No other changes are required to SSCs, procedures, programs, processes, etc.

No additional changes are required to SSCs, procedures, programs, processes, etc.

There is no impact on any temporary changes that are active as of 6/7/2013.

The Drawing Control Team did not identify any outstanding drawing changes that required disposition as a result of system abandonment.

5.0 Special conditions to support categorization(s):

RCS and CVCS system abandoned (drained/vented).
Gas Decay tanks and associated vent header piping purged and vented.

6.0 Assumptions/Open Items to be validated or dispositioned:

Validate that the status of the systems and plant condition are such that conditions can not be established for the accident analysis for a gas decay tank rupture per USAR section 14.2.3 Accidental Release-Waste Gas.

7.0 Expected duration for SSC category if NOT ABANDONED:

N/A

8.0 **PREPARE** and **ATTACH** the following documents:

- Completed 10 CFR 50.59 Screening or Evaluation, if required
- Proposed DUs for appropriate drawings

9.0 Technical Concurrence:

Type Of Review	Name (Print)	Approval Signature	Date
Engineering	Thomas P. Schneider	[signature]	8/19/13
Type Of Review Fire Protection	Name (Print) Michael Townsend	Approval Signature [signature]	Date 8/19/13
Type Of Review Security	Name (Print) David Falk	Approval Signature [signature]	Date 08-19-13
Type Of Review Radiation Protection	Name (Print) Daniel J. Shannon	Approval Signature [signature]	Date 8-15-13
Type Of Review Decom - Ops	Name (Print) Bill Swanson	Approval Signature [signature]	Date 8/19/13
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date
Type Of Review	Name (Print)	Approval Signature	Date

10.0 Review and Approval:

TIM SMITH	7/1/13
Prepared By (Print/Sign)	Date
SCOTT CIESLEWICZ	7/10/13
Reviewed By (Screen Qual.) (Print/Sign)	Date
SMOKER	7/10/13
Nuclear Licensing (Print/Sign)	Date
DD VICSTRA	7-16-13
Concurrence by DSERT Coordinator (Print/Sign)	Date
Jeffrey Stafford	8-19-13
FSRC (Print/Sign), if required	Date

FSRC Meeting Number: 13-035

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Dominion

SSC Category Determination Document

1.0 Doc Type: Report Revision No.: 0 Date: 5/6/2013
Sub Type: DEC
Document Number (ID): SYS-35-DSERT
Title: Chemical and Volume Control

1.1 Brief description or reason for revision: Not applicable for Revision 0.

2.0 System Category (Check Appropriate):

NOTE:	*A SSC may be divided and have more than one category determination depending upon its functional requirements.*

☐ Available (Category A) ☒ Abandoned (Category X)

Describe the assessed boundaries:
This is a complete functional abandonment of the Chemical And Volume Control System (CVCS), including the following components: Letdown Heat Exchanger, Seal Water Heat Exchanger, Regenerative Heat Exchanger, Charging Pumps A, B, and C, Volume Control Tank (VCT), Chemical Mixing Tank, CVCS Mixed Bed Demineralizers A and B, CVCS Cation Bed Demineralizer, CVCS Deborating Demineralizers A and B, Boric Acid Transfer Pumps A and B, Boric Acid Storage Tanks (BAST) A and B, Boric Acid Batching Tank, Concentrates Holding Tank, Concentrates Holding Tank Transfer Pumps A and B, CVCS Hold Up Tanks (HUT) A, B, and C, CVCS Monitor Tanks A and B, CVCS HUT Recirculation Pump, CVCS Monitor Tank Pumps A and B, Gas Stripper Feed Pumps A and B, Evaporator Feed Ion Exchangers #1, #2, and #3, Evaporator Condensate Demineralizers #1 and #2, the Boric Acid Evaporator Package, Component Cooling used by the Letdown Heat Exchanger and Seal Water Heat Exchanger, Instrument Air supply to control valves, Demineralized Water supplies, 480V electrical power supplies, all associated piping, instrumentation, filters, and Boric Acid Heat Tracing. The Excess Letdown Heat Exchanger, which directs flow to the VCT, and Reactor Coolant Pumps (RXCPs), which include seal injection from charging and seal leakoff to the VCT, have been evaluated for abandonment in the Reactor Coolant System abandonment plan, and are not evaluated here.

The Boric Acid Evaporator (BA Evap) has already been abandoned, but will be formally abandoned as a package in this plan. This will be a complete functional abandonment of the Boric Acid

Evaporator, including the following components: Evaporator, Feed Preheater, Absorption Tower, Evaporator Condenser, Distillate Cooler, Stripping Column, Vent Condenser, Condensate Return Tank, Condensate Return Unit Heat Exchanger, Condensate Return Pumps 1A & 1B, Distillate Pumps 1A & 1B, Boric Acid Concentrate Pumps 1A & 1B, Heating Steam, Component Cooling, Service Water, all associated piping, instrumentation, controls, and Boric Acid Heat Tracing.

The following instrument boundaries will be abandoned along with their respective sensing lines

FI-651 (18232), FI-642 (18218), FI-652 (18234), PT-135 (21075), FT-134 (23021), FIT-116 (23112), FIT-115 (23111), PI-136 (11126), PI-11319, PI-11320, PI-137 (11127), PI-138 (11128), FI-143 (18212), FT-111 (23020), TI-120(12072), LT-141 (24016), LT-112 (24015), PT-139 (21076), PI-152 (11129), FT-110 (23019), FT-113 (23031), TI-117 (12071), PI-118 (11130), PI-119 (11131), FT-128 (23022), PIC-183B (11180), PIC-183A (11181), LT-153 (24017), PI-11724, LT-154 (24018), LT-156 (24019), PI-168A (11136), PI-168B (11137), LIT-165 (24021), LIT-162 (24020), PI-165 (11135), PI-162 (11134), PI-160A (11132), PI-160B (11133), FI-164 (18215), PI-163 (11138), FT-159 (23069), PI-147 (11140), PI-146 (11139), PI-194A (11186), PI-194B (11187), LT-151 (24022), TW-150 (22021), PI-149 (11144), PI-148 (11143), TICA-107 (26318), TICA-105 (26319), LT-190 (24025), LT-172 (24024), LT-106 (24023), LT-196 (24038), LT-189 (24028), LT-171 (24027), LT-102 (24026), LT197 (24039), TICA-104 (26321), TICA-103 (26320), PI-195A (11188), PI-195B (11189), PI-109 (11142), PI-108 (11141), TICA-100 (26317), LT-101 (24061), FT-300 (23058), PI-11641, LT-315 (24064), TT-304 (22022), CE-303 (25009), FT-307 (23059), LT-306 (24063), TT321 (22023), TT-321 (54101), PI-309 (11195), PI-310 (11194), PT-316 (21116), PI-311 (11197), PT-21128, PI-312 (11196), PT-21129, TI-12205, PS-16163, PS-16164, PS-16165, FI-605 (18233), TI-604 (12077), FI-601 (18217), TI-600 (12079).

TE-126 (15056), TE-127 (15055), TE-150 (15119), TE-145 (15118), TE-140 (15057), TE-313 (13024), TE-13181 through 13422 (242 Total Temperature Elements used for Boric Acid Heat Tracing

3.0 Mark up the affected drawings using color coding to identify system category type and boundaries. These drawings are to include system, electrical one-line and distribution, and select building and isometric drawings. Related system drawings NOT incorporated in the system category require an explanation. REFER to Step 2.7 for a list of drawings.

Abandon all piping, components, instrumentation, valves, and heat tracing of System 35, Chemical And Volume Control as shown on the following drawings:

Operations Critical Drawing OPERXK-100-10, Reactor Coolant System (Revision BW)

- Letdown line from Boundary Isolation Valve LD-1, Cold Leg Loop B to Letdown Line

Operations Critical Drawing OPERXK-100-35, Chemical And Volume Control System (Revision AG)

- Letdown Line (continued from OPERXK-100-10)
- Letdown Line continued on OPERXK-100-36
- RHR to CVCS Letdown piping from Boundary Isolation Valve LD-60/MV32099, RHR to CVCS Letdown Line.
- RXCP Seal Leakoff line from Boundary Isolation Valve CVC-212/MV-32115, RXCP Seal Water Return Isolation (continued on OPERXK-100-36).
- Charging Line from drawing OPERXK-100-36, to the following Boundary Isolation Valves:
    - CVC-11/CV-31229, Charging Line Isolation
    - CVC-13, Regenerative Heat Exchanger Flow Control Bypass
    - CVC-15/CV-31230, Przr Auxiliary Spray Valve
- RXCP Seal Injection Line and Seal Water Injection Filters By-Pass Line from OPERXK-100-36, to the following Boundary Isolation Valves:
    - CVC-204A, 1A RXCP Seal Supply Line Throttle valve
    - CVC-204B, 1B RXCP Seal Supply Line Throttle valve
    -

Operations Critical Drawing OPERXK-100-36, Chemical And Volume Control System (Revision BH)

- Letdown line (continued from OPERXK-100-35)
- RHR to CVCS penetration from Boundary Isolation Valve RHR-211, RHR/CVC Outlet Isolation
- Letdown Heat Exchanger Drain piping (hard-piped to the Sludge Interceptor Tank), up to the following Boundary Isolation Valves:
    - MD(R)-270, Letdown Heat Exchanger Drain
    - MD(R)-271, Letdown Heat Exchanger Drain
    - MD(R)-272, Letdown Heat Exchanger Drain
    - MD(R)-273, Letdown Heat Exchanger Drain
- Letdown piping up to Boundary Isolation Valve LD-70, Letdown Line Sample
- Letdown piping up to Boundary Isolation Valve LD-36, Boron Measuring System Isol

- *NOTE* The Boron Measuring System has previously been officially abandoned downstream of LD-36, and is therefore not considered in this abandonment plan.

- Letdown Line to the Volume Control Tank (VCT) from LD-14/CV-31098, LD Demin High Temp Divert Valve
  - Letdown piping up to Boundary Isolation Valve LD-80, Letdown to VCT Line Sample
  - Reactor Coolant Filter drain line piping (hard-piped to SIT), up to Boundary Isolation Valve LD-47, Reactor Coolant Filter Drain
  - Letdown flow divert to CVC HUTs line from LD-27/CV-31096, VCT/Holdup Tank Divert Valve (continued on OPERXK-100-37)
  - Letdown piping and the VCT

- Letdown piping from LD-14 through the CVCS Demineralizers, and return piping to downstream of LD-14
  - Letdown Prefilter 1A drain line piping (hard-piped to SIT) up to Boundary Isolation Valve LD-39A, Letdown Demineralizer Prefilter 1A Drn.
  - Letdown Prefilter 1B drain line piping (hard-piped to SIT) up to the following Boundary Isolation Valves:
    - LD-39B, Letdown Demineralizer Prefilter 1B Drn
    - LD-39B-1, Letdown Demineralizer Prefilter 1B Inlet Drain
  - Mixed Bed Demineralizer 1A, up to the following Boundary Isolation Valves:
    - CVC-510A, 1A Mixed Bed Demineralizer Vent (hard-piped to SIT)
    - CVC-503A, 1A Mixed Bed DEMIN Resin Discharge Isolation (hard-piped to Spent Resin Storage Tank)
    - LD-42A, 1A Mixed Bed Demineralizer Drain (hard-piped to SIT)
  - Mixed Bed Demineralizer 1B, up to the following Boundary Isolation Valves:
    - CVC-510B, 1B Mixed Bed Demineralizer Vent (hard-piped to SIT)
    - CVC-503B, 1B Mixed Bed DEMIN Resin Discharge Isolation (hard-piped to Spent Resin Storage Tank)
    - LD-42B, 1B Mixed Bed Demineralizer Drain (hard-piped to SIT)
  - Cation Bed Demineralizer, up to the following Boundary Isolation Valves:
    - CVC-511, Cation Bed Demineralizer Vent (hard-piped to SIT)
    - CVC-505, Cation Bed DEMIN Resin Discharge Isolation (hard-piped to Spent Resin Storage Tank)
    - LD-151, Cation Bed Demineralizer Drain (hard-piped to SIT)
  - Deborating Demineralizer 1A, up to the following Boundary Isolation Valves:
    - CVC-512A, 1A Deborating Demineralizer Vent (hard-piped to SIT)
    - CVC-507A, 1A Deborating DEMIN Resin Discharge ISOL (hard-piped to Spent Resin Storage Tank)
    - CVC-553, Deborating Demineralizers Drain (hard-piped to SIT)
  - Deborating Demineralizer 1B, up to the following Boundary Isolation Valves:
    - CVC-512B, 1B Deborating Demineralizer Vent (hard-piped to SIT)
    - CVC-507B, 1B Deborating DEMIN Resin Discharge ISOL (hard-piped to

Spent Resin Storage Tank)
  - Flushing water supply to all Demineralizers up to Boundary Isolation Valve DW-216, Demineralized Water To Demineralizers.

- Volume Control Tank (VCT) up to the following Boundary Isolation Valves:
  - NG-802, Nitrogen to VCT Line Isolation
  - HG-302, Hydrogen to VCT Line Isolation
  - CVC-50, VCT Vent to Cntmt Isol
  - MG(R)-534, VCT Vent to WDS Isolation
  - MG(R)-540, VCT Vent to Sampling System Isol
  - MG(R)-531, VCT to Gas Analyzer Isol
  - CVC-37, Boron Measuring System Isolation

  NOTE The Boron Measuring System has previously been officially abandoned upstream of CVC-37, and is therefore not considered in this abandonment plan.

- Seal Water Return and Seal Water Return Bypass piping from Boundary Isolation Valve CVC-212 on OPERXK-100-35 to the VCT, up to the following Boundary Isolation Valves:
  - CVC-264, Seal Water Return Filter Drain (Hard-piped to SIT)
  - MD(R)-260, Seal Water Heat Exchanger Drain (Hard-piped to SIT)
  - MD(R)-261, Seal Water Heat Exchanger Drain (Hard-piped to SIT)
  - MD(R)-262, Seal Water Heat Exchanger Drain (Hard-piped to SIT)

- Charging Pumps from the VCT to Charging line (continued on OPERXK-100-35) and Seal Water Injection line, including Seal Water Injection Bypass line, (continued on OPERXK-100-35) up to the following Boundary Isolation Valves:
  - CVC-301/MV-32056, RWST Supply To Charging Pumps
  - CVC-302, RWST Emergency Suct Isol
  - CVC-30C, 1C Charging Pump Vent (Hard-piped to Zone SV ductwork)
  - CVC-30B, 1B Charging Pump Vent (Hard-piped to Zone SV ductwork)
  - CVC-30A, 1A Charging Pump Vent (Hard-piped to Zone SV ductwork)
  - CVC-230A, Seal Supply Line Filter 1A Drain (Hard-piped to SIT)
  - CVC-230B, Seal Supply Line Filter 1B Drain (Hard-piped to SIT)

- Reactor Makeup supply piping to the VCT and Charging Pump suction, up to the following Boundary Isolation Valves:
  - MU-1020, Makeup Water Line Isol
  - CVC-412, Blndr Mkup To Rfling Water Storage Tank Isol
  - CVC-413, Blended Makeup to Spent Fuel Pit Isol

- Boric Acid Supply to the Reactor Makeup piping (continued on OPERXK-100-38)

- The following valves will be abandoned and have stem leakoff lines to the Deaerated Drains Tank (DDT). They will be abandoned up to their respective stem leakoff line Boundary Isolation Valves:
  - LD-10/CV-31099, Letdown Cont Pressure:
    - LD-61, LD-10 Valve Stem Leakoff
  - MU-1022/CV-31095, Blender Control Rx MU Flow:
    - MU-1022-1, MU-1022 Valve Stem Leakoff
  - LD-27/CV-31096, VCT/Holdup Tank Divert Valve
    - LD-51, LD-27 Valve Stem Leakoff
  - CVC-7/CV-31103, Charging Control Chg Line:
    - CVC-60, CVC-7 Valve Stem Leakoff
  - CVC-200/CV-31688, Seal Injection Filter Block Valve:
    - CVC-200-1, CVC-200 Valve Stem Leakoff
  - CVC-203B/CV-31689, Seal Injection Filter Bypass Valve:
    - CVC-203B-1, CVC-203B Valve Stem Leakoff
    -

Operations Critical Drawing OPERXK-100-37, Chemical & Volume Control System (Revision AH)

- Abandon CVC Holdup Tank fill header up to Boundary Isolation Valve CVC-802, Reactor Coolant Drn Tank Pump Discharge
- CVC Holdup Tanks A, B, and C, including Recirculation Pump and Gas Stripper Feed Pumps A & B, up to the following Boundary Isolation Valves:
  - NG-715A, Holdup Tank 1A to Vent Header Isol
  - MG(R)-519A, Holdup Tank 1A Vent
  - MG(R)-516A, Holdup Tank 1A to Gas Analyzer Isol
  - CVC-813A, Holdup Tank 1A Drain (Hard-piped to DDT)

  - NG-715B, Holdup Tank 1B to Vent Header Isol
  - MG(R)-519B, Holdup Tank 1B Vent
  - MG(R)-516B, Holdup Tank 1B to Gas Analyzer Isol
  - CVC-813B, Holdup Tank 1B Drain (Hard-piped to DDT)
  - NG-715C, Holdup Tank 1C to Vent Header Isol
  - MG(R)-519C, Holdup Tank 1C Vent
  - MG(R)-516C, Holdup Tank 1C to Gas Analyzer Isol
  - CVC-813C, Holdup Tank 1C Drain (Hard-piped to DDT)

- Evaporator Feed Ion Exchanger #1 up to the following Boundary Isolation Valves:
  - CVC-855A, #1 Evap Feed Ion Exch Vent (Hard-piped to SIT)
  - CVC-856A, #1 Evap Feed Ion Exch Drain (Hard-piped to SIT)
  - CVC-857A, #1 Evap Feed Ion Exch Resin Disch (hard-piped to Spent Resin Storage Tank)
  - DW-214A, #1 Evap Feed Ion Exch Backwash

- Evaporator Feed Ion Exchanger #2 up to the following Boundary Isolation Valves:

- CVC-855B, #2 Evap Feed Ion Exch Vent (Hard-piped to SIT)
- CVC-856B, #2 Evap Feed Ion Exch Drain (Hard-piped to SIT)
- CVC-857B, #2 Evap Feed Ion Exch Resin Disch (hard-piped to Spent Resin Storage Tank)
- DW-214B, #2 Evap Feed Ion Exch Backwash

- Evaporator Feed Ion Exchanger #3 up to the following Boundary Isolation Valves:
  - CVC-859, #3 Evap Feed Ion Exch Vent (Hard-piped to SIT)
  - CVC-861, #3 Evap Feed Ion Exch Drain (Hard-piped to SIT)
  - CVC-860, #3 Evap Feed Ion Exch Resin Disch (hard-piped to Spent Resin Storage Tank)
  - DW-215, #3 Evap Feed Ion Exch Backwash

- Boric Acid Evap Feed Ion Exchange Filter up to Boundary Isolation Valve CVC-865, Ion Exchange Filter Drain (Hard-piped to SIT)

- Evaporator Condensate Demineralizers #1 and #2 up to the following Boundary Isolation Valves:
  - CVC-944A, #1 Evap Condensate Demin Vent (Hard-piped to SIT)
  - CVC-945A, #1 Evap Condensate Demin Resin Disch (hard-piped to Spent Resin Storage Tank)
  - CVC-944B, #2 Evap Condensate Demin Vent (Hard-piped to SIT)
  - CVC-945B, #2 Evap Condensate Demin Resin Disch (hard-piped to Spent Resin Storage Tank)
  - DW-219-1A, Regenerant Chemical Line Flush
  - DW-219-1B, Demin Water to Demineralizers Isol
  - CVC-936, Backwash Line Drain (Hard-piped to SIT)

- CVC Monitor Tanks A & B, including Condensate Filter, and Monitor Tank Pumps A and B, up to the following Boundary Isolation Valves:
  - DW-151A, Demin Water to 1A Monitor Tank
  - DW-151B, Demin Water to 1B Monitor Tank
  - CVC-916, Tank Pumps Disch to RMW Storage Tank
  - Monitor Tank Pumps Disch to Waste Discharge Line (continued on Drawing OPERXK-100-131)
  - Abandon 2" lines from SGBT Sys & Waste Evap Dist. Filter (continued on Drawing OPERM-368) that enter CVC Monitor Tank A & B fill line.

Operations Critical Drawing OPERXK-100-38, Chemical & Volume Control System (Revision Z)

- Abandon Concentrates Holding Tank, Concentrates Holding Tank Heater, and Concentrates Holding Tank Transfer Pumps A and B, up to the following Boundary Isolation Valves:
  - CVC-620, Boric Acid Evap to Waste Evap
  - CVC-637, BA Evap to Waste Concentrates Tank

- Abandon Boric Acid Batch Tank and Batching Tank Agitator, up to the following Boundary Isolation Valves:
    - DW-250, Demineralized Water Supply to Batching Tank
    - HS-5475, Batching Tank Htg Coils Outlet To Trap
    - HS-5478, Batching Tank Htg Coils Outlet Trap Bypass

- Abandon Boric Acid Storage Tanks A and B, Boric Acid Storage Tanks A and B Heaters, and Boric Acid Transfer Pumps A and B, up to the following Boundary Isolation Valves:
    - CI-531, Caustic Inlet for P_H Adjustment
    - MU-1031A, RMW to 1A Boric Acid Transfer Pump
    - MU-1031B, RMW to 1B Boric Acid Transfer Pump
    - CVC-739, Boric Acid Alternate Supply to Safety Inj Sys
    - SI-1A, Boric Acid Tank 1A to SI Pumps Suct Isol
    - SI-1B, Boric Acid Tank 1A to SI Pumps Suct Isol
    -

Operations Critical Drawing OPERXK-100-400, 15 GPM Boric Acid Evap. + Gas Stripper Flow Diagram (Revision 11T)

- Abandon the entire Boric Acid Evaporator package, including the Evaporator, Stripping Column, Absorption Tower, Evaporator Condenser, Vent Condenser, Feed Preheater, Distillate Cooler, Distillate Pumps 1A and 1B, and Boric Acid Concentrate Pumps 1A and 1B, up to the following Boundary Isolation Valves:
    - BEF-35/CV-31288, Evaporator Drain Valve (Hard-piped to Sump Tank)
      NOTE There is no manual isolation valve in the Evaporator Drain line to the Sump Tank. BEF-35 needs to be failed close to serve as a Boundary Isolation Valve. As shown on Drawing E-2029, Integrated Logic Diagram Chemical & Volume Control System, BEF-35/CV-31288 fails closed with no Instrument Air.
    - BEF-4-1, Vent Condenser Vent Isolation
    - HS-403-1, BA Evap Vent Relief Valve Bypass
    - MG(R)-550, Vent Hdr #2 to WGA Filter Inlet Isol
    - SW-5027-1, SW to BA Evap Distillate Sample Cooler
    - Abandon Nitrogen Supply line to the Evaporator Condenser, including valves: NG-913/CV-31283 and NG-912/CV-31282. Nitrogen supply line continued on drawing OPERM-216, Miscellaneous Gas Systems.
    - Abandon Demineralized Water Supply piping to the Vent Condenser, Evaporator Condenser, Absorption Tower, Evaporator, and Boric Acid Concentrates Pumps A & B. Demineralizer Supply lines continued on drawing OPERM-209-2, Make-Up And Demineralized Water Systems

Operations Critical Drawing OPERM-216, Miscellaneous Gas Systems (Revision CV)

- Abandon all piping downstream of Boundary Isolation Valve NG-911, Nitrogen to BA Evap
- Abandon all piping downstream of the following Boundary Isolation Valves:
    - NG-802, Nitrogen to VCT Line Isolation

- HG-302, Hydrogen to VCT Line Isolation

Operations Critical Drawing OPERM-209-2, Make-Up And Demineralized Water Systems (Revision P)

- Abandon all piping downstream of the following Boundary Isolation Valves:
  - DW-140, Evap Flush Conn from Makeup Water
  - DW-216, Demineralized Water To Demineralizers

Operations Critical Drawing OPERXK-100-44, Sampling System (Revision AT)

- Abandon all piping downstream of Boundary Isolation Valve RC-438, Sample Outlet to VCT

Operations Critical Drawing OPERXK-100-19, Component Cooling System (Revision AQ)

- Abandon the Seal Water Heat Exchanger, including all Component Cooling Water piping, valves, and instrumentation up to the following Boundary Isolation Valves:
  - CC-200, Seal Water Heat Exchanger Inlet
  - CC-203, Seal Water Heat Exchanger Outlet Isolation

- Abandon the Letdown Heat Exchanger, including all Component Cooling Water piping, valves, and instrumentation up to the following Boundary Isolation Valves:
  - CC-300, Letdown Heat Exchanger Inlet
  - CC-310, To Hi Rad Sample Hxs
  - CC-318, From Hi Rad Sample Hxs
  - CC-303, Letdown Heat Exchanger Outlet

  NOTE Isolating the Component Cooling side of the Letdown Heat Exchanger also isolates the Component Cooling side of the Residual Heat Removal High Radiation Sample Heat Exchanger and Reactor Coolant High Radiation Sample Heat Exchanger. These Sample Heat Exchangers are not evaluated under this abandonment plan.

Operations Critical Drawing OPERXK-100-20, Component Cooling System (revision AE)

- Abandon the Boric Acid Evaporator, including all Component Cooling Water piping, valves, and instrumentation up to the following Boundary Isolation Valves:
  - CC-800, Main CC Supply to Boric Acid Evap
  - CC-809, Boric Acid Evap Return Isolation

Operations Critical Drawing OPERXK-100-132, Waste Disposal System (Revision AH)

- Abandon all piping from Gas Stripper Boric Acid Evaporator (Vent Condenser) vent line (continued from OPERXK-100-400) up to the following Boundary Isolation Valves:
  - BEF-4-1, Vent Condenser Vent Isolation
  - MG(R)-550, Vent Hdr #2 to WGA Filter Inlet Isol

Operations Critical Drawing OPERM-368, Steam Generator Blowdown Treatment System (Revision AM)

- Abandon all piping downstream of the following Boundary Isolation Valves:
  - BT-232A, SGBT To CVC Monitor Tank 1A

- BT-232B, SGBT To CVC Monitor Tank 1B

Operations Critical Drawing OPERM-350, Reactor Plant Misc. Vents, Drains, & Sump Pump Piping (Revision AZ)

- Abandon all piping downstream of the following Boundary Isolation Valves:
    - MD(R)-307A, DDT To CVC Holdup Tank A
    - MD(R)-307B, DDT To CVC Holdup Tank B
    - MD(R)-307C, DDT to CVC Holdup Tank C
- Abandon all piping upstream of Boundary Isolation Valve LD-61, LD-10 Valve Stem Leakoff
- Abandon all piping upstream of Boundary Isolation Valve MU-1022-1, MU-1022 Valve Stem Leakoff
- Abandon all piping upstream of Boundary Isolation Valve CVC-60, CVC-7 Valve Stem Leakoff
- Abandon all piping upstream of Boundary Isolation Valve LD-51, LD-27 Valve Stem Leakoff
- Abandon all piping upstream of Boundary Isolation Valve CVC-200-1, CVC-200 Valve Stem Leakoff
- Abandon all piping upstream of Boundary Isolation Valve CVC-203B-1, CVC-203B Valve Stem Leakoff
- Abandon the Seal Water Heat Exchanger, and all piping upstream of the following Boundary Isolation Valves:
    - MD(R)-260, Seal Water Heat Exchanger Drain
    - MD(R)-261, Seal Water Heat Exchanger Drain
    - MD(R)-262, Seal Water Heat Exchanger Drain
- Abandon the Letdown Heat Exchanger, and all piping upstream of the following Boundary Isolation Valves:
    - MD(R)-270, Letdown Heat Exchanger Drain
    - MD(R)-271, Letdown Heat Exchanger Drain
    - MD(R)-272, Letdown Heat Exchanger Drain
    - MD(R)-273, Letdown Heat Exchanger Drain

Operations Critical Drawing OPERM-605-1, Heating System (Revision R)

- Abandon all steam piping for the Boric Acid Batching Tank:
    - Downstream of Boundary Isolation Valve HS-475, Steam Supply to CVCS Batching Tank
    - Upstream of the following Boundary Isolation Valves:
        - HS-5475, Batching Tank Htg Coils Outlet To Trap
        - HS-5478, Batching Tank Htg Coils Outlet Trap Bypass
- Abandon all steam and condensate piping for the Boric Acid Evaporator, Boric Acid Evaporator Feed Preheater, Boric Acid Evap Condensate Return Heat Exchanger, Boric Acid Evaporator Condensate Return Tank, and Condensate Return Pumps 1A and 1B:
    - Downstream of the following Boundary Isolation Valves:
        - HS-401, Boric Acid Evaporator Inlet
        - HS-410, BA Evap Steam Line Trap Inlet
    - Upstream of the following Boundary Isolation Valves:
        - HS-7402A, Condensate Return Pump 1A Discharge

- HS-7402B, Condensate Return Pump 1B Discharge

Operations Critical Drawing OPERM-606, Air Cond. Cooling Water Piping (Revision BY)
- Abandon the Boric Acid Evaporator Condensate Return Heat Exchanger, all Service Water piping, and instrumentation between the following Boundary Isolation Valves:
    - Downstream of SW-1256, BA Evap Cond Return Heat Exch Inlet
    - Upstream of SW-1257, From BA Evap Cond Return Heat Exch

Operations Critical Drawing OPERXK-100-29, Safety Injection System (Revision AN)
- Abandon all piping upstream of Boundary Isolation Valve CVC-412, Blndr Mkup To Rfling Water Storage Tank Isol

Operations Critical Drawing OPERXK-100-131, Waste Disposal System (Revision CQ)
- Abandon all piping upstream of Boundary Isolation Valve CVC-920, CVC Monitor Tank Pump to Discharge Line
- Abandon all piping upstream of Boundary Isolation Valve CVC-936, Backwash Line Drain
- Abandon all piping upstream of Boundary Isolation Valve CVC-553, Deborating Demineralizers Drain
- Abandon all piping upstream of Boundary Isolation Valve CVC-620, Boric Acid Evap to Waste Evap
- Abandon all piping upstream of Boundary Isolation Valve CVC-802, Reactor Coolant Drn Tank Pump Discharge

Operations Critical Drawing E-240, 4160V & 480V Power Sources
- Abandon 480V Bus 1-52 Breaker 15203, Charging Pump 1C, to load

Operations Critical Drawing E-254, Circuit Diagram 480 V MCC 1-35A, 1-35D, 1-45A & 1-45D
- Abandon from the 480V Breaker to load:
    - 480V MCC 1-35A (B2), Boric Acid Evaporator Package
    - 480V MCC 1-35A (B7), Boric Acid Evaporator Condensate Return Pump 1A
    - 480V MCC 1-45A (B7), Boric Acid Evaporator Condensate Return Pump 1B
    - 480V MCC 1-35D (B6), CVC Monitor Tank Pump 1A
    - 480V MCC 1-45D (A6), CVC Monitor Tank 1B
    - 480V MCC 1-45D (B5), Boric Acid Batching Tank Agitator

Operations Critical Drawing E-255, Circuit Diagram 480 V MCC 1-35B & 1-45B
- Abandon from the 480V Breaker to load:
    - 480V MCC 1-35B (B6), Concentrates Holding Tank Heater
    - 480V MCC 1-35B (A7), Gas Stripper Feed Pump 1A
    - 480V MCC 1-35B (B1), Concentrates Holding Tank Transfer Pump 1A
    - 480V MCC 1-35B (A5), Hold Up Tank Recirculation Pump
    - 480V MCC 1-45B (C8), Gas Stripper Feed Pump 1B
    - 480V MCC 1-45B (B3), Concentrates Holding Tank Transfer Pump 1B

Operations Critical Drawing E-258, Circuit Diagram 480V MCC 1-52A, 1-52F, & 1-52B
- Abandon from the 480V Breaker to load:
    - 480V MCC 1-52B (F4), Seal Water Leak Off Isolation MV CVC212/32115
    - 480V MCC 1-52B (A1), Boric Acid Tank 1A Immersion Heater 1A1
    - 480V MCC 1-52B (B1), Volume Control Tank To Charging Pumps Isolation MV CVC1/32057

- 480V MCC 1-52B (E5), Boric Acid Transfer Pump 1A
- 480V MCC 1-52B (A2), Boric Acid Tank 1B Immersion Heater 1B1

Operations Critical Drawing E-259, Circuit Diagram 480V MCC 1-62D & 1-62E
- Abandon from the 480V Breaker to load:
    - 480V MCC 1-62E (A6), Charging Pump 1B
    - 480V MCC 1-62E (H4), Boric Acid Transfer Pump 1B
    - 480V MCC 1-62E (J2), Boric Acid Tank 1B Immersion Heater 1B2
    - 480V MCC 1-62E (J1), Boric Acid Tank 1A Immersion Heater 1A2

Operations Critical Drawing E-260, Circuit Diagram 480V MCC 1-52C, 1-52E & 1-62C
- Abandon from the 480V Breaker to load:
    - 480V MCC 1-52E (D3), Refueling Water Emergency Make-Up To Charging Pump MV CVC301/32056
    - 480V MCC 1-52E (F3), Emergency Boration From Boric Tank MV CVC440/32127
    - 480V MCC 1-52E (H4), Charging Pump 1A

Operations Critical Drawing E-261, Circuit Diagram 480V MCC 1-62A, 1-52D, 1-5262 & 1-62B
- Abandon from the 480V Breaker to load:
    - 480V MCC 1-62B (D5), Residual Heat Exchanger Outlet To LTDN Line MV LD60/32099

Operations Critical Drawing OPERM-213-2, Station & Instrument Air System (Sheet 2, Revision R)
- Abandon all Instrument Air piping for CVC-7/CV-31103, Charging Line Flow Control Valve downstream of the following Boundary Isolation Valves:
    - IA-31103-1, IA to CVC-7
    - IA-421, Instrument Air to CVC-7
- Abandon all Nitrogen Bottles, piping, instrumentation, and regulators for Nitrogen Backup Supply to CVC-7/CV-31103, Charging Line Flow Control Valve
- Abandon all Instrument Air piping for LD-27/CV-31096, VCT/Holdup Tank Divert Valve, downstream of the following Boundary Isolation Valves:
    - IA-31096-1, IA to LD-27
    - IA-31096-2, IA to LD-27
- Abandon all Instrument Air piping for LD-22/CV-31242, VCT/Deborator Divert Valve, downstream of Boundary Isolation Valve IA-31242, IA to LD-22
- Abandon all Instrument Air piping for LD-6/CV-31234, Letdown Line Isolation, downstream of the following Boundary Isolation Valves:
    - IA-31234-1, IA to LD-6
    - IA-31234-2, IA to LD-6
- Abandon all Instrument Air piping for LD-14/CV-31098, LD Demin High Temp Divert Valve, downstream of Boundary Isolation Valve IA-31098, IA to LD-14
- Abandon all Instrument Air piping for LD-10/CV-31099, Letdown Cont Pressure, downstream of the following Boundary Isolation Valves:
    - IA-31099-1, IA to LD-10
    - IA-31099-2, IA to LD-10
    - IA-31099-3, IA to LD-10

Operations Critical Drawing OPERM-213-5, Station & Instrument Air System (Sheet 5, Revision AE)

- Abandon all Instrument Air piping for BA Evaporator, instrumentation, and control valves downstream of Boundary Isolation Valve IA-1603, IA Header Isolation
- Abandon all Instrument Air piping for Concentrates Holding Tank level and temperature downstream of Boundary Isolation Valve IA-1607, IA Isolation for 22021 and 24022.
- Abandon all Instrument Air piping for CVC-403/CV-31092, Boric Acid To Blender, CVC-406/CV-31094, BA Blender To VCT, and CVC-408/CV-31093, BA Blender To Charging Pumps, downstream of Boundary Isolation Valve IA-1430, IA Header Isolation.
- Abandon all Instrument Air piping for Boric Acid Evaporator Feed Flow Indication, downstream of Boundary Isolation Valve IA-18236, IA Isolation for 23069.
- Abandon all Instrument Air piping for MU-1022/CV-31095, Reactor Makeup Water To Blender, downstream of the following Boundary Isolation Valves:
    - IA-31095-1, IA to MU-1022
    - IA-31095-2, IA to MU-1022
- Abandon all Instrument Air piping downstream of Boundary Isolation Valve IA-1407, IA to CVC-200 & 203B, for the following valves:
    - LD-13A/CV-31685, Rx Coolant Filter Block Valve
    - CVC-212-1/CV-31683, Seal Water Filter Block Valve
    - CVC-200/CV-31688, Seal Injection Filter Block Valve
    - CVC-203B/CV-31689, Seal Injection Filter Bypass Valve
    - CVC-215B/CV-31682, Seal Water Filter Bypass Valve
    - LD-13B/CV-31684, Rx Coolant Filter Bypass Valve
- Abandon all Instrument Air piping for CVC-832/CV-31626, Gas Stripper Feed Pumps Recirc Line Control Valve, downstream of Boundary Isolation Valve IA-31626, IA to CVC-832
- Abandon all Instrument piping for the Boric Acid Evaporator Control Panel downstream of Boundary Isolation Valve IA-1429, IA To BA Evap Panel.
- Abandon all Instrument Air piping downstream of the following Boundary Isolation Valves:
    - IA-24018, IA to CVC HUT B Level
    - IA-24017, IA to CVC HUT A Level
    - IA-24020, IA to CVC Mon Tank A Level
    - IA-24021, IA to CVC Mon Tank B Level
    - IA-24061, IA to BA Batch Tank Level
    - IA-31105-1, IA to HS-476
    - IA-31105-2, IA to HS-476

Operations Critical Drawing OPERM-213-6, Station & Instrument Air System (Sheet 6, Revision R)

- Abandon all Instrument Air piping for CVC-712A/CV-31106, BAT Recirc Control Tank A, downstream of the following Boundary Isolation Valves:
    - IA-31106-1, IA to CVC-712A
    - IA-31106-2, IA to CVC-712A
- Abandon all Instrument Air piping for CVC-712B/CV-31107, BAT Recirc Control Tank B, downstream of the following Boundary Isolation Valves:
    - IA-31107-1, IA to CVC-712B
    - IA-31107-2, IA to CVC-712B

Operations Critical Drawing OPERM-213-8, Station & Instrument Air System (Sheet 8, Revision L)

- Abandon all Instrument Air Piping, and Accumulator, downstream of Boundary Isolation Valve IA-166-1, IA to LD-4A(B)(C), CVC-11, & CVC-15, for the following valves:
    - LD-4A/CV-31231, Letdown Orifice A Isolation
    - LD-4B/CV-31232, Letdown Orifice B Isolation
    - LD-4C/CV-31233, Letdown Orifice C Isolation
    - CVC-11/CV-31229, Charging Line Isolation
    - CVC-15/CV-31230, Przr Auxiliary Spray Valve
- Abandon all Instrument Air Piping, and Accumulator, downstream of Boundary Isolation Valve IA-147, IA to LD-2 & LD-3, for the following valves:
    - LD-2/CV-31108, Letdown Isolation
    - LD-3/CV-31104, Letdown Isolation

4.0 Evaluation (Basis for choosing category type):

Purpose/Function

The Chemical and Volume Control System:

1. Adjusts the concentration of chemical neutron absorber for chemical reactivity control
2. Maintains the proper water inventory in the RCS
3. Provides the required seal water flow for the reactor coolant pump shaft seals
4. Processes reactor coolant letdown for reuse of boric acid
5. Maintains the proper concentration of corrosion inhibiting chemicals in the reactor coolant, and
6. Keeps the reactor coolant fission product and corrosion product activities to within design levels.

The system is also used to fill and hydrostatically test the RCS.

During normal operation, therefore, this system has provisions for supplying:

1. Hydrogen to the volume control tank
2. Nitrogen as required for purging the volume control tank
3. Hydrazine or pH control chemical, as required, via the chemical mixing tank to the charging pumps suction.

Additionally, reactivity control is provided by the Chemical and Volume Control System which regulates the concentration of boric acid solution neutron absorber in the Reactor Coolant System.

The system is also designed to prevent uncontrolled or inadvertent reactivity changes, which might cause system parameters to exceed design limits.

Boric Acid as a chemical shim is used in combination with Control Rods to provide control of the reactivity changes of the core throughout the life of the core at power conditions. This chemical shim control is used to compensate for the more slowly occurring changes in reactivity throughout core life such as those due to fuel depletion, fission product buildup and decay, and the xenon transient associated with power level changes.

Basis for Category

On May 15, 2103, the NRC docketed DEKs certification of permanent defueling of the Kewaunee Power Station. Therefore, effective immediately, pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license for KPS no longer authorizes operation of the reactor or emplacement or retention of fuel into the reactor vessel, as specified in 10 CFR 50.82(a)(2).

With irradiated fuel being stored in the SFP and the ISFSI, the reactor, RCS and secondary system are no longer in operation and have no function related to the storage of the irradiated fuel. Therefore, the postulated accidents involving failure or malfunction of the reactor, RCS or secondary system are no longer applicable. The analyzed accident and operational event applicable to KPS in the permanently shut down and defueled condition (long term SAFSTOR condition) is a fuel handling accident (FHA) in the auxiliary building. The Gas Decay Tank Rupture accident will not be credible following abandonment of the Gaseous Waste System, scheduled to be completed in August of 2013.

The basis for the abandonment category for the Chemical and Volume Control System is determined by screening to the following criteria:

1. To prevent or mitigate the consequences of a design basis accident of a permanently defueled plant.
2. Fuel Handling Accident and Gas Decay Tank Rupture as defined in Updated safety Analysis Report (USAR).

3. For safe storage and handling of radioactive waste or spent fuel.

4. To support the technical Specifications, License Requirements, Design Basis, Permits, regulatory requirements, insurance requirements, or other commitments. Provide support for safe storage of Spent Fuel and the Radiological Effluent Monitoring/Offsite Dose Calculation Manual for KPS.

5. The requirements of SSCs that support the execution of plans and programs at KPS (e.g., Security Plan, Fire Protection Plan, Emergency Management Plan, Radiation Protection Program).

6. Support day to day operations in the decommissioning plant.
7. Support decommissioning efforts.

The Chemical and Volume Control System is no longer required to perform/support the needs of the above criteria and is therefore abandoned.

Regulatory Impact

UPDATED SAFETY ANALYSIS REPORT (USAR)

Reviewed all sections of the USAR, and the following sections\subsections reference the Chemical And Volume Control System:

Chapter 1: Introduction

Under Section 1.3: General Design Criteria, Subsection 1.3.5: Reactivity Control, the CVCS is briefly described under topic #6: Maximum Reactivity Worth of Control Rods:
In addition to the reactivity control achieved by the RCC assemblies (RCCA), reactivity control is provided by the Chemical and Volume Control System which regulates the concentration of boric acid solution neutron absorber in the Reactor Coolant System.
The system is designed to prevent uncontrolled or inadvertent reactivity changes, which might cause system parameters to exceed design limits.
The chemical shim control (CVCS) is used to compensate for the more slowly occurring changes in reactivity throughout core life such as those due to fuel depletion, fission product buildup and decay, and load follow.
Any time that the plant is at power, the quantity of boric acid ready for injection always exceeds that quantity required for normal cold shutdown.

Chapter 3: Reactor

Under Section 3.1: Design Bases, Subsection 3.1.2: Principal Design Criteria, the CVCS is discussed under topic 3.1.2.6: Reactivity Holddown Capability:
The reactivity control systems provided are capable of making and holding the core sub-critical under accident conditions, in a timely fashion with appropriate margins for contingencies. Normal reactivity shutdown capability is provided within 2 seconds following a trip signal by the insertion of the RCCAs with soluble poison (boric acid) injection used to compensate for the long-term xenon decay transient and for plant cooldown. Any time that the reactor is at power, the quantity of boric acid retained in the boric acid tanks and Refueling Water Storage Tank (RWST) is ready for injection always exceeds that required for the normal cold shutdown condition. This quantity also exceeds that required to bring the reactor to hot shutdown (Hot Shutdown defined as: Reactivity in $\Delta k/k$ is the Required Shutdown Margin in COLR (Cycle 32 requires Shutdown Margin $\geq$ 1554

pcm), Coolant Temperature ≥ 540°F, and ≈ 0% fission power) and to compensate for subsequent xenon decay.
Boric acid is pumped from the boric acid tanks by the boric acid transfer pumps to the suction of one-of-three charging pumps, which inject boric acid into the reactor coolant. Any charging pump and any boric acid transfer pump can be operated from diesel generator power on loss of offsite power. Boric acid can be injected by one pump at a rate which takes the reactor to hot shutdown with no rods inserted, and also compensates for xenon decay. Additional boric acid injection is employed if it is desired to bring the reactor to cold shutdown conditions.
Based on the above, the injection of boric acid is shown to afford backup reactivity shutdown capability, independent of the RCCAs which normally serve this function in the short-term situation. Shutdown for long-term and reduced-temperature conditions can be accomplished with boric acid injection using redundant components, thus achieving the measure of reliability implied by the criterion.

Chapter 6: Engineered Safety Features

Under Section 6.5: Leakage Detection And Provisions For The Primary And Auxiliary Coolant Loops, Subsection 6.5.1: Leakage Detection Systems, Subsection 6.5.1.2: Systems Design And Operation, CVCS is discussed under topic 6.5.1.2.9: Charging Pump Operation:
During normal operation charging pumps are operated as necessary to maintain inventory in the reactor coolant system. Leakage from the reactor coolant system will cause a decrease in the pressurizer level. If the charging pump(s) are in automatic control, an increase in charging pump speed will occur. If the pump(s) are in manual control, a decreasing volume control tank level and/or low pressurizer level will cause an alarm to actuate.
Any automatic increase in charging pump speed will try to maintain the equivalence between the letdown flow and the combined charging line flow and the flow across the reactor coolant pumps seals. If the pump(s) reach a high speed limit, an alarm is actuated.
Also under topic 6.5.1.2.10: Liquid Inventory:
Gross leaks might be detected by unscheduled increases in the amount of reactor coolant makeup water, which is required to maintain the normal level in the pressurizer. This is inherently a low precision measurement, since makeup water is also necessary for leaks from systems outside the containment.

Chapter 7: Instrumentation & Controls

Under Section 7.3: Regulating Systems, Subsection 7.3.2: System Design, CVCS is discussed under topic 7.3.2.5: Pressurizer Level Control:
A programmed pressurizer water level as a function of auctioneered average reactor coolant temperature is provided in conjunction with the programmed coolant

temperature. This minimizes the demands upon the Chemical and Volume Control System and the Waste Disposal System imposed by coolant density changes during loading and unloading. The pressurizer water level decreases as the load is reduced from full load. This is the result of coolant contraction following programmed coolant temperature reduction from full power to low power. The programmed level is designed to match as nearly as possible the level changes resulting from the coolant temperature changes. To permit manual control of pressurizer level during startup and shutdown operations, the charging-pump speed can be manually regulated from the main Control Room.

Under Section 7.7: Operating Control Stations, Subsection 7.7.6: Emergency Shutdown Control, Subsection 7.7.6.1: Equipment Control Outside Control Room (specifically the Dedicated Shutdown Panel), CVCS is discussed under the following topics:

7.7.6.1.2 Reactivity Control

Following plant shutdown to the hot shutdown condition, boric acid is added to the RCS to maintain sub-criticality. For boron addition, the Chemical and Volume Control System is used. Boration requires the use of:

1. Charging pumps and volume control tank with associated piping.
2. Boric acid transfer pumps with tanks and associated piping.

It should be noted that with the reactor held at hot shutdown conditions, boration of the plant is not required immediately after shutdown. The xenon transient does not decay to the equilibrium level until some ten to fifteen hours after shutdown, and a further period would elapse before the 1 percent reactivity shutdown margin provided by the full-length control rods would be cancelled. This delay would provide ample time for emergency measures.

7.7.6.1.3 Pressurizer Pressure and Level Control

Following a reactor trip, the reactor coolant temperature will automatically reduce to the no-load temperature condition as dictated by the steam generator temperature conditions. This reduction in the reactor coolant water temperature reduces the reactor volume, and if continued pressure control is to be maintained, reactor coolant makeup is required.

The pressurizer level is controlled in normal circumstances by the CVCS. The facility for boration is provided as described above; it is necessary only to supply water for makeup. Water may be readily obtained from normal sources such as the reactor makeup storage tanks or RWST.

Under Section 7.7: Operating Control Stations, Subsection 7.7.6: Emergency Shutdown Control, Subsection 7.7.6.2: Indication And Controls Outside Control Room, CVCS is discussed under the Dedicated Shutdown Panel as follows:

- Controls:

Start/stop motor controls along with a selector switch are provided for Charging Pump 1C. These controls are located on the dedicated shutdown panel. The selector switch transfers control of the equipment from the Control Room to the dedicated shutdown panel. Placing the selector switch in the local position provides an annunciator alarm in the Control Room and will turn out the Charging Pump 1C motor control indicating lights in the Control Room.

- Speed Control:

Speed control for two of the charging pumps is provided locally;

Speed control for one of the charging pumps is located on the dedicated shutdown panel.

- Valve Control:

Letdown orifice isolation valves (Controls mounted on the dedicated shutdown panel. Selector switch and position lamp are also provided).
The control for the charging line flow control valve is located on the dedicated shutdown panel.

Chapter 8: Electrical System

Under Section 8.2: Electrical System, Subsection 8.2.4: Station Blackout, CVCS is discussed under the following subsections:
8.2.4.9 Reactor Coolant Inventory
The TSC diesel generator will power one of two charging pumps each having a capability of supplying water at the rate of 60 gpm. This will provide makeup for a total of 50 gpm reactor coolant pumps seal leakage (25 gpm per pump) and 10 gpm reactor coolant system leakage (maximum allowed by the TS). The water supply for the pumps will be from the refueling water storage tank. Technical Specifications provide the necessary inventory for four hours of primary make-up water.
8.2.4.12 SBO Modifications
An air (nitrogen) supply has been provided for RCS inventory valve CVC-7 in order to provide control room control of the amount of charging flow to the reactor coolant loop versus the reactor coolant pump seals.

Chapter 9: Auxiliary And Emergency Systems

Section 9.2: Chemical And Volume Control System, describes the design bases (section 9.2.1), system design and operation, components, and control (section 9.2.2), and the System Design Evaluation (section 9.2.3) which addresses availability and reliability, tritium control, leakage prevention, incident control, malfunction analysis, galvanic corrosion, and fuel element failure detection.
Under Section 9.3: Auxiliary Coolant System, Subsection 9.3.2: System Design And Operation, CVCS is discussed under topic 9.3.2.3: Spent Fuel Pool Cooling System:
Boron addition can be made to the spent fuel pool by use of the boric acid makeup portion of the CVCS.
Also under Section 9.3, Subsection 9.3.4: System Evaluation, Subsection 9.3.4.3: Incident Control, Subsection 9.3.4.3.2: Residual Heat Removal System, CVCS is discussed under topic 9.3.4.3.2.1: Low Temperature Overpressure Protection:
Overpressurization transients can result from either a mass input or an energy input transient, and typically occur when the RCS is in a water solid condition. The LTOP design assumed as the most limiting mass input transient, an inadvertent start of one SI pump, with two RHR & RXCPs operating. The design transients considered in the LTOP design also includes a mass addition transient involving all three charging pumps injecting water into

the RCS with the letdown line isolated with two RHR & RXCPs operating. The most limiting energy input, i.e., thermal expansion, transient assumed an initial starting of a RXCP with an assumed secondary to primary temperature difference of 100°F, with two RHR pumps operating.

Chapter 11: Waste Disposal And Radiation Protection System

Under Section 11.1: Waste Disposal System, Subsection 11.1.1: Design Basis, Subsection 11.1.1.1: Control of Releases of Radioactivity to the Environment, mentions the CVC System:
The bulk of the radioactive liquids discharged from the Reactor Coolant System (RCS) are processed by the boron recycle portion of the Chemical and Volume Control System (CVCS).
This design minimizes liquid processed by the Waste Disposal System.
Under Subsection 11.1.2: System Design and Operation, CVCS is described under topic 11.1.2.1: System Description:
To facilitate storage, processing and disposal, the Liquid Waste Disposal System is designed to segregate various waste streams at their point of collection into the following categories:

- Boron recycled distillate (deaerated waste from Boric Acid Evaporator)
- Miscellaneous rad waste drains (aerated waste)
- Laundry and hot shower waste

Part of the boron recycled distillate waste stream (deaerated waste) is the RCS drainage, which is transferred directly to the CVCS holdup tank or waste holdup tank for processing.
Sources of this drainage include:

- Reactor coolant loops
- Pressurizer relief tank
- Reactor coolant pump secondary seals
- Excess letdown (during startup)
- Accumulators
- Reactor vessel flange leakoffs
- Refueling cavity drains
- Valve leakoffs

These liquids flow to the reactor coolant drain tank or suction of the reactor coolant drain tank pumps and are discharged either directly to the CVCS holdup tanks or to the waste holdup tank by the reactor coolant drain pumps. These pumps can also return water from the refueling cavity to the RWST. There is one reactor coolant drain tank with two reactor coolant drain tank pumps located inside of the Containment.
The remaining deaerated liquid waste originates in the CVCS charging and letdown paths and from miscellaneous equipment drains. These liquid waste streams are collected and handled in a closed system to minimize the hydrogen explosion hazard and prevent the escape of gaseous radioactivity. This is accomplished by collecting deaerated waste in a closed piping system that drains to a deaerated drain tank. The deaerated drain tank is

isolated from the atmosphere by diaphragm valves and diaphragm sealed instruments. From the tanks the deaerated waste is pumped to the CVCS holdup tanks for processing through the Boron Recovery System. The CVCS fluid is pumped from the monitor tanks to the Waste Disposal System through flow meters and discharged in the environment.

Chapter 14: Safety Analysis

CVCS is analyzed under Section 14.1: Core And Coolant Boundary Protection Analysis, Subsection 14.1.4: Chemical and Volume Control System Malfunction
The accident analysis addresses boron dilutions during refueling, startup, and power operation. Boron dilutions during Hot Standby, Hot Shutdown, and Cold Shutdown are not part of the KPS licensing basis.
CVCS is also mentioned under Section 14.3: Reactor Coolant System Piping Ruptures (LOCA), Subsection 14.3.2: Loss of Reactor Coolant From Small Ruptured Pipes or From Cracks In Large Pipes Which Actuates Emergency Core Cooling System, Subsection 14.3.2.1: Identification of Causes and Accident Description:
A LOCA is defined as a rupture of the RCS piping or of any line connected to the system. Ruptures of small cross section will cause expulsion of the coolant at a rate which can be accommodated by the charging pumps, which would maintain an operational water level in the pressurizer, permitting the operator to execute an orderly shutdown. However, ruptures of small cross section in lines connected to the pressurizer steam space could cause the steam discharge through the break to exceed the vapor generation capacity of the pressurizer heaters. This situation would not allow for an orderly shutdown, even though an operational water level might be maintained in the pressurizer. In either case, the coolant which would be released to the containment, contains the fission products existing in it.
If the break is such that either pressurizer level or pressurizer pressure cannot be maintained, depressurization of the RCS follows. Reactor trip occurs when the pressurizer low-pressure trip setpoint is reached. The SIS is actuated when the appropriate setpoint is reached.

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Since KPS will no longer be authorized to operate or place fuel in the reactor the functions credited in the USAR are no longer required. The USAR will be revised to address requirements following cessation of power operation.

Technical Specifications (TS)

Reviewed all sections of TS and the following section is applicable to CVCS:

5.5.2 Primary Coolant Sources Outside Containment
The System Integrity Program (SIP) provides controls to minimize leakage from those portions of systems outside containment that could contain highly radioactive fluids during a serious transient or accident to levels as low as practicable. The systems include Safety Injection System, Chemical and Volume Control System, Containment Spray System, Miscellaneous Sumps and Drains System, Reactor Building Ventilation System, Residual Heat Removal System, and Primary Sampling System.
On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Therefore the System Integrity Program requirements are no longer applicable and the System Integrity Program will require revision.

Technical Requirements Manual (TRM)

Reviewed all sections of the TRM, and the following section is applicable to the Chemical and Volume Control System:

8.1 REACTIVITY CONTROL SYSTEMS
8.1.1 Chemical and Volume Control System
TNC 8.1.1 The Chemical and Volume Control System shall be FUNCTIONAL consisting of EITHER:
a. A flow path from the RWST or BAST via a FUNCTIONAL Charging pump to the Reactor Coolant System (RCS);
OR
b. A flow path from the RWST or BAST via a FUNCTIONAL Safety Injection Pump to the Reactor Coolant System (RCS).
APPLICABILITY: All MODES.

With the reactor defueled, the plant condition is NO MODE.

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Since KPS will no longer be authorized to operate or place fuel in the reactor the TRM requirements for Modes 1-6 and Refueling no longer apply.

Offsite Dose Calculation Manual (ODCM)

15.1 Major Changes to Radioactive Waste Systems
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.

This is a complete abandonment of CVCS. On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. On May 15, 2013 the NRC docketed the certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii). Therefore the 10 CFR Part 50 license no longer authorizes KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). With the Reactor Coolant System abandoned and drained there will be no liquid waste created and no releases from the CVCS. With no liquid entering the CVCS and no releases from CVCS this change results in no increase in maximum exposures in the UNRESTRICTED AREA, to the general population and to plant operating personnel. Detailed information concerning the predicted releases and exposure estimates will be included in the annual Radioactive Effluent Release Report.

Shutdown Safety Assessment (SSA)

Reviewed OU-KW-201, Shutdown Safety Assessment Checklist (Revision 13), for CVCS requirements. Under **Attachment 1: Shutdown Safety Assessment (SSA) Checklist**, the **Spent Fuel Pool Cooling** section requires the following:

- 3. At least one non-QA SFP makeup flowpath available and Service Water Emergency Makeup flowpath available (0-1)
-

This requirement is addressed in detail under **Attachment 7: Spent Fuel Pool Cooling:**

- 3. SFP Non-QA Makeup Flowpaths:
    - SFP Makeup from RMST's through MU-1099 or via CVC Blender.
    - SFP Makeup from CVC HUT.
    - SFP Makeup from RWST

    For RMST, RWST, and CVC HUT a usable volume of 15,120 gals shall be available.
    - The CVC HUT combined volume of 60 percent is required.
    - RMST greater than 150 percent combined level, to be consistent with other requirements in this procedure.
    - RWST level greater than 30 percent to be consistent with other requirements in this procedure.

  Additionally, further requirements for makeup flow paths available that exceed a capacity of 42 gpm are specified for the following conditions:
    - Elevated risk on SFP Cooling
    - Time for SFP to reach 200°F (upon loss of normal cooling) is less than 72 hours requires one alternate makeup flowpath capable of providing a minimum of 42 gpm to be protected.

  Finally, under General SFP Notes, proceduralized flowpaths that meet the 42 gpm requirement are specified:
    - Makeup directly from the RMSTs via MU-1099, or makeup from the RMSTs through the blender in the CVC System (OP-KW-MOP-SFP-001, OP-KW-NOP-CVC-001).
    - Makeup to the SFP from CVC HUT (OP-KW-MOP-SFP-001, OP-KW-NOP-CVC-009).
    - Makeup to the SFP from RWST (OP-KW-MOP-SFP-001).
    - Emergency Makeup from Service Water (OP-KW-AOP-SFP-001, Attachment A).

The SSA requirements for Spent Fuel Pool Cooling will still apply. The abandonment of the CVC System will remove the ability to satisfy all of the non-QA-1 Makeup Flowpaths to the SFP. The SFP Non-QA-1 Makeup Flowpaths being abandoned are:

- SFP Makeup from the CVC Blender.
- SFP Makeup from CVC HUT.

With these sources being abandoned, the SFP Non-QA-1 Makeup Flowpaths that will remain available are:

- SFP Makeup from RMST's through MU-1099.
- SFP Makeup from RWST

Attachment 1, Shutdown Safety Assessment (SSA) Checklist, requires ONE non-QA-1 SFP makeup flowpaths available and Service Water Emergency Makeup flowpath available. This requirement will remain satisfied after abandoning the CVC System as follows:

- Both RMST's, and at least one Reactor Makeup Water Pump, will remain available to provide makeup through MU-1099.
- The RWST, and the RWST Purification Pump, will remain available to provide makeup to the SFP.
- The Service Water System will also remain available.

The requirement is for at least one non-QA-1 SFP makeup flowpath available and Service Water Emergency Makeup flowpath available, and there will be two non-QA-1 SFP makeup flowpaths available.

Licensing Commitments

Outstanding commitments to the regulator were reviewed. The following was found that affects the Chemical And Volume Control System:

Commitment Number: 92-057 **Commitment Made to:** NRC

Title: BULLETIN 88-08: TEMP. MONITORING

Background: ADDITIONAL INFORMATION PROVIDED TO THE NRC REGARDING BULLETIN 88-08,

THERMAL STRESSES IN PIPING CONNECTED TO REACTOR COOLANT SYSTEMS.

Reference letter NRC-92-27, dated 3110192. Also reference comtrak 92-058.

Item 1 - Perform manual temperature monitoring on the Auxiliary Pressure Spray Line to enhance the ability to detect valve leakage.

Item 2 - Perform a NDE of a section of pipe located adjacent to CVC-16, to demonstrate the integrity of that line.

On February 25, 2013, DEK submitted a certification of permanent cessation of power operations pursuant to 10 CFR 50.82(a)(1)(i), stating that DEK has decided to permanently cease power operation of KPS on May 7, 2013. Upon docketing of the subsequent certification for permanent removal of fuel from the reactor vessel pursuant to 10 CFR 50.82(a)(1)(ii), the 10 CFR Part 50 license will no longer authorize KPS to operate the reactor or emplace or retain fuel in the reactor vessel, as specified in 10 CFR 50.82(a)(2). Since the KPS license will be modified to a possession only license, the regulatory commitments associated with the Chemical and Volume Control System will not be maintained. These commitments will be dispositioned per LI-AA-110, Commitment Management.

This package does not negatively impact the Environmental Permits, Security Plan, REMM\ODCM, Fire Protection Plan, Health Physics Requirements or Insurance requirements.

Plant Impact

There is no impact on any temporary changes that are active as of 6-4-2013.

The Drawing Control Team did not identify any outstanding drawing changes that required disposition as a result of system abandonment.

This DSERT package does not impact Spent Fuel Pool Cooling therefore does not require FSRC approval.

5.0 Special conditions to support categorization(s):

None

6.0 Assumptions/Open Items to be validated or dispositioned:

- Validate the assumptions in this document for Spent Fuel Pool Non-QA-1 Makeup Flowpath requirements in the Shutdown Safety Assessment. Procedure OU-KW-201, Shutdown Safety Assessment Checklist, contains the requirements.

7.0 Expected duration for SSC category if NOT ABANDONED:

N/A

8.0 **PREPARE** and **ATTACH** the following documents:

- Completed 10 CFR 50.59 Screening or Evaluation, if required
- Proposed DUs for appropriate drawings

9.0 Technical Concurrence:

Type Of Review	Name (Print)	Approval Signature	Date
Engineering	Richard Reimer	[signature]	5/29/2013
Type Of Review Fire Protection	Name (Print) Michael Townsend	Approval Signature [signature]	Date 5/31/2013
Type Of Review Security	Name (Print) Brian Presl	Approval Signature [signature]	Date 05-28-13
Type Of Review Radiation Protection	Name (Print) Daniel J. Shannon	Approval Signature [signature]	Date 5-30-13
Type Of Review	Name (Print)	Approval Signature	Date

10.0 Review and Approval:

Paul T. Rappel / [signature] — 5/28/13
Prepared By (Print/Sign) — Date

Scott Cieslewicz [signature] — 5/28/13
Reviewed By (Screen Qual.) (Print/Sign) — Date

[signature] / [signature] — 6/4/13
Nuclear Licensing (Print/Sign) — Date

DOYKSTRA [signature] — 6-4-13
Concurrence by DSERT Coordinator (Print/Sign) — Date

Stewart J Yuen / [signature] — 6/20/13
FSRC (Print/Sign), if required — Date

FSRC Meeting Number: 13-031

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DOMINION
Kewaunee Power Station FSRC MTG # 13-031

Facility Safety Review Committee

June 19, 2013 **1300 Hours**

ATTENDEES:

Quorum

Chairperson: SJ Yuen, Chairperson – Director Decommissioning *(1)*
JD Helbing, Supervisor - Maintenance *(alt)*
JM Hale, Manager - RP/Chem *(1)*
JJ Madden, Manager - Component and System Engineering *(1)*

FSRC Coordinator: JM Schuh, Administrative Assistant, Director Decommissioning

Presenters: DE Dykstra, DSERT Coordinator/Operations
SM Cieslewicz, Ops

Guests: -None-

(1) Indicates Chairperson and Members required for quorum per LI-AA-600.
(alt) Alternate Member *(nv)* Non-Voting Member

The Chairperson called the meeting to order and noted that quorum requirements were met. The following items were discussed and dispositioned as noted.

FSRC 13-063 Miscellaneous Item
Presenter: Dykstra *Approved w/comments*

1) CVC documents

These require FSRC review due to ODCM 15.1, Major Changes to Radioactive Waste Systems, not because it may impact Spent Fuel Pool Cooling. Section 15.1 of the ODCM states: 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.

Discussion: FSRC reviewed and discussed the documents and identified no safety issues. The following comments were made:

- Page 15, list all accidents or why they were excluded.
- Page 25, under "Plant Impact" uses a date "as of 3-7-2013". This should be updated.

The Committee recommended approval of the CVC documents with comments and final review of the comments by the FSRC chair.

FSRC 13-064 Miscellaneous Item
Presenter: Dykstra *Approved*

1) RBV documents

This item is being brought to FSRC for some major changes to Radioactive Waste Systems. 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

Discussion: FSRC reviewed and discussed the documents and identified no safety issues or concerns.

The Committee recommended approval of the RBV Documents.

FSRC 13-065 Miscellaneous Item
Presenter: Cieslewicz *Approved w/comments*

1) NLAR 91 – Revise the TRM sections related to fuel movement to reflect only those conditions required in the permanently defueled condition.

TRM 7.0, Use and Applications

- Delete the definition REFUELING OPERATION
- Delete the "MODES or other" from the phrase "MODES or other specified conditions" and delete the phrase "or that are part of a shutdown of the unit".
- Replace the terms "unit", "operation of the unit" or "operation of the plant" with more appropriate terms

TRM 8.7.8 Spent Fuel Pool Temperature

- A new TRM section is being proposed to incorporate the License Amendment 172 requirement to maintain the temperature of the SFP water below 150°F.

TRM Section 8.9 Refueling Operations

- Rename Section 8.9 "Fuel Handling Operations" as a more appropriate title in the defueled condition.

TRM 8.9.2, Fuel Handling and Manipulator Cranes

- Rename TRM 8.9.2 "Spent Fuel Pool Bridge Crane" and replace "Fuel Handling Crane" with "Spent Fuel Pool Bridge Crane" throughout the section.
- Change APPLICABILITY from "During REFUELING OPERATIONS" to "During movement of irradiated fuel assemblies or fuel assembly components."
- Delete requirements related to Manipulator Crane and fuel movement in the reactor.

TRM 8.9.4, Radiation Monitoring During REFUELING OPERATIONS

- Rename TRM 8.9.4 "Radiation Monitoring During Fuel Movement"
- Change APPLICAVILITY from "During REFUELING OPERATIONS" to "During movement of irradiated fuel assemblies or fuel assembly components."
- Delete requirements related to fuel movement in the reactor

TRM 8.9.6, Spent Fuel Pool Sweep System is being proposed for deletion.

- Functionality requirements for the Spent Fuel Pool Sweep system apply only when irradiated fuel in the pool has decayed less than 30 days.

As of June 7, 2013, all fuel on site will have decayed for greater than 30 days. Entry into any conditions that could restart the 30 day clock are prohibited by 10CFR50.82(a)(2).

Discussion: FSRC reviewed and discussed the NLAR and identified no safety issues. The following action was taken by the Engineering FSRC representative: write a condition report regarding why the deletion of the functional check of refueling systems interlocks was being made since there were still interlocks on the bridge.

The Committee recommended approval of NLAR 91 with comments and final review of the comments by the FSRC chair.

The meeting adjourned at 1344.

To the best of the Committee's knowledge, none of the above items required NRC approval prior to implementation.

Submitted by: Sarah Smidel for 7-9-13
J Schuh — Date
Recording Secretary

APPROVED: Stewart J Yuen 8/6/13
SJ Yuen — Date
FSRC Committee Chairman

APPROVED: 8-15-13
AJ Jordan — Date
Site Vice President

ATTACHMENTS:
None

Facility Safety Review Committee

August 15, 2013 **0958 Hours**

ATTENDEES:

Quorum

Chairperson:	J Stafford, Chairperson – Director Safety and Licensing *(1)* JD Helbing, Supervisor - Maintenance *(1)* JM Hale, Manager - RP/Chem *(1)* ME Aulik, Manager – Engineering *(1)* B McMahon, Manager –Operations *(1)*
FSRC Coordinator:	JM Schuh, Administrative Assistant -Decommissioning
Presenters:	TS Wattleworth, Engineer III MW Grapentine, Electrical Maintenance Supervisor DA Jeanquart, Mechanical Maintenance Supervisor WG Swanson, Decommissioning Team—Ops
Guests:	MD Townsend, Hughes Associates – Fire Protection RG Krsek, NRC

(1) Indicates Chairperson and Members required for quorum per LI-AA-600.
(alt) Alternate Member *(nv)* Non-Voting Member

The Chairperson called the meeting to order and noted that quorum requirements were met. The following items were discussed and dispositioned as noted.

FSRC 13-078 Design Change (DC)
Presenter: Wattleworth *Approved*

1) DC-KW-13-01128, Discharge Structure Outfall Stop Logs and B.5.b Pump Suction Point

The Design Change (DC) will install stop logs in the discharge structure to maintain water in the pipe and confine the remaining service water discharge to a concentrated flow along the north sheet pile wall to assist in keeping a discharge channel open. The DC will also change the B.5.b Emergency Pump Suction location to the Warm Water Pump Pit. This is being done because the plant's discharge channel will begin filling with alluvial deposits from Lake Michigan currents after the CW pumps are shut down. This has previously occurred within weeks of stopping the CW pumps. It will also be necessary to maintain the discharge structure and piping full for security purposes.

Discussion: FSRC reviewed and discussed the design change and had the following comment:

- In section 5 of CM-AA-DDC-201 remove the statement "no formal Training".

The Committee recommended approval of the procedure as modified with final review by the chairperson.

FSRC 13-079

Miscellaneous Item

Presenter: Grapentine *Approved, w/comments*

1) MA-KW-EPM-039A, Linear Fire Control Panel (LFCP-1) Inspection

New procedure for the preventative maintenance and checks on the Linear Fire Control Panel, LFCP-1

Discussion: FSRC reviewed and discussed the procedure and had the following comment:

- On page 19, step 6.1.3 – the step leads you to believe that it is normal to ONLY write a CR if out of acceptance. This should be clarified.

The Committee recommended approval of the procedure as modified with final review by the chairperson.

FSRC 13-080

Miscellaneous Item

Presenter: Grapentine *Approved w/comments*

1) MA-KW-EPM-040A, Linear Fire Control Panel (LFCP-2) Inspection

New procedure for the preventative maintenance on the Linear Fire Control Panel, LFCP-1

Discussion: FSRC reviewed and discussed the procedure had the following comment:

- On page 26, step 6.1.3 – the step leads you to believe that it is normal to ONLY write a CR if out of acceptance. This should be clarified.

The Committee recommended approval of the procedure as modified with final review by the chairperson.

FSRC 13-081

Miscellaneous Item
Presenter: Jeanquart *Approved*

1) MA-KW-MPM-FP-007, Fire Hose Pressure Test, Rev. 5

This procedure revision removes steps requiring performer(s) to obtain, Mark, and Record Identification numbers on fire hoses (if not already marked/identified).

Discussion: FSRC reviewed and discussed the procedure and identified no safety issues or concerns.

The Committee recommended approval of the procedure.

FSRC 13-082

Miscellaneous Item
Presenter: Swanson *Approved w/comments*

1) Waste Gas System (32B) DSERT SSC Category Determination Document

OP-KW-DEC-SYC-001 Attachment B. Document details total abandonment of the Waste Gas Processing System, what will be abandoned and justifies complete abandonment.

Discussion: FSRC reviewed and discussed the documents and identified no safety issues. The following comments were made:

- On Page 5, add "based on the above" to paragraph 3.

The Committee recommended approval of the document with comments and final review of the comments by the FSRC chair.

The meeting adjourned at 1029.

To the best of the Committee's knowledge, none of the above items required NRC approval prior to implementation.

Submitted by: ~~Sarah Snidell for~~ 9/11/13
JM Schuh Date
Recording Secretary

APPROVED: JT Stafford 9-16-13
JT Stafford Date
FSRC Committee Chairman

APPROVED: AJ Jordan 9/19/13
AJ Jordan Date
Site Vice President

ATTACHMENTS:
None

Facility Safety Review Committee

December 19, 2013 **1002 Hours**

ATTENDEES:

Quorum

Chairperson: J Stafford, Chairperson – Director Safety and Licensing *(1)*
BJ McMahon, Manager – Operations *(1)*
ME Aulik, Manager – Engineering Design *(1)*
JD Helbing, Nuclear Specialist—Maintenance *(1)*

FSRC Coordinator: SA Smidel, Administrative Assistant –Plant Manager

Presenters: WG Swanson, Decommissioning Ops
J Gadzala, Decommissioning

Guests: R Edwards, USNR
T Hanna, Supervisor Engineering

(1) Indicates Chairperson and Members required for quorum per LI-AA-600.
(alt) Alternate Member *(nv)* Non-Voting Member

The Chairperson called the meeting to order and noted that quorum requirements were met. The following items were discussed and dispositioned as noted.

FSRC 13-112 Licensing Amendment Request (LAR)
Presenter: Gadzala *Approved*

1) LAR 256- PDTS, Supplement 2

By application dated May 29, 2013, Dominion Energy Kewaunee, Inc. (DEK), requested an amendment to Facility Operating License Number DPR-43 for Kewaunee Power Station (KPS). The proposed amendment would revise the Operating License and revise the associated Technical Specifications (TS) to Permanently Defueled Technical Specifications (PDTS). Supplement 1 to the application was submitted on October 15, 2013.

Include within the changes proposed in the application was deletion of the cyber security provisions contained in License Condition 2.C.(4). This proposal was based on the requirements of 10 CFR 73.54. regarding cyber security, no longer applying to KPS. However, the NRC staff recently verbally informed DEK that 10 CFR 73.54 continues to apply to facilities that were previously licensed to operate on the November 23, 2009 mandated date for that rule.

In response to the staff's comments, DEK is revising the originally proposed amendment. The revised request retracts the original proposal to delete the cyber security provisions contained in License Condition 2.C.(4), which will result in this license condition remaining unchanged. Attachment 1 to this letter provides a supplement to the proposed amendment describing the revision.

Discussion: FSRC reviewed and discussed LAR 256- PDTS supplement and identified no safety issues or concerns.

The Committee recommended approval of LAR 256, Supplement 2.

FSRC 13-113 Miscellaneous Item (NLAR)
Presenter: Gadzala *Approved w/comments*

1) NLAR 88- PDTS, Deletion of TRM 8.3.7, Explosive Gas Monitoring System

The purpose of NLAR 88 is to delete Technical Requirements Manual (TRM) 8.3.7 "Explosive Gas Monitoring System" due to the permanent shutdown and abandonment of the gaseous waste system. The Explosive Gas Monitoring System utilizes an inline Waste Gas Analyzer (WGA) to monitor the in service Waste Gs Decay Tank (WGDT) on a continuous basis to determine if the tank contains an explosive mixture and is set to 2% oxygen by volume.

With the hydrogen supply portion of the Miscellaneous Gas abandoned (hydrogen banks are permanently removed) and the Chemical and Volume Control (CVCS) and Reactor Coolant Systems (RCS) drained and vented, gaseous waste is no longer being produced. The Gaseous Waste System, including WGDTs, has been purged of radioactive and explosive gases, vented to atmosphere and abandoned. Therefore, with no source of explosive gas the TRM requirements for the Explosive Gas Monitoring System are no longer necessary.

Discussion: FSRC asked the presenter to update the screening to add reference to Technical Specifications 5.5.10.

The Committee recommended approval of this NLAR.

FSRC 13-114 Miscellaneous Item (NLAR)
Presenter: Gadzala *Approved*

1) NLAR 90, Deletion of TRM 8.7.7, Flooding Protection – Circulating Water Pump Trip Circuitry"

The purpose of NLAR 90 is to delete Technical Requirements Manual (TRM) 8.7.7 "Flooding Protection—Circulating Water Pump trip Circuitry" due to the permanent shutdown and abandonment of the Circulating Water (CW) System. With the CW system permanently shut down, flooding protection from the system is no longer required.

Discussion: FSRC reviewed and discussed the NLAR and identified no safety issues or concerns.

The Committee recommended approval of this NLAR.

FSRC 13-115 Miscellaneous Item (NLAR)
Presenter: Gadzala *Tabled*

1) NLAR 95, Deletion of TRM 8.3.6, Seismic Monitoring Instrumentation

The purpose of NLAR 95 is to delete Technical Requirements Manual (TRM) 8.3.6 Seismic Monitoring Instrumentation. TRM 8.3.6 Bases states the seismic monitoring instrumentation is used to provide data on seismic events in order to permit a timely determination of the need for shutting down the reactor as a result of the event. With the reactor permanently shut down and defueled, TRM 8.3.6 "Seismic Monitoring Instrumentation" can be deleted as this function of the seismic monitor is no longer required.

Discussion: FSRC requested information regarding what administrative controls currently exist to set the frequency and requirement for demonstrating functionality of the seismic monitor for EAL purposes (currently contained in TVR 8.3.6.1, which is being proposed for deletion); and what administrative controls ensure that these functionality checks remain in place.

The Committee recommended tabling NLAR 95.

FSRC 13-116 Miscellaneous Item (NLAR)
Presenter: Gadzala *Approved*

1) NLAR 89, Deletion of TRM 8.7.5, Snubbers

The purpose of NLAR 89 is to delete Technical Requirements Manual (TRM) 8.7.5 Snubbers. TRM 8.7.5 lists the snubbers in the Snubber program and the plant MODES for which the snubbers are required to be functional. Snubbers in the program are required to be functional in MODES 1,2, 3, 4, 5 and/or 6 only. No snubbers are required by the TRM to be functional in the defueled condition. Consequently TRM 8.7.5 is unnecessary in the permanently defueled condition and can be deleted.

Discussion: FSRC reviewed and discussed the NLAR and identified no safety issues or concerns.

The Committee recommended approval of this NLAR.

FSRC 13-117 Miscellaneous Item (NLAR)
Presenter: Gadzala *Approved w/comments*

1) NLAR 97, Revision of TRM 8.8.3, "Emergency Diesel Generator (EDG) Ventilation Damper Control Air Supply

The purpose of NLAR 97 is revise TRM 8.8.3, Emergency Diesel Generator (EDG) Ventilation Damper Control Air Supply, to reflect only those conditions required following certification for permanent cessation of operations and permanent removal of fuel from the reactor vessel.

TRM 8.8.3 references evaluation of EDG operability Technical Specifications (TS) 3.8.1, AC Sources –Operating (Applicable in Modes 1-4) and TS 3.8.2, AC Sources –Shutdown (Applicable in Modes 5-6 and during the movement of irradiated fuel assemblies). Following certification of permanent defueling on May 15, 2013, operation of the plant or placing fuel in the reactor vessel is prohibited by 10CFR 50.82(a)(2). This prevents entering Modes 1-6. Therefore, references to evaluating operability per TS 3.8.1 are unnecessary and can be deleted. Since the condition – During the movement of irradiated fuel assemblies – can be still entered, references to evaluating operability per TS 3.8.2 remain valid.

Discussion: FSRC asked the presenter to consider the following comments:

- Add reference to Technical Specifications 3.8.1 and 3.8.2 on the 10 CFR 50.59 screening section B

The Committee recommended approval with comments of NLAR 97.

FSRC 13-118

Operation Procedure
Presenter: McMahon *Approved*

1) OP-KW-OSP-FP-002, Fire Pump Test

Updated procedure to framemaker standards and renumbered procedure. Major changes include:

- Removal of License Renewal Statement
- Added step to check the fire pump tested in run for at least 30 minutes to meet Fire Plan requirements
- Added steps to document and track Fire Pump run time
- Changed preferred method for auto start to be via opening hose station #0
- Updated Acceptance Criteria to be consistent with Fire Plan

Discussion: FSRC reviewed and discussed the procedure and identified no safety issues or concerns.

The Committee recommended approval of this procedure.

FSRC 13-119

Miscellaneous Item
Presenter: Swanson *Approved w/comments*

1) SYS-07-DSERT, Blowdown and Blowdown Treatment System Categorization package

S/G Blowdown and Blowdown Treatment System Categorization plan was submitted to FSRC because this system is an effluent processing system and per ODCM chapter 15 requires a review by FSRC.

Discussion: FSRC asked the presenter to consider the following comments:

- Remove the word solid on page 5 of 12 under item 3
- Move the following statement under #3 on page 5 of 12 as justification [Support draining of systems in the Auxiliary Building. One train is being maintained available to support draining.]
- Make the following sentence specific to blowdown systems on 8 of 12. [Since KPS will no longer be authorized to operate or place fuel in the reactor the functions credited in the USAR are no longer required.]
- Validate the date 3/7/13 for temporary changes

The Committee recommended approval with comments of SYS-07-DSERT.

FSRC 13-120

Miscellaneous Item
Presenter: Swanson *Approved w/comments*

1) SYS-45-2-DSERT, Radiation Monitoring System Categorization package for R-11, R-12, and R-21.

Categorization plan was submitted to FSRC because this system is an effluent monitoring system and per ODCM chapter 15 requires a review by FSRC.

Discussion:

FSRC asked the presenter to consider the following comments:

- On page 1 of 8 check the box for Abandoned
- On page 3 of 8 number 5 justify
- On page 4 of 8 narrow the following statement to R-11 and R-12 [Since KPS will no longer be authorized to operate or place fuel in the reactor the functions credited in the USAR are no longer required.]

The Committee recommended approval with comments of SYS-45-2-DSERT.

The meeting adjourned at 1046.

To the best of the Committee's knowledge, none of the above items required NRC approval prior to implementation.

Submitted by: Sarah Smidel 1/9/14
SA Smidel Date
Recording Secretary

APPROVED: JT Stafford 1-13-14
JT Stafford Date
FSRC Committee Chairman

APPROVED: [signature] 1-15-14
AJ Jordan Date
Site Vice President

ATTACHMENTS:
None

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