WOLF CREEK
NUCLEAR OPERATING CORPORATION

Britt T. McKinney
Vice President Plant Operations
and Plant Manager

APR 27 2001

WO 01-0012

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-137
Washington, D. C. 20555

Subject: Docket No. 50-482: Wolf Creek Generating Station Annual Radioactive Effluent Release Report - Report 24

Gentlemen:

This letter transmits the enclosed Wolf Creek Generating Station (WCGS) Annual Radioactive Effluent Release Report. The report covers the period from January 1, 2000, through December 31, 2000. It is being submitted pursuant to Section 5.6.3 of the WCGS Technical Specifications. The WCGS Offsite Dose Calculation Manual and the WCGS Solid Radwaste Process Control Program are included as attachments to the report. There are no commitments in this submittal.

If you should have any questions regarding this submittal, please contact me at (620) 364-4112, or Mr. Karl A. (Tony) Harris at (620) 364-4038.

Very truly yours,

Britt T. McKinney

BTM/rlr

Enclosure

cc: J. N. Donohew (NRC), w/a, w/e
W. D. Johnson (NRC), w/a, w/e
E. W. Merschoff (NRC), w/a, w/e
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IE48

Wolf Creek Nuclear Operating Corporation

Wolf Creek Generating Station

Docket No: 50-482
Facility Operating License No: NPF-42

Annual Radioactive Effluent Release Report

Report No. 24

Reporting Period: January 1, 2000 - December 31, 2000

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EXECUTIVE SUMMARY

This Annual Radioactive Effluent Release Report (Report # 24) documents the quantities of liquid and gaseous effluents and solid waste released by the Wolf Creek Generating Station (WCGS) from January 1, 2000, through December 31, 2000. The format and content of this report is in accordance with Regulatory Guide 1.21, Revision 1. Sections I, II, III, and IV of this report provide information required by NRC Regulatory Guide 1.21 and Section 7.2 of the Offsite Dose Calculation Manual (ODCM).

Section I — Section I of this report lists in detail the quantities of radioactive liquid and gaseous effluents and cumulative dose summaries for 2000, tabulated for each quarter and for yearly totals. Specific ODCM effluent limits and dose limits are also listed in Section I, along with the percentage of the effluent limits actually released, and the percentages of the dose limit actually received. No effluent or dose limits were exceeded during 2000.

An elevated release pathway does not exist at WCGS. All airborne releases are considered to be ground level releases. The gaseous pathway dose determination is met by the WCGS ODCM methodology of assigning all gaseous pathways to a hypothetical individual residing at the highest annual X/Q and D/Q location, as specified in the ODCM. This results in a conservative estimate of dose to a member of the public, rather than determining each pathway dose for each release condition. A conservative error of thirty percent has been estimated in the effluent data. As stated above, no ODCM dose limits were exceeded in 2000.

Section II --- This section includes supplemental information on continuous and batch releases, calculated doses, and solid waste disposal. There were approximately the same number of gaseous batch releases in 2000 and 1999 (75 versus 74). There were more liquid batch releases in 2000 than there were in 1999 (98 versus 84). We released 0.418 Curries in 1999, excluding gas and tritium. We reduced this release amount significantly in 2000, as we released 0.0356 Curies during that year. Continuous release pathways remained the same as previous years and all continuous releases were monitored. Maximum estimated doses to members of the public decreased from the 1999 estimates (4.55E-01mRem to 4.14E-01mRem) due to decreased mRem estimates for plant deliveries. Plant access road users and William Allen White Building workers received lower estimated doses than in 1999 (4.22E-03 mRem from 4.69E-03 mRem and 9.52 E-03 mRem from 1.06E-02 mRem, respectively). Section II also includes additional information regarding the presence of Co-57 in gaseous releases.

Section III --- This section documents WCGS meteorological data for wind speed, wind direction, and atmospheric stability. The quantity of missing hours of data for 2000 was 1235 hours. This corresponds to approximately 85.9% data availability. This lower availability was largely due to the unavailability of the computer from approximately September 14 through October 1, 2000. The data missing in September is due to corruption of the archive history files on Nuclear Plant Information System (NPIS); therefore, it was not possible to transfer the information to the archival database (LANCE). The strip chart recordings were available and could have been used as they are our official back-up.

Section IV --- Planned and unplanned releases, changes to radwaste treatment systems, land use census, monitoring instruments, radwaste shipments, and storage tank quantities are given in this section. No changes or events occurred to the land use census, monitoring instruments, radwaste shipments, and storage tanks. AP 07B-003, Revision 3, "Offsite Dose Calculation Manual" is included as Attachment I; AP 07B-004, Revision 1, "Offsite Dose Calculation Manual (Radiological Environmental Monitoring Program)" is included as Attachment II; and. AP 31A-100, Solid Radwaste Process Control Program" is included as Attachment III. A few modifications took place on the radwaste systems during 2000. More specifically, the membranes on the Tubular Ultra-filtration (TUF) were changed and a Sea Water Reverse Osmosis (SWRO) was placed in service June 27, 2000.

SECTION I

REPORT OF 2000 RADIOACTIVE EFFLUENTS: LIQUID

		Unit	Quarter 1	Quarter 2
A. Fission and Activation Products				
1. Total Release (not including tritium, gases, alpha)		Ci	4.163E-03	1.664E-02
2. Average Diluted Concentration During Period		µCi/ml	3.495E-10	5.450E-10
3. Percent of Applicable Limit	(1)	%	8.326E-02	3.328E-01
B. Tritium				
1. Total Release		Ci	1.188E+02	7.441E+02
2. Average Diluted Concentration During Period		µCi/ml	9.976E-06	2.437E-05
3. Percent of Applicable Limit	(ECL) (2)	%	9.976E-01	2.437E+00
C. Dissolved and Entrained Gases				
1. Total Release		Ci	1.320E-03	1.470E-01
2. Average Diluted Concentration During Period		µCi/ml	1.108E-10	4.815E-09
3. Percent of Applicable Limit	(3)	%	5.540E-05	2.408E-03
D. Gross Alpha Radioactivity				
1. Total Release		Ci	2.061E-04	5.552E-05
E. Volume of waste released (prior to dilution)		liters	4.502E+07	5.330E+07
F. Volume of dilution water used		liters	1.187E+10	3.048E+10

NOTES:

1) The applicable limit for the Wolf Creek Generating Station is 5 Curies per year. (Reference 10 CFR 50, Appendix I, "Guides On Design Objectives For Light-Water Cooled Nuclear Power Reactors," Paragraph A.2.) The value printed here is derived by dividing the total release Curies by 5 Curies and then multiplying the result by 100.

2) This value is derived by the following formula:

$$\%\text{ of Applicable Limit} = \frac{\text{(Average Diluted Concentration) (100)}}{\text{(MPC or ECL, Appendix B, Table 2 10CFR20)}}$$

3) This value is derived by the following formula:

$$\%\text{ of Applicable Limit} = \frac{\text{(Average Diluted Concentration) (100)}}{\text{(2E - 4 from ODCM Section 2.1)}}$$

REPORT OF 2000 RADIOACTIVE EFFLUENTS: LIQUID

	Unit	Quarter 3	Quarter 4
A. Fission and Activation Products			
1. Total Release (not including tritium, gases, alpha)	Ci	6.647E-03	8.146E-03
2. Average Diluted Concentration During Period	µCi/ml	2.025E-10	4.431E-10
3. Percent of Applicable Limit (1)	%	1.329E-01	1.629E-01
B. Tritium			
1. Total Release	Ci	5.878E+02	1.132E+02
2. Average Diluted Concentration During Period	µCi/ml	1.790E-05	6.158E-06
3. Percent of Applicable Limit (ECL) (2)	%	1.790E+00	6.158E-01
C. Dissolved and Entrained Gases			
1. Total Release	Ci	1.065E+00	1.137E-02
2. Average Diluted Concentration During Period	µCi/ml	3.244E-08	6.185E-10
3. Percent of Applicable Limit (3)	%	1.623E-02	3.093E-04
D. Gross Alpha Radioactivity			
1. Total Release	Ci	9.380E-06	3.768E-04
E. Volume of waste released (prior to dilution)	liters	1.026E+08	3.342E+07
F. Volume of dilution water used	liters	3.272E+10	1.835E+10

NOTES:

1) The applicable limit for the Wolf Creek Generating Station is 5 Curies per year. (Reference 10 CFR 50, Appendix I, "Guides On Design Objectives For Light-Water Cooled Nuclear Power Reactors," Paragraph A.2.) The value printed here is derived by dividing the total release Curies by 5 Curies and then multiplying the result by 100.

2) This value is derived by the following formula:

$$\text{\% of Applicable Limit} = \frac{\text{(Average Diluted Concentration) (100)}}{\text{(MPC or ECL, Appendix B, Table 2 10CFR20)}}$$

3) This value is derived by the following formula:

$$\text{\% of Applicable Limit} = \frac{\text{(Average Diluted Concentration) (100)}}{\text{(2E - 4 from ODCM Section 2.1)}}$$

2000 LIQUID EFFLUENTS

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 1	Continuous Mode Quarter 2	Batch Mode Quarter 1	Batch Mode Quarter 2
H-3	Ci	6.84E-01	6.98E-01	1.18E+02	7.44E+02
Cr-51	Ci	n/a	n/a	n/a	9.850E-05
Mn-54	Ci	<2.24E-02	<2.62E-02	2.140E-05	2.110E-05
Fe-55	Ci	<4.48E-02	<5.23E-02	1.03E-03	<9.79E-04
Fe-59	Ci	<2.24E-02	<2.62E-02	<1.31E-04	<4.90E-04
Co-57	Ci	n/a	n/a	1.16E-05	2.49E-05
Co-58	Ci	<2.24E-02	<2.62E-02	2.66E-04	1.47E-03
Co-60	Ci	<2.24E-02	<2.62E-02	9.12E-04	2.22E-03
Zn-65	Ci	<2.24E-02	<2.62E-02	<1.31E-04	<4.90E-04
Sr-89	Ci	<2.24E-03	<2.62E-03	<1.31E-05	<4.90E-05
Sr-90	Ci	<2.24E-03	<2.62E-03	<1.31E-05	<4.90E-05
Sr-92	Ci	n/a	n/a	n/a	n/a
Nb-95	Ci	n/a	n/a	n/a	n/a
Zr-95	Ci	n/a	n/a	n/a	n/a
Zr-97	Ci	n/a	n/a	n/a	n/a
Mo-99	Ci	<2.24E-02	<2.62E-02	<1.31E-04	<4.90E-04
Ag-110M	Ci	n/a	n/a	n/a	n/a
Sn-113	Ci	n/a	n/a	n/a	n/a
Sn-117M	Ci	n/a	n/a	n/a	n/a
Sb-124	Ci	n/a	n/a	n/a	n/a
Sb-125	Ci	n/a	n/a	1.65E-03	1.25E-02
I-131	Ci	<4.48E-02	<5.23E-02	<2.61E-04	<9.79E-04
Cs-134	Ci	<2.24E-02	<2.62E-02	7.17E-05	6.86E-05
Cs-137	Ci	<2.24E-02	<2.62E-02	1.96E-04	2.62E-04
Ce-141	Ci	<2.24E-02	<2.62E-02	<1.31E-04	<4.90E-04
Ce-144	Ci	<2.24E-02	<2.62E-02	<1.31E-04	<4.90E-04
Gross Alpha	Ci	2.01E-04	5.31E-05	2.06E-04	5.55E-05
Ar-41	Ci	<4.48E-01	<5.23E-01	<2.61E-03	<9.79E-03
Kr-85M	Ci	<4.48E-01	<5.23E-01	<2.61E-03	<9.79E-03
Kr-85	Ci	<4.48E-01	<5.23E-01	1.32E-03	5.05E-04
Kr-87	Ci	<4.48E-01	<5.23E-01	<2.61E-03	<9.79E-03
Kr-88	Ci	<4.48E-01	<5.23E-01	<2.61E-03	<9.79E-03
Xe-131M	Ci	<4.48E-01	<5.23E-01	<2.61E-03	2.22E-03
Xe-133M	Ci	<4.48E-01	<5.23E-01	<2.61E-03	9.81E-04
Xe-133	Ci	<4.48E-01	<5.23E-01	<2.61E-03	1.43E-01
Xe-135M	Ci	<4.48E-01	<5.23E-01	<2.61E-03	<9.79E-03
Xe-135	Ci	<4.48E-01	<5.23E-01	<2.61E-03	5.53E-05

NOTE

"Less than" values are calculated using the Lower Limit of Detection (LLD) values listed in Table 2-1 of the ODCM multiplied by the volume of waste discharged during the respective quarter. The "less than" values are not included in the summation for the total release values.

2000 LIQUID EFFLUENTS

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 3	Continuous Mode Quarter 4	Batch Mode Quarter 3	Batch Mode Quarter 4
H-3	Ci	1.09E+00	4.79E-01	5.87E+02	1.13E+02
Cr-51	Ci	n/a	n/a	n/a	4.21E-04
Mn-54	Ci	<5.07E-02	<1.62E-02	1.43E-04	2.26E-04
Fe-55	Ci	<1.01E-01	<3.25E-02	<1.34E-03	<9.55E-04
Fe-59	Ci	<5.07E-02	<1.62E-02	<6.71E-04	<4.78E-04
Co-57	Ci	n/a	n/a	4.45E-06	8.69E-06
Co-58	Ci	<5.07E-02	<1.62E-02	3.80E-04	3.35E-03
Co-60	Ci	<5.07E-02	<1.62E-02	1.90E-03	1.08E-03
Rb-88	Ci	n/a	n/a	2.44E-04	n/a
Zn-65	Ci	<5.07E-02	<1.62E-02	<6.71E-04	<4.78E-04
Sr-89	Ci	<5.07E-03	<1.62E-03	<6.71E-05	<4.78E-05
Sr-90	Ci	<5.07E-03	<1.62E-03	<6.71E-05	<4.78E-05
Sr-92	Ci	n/a	n/a	n/a	n/a
Nb-95	Ci	n/a	n/a	n/a	3.85E-06
Ru-103	Ci	n/a	n/a	n/a	n/a
Zr-95	Ci	n/a	n/a	n/a	n/a
Zr-97	Ci	n/a	n/a	n/a	n/a
Mo-99	Ci	<5.07E-02	<1.62E-02	<6.71E-04	<4.78E-04
Ag-110M	Ci	n/a	n/a	n/a	n/a
Sn-113	Ci	n/a	n/a	7.09E-06	n/a
Na-24	Ci	n/a	n/a	1.84E-05	n/a
Sb-125	Ci	n/a	n/a	2.38E-03	2.52E-03
I-131	Ci	<1.01E-01	<3.25E-02	2.48E-05	3.27E-04
Cs-134	Ci	<5.07E-02	<1.62E-02	4.47E-05	5.28E-05
Cs-137	Ci	<5.07E-02	<1.62E-02	1.84E-04	1.58E-04
Cs-138	Ci	n/a	n/a	n/a	n/a
Ce-141	Ci	<5.07E-02	<1.62E-02	<6.71E-04	<4.78E-04
Ce-144	Ci	<5.07E-02	<1.62E-02	<6.71E-04	<4.78E-04
Gross Alpha	Ci	9.38E-06	3.50E-04	<1.34E-04	2.72E-05
Ar-41	Ci	<1.01	<3.25E-01	2.29E-04	<9.55E-03
Kr-85M	Ci	<1.01	<3.25E-01	2.39E-03	<9.55E-03
Kr-85	Ci	<1.01	<3.25E-01	1.25E-02	6.07E-03
Kr-87	Ci	<1.01	<3.25E-01	1.29E-04	<9.55E-03
Kr-88	Ci	<1.01	<3.25E-01	2.05E-03	<9.55E-03
Xe-131M	Ci	<1.01	<3.25E-01	9.78E-03	3.38E-04
Xe-133M	Ci	<1.01	<3.25E-01	1.31E-02	7.26E-05
Xe-133	Ci	<1.01	<3.25E-01	9.20E-01	4.87E-03
Xe-135M	Ci	<1.01	<3.25E-01	<1.34E-02	<9.55E-03
Xe-135	Ci	<1.01	<3.25E-01	1.05E-01	1.55E-05

NOTE

"Less than" values are calculated using the Lower Limit of Detection (LLD) values listed in Table 2-1 of the ODCM multiplied by the volume of waste discharged during the respective quarter. The "less than" values are not included in the summation for the total release values.

2000 LIQUID CUMULATIVE DOSE SUMMARY
TABLE 1

QUARTER 1 OF 2000	ODCM CALCULATED DOSE	ODCM[1] LIMIT	% OF LIMIT
TOTAL DOSE (mRem) FOR BONE	1.24E-03	5.00E+00	2.48E-02
TOTAL DOSE (mRem) FOR LIVER	3.07E-02	5.00E+00	6.14E-01
TOTAL DOSE (mRem) FOR TOTAL BODY	3.01E-02	1.50E+00	2.01E+00
TOTAL DOSE (mRem) FOR THYROID	2.87E-02	5.00E+00	5.74E-01
TOTAL DOSE (mRem) FOR KIDNEY	2.93E-02	5.00E+00	5.86E-01
TOTAL DOSE (mRem) FOR LUNG	2.89E-02	5.00E+00	5.78E-01
TOTAL DOSE (mRem) FOR GI-LLI	2.89E-02	5.00E+00	5.78E-01
QUARTER 2 OF 2000			
TOTAL DOSE (mRem) FOR BONE	1.07E-03	5.00E+00	2.14E-02
TOTAL DOSE (mRem) FOR LIVER	7.56E-02	5.00E+00	1.51E+00
TOTAL DOSE (mRem) FOR TOTAL BODY	7.51E-02	1.50E+00	5.01E+00
TOTAL DOSE (mRem) FOR THYROID	7.39E-02	5.00E+00	1.48E+00
TOTAL DOSE (mRem) FOR KIDNEY	7.45E-02	5.00E+00	1.49E+00
TOTAL DOSE (mRem) FOR LUNG	7.41E-02	5.00E+00	1.48E+00
TOTAL DOSE (mRem) FOR GI-LLI	7.44E-02	5.00E+00	1.49E+00
QUARTER 3 OF 2000			
TOTAL DOSE (mRem) FOR BONE	7.07E-04	5.00E+00	1.41E-02
TOTAL DOSE (mRem) FOR LIVER	6.58E-02	5.00E+00	1.32E+00
TOTAL DOSE (mRem) FOR TOTAL BODY	6.55E-02	1.50E+00	4.36E+00
TOTAL DOSE (mRem) FOR THYROID	6.48E-02	5.00E+00	1.30E+00
TOTAL DOSE (mRem) FOR KIDNEY	6.51E-02	5.00E+00	1.30E+00
TOTAL DOSE (mRem) FOR LUNG	6.48E-02	5.00E+00	1.30E+00
TOTAL DOSE (mRem) FOR GI-LLI	6.49E-02	5.00E+00	1.30E+00
QUARTER 4 OF 2000			
TOTAL DOSE (mRem) FOR BONE	9.90E-04	5.00E+00	1.98E-02
TOTAL DOSE (mRem) FOR LIVER	4.45E-02	5.00E+00	8.90E-01
TOTAL DOSE (mRem) FOR TOTAL BODY	4.05E-02	1.50E+00	2.70E+00
TOTAL DOSE (mRem) FOR THYROID	5.41E-02	5.00E+00	1.08E+00
TOTAL DOSE (mRem) FOR KIDNEY	3.98E-02	5.00E+00	7.96E-01
TOTAL DOSE (mRem) FOR LUNG	3.94E-02	5.00E+00	7.88E-01
TOTAL DOSE (mRem) FOR GI-LLI	4.14E-02	5.00E+00	8.28E-01
TOTALS FOR 2000			
TOTAL DOSE (mRem) FOR BONE	4.01E-03	1.00E+01	4.01E-02
TOTAL DOSE (mRem) FOR LIVER	2.17E-01	1.00E+01	2.17E+00
TOTAL DOSE (mRem) FOR TOTAL BODY	2.11E-01	3.00E+00	7.03E+00
TOTAL DOSE (mRem) FOR THYROID	2.22E-01	1.00E+01	2.22E+00
TOTAL DOSE (mRem) FOR KIDNEY	2.09E-01	1.00E+01	2.09E+00
TOTAL DOSE (mRem) FOR LUNG	2.07E-01	1.00E+01	2.07E+00
TOTAL DOSE (mRem) FOR GI-LLI	2.10E-01	1.00E+01	2.10E+00

1. Based on ODCM Section 2.2, which restricts dose to the whole body to less than or equal to 1.5 mRem per quarter and 3.0 mRem per year. Dose restriction of any organ is less than or equal to 5 mRem per quarter and 10 mRem per year.

2000 LIQUID CUMULATIVE DOSE SUMMARY
TABLE 2

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
A.	Fission and Activation Products (not including H-3, gases, alpha)					
1.	Total Release - (Ci)	4.16E-03	1.66E-02	6.65E-03	8.15E-03	3.56E-02
2.	Maximum Organ Dose (mRem)	1.99E-03	1.65E-03	1.09E-03	1.63E-02	2.10E-02
3.	Organ Dose Limit (mRem)	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
4.	Percent of Limit	3.98E-02	3.30E-02	2.18E-02	3.62E-01	2.10E-01
B.	Tritium					
1.	Total Release - (Ci)	1.19E+02	7.44E+02	5.88E+02	1.13E+02	1.56E+03
2.	Maximum Organ Dose (mRem)	2.87E-02	7.39E-02	6.47E-02	3.92E-02	2.06E-01
3.	Organ Dose Limit (mRem)	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
4.	Percent of Limit	5.74E-01	1.48E+00	1.29E+00	7.84E-01	2.06E+00

This table is included to show the correlation between Curies released and the associated calculated maximum organ dose. Wolf Creek ODCM methodology is used to calculate the maximum organ dose which assumes that an individual drinks the water and eats the fish from the discharge point. ODCM Section 2.2 organ dose limits are used.

REPORT OF 2000 RADIOACTIVE EFFLUENTS: AIRBORNE

	Unit	Quarter 1	Quarter 2
A. Fission and Activation Gases			
1. Total Release	Ci	2.91E+00	2.80E+00
2. Average Release Rate for Period	μCi/sec	3.74E-01	3.24E-01
3. Percent of ODCM Limit (1)	%	4.31E-03	2.91E-03
B. Iodines			
1. Total Iodine-131	Ci	0.00E+00	0.00E+00
2. Average Release Rate for Period	μCi/sec	0.00E+00	0.00E+00
3. Percent of Applicable Limit (2)	%	0.00E+00	0.00E+00
C. Particulates			
1. Particulates with Half-lives > 8 days	Ci	0.00E+00	0.00E+00
2. Average Release Rate for Period	μCi/sec	0.00E+00	0.00E+00
3. Percent of ODCM Limit (3)	%	0.00E+00	0.00E+00
4. Gross Alpha Radioactivity	Ci	0.00E+00	0.00E+00
D. Tritium			
1. Total Release	Ci	1.52E+01	1.36E+01
2. Average Release Rate for Period	μCi/sec	1.95E+00	1.73E+00
3. Percent of ODCM Limit (4)	%	1.49E-01	1.27E-01

NOTES:

1) The percent of ODCM limit for fission and activation gases is calculated using the following methodology:

$$\%\text{ of ODCM Limit} = \frac{(\text{Qtrly Total Beta Airdose})(100)}{10\text{ mrad}} \text{ or } \frac{(\text{Qtrly Total Gamma Airdose})(100)}{5\text{ mrad}}$$

The largest value calculated between Gamma and Beta air dose is listed as the % of ODCM Limit.

2) The percent of ODCM limit for iodine is calculated using the following methodology:

$$\%\text{ of ODCM Limit} = \frac{(\text{Total Curies of Iodine - 131})(100)}{1\text{ Curie}}$$

3) The percent of ODCM limit for particulates is calculated using the following methodology:

$$\%\text{ of ODCM Limit} = \frac{(\text{Highest Organ Dose Due to Particulates})(100)}{7.5\text{ mrem}}$$

NOTE

This type of methodology is used since the Wolf Creek ODCM ties release limits to doses rather than Curie release rates. 2)

4) The percent of ODCM limit for tritium is calculated using the following methodology:

$$\%\text{ of ODCM Limit} = \frac{(\text{Highest Organ Dose Due to H - 3})(100)}{7.5\text{ mrem}}$$

REPORT OF 2000 RADIOACTIVE EFFLUENTS: AIRBORNE

	Unit	Quarter 3	Quarter 4
A. Fission and Activation Gases			
1. Total Release	Ci	1.48E+01	2.10E+00
2. Average Release Rate for Period	µCi/sec	1.86E+00	2.64E-01
3. Percent of ODCM Limit (1)	%	1.32E-02	1.79E-03
B. Iodines			
1. Total Iodine-131	Ci	0.00E+00	1.10E-05
2. Average Release Rate for Period	µCi/sec	0.00E+00	1.38E-06
3. Percent of Applicable Limit (2)	%	0.00E+00	1.10E-03
C. Particulates			
1. Particulates with Half-lives > 8 days	Ci	0.00E+00	2.48E-06
2. Average Release Rate for Period	µCi/sec	0.00E+00	3.12E-07
3. Percent of ODCM Limit (3)	%	0.00E+00	1.33E-05
4. Gross Alpha Radioactivity	Ci	0.00E+00	2.76E-08
D. Tritium			
1. Total Release	Ci	1.65E+01	8.81E+00
2. Average Release Rate for Period	µCi/sec	2.07E+00	1.11E+00
3. Percent of ODCM Limit (4)	%	1.55E-01	7.99E-02

NOTES:

1) The percent of ODCM limit for fission and activation gases is calculated using the following methodology:

$$\text{\% of ODCM Limit} = \frac{\text{(Qtrly Total Beta Airdose)(100)}}{\text{10 mrad}} \text{ or } \frac{\text{(Qtrly Total Gamma Airdose)(100)}}{\text{5 mrad}}$$

The largest value calculated between Gamma and Beta air dose is listed as the % of ODCM Limit.

2) The percent of ODCM limit for iodine is calculated using the following methodology:

$$\text{\% of ODCM Limit} = \frac{\text{(Total Curies of Iodine - 131)(100)}}{\text{1 Curie}}$$

3) The percent of ODCM limit for particulates is calculated using the following methodology:

$$\text{\% of ODCM Limit} = \frac{\text{(Highest Organ Dose Due to Particulates)(100)}}{\text{7.5 mrem}}$$

NOTE

This type of methodology is used since the Wolf Creek ODCM ties release limits to doses rather than Curie release rates.

4) The percent of ODCM limit for tritium is calculated using the following methodology:

$$\text{\% of ODCM Limit} = \frac{\text{(Highest Organ Dose Due to H - 3)(100)}}{\text{7.5 mrem}}$$

2000 GASEOUS EFFLUENTS

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 1	Continuous Mode Quarter 2	Batch Mode Quarter 1	Batch Mode Quarter 2
1. Fission and Activation Gases					
Ar-41	Ci	N/A	N/A	4.17E-01	2.55E-01
Kr-85	Ci	N/A	N/A	2.31E+00	1.03E+00
Kr-85M	Ci	N/A	N/A	N/A	N/A
Kr-87	Ci	<4.24E+01	<4.22E+01	<8.52E-02	<3.98E-02
Kr-88	Ci	<5.09E+01	<5.07E+01	<1.02E-01	<4.78E-02
Xe-131M	Ci	N/A	N/A	N/A	N/A
Xe-133	Ci	<3.49E+01	1.42E+00	9.70E-02	9.00E-02
Xe-133M	Ci	<9.97E+01	<9.93E+01	<2.01E-01	<9.37E-02
Xe-135	Ci	8.61E-02	<1.23E+01	1.66E-04	3.74E-04
Xe-138	Ci	<1.12E+03	<1.12E+03	<2.25E+00	<1.05E+00
Total	Ci	8.61E-02	1.42E+00	2.82E+00	1.38E+00
2. Halogens (Gaseous)					
I-131	Ci	<2.58E-04	<2.57E-04	<5.20E-07	<2.43E-07
I-133	Ci	<2.58E-02	<2.57E-02	<5.20E-05	<2.43E-05
Total	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3. Particulates and Tritium					
H-3	Ci	1.37E+01	1.32E+01	1.52E+00	4.04E-01
Mn-54	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Fe-59	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Co-58	Ci	<2.58E-03	1.54E-06	<5.20E-06	<2.43E-06
Co-60	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Zn-65	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Mo-99	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Cs-134	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Cs-137	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Ce-141	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Ce-144	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Sr-89	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Sr-90	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Gross Alpha	Ci	<2.58E-03	<2.57E-03	<5.20E-06	<2.43E-06
Co-57	Ci	n/a	n/a	n/a	n/a
Total	Ci	1.37E+01	1.32E+01	1.52E+00	4.04E-01

NOTE

"Less than" values for Noble Gases are calculated using the Lower Limit of Detection (LLD) values obtained at Wolf Creek Generating Station multiplied by the volume of air discharged during the respective quarter. For the Halogens and Particulates the ODCM LLD values are used.

2000 GASEOUS EFFLUENTS (Continued)

NUCLIDES RELEASED	Unit	Continuous Mode Quarter 3	Continuous Mode Quarter 4	Batch Mode Quarter 3	Batch Mode Quarter 4
1. Fission and Activation Gases					
Ar-41	Ci	N/A	N/A	1.03E+00	1.61E-01
Kr-85	Ci	N/A	N/A	N/A	N/A
Kr-85M	Ci	N/A	N/A	N/A	2.36E-04
Kr-87	Ci	<4.23E+01	<4.42E+01	<1.51E-01	<2.36E+00
Kr-88	Ci	<5.09E+01	<5.31E+01	<1.81E-01	<2.36E+00
Xe-131M	Ci	4.58E+00	N/A	N/A	N/A
Xe-133	Ci	8.29E+00	3.08E-02	3.28E-01	1.90E+00
Xe-133M	Ci	<9.96E+01	<1.04E+02	<3.55E-01	<5.55E+00
Xe-135	Ci	5.72E-01	<1.28E+01	1.54E-02	<6.85E-01
Xe-138	Ci	<1.12E+03	<1.17E+03	<3.99E+00	<6.24E+01
Total	Ci	1.34E+01	3.08E-02	1.37E+00	2.06E+00
2. Halogens (Gaseous)					
I-131	Ci	<2.58E-04	1.06E-05	<9.20E-07	3.95E-07
I-133	Ci	<2.58E-02	<2.70E-02	<9.20E-05	<1.44E-03
Total	Ci	0.00E+00	1.06E-05	0.00E+00	3.95E-07
3. Particulates and Tritium					
H-3	Ci	1.47E+01	7.76E+00	1.77E+00	1.06E+00
Mn-54	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Fe-59	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Co-58	Ci	<2.58E-03	1.54E-06	<9.20E-06	<1.44E-04
Co-60	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Zn-65	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Mo-99	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Cs-134	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Cs-137	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Ce-141	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Ce-144	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Sr-89	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Sr-90	Ci	<2.58E-03	<2.70E-03	<9.20E-06	<1.44E-04
Gross Alpha	Ci	<2.58E-03	2.76E-08	<9.20E-06	<1.44E-04
Co-57	Ci	N/A	9.37E-07	N/A	N/A
Total	Ci	1.47E+01	7.76E+00	1.77E+00	1.06E+00

NOTE

"Less than" values for Noble Gases are calculated using the Lower Limit of Detection (LLD) values obtained at Wolf Creek Generating Station multiplied by the volume of air discharged during the respective quarter. For the Halogens and Particulates, the ODCM LLD values are used.

2000 GASEOUS CUMULATIVE DOSE SUMMARY
TABLE 1

QUARTER 1 OF 2000	ODCM CALCULATED DOSE	ODCM[1] LIMIT	% OF LIMIT
TOTAL DOSE (mRem) FOR BONE	0.00E+00	7.50E+00	0.00E+00
TOTAL DOSE (mRem) FOR LIVER	1.11E-02	7.50E+00	1.48E-01
TOTAL DOSE (mRem) FOR TOTAL BODY	1.11E-02	7.50E+00	1.48E-01
TOTAL DOSE (mRem) FOR THYROID	1.11E-02	7.50E+00	1.48E-01
TOTAL DOSE (mRem) FOR KIDNEY	1.11E-02	7.50E+00	1.48E-01
TOTAL DOSE (mRem) FOR LUNG	1.11E-02	7.50E+00	1.48E-01
TOTAL DOSE (mRem) FOR GI-LLI	1.11E-02	7.50E+00	1.48E-01
QUARTER 2 OF 2000			
TOTAL DOSE (mRem) FOR BONE	0.00E+00	7.50E+00	0.00E+00
TOTAL DOSE (mRem) FOR LIVER	9.59E-03	7.50E+00	1.28E-01
TOTAL DOSE (mRem) FOR TOTAL BODY	9.59E-03	7.50E+00	1.28E-01
TOTAL DOSE (mRem) FOR THYROID	9.59E-03	7.50E+00	1.28E-01
TOTAL DOSE (mRem) FOR KIDNEY	9.59E-03	7.50E+00	1.28E-01
TOTAL DOSE (mRem) FOR LUNG	9.59E-03	7.50E+00	1.28E-01
TOTAL DOSE (mRem) FOR GI-LLI	9.59E-03	7.50E+00	1.28E-01
QUARTER 3 OF 2000			
TOTAL DOSE (mRem) FOR BONE	0.00E+00	7.50E+00	0.00E+00
TOTAL DOSE (mRem) FOR LIVER	1.15E-02	7.50E+00	1.53E-01
TOTAL DOSE (mRem) FOR TOTAL BODY	1.15E-02	7.50E+00	1.53E-01
TOTAL DOSE (mRem) FOR THYROID	1.15E-02	7.50E+00	1.53E-01
TOTAL DOSE (mRem) FOR KIDNEY	1.15E-02	7.50E+00	1.53E-01
TOTAL DOSE (mRem) FOR LUNG	1.15E-02	7.50E+00	1.53E-01
TOTAL DOSE (mRem) FOR GI-LLI	1.15E-02	7.50E+00	1.53E-01
QUARTER 4 OF 2000			
TOTAL DOSE (mRem) FOR BONE	1.94E-05	7.50E+00	2.59E-04
TOTAL DOSE (mRem) FOR LIVER	6.25E-03	7.50E+00	8.33E-02
TOTAL DOSE (mRem) FOR TOTAL BODY	6.24E-03	7.50E+00	8.32E-02
TOTAL DOSE (mRem) FOR THYROID	1.25E-02	7.50E+00	1.67E-01
TOTAL DOSE (mRem) FOR KIDNEY	6.26E-03	7.50E+00	8.35E-02
TOTAL DOSE (mRem) FOR LUNG	6.23E-03	7.50E+00	8.31E-02
TOTAL DOSE (mRem) FOR GI-LLI	6.23E-03	7.50E+00	8.31E-02
TOTALS FOR 2000			
TOTAL DOSE (mRem) FOR BONE	1.94E-05	1.50E+01	1.29E-04
TOTAL DOSE (mRem) FOR LIVER	3.84E-02	1.50E+01	2.56E-01
TOTAL DOSE (mRem) FOR TOTAL BODY	3.84E-02	1.50E+01	2.56E-01
TOTAL DOSE (mRem) FOR THYROID	4.47E-02	1.50E+01	2.98E-01
TOTAL DOSE (mRem) FOR KIDNEY	3.85E-02	1.50E+01	2.56E-01
TOTAL DOSE (mRem) FOR LUNG	3.84E-02	1.50E+01	2.56E-01
TOTAL DOSE (mRem) FOR GI-LLI	3.84E-02	1.50E+01	2.56E-01

1. Based on Wolf Creek ODCM Section 3.2.2 which restricts dose during any calendar quarter to less than or equal to 7.5 mRem to any organ and during any calendar year to less than or equal to 15 mRem to any organ.

2000 GASEOUS CUMULATIVE DOSE SUMMARY
TABLE 2

	Nuclides Released	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
A.	Fission and Activation Gases					
1.	Total Release - (Ci)	2.91E+00	2.80E+00	1.48E+01	2.10E+00	2.26E+01
2.	Total Gamma Airdose (mRad)	2.87E-04	1.98E-04	1.01E-03	1.52E-04	1.65E-03
3.	Gamma Airdose Limit (mRad)	5.00E+00	5.00E+00	5.00E+00	5.00E+00	1.00E+01
4.	Percent of Gamma Airdose Limit	5.74E-03	3.96E-03	2.02E-02	3.04E-03	1.65E-02
5.	Total Beta Airdose (mRad)	4.31E-04	2.91E-04	1.32E-03	1.79E-04	2.22E-03
6.	Beta Airdose Limit (mRad)	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
7.	Percent of Beta Airdose Limit (mRad)	4.31E-03	2.91E-03	1.32E-02	1.79E-03	1.11E-02
B.	Particulates					
1.	Total Particulates (Ci)	0.00E+00	0.00E+00	0.00E+00	2.48E-06	2.48E-06
2.	Maximum Organ Dose (mRem)	0.00E+00	0.00E+00	0.00E+00	9.96E-07	9.96E-07
3.	Organ Dose Limit (mRem)	7.50E+00	7.50E+00	7.50E+00	7.50E+00	1.50E+01
4.	Percent of Limit	0.00E+00	0.00E+00	0.00E+00	1.33E-05	6.64E-06
C.	Tritium					
1.	Total Release (Ci)	1.53E+01	1.36E+01	1.65E+01	8.81E+00	5.42E+01
2.	Maximum Organ Dose (mRem)	1.12E-02	9.53E-03	1.16E-02	5.99E-03	3.83E-02
3.	Organ Dose Limit (mRem)	7.50E+00	7.50E+00	7.50E+00	7.50E+00	1.50E+01
4.	Percent of Limit	1.49E-01	1.27E-01	1.55E-01	7.99E-02	2.55E-01
D.	Iodine					
1.	Total I-131, I-133 (Ci)	0.00E+00	0.00E+00	0.00E+00	1.10E-05	1.10E-05
2.	Maximum Organ Dose (mRem)	0.00E+00	0.00E+00	0.00E+00	6.32E-03	6.32E-03
3.	Organ Dose Limit (mRem)	7.50E+00	7.50E+00	7.50E+00	7.50E+00	1.50E+01
4.	Percent of Limit	0.00E+00	0.00E+00	0.00E+00	8.43E-02	4.21E-02

This table is included to show the correlation between Curies released and the associated calculated maximum organ dose. The maximum organ dose is calculated using Wolf Creek ODCM methodology which assumes that an individual actually resides at the release point. ODCM Section 3.2.2 organ dose limits are used.

SECTION II

SUPPLEMENTAL INFORMATION

1. **Offsite Dose Calculation Manual Limits**

A. **For <u>liquid</u> waste effluents**

A.1 The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microCuries/ml total activity.

A.2 The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each unit, to UNRESTRICTED AREAS shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrems to the whole body and to less than or equal to 5 mrems to any organ, and
b. During any calendar year to less than or equal to 3 mrems, to the whole body and to less than or equal to 10 mrems to any organ.

B. **For <u>gaseous</u> waste effluents**

B.1 The dose rate due to radioactive material released in gaseous effluents from the site to area at and beyond the SITE BOUNDARY shall be limited to the following:

a. For noble gases: Less than or equal to 500 mrems/yr to the whole body and less than or equal to 3000 mrems/yr to the skin, and
b. For Iodine-131, Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrems/yr to any organ.

B.2 The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation, and
b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads for beta radiation.

B.3 The dose from Iodine-131, Iodine-133, tritium, and a radionuclide in particulate form with half-lives greater than 8 days in gaseous effluents released to area at and beyond the SITE BOUNDARY shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrems to any organ, and
b. During any calendar year: Less than or equal to 15 mrems to any organ.

2. **Effluent Concentration Limits (ECLs)**

Water - covered in Section 1.A.
Air - covered in Section 1.B.

3. **Average Energy**

Average energy of fission and activation gaseous effluents is not applicable. See ODCM Section 3.1 for the methodology used in determining the release rate limits from noble gas releases.

4. **Measurements and Approximations of Total Radioactivity**

A. **Liquid Effluents**

Liquid Release Type	Sampling Frequency	Method of Analysis	Type of Activity Analysis
1. Batch Waste Release Tank	P Each Batch	P.H.A.	Principal Gamma Emitters
	P Each Batch	P.H.A.	I-131
a. Waste Monitor Tank	P One Batch/M	P.H.A.	Dissolved and Entrained Gases (Gamma Emitters)
b. Secondary Liquid Waste Monitor Tanks	P Each Batch	L.S. S.A.C.	H-3 Gross Alpha
	P	O.S.L.	Sr-89, Sr-90
2. Continuous Releases	Daily Grab Sample	P.H.A.	Principal Gamma Emitters
		P.H.A.	I-131
a. Steam Generator Blowdown	M Grab Sample	P.H.A.	Dissolved and entrained Gases (Gamma Emitters)
b. Turbine Building Sump/Waste Water Treatment	Daily Grab Sample	L.S.	H-3
		S.A.C.	Gross Alpha
c. Lime Sludge Pond	Daily Grab Sample	O.S.L.	Sr-89, Sr-90
		O.S.L.	Fe-55

P = prior to each batch
M = monthly
L. S. = Liquid scintillation detector
S.A.C. = scintillation alpha counter
O.S.L. = performed by an offsite laboratory
P.H.A. = gamma spectrum pulse height analysis using a High Purity Germanium detector

B. Gaseous Waste Effluents

Gaseous, Release Type	Sampling Frequency	Method of Analysis	Type of Activity Analysis
Waste Gas Decay Tank	P Each Tank Grab Sample	P.H.A.	Principal Gamma Emitters
Containment Purge or Vent	P Each Purge Grab Sample	P.H.A. Gas Bubbler and L.S.	Principal Gamma Emitters H-3 (oxide)
Unit Vent	M Grab Sample	P.H.A. Gas Bubbler and L.S.	Principal Gamma Emitters H-3 (oxide)
Radwaste Building Vent	M Grab Sample	P.H.A	Principal Gamma Emitters
For Unit Vent and Radwaste Building Vent release types listed above	Continuous	P.H.A.	I-131 I-133
	Continuous	P.H.A. Particulate Sample	Principal Gamma Emitters
	Continuous Composite	S.A.C. Particulate Sample	Gross Alpha
	Continuous	O.S.L. Composite Particulate Sample	Sr-89, Sr-90

P = prior to each batch
M = monthly
L.S. = Liquid scintillation detector

S.A.C. = scintillation alpha counter
O.S.L. = performed by an offsite laboratory
P.H.A. = gamma spectrum pulse height analysis using a High Purity Germanium detector

5. **Batch Releases**

A batch release is the discontinuous release of gaseous or liquid effluents which takes place over a finite period of time; usually hours or days.

There were 75 gaseous batch releases during the reporting period. The longest gaseous batch release lasted 9,810 minutes, while the shortest lasted 20 minutes. The average release lasted 597 minutes with a total gaseous batch release time of 44,794 minutes.

There were 98 liquid batch releases during the reporting period. The longest liquid batch release lasted 398 minutes, while the shortest lasted 40 minutes. The average release lasted 166 minutes with a total liquid batch release time of 16,314 minutes.

6. **Continuous Releases**

A continuous release is a release of gaseous or liquid effluent, which is essentially uninterrupted for extended periods during normal operation of the facility. There were four liquid release pathways designated as continuous releases during this reporting period: Steam Generator Blowdown, Turbine Building Sump, Waste Water Treatment, and Lime Sludge Pond. There were two gas release pathways designated as continuous releases: Unit Vent and Radwaste Building Vent.

7. **Doses to a Member of the Public from Activities Inside the Site Boundary**

Four activities by members of the public were considered in this evaluation: personnel making deliveries to the plant, workers at the William Allen White Building located outside of the restricted area, the use of the access road south of the Radwaste Building, and personnel using the lake during times when fishing was allowed. The dose calculated for the maximum exposed individual for these four activities was as follows:

Plant Deliveries	4.14E-01 mRem
William Allen White Building Workers	9.52E-03 mRem
Access Road Users	4.22E-03 mRem
Lake Use	6.10E-02 mRem

The plant delivery calculations were based on deliveries 3 hours per week for 50 weeks per year. The William Allen White Building occupancy was based on normal working hours of 2000 per year. The usage factor for the access road south of the Radwaste Building was 25 hours per year. The dose to fishermen on the lake was based upon 4368 hours (12 hours a day for 364 days, based on the number of days that the lake was open to fisherman). Pathways used in the calculation were gaseous inhalation, submersion, and ground plane. All calculations were performed in accordance with the methodology and parameters in the ODCM.

8. **Additional Information**

A small amount of Co-57 was included in gaseous releases for quarter 4 of 2000. Wolf Creek's Offsite Dose Calculation Manual (ODCM) is based on Regulatory Guide 1.109, Revision 1, which contains no dose conversion factors for Co-57. Dose due to Co-57 was calculated using numbers found in the Offsite Dose Calculation Manual from Callaway Plant, APA-ZZ-01003, Rev. 012.

2000 EFFLUENT CONCENTRATION LIMITS

Nuclides	Curies	Average Diluted Concentration (uCi/ml)	10 CFR 20 ECL (uCi/ml)	% of ECL
H-3	1.56E+03	1.67E-05	1.00E-03	1.67E+00
Cr-51	5.20E-04	5.55E-12	5.00E-04	1.11E-06
Mn-54	4.12E-04	4.40E-12	3.00E-05	1.47E-05
Fe-55	1.03E-03	1.10E-11	1.00E-04	1.10E-05
Sn-113	7.09E-06	7.58E-14	3.00E-05	2.53E-07
Co-57	4.96E-05	5.31E-13	6.00E-05	8.84E-07
Co-58	5.47E-03	5.84E-11	2.00E-05	2.92E-04
Co-60	6.11E-03	6.53E-11	3.00E-06	2.18E-03
Rb-88	2.44E-04	2.61E-12	4.00E-04	6.52E-07
Na-24	1.84E-05	1.97E-13	5.00E-05	3.93E-07
Nb-95	3.85E-06	4.11E-14	3.00E-05	1.37E-07
Sb-125	1.91E-02	2.04E-10	3.00E-05	6.79E-04
I-131	3.52E-04	3.76E-12	1.00E-06	3.76E-04
Cs-134	2.38E-04	2.54E-12	9.00E-07	2.82E-04
Cs-137	8.00E-04	8.55E-12	1.00E-06	8.55E-04
Kr-85M	2.39E-03	2.55E-11	2.00E-04	1.28E-05
Kr-85	2.04E-02	2.18E-10	2.00E-04	1.09E-04
Kr-87	1.29E-04	1.38E-12	2.00E-04	6.90E-07
Kr-88	2.05E-03	2.19E-11	2.00E-04	1.10E-05
Ar-41	2.29E-04	2.45E-12	2.00E-04	1.22E-06
Xe-131M	1.23E-02	1.32E-10	2.00E-04	6.60E-05
Xe-133	1.07E+00	1.14E-08	2.00E-04	5.71E-03
Xe-133M	1.42E-02	1.51E-10	2.00E-04	7.56E-05
Xe-135	1.05E-01	1.12E-09	2.00E-04	5.62E-04

EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
2000 SOLID WASTE SHIPMENTS

A. SOLID RADWASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (Not irradiated fuel)

1. **Type of Waste**	**Unit**	**1- Year Period**	**Est. Total Error %**
a. Spent resins, filter sludges,	m3*	8.14E+01**	
evaporator bottoms, etc.	Ci	1.53E+03	2.50E+01
b. Dry compressible waste,	m3*	3.35E+02**	
contaminated equip. etc.	Ci	2.96E+00	2.50E+01
c. Irradiated components,	m3*	0.00E+00	
control rods, etc.	Ci	0.00E+00	2.50E+01
d. Other	m3*	0.00E+00	
	Ci	0.00E+00	2.50E+01

*m3 = cubic meters ** This is the volume sent offsite for volume reduction, prior to disposal.

2. **Estimate of Major Nuclide Composition (by type of waste).**
[Nuclides listed with % abundance greater than 10 %]

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

Nuclide Name	Percent Abundance	Curies
Fe-55	29.950	4.60E+02
Ni-63	12.305	1.89E+02
Co-60	46.419	7.13E+02

b. Dry compressible waste, contaminated equipment, etc.

Nuclide Name	Percent Abundance	Curies
Fe-55	34.459	1.02E+00
Co-58	11.115	3.29E-01
Co-60	13.108	3.88E-01
Cs-137	12.669	3.75E-01

c. Irradiated components, control rods, etc.

none

d. Other

none

3. **Solid Waste Disposition**

Number of Shipments	Mode of Transportation	Destination
5	Truck (Hittman Transport Services)	LARON Corporation; Wampum, PA.
7	Truck (Hittman Transport Services)	Barnwell Waste Management Facility; Barnwell, SC.
1	Truck (Roberts Express)	Barnwell Waste Management Facitity; Barnwell, SC
3	Truck (Hittman Transport Services)	TS Duratek; Oak Ridge, TN
2	Truck (Hittman Transport Services)	Studsvik Processing Facility, LLC; Columbia, SC
2	Truck (TAG Transport)	Studsvik Processing Facility, LLC; Columbia, SC
1	Truck (TRISM)	Studsvik Processing Facility, LLC; Columbia, SC

4. **Class of Solid Waste**

   a. Class A, Class B, Class C- Corresponding to 2a
   b. Class A - corresponding to 2b
   c. Not applicable
   d. Not applicable

5. **Type of Container**

   a. LSA (Strong, tight), Type A, Type B - corresponding to 2a
   b. LSA (Strong, tight) - corresponding to 2b
   c. Not applicable
   d. Not applicable

6. **Solidification Agent**

   a. Not applicable
   b. Not applicable
   c. Not applicable
   d. Not applicable

B. IRRADIATED FUEL SHIPMENTS (Disposition)

No irradiated fuel shipments occurred during the 2000 period.

SECTION III

HOURS AT EACH WIND SPEED AND DIRECTION

This section documents WCGS meteorological data for wind speed, wind direction, and atmospheric stability.

The meteorological data supplied in the following tables covers the period from January 1, 2000, through December 31, 2000, and indicates the number of hours at each wind speed and direction for each stability class. All gaseous releases at the WCGS are ground level releases.

The quantity of missing hours in the following tables is 1235 hours. The computer was down from approximately September 14, 2000, through October 1, 2000. The strip chart recordings were available for use if needed. The part of the computer that was down was the archive history data file. The current data was available to the control room; it just could not be stored by the computer for retrieval at a later date.

The missing/bad hours represent approximately 14% of the total, or there is about 86% data availability. The amount of time the computer was down, but strip chart recording was available as a back-up was about 4%, which if added to the available data brings it very close to the recommended 90%.

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: JANUARY 1 THROUGH DECEMBER 31 2000
STABILITY CLASS: A
ELEVATION: 10 METERS

WIND DIRECTION	WIND SPEED (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	7	17	19	8	0	51
NNE	1	18	23	17	4	0	63
NE	1	39	21	1	1	0	63
ENE	2	25	14	5	0	0	46
E	0	7	14	7	0	0	28
ESE	0	12	20	7	0	0	39
SE	0	15	17	15	0	0	47
SSE	4	41	55	27	8	0	135
S	0	54	161	154	37	0	406
SSW	2	31	98	143	26	5	305
SW	0	24	53	21	0	0	98
WSW	1	22	22	18	0	0	63
W	3	15	47	15	3	0	83
WNW	0	8	14	15	15	0	52
NW	1	4	7	18	8	4	42
NNW	0	4	10	35	13	2	64
TOTAL	15	326	593	517	123	11	1585

PERIOD OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: JANUARY 1 THROUGH DECEMBER 31 2000
STABILITY CLASS: B
ELEVATION: 10 METERS

WIND DIRECTION	WIND SPEED (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	4	3	2	0	10
NNE	1	4	10	10	0	0	25
NE	0	13	7	1	0	0	21
ENE	0	11	4	1	0	0	16
E	0	4	11	4	0	0	19
ESE	1	3	7	2	0	0	13
SE	0	9	4	2	0	0	15
SSE	0	8	8	9	1	0	26
S	0	10	21	14	6	0	51
SSW	1	5	11	12	12	1	42
SW	3	7	5	3	0	1	19
WSW	1	5	3	1	0	0	10
W	0	4	9	2	1	0	16
WNW	0	4	10	10	9	0	33
NW	0	3	4	17	9	3	36
NNW	0	2	9	12	7	1	31
TOTAL	7	93	127	103	47	6	383

PERIOD OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: JANUARY 1 THROUGH DECEMBER 31 2000
STABILITY CLASS: C
ELEVATION: 10 METERS

WIND DIRECTION	WIND SPEED (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	1	14	6	1	0	22
NNE	0	6	14	9	2	0	31
NE	0	15	6	2	0	0	23
ENE	0	12	9	0	0	0	21
E	0	9	9	3	0	0	21
ESE	1	9	4	3	0	0	17
SE	1	6	8	3	0	0	18
SSE	2	7	11	13	2	0	35
S	0	8	20	26	9	2	65
SSW	0	3	7	16	4	1	31
SW	2	7	5	2	0	1	17
WSW	1	3	4	2	0	0	10
W	0	2	5	1	0	1	9
WNW	0	3	7	11	3	2	26
NW	1	7	12	19	9	6	54
NNW	0	4	10	19	4	1	38
TOTAL	8	102	145	135	34	14	438

PERIOD OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: JANUARY 1 THROUGH DECEMBER 31 2000
STABILITY CLASS: D
ELEVATION: 10 METERS

WIND DIRECTION	WIND SPEED (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	0	19	52	59	2	0	132
NNE	5	23	58	62	24	1	173
NE	12	47	28	3	0	0	90
ENE	9	38	48	1	0	1	97
E	3	26	51	11	0	0	91
ESE	3	30	46	18	0	0	97
SE	7	30	61	23	0	0	121
SSE	5	37	116	90	12	0	260
S	7	38	174	173	62	8	462
SSW	3	32	104	79	14	7	239
SW	3	28	27	9	4	0	71
WSW	1	17	20	3	1	3	45
W	1	12	26	15	4	4	62
WNW	0	3	43	18	5	0	69
NW	2	20	85	69	18	5	199
NNW	0	28	85	71	24	9	217
TOTAL	61	428	1024	704	170	38	2425

PERIOD OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: JANUARY 1 THROUGH DECEMBER 31 2000
STABILITY CLASS: E
ELEVATION: 10 METERS

WIND DIRECTION	WIND SPEED (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	2	30	20	7	1	0	60
NNE	9	33	26	8	1	0	77
NE	14	37	6	0	0	0	57
ENE	10	38	14	2	0	0	64
E	4	57	23	1	0	0	85
ESE	13	56	14	0	0	0	83
SE	9	72	30	6	1	0	118
SSE	10	98	168	77	9	0	362
S	4	52	148	104	48	3	359
SSW	6	25	88	26	5	1	151
SW	5	39	19	4	0	0	67
WSW	6	33	16	4	0	0	59
W	2	15	17	1	0	0	35
WNW	3	15	11	1	0	0	30
NW	1	24	40	0	0	0	65
NNW	1	34	52	7	1	0	95
TOTAL	99	658	692	248	66	4	1767

PERIOD OF CALM (HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: JANUARY 1 THROUGH DECEMBER 31 2000
STABILITY CLASS: F
ELEVATION: 10 METERS

	WIND SPEED (mph)						
WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	1	20	7	0	0	0	28
NNE	4	45	8	0	0	0	57
NE	15	17	2	0	0	0	34
ENE	5	30	3	0	0	0	38
E	6	61	3	0	0	0	70
ESE	4	62	6	0	0	0	72
SE	4	81	17	0	0	0	102
SSE	4	66	40	2	0	0	112
S	4	22	33	9	0	0	68
SSW	2	3	6	0	0	0	11
SW	7	5	2	0	0	0	14
WSW	1	6	1	0	0	0	8
W	2	6	1	0	0	0	9
WNW	3	3	2	0	0	0	8
NW	9	9	7	0	0	0	25
NNW	7	19	10	0	0	0	36
TOTAL	78	455	148	11	0	0	692

PERIOD OF
CALM
(HOURS): 1

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: JANUARY 1 THROUGH DECEMBER 31 2000
STABILITY CLASS: G
ELEVATION: 10 METERS

WIND DIRECTION	WIND SPEED (mph) 1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	1	8	3	0	0	0	12
NNE	3	30	17	0	0	0	50
NE	2	11	1	0	0	0	14
ENE	2	11	0	0	0	0	13
E	2	36	1	0	0	0	39
ESE	2	35	0	0	0	0	37
SE	5	37	0	0	0	0	42
SSE	1	18	2	0	0	0	21
S	2	4	2	0	0	0	8
SSW	1	1	0	0	0	0	2
SW	1	1	0	0	0	0	2
WSW	0	2	1	0	0	0	3
W	2	0	0	0	0	0	2
WNW	0	0	0	0	0	0	0
NW	1	2	1	0	0	0	4
NNW	2	6	1	0	0	0	9
TOTAL	27	202	29	0	0	0	258

PERIOD OF
CALM
(HOURS): 0

HOURS AT EACH WIND SPEED AND DIRECTION

PERIOD OF RECORD: JANUARY 1 THROUGH DECEMBER 31 2000
STABILITY CLASS: ALL
ELEVATION: 10 METERS

			WIND	SPEED	(mph)		
WIND DIRECTION	1-3	4-7	8-12	13-18	19-24	>24	TOTAL
N	4	86	117	94	14	0	315
NNE	23	159	156	106	31	1	476
NE	44	179	71	7	1	0	302
ENE	28	165	92	9	0	1	295
E	15	200	112	26	0	0	353
ESE	24	207	97	30	0	0	358
SE	26	250	137	49	1	0	463
SSE	26	275	400	218	32	0	951
S	17	188	559	480	162	13	1419
SSW	15	100	314	276	61	15	781
SW	21	111	111	39	4	2	288
WSW	11	88	67	28	1	3	198
W	10	54	105	34	8	5	216
WNW	6	36	87	55	32	2	218
NW	15	69	156	123	44	18	425
NNW	10	97	177	144	49	13	490
TOTAL	295	2264	2758	1718	440	73	7548

PERIOD OF
CALM
(HOURS):1
HOURS OF
MISSING
DATA: 1235

SECTION IV

ADDITIONAL INFORMATION

1. **Unplanned or Abnormal Releases**

On June 30, 2000, Secondary Liquid Waste Monitor Tank A was released via Liquid Release Permit (LRP) 2000053. Valve HF-V040 was not closed per SYS HF-203, Radwaste Secondary Liquid Waste Monitor Operations. This resulted in 1,100 gallons being released from Secondary Liquid Waste Monitor Tank B. LRP 2000055 was issued to capture the 1,100 gallons released from THF04B. PIR 20001893 was issued. Total Curies released were 1.36, of which, 1.35 Curies were Tritium. No ODCM limits were exceeded.

2. **Offsite Dose Calculation Manual (ODCM)**

The ODCM is in the form of two separate Wolf Creek Nuclear Operating Corporation (WCNOC) administrative procedures. One of these procedures, the WCNOC "Offsite Dose Calculation Manual", AP 07B-003, Revision 3, was not revised in 2000; however, it is included with this report as Attachment I. The other procedure, AP 07B-004, "Offsite Dose Calculation Manual (Radiological Environmental Monitoring Program), was revised in 2000, and Revision 1, the current revision, is being submitted as Attachment II.

3. **Major Changes to Liquid, Solid, or Gaseous Radioactive Waste Treatment Systems**

As previously reported in the "1999 Annual Radioactive Effluent Release Report- Report 22", a state-of-the-art filtration system was installed in 1998. Below is a summary of the improvements that were made to the system in 2000.

A Sea Water Reverse Osmosis unit, SWRO, was installed June, 2000. It is a concentrate reduction component to reduce the total volume of material that the drum dryer receives. The SWRO produces approximately 1 gpm of permeate while rejecting from approximately 5 to 7 gpm of concentrates to the Primary Evaporator Bottoms Tank (PEBT). The result is a significant volume reduction for the concentrates of >10 to 1. The concentrates from the PEBT are then transferred to the drum dryer in a much smaller volume. The SWRO has allowed us to eliminate rejecting concentrates to the Floor Drain Tanks. By eliminating this flow we have reduced the antimony levels, in turn allowing the process components to achieve the decontamination factor necessary for consistently producing releasable water.

New membrane types were installed into the SWRO on June 29, 2000. This was done to achieve a better decontamination factor for Antimony.

4. **Land Use Census**

No new locations for dose calculation were identified during this report period.

5. **Radwaste Shipments**

Twenty-one shipments of radioactive waste occurred during this report period. Section II, Subsection 3, of this report contains specific details regarding each shipment's mode of transportation and destination.

6. **Inoperability of Effluent Monitoring Instrumentation**

No events occurred that violated ODCM Requirements Tables 2-2 and 3-2, liquid or gaseous effluent monitoring instrumentation.

7. **Storage Tanks**

Technical Specification requirements for the program are now covered by Technical Requirements Manual Section 3.10, "Explosive Gas and Storage Tank Radioactivity Monitoring." At no time during the year 2000 was there an event that led to liquid holdup tanks or gas storage tanks exceeding specifications, including those limits of Technical Requirements Manual Sections 3.10.1 and 3.10.3.

ATTACHMENTS I, II, and III

Changes to the Wolf Creek Generating Station (WCGS) Offsite Dose Calculation Manual (ODCM) are submitted annually with the "Annual Radioactive Effluent Release Report". The WCGS ODCM is divided into two administrative procedures: WCNOC procedure AP 07B-003, "Offsite Dose Calculation Manual" and WCNOC procedure AP 07B-004, "Offsite Dose Calculation Manual (Radiological Environmental Monitoring Program)".

AP 07B-003, Revision 3, "Offsite Dose Calculation Manual" is included in this Annual Radioactive Effluent Release Report 24 as Attachment I. AP 07B-004, Revision 1, "Offsite Dose Calculation Manual (Radiological Environmental Monitoring Program)" is being submitted as Attachment II.

Changes to the WCGS "Solid Radwaste Process Control Program" are also submitted annually with the WCGS "Annual Radioactive Effluent Release Report". WCNOC Administrative Procedure AP 31A-100, Revision 3, "Solid Radwaste Process Control Program" is included as Attachment III of this report.

ATTACHMENT I

Wolf Creek Nuclear Operating Corporation

Administrative Procedure AP 07B-003, Revision 3,

"Offsite Dose Calculation Manual"

WOLF CREEK
NUCLEAR OPERATING CORPORATION

AP 07B-003

OFFSITE DOSE CALCULATION MANUAL

Responsible Manager

Manager Chemistry/Radiation Protection

Revision Number	3
Use Category	Reference
Administrative Controls Procedure	Yes
Infrequently Performed Procedure	No
Program Number	07B

DC22 12/18/1999

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1.0 PURPOSE

1.1 This procedure contains the Offsite Dose Calculation Manual (ODCM) and the requirements for revision and submittal to the NRC.

2.0 SCOPE

2.1 This procedure partially fulfills the requirements of Technical Specifications 3.3.6, 3.3.7, and 3.3.8 Radiation Monitoring Instrumentation; 5.5.2 Primary Coolant Sources Outside Containment; 5.6.3 Radioactive Effluent Release Report and 5.5.1 Offsite Dose Calculation Manual.

2.2 Requirements for the Radiological Environmental Monitoring Program have been moved to AP 07B-004.

3.0 REFERENCES AND COMMITMENTS

3.1 References

3.1.1 WCGS Technical Specifications

3.1.2 AP 15C-001, PROCEDURE WRITERS GUIDE

3.1.3 AP 15C-004, PREPARATION, REVIEW, AND APPROVAL OF DOCUMENTS

3.1.4 Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFRPart50, Appendix I

3.1.5 NUREG 0133, Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants

3.1.6 AP 07B-004 OFFSITE DOSE CALCULATION MANUAL (RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM)

3.1.7 PIR 98-0112, Revising the ODCM with an OTSC

3.1.8 Technical Requirements Manual

3.2 Commitments

3.2.1 None

4.0 DEFINITIONS

4.1 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.

4.2 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.

5.0 RESPONSIBILITIES

5.1 The Manager Chemistry/Radiation Protection is responsible for the ODCM.

6.0 PROCEDURE

6.1 Revision Of The ODCM

NOTE

To comply with Technical Specification 5.5.1, revisions to the ODCM are not permitted via APF 15C-004-04, ON THE SPOT CHANGE form (3.1.7).

6.1.1 All revisions to the ODCM are to be submitted through the Manager Chemistry/Radiation Protection via a document revision request (APF 15C-004-01).

6.1.2 The Manager Chemistry/Radiation Protection shall ensure the Document Revision Request (APF 15C-004-01) package includes the following:

1. Each change shall be identified by markings in the margins of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (e.g., month/year) the change was implemented.
2. Sufficient information to support the change together with the appropriate analyses or evaluations justifying the change(s) and
3. A determination that the change will maintain the level of Radioactive Effluent Control required by 10 CFR 20.106 (gaseous effluent), 10CFR 20.1302 (liquid effluent), 40 CFR Part 190, 10 CFR 50.36A, and Appendix I to 10 CFR Part 50 and not adversely impact the accuracy or reliability of effluent dose, or setpoint calculations.

6.1.3 The ODCM revision shall become effective after review and acceptance by the PSRC and the approval of the Plant Manager.

6.2 ODCM Submittal To NRC

6.2.1 Changes to the ODCM shall be submitted to the Commission in the form of a complete, legible copy of the entire ODCM as a part of or concurrent with the Annual Radioactive Effluent Release Report for the period of the report in which any change to the ODCM was made.

7.0 RECORDS

7.1 The following is a lifetime QA Record:

7.1.1 AP 07B-003, OFFSITE DOSE CALCULATION MANUAL

8.0 FORMS

8.1 None

ATTACHMENT A
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OFFSITE DOSE CALCULATION MANUAL

Wolf Creek Generating Station

Offsite Dose Calculation Manual

ATTACHMENT A

OFFSITE DOSE CALCULATION MANUAL

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OFFSITE DOSE CALCULATION MANUAL

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1.0 Introduction

The Offsite Dose Calculation Manual describes the Radioactive Effluent Controls Program. The implementation of this program ensures compliance with the requirements of 10 CFR 50.36, 10 CFR 20.106, 10 CFR 20.1302, 10 CFR 50 Appendix I and 40 CFR 190. ***11/99***

On January 1, 1994, 10CFR20.20.1001-20.2402 was implemented. Wolf Creek continues to maintain the existing level of gaseous effluent control, 10 CFR 20.106. Compliance with 10 CFR 20.106 has been determined by the NRC to be ALARA. ***11/99***

On December 18, 1999 Wolf Creek implemented 10 CFR 20.1302 limits for radioactive liquid effluents. The concentration of radioactive material released in liquid effluents to unrestricted area conforms to 10 times the concentration values in Appendix B, Table 2, Column 2, to 10 CFR 20.1001-20.2402. ***11/99***

The ODCM describes the methodology and parameters used in the calculation of offsite doses due to radioactive liquid and gaseous effluents. The ODCM contents for calculation of dose are based on "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants (NUREG-0133)," and Regulatory Guide 1.109, Revision 1.

Dose calculations are performed for the limiting age group i.e., Adult age group for the liquid pathway, and the Child age group for gaseous effluent organ doses.

The ODCM provides the limitations on the operability of radioactive liquid and gaseous monitoring instrumentation including surveillance tests and setpoint determination. Each Surveillance Requirement shall be performed within the specified surveillance interval with a maximum allowable extension not to exceed 25% of the specified interval.

The ODCM provides descriptions of the information that should be included in the Annual Radioactive Effluent Release Reports.

2.0 Liquid Effluents

2.1 Concentration - Compliance With 10 CFR 20

The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 2.1) shall be limited to the concentration specified in 10 CFR Part 20, Appendix B, Table II, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to $2x\ 10^{-4}$ microCurie/mL total activity.

2.1.1 Remedial Action

With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within the above limits.

2.1.2 Surveillance Requirements

To show compliance with this requirement, concentrations of actual liquid effluents will be determined by performing Isotopic Analyses. Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 2-1.

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OFFSITE DOSE CALCULATION MANUAL

TABLE 2-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

LIQUID RELEASE TYPE	SAMPLE FREQUENCY	PRINCIPAL GAMMA EMITTERS	I-131	DISSOLVED/ ENTRAINED GASES (GAMMA)	GROSS ALPHA AND H-3	Sr-89, Sr-90	Fe-55
1. Batch Tanks (2) a. THB07A&B LLD (1)	P	P(3) 5E-7	P 1E-6	M 1E-5	M Composite(4) 1E-7 for Alpha 1E-5 for H-3	Q Composite(4) 5E-8	Q Composite(4) 1E-6
b. THF04A&B LLD (1)	P	P(3) 5E-7	P 1E-6	M 1E-5	M Composite(4) 1E-7 for Alpha 1E-5 for H-3	Q Composite(4) 5E-8	Q Composite(4) 1E-6
2. Continuous Releases (5) a. Steam Generator Blowdown LLD(1)	Daily (6)	W(3) Composite(4) 5E-7	W Composite(4) 1E-6	M 1E-5	M Composite(4) 1E-7 for Alpha 1E-5 for H-3	Q Composite(4) 5E-8	Q Composite(4) 1E-6
b. Turbine Building Sump LLD(1)	Daily (6)	W(3) Composite(4) 5E-7	W Composite(4) 1E-6	M 1E-5	M Composite(4) 1E-7 for Alpha 1E-5 for H-3	Q Composite(4) 5E-8	Q Composite(4) 1E-6
c. Waste Water Treatment LLD(1)	Daily (6)	W(3) Composite(4) 5E-7	W Composite(4) 1E-6	M 1E-5	M Composite(4) 1E-7 for Alpha 1E-5 for H-3	Q Composite(4) 5E-8	Q Composite(4) 1E-6
d. Lime Sludge Pond LLD (1)	Daily (6)	W(3) Composite(4) 5E-7	W Composite(4) 1E-6	M 1E-5	M Composite(4) 1E-7 for Alpha 1E-5 for H-3	Q Composite(4) 5E-8	Q Composite(4) 1E-6

LLD = (µCi/mL)

TABLE 2-1 (Continued)
TABLE NOTATIONS

(1) The LLD is defined, 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:

$$LLD = \frac{4.66\, s_b}{E \times V \times 2.22 \times 10^6 \times Y \times Decay}$$

Where:

LLD = the "a priori" lower limit of detection (microCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, (counts per minute), $s_b = \sqrt{B} / LT$

Where: B = background sum (counts)

LT = live time (minutes),

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22×10^6 = the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

Decay = decay factor(s), There are three decay factors that may be appropriate for use depending on the nature of the sample and the half life of the nuclide. Any combination of the three may be used. The factors are as follows:

A) This decay factor corrects for decay from the time of sampling to the start of the analysis.

$e^{-\lambda \Delta t_s}$, where:

Δts = decay time = acquisition start time - sample time

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TABLE 2-1 (Continued)
TABLE NOTATIONS

λ = ln2/half-life

B) This decay factor corrects for decay during the analysis.

$$\frac{1 - e^{-\lambda RT}}{\lambda \times RT}$$

λ = ln2/half-life

RT = real time of counting

C) This decay factor corrects for decay during sampling.

$$\frac{1 - e^{-\lambda \Delta td}}{\lambda \Delta td}$$

λ = ln2/half-life

td = deposition time = sample time - deposition start time

NOTE

All times used in decay calculations should be in the same units.

Typical values of E, V, Y, t_s, t_d 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.

(2) 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 by a method described in plant procedures to assure representative sampling.

TABLE 2-1 (Continued)
TABLE NOTATIONS

(3) The principal gamma emitters for which the LLD specification applies include 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 identifiable, together with those of the above nuclides, shall also be analyzed and reported in the annual Radioactive Effluent Release Report in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(4) 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. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite samples to be representative of the effluent release.

(5) 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.

(6) Samples shall be taken at the initiation of effluent flow and at least once per 24 hours thereafter while the release is occurring. To be representative of the liquid effluent, the sample volume shall be proportioned to the effluent stream discharge volume. The ratio of sample volume to effluent discharge volume shall be maintained constant for all samples taken for the composite sample.

FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At least once per 12 hours.
D	At least once per 24 hours.
W	At least once per 7 days
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
R	At least once per 18 months.
S/U	Prior to each reactor startup.
N.A.	Not applicable.
P	Completed prior to each release.

2.2 Dose - Compliance With 10 CFR 50 Appendix I

The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each unit, to UNRESTRICTED AREAS (see Figure 2.1) shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrems to the whole body and to less than or equal to 5 mrems to any organ, and

b. During any calendar year to less than or equal to 3 mrems to the whole body and to less than or equal to 10 mrems to any organ.

2.2.1 Remedial Action

With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, a Special Report that identifies the cause(s) for exceeding the limit(s) and 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 the above limits. This Special Report shall also include the results of radiological analyses of the drinking water source, and the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR Part 141, Clean Drinking Water Act. This requirement of (1.) and (2.) are applicable only if drinking water supply is taken from the receiving body within 3 miles of the plant discharge. ***11/99***

2.2.2 Surveillance Requirements

Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined using the following methodology at least once per 31 days.

$$D_T = \Sigma_i \left(A_{iT} \sum_{L=1}^{m} \Delta t_L C_{iL} F_L \right)$$

Where,

D_T = the cumulative dose commitment to the total body or any organ, T, from the liquid effluent for the total

$$\text{time period} \sum_{L=1}^{m} \Delta t_L, \text{in mrem}$$

Δt_L = the length of the Lth time period over which C_{iL} and F_L are averaged for all liquid releases, in hours.

C_{iL} = the average concentration of radionuclide, 'i', in undiluted liquid effluent flow during time period Δt_L, in µCi/mL.

F_L = the near field average dilution factor for C_{iL} during any liquid effluent release where:

$$F_L = \frac{f}{(F)K}$$

Where:

f = Liquid Radioactive Waste Flow

F = Discharge Structure Exit Flow, the sum of the release and dilution flow.

K = Applicable factor; the site dependent value for the mixing effect of the discharge structure. This value is conservatively assumed to be 1 (one) for this section.

A_{iT} = The site related ingestion dose commitment factor to the total body or any organ, 'T', for each identified principal gamma and beta emitter, mrem/hr per µCi/mL. See Tables A.4-1 through A.4-4.

The limiting age group for liquid dose calculations is the Adult age group.

$$A_{iT} = 1.14E5\left(U_W / D_W + U_F \times BF_i\right)DF_i$$

Where,

DW = Dilution factor from the near field area to the potable water intake for water consumption, for Wolf Creek Generating Station this factor is 1 (one).

BF_i = Bioaccumulation factor for radionuclide 'i', in fish, pCi/Kg per pCi/l, from Table A.1-1 from Regulatory Guide 1.109 (Rev. 1).

DF_i = Adult dose Conversion factor for radionuclide, 'i', in mrem/pCi, from Table A.3-1 through A.3-4, from Regulatory Guide 1.109 (Rev. 1).

U_W = Adult water consumption,(730 l/yr.from Reg. Guide 1.109)

U_F = Adult fish consumption,(21 kg/yr.from Reg. Guide 1.109)

$$1.14E5 = \text{Units conversion factor} = \frac{10^6 \text{pCi} / \mu Ci \text{ x } 10^3 \text{ml} / \text{Kg}}{8760 \text{ hr} / \text{yr}}$$

The dose calculations are based on the actual isotopic analysis of the radioactive liquid effluents, the radioactive liquid effluent flow, and the dilution flow.

2.3 Projected Dose

The Liquid Radwaste Treatment System shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due the liquid effluent, from each unit, to UNRESTRICTED AREAS (see Figure 2.1) would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31 day period.

2.3.1 Remedial Action

With radioactive liquid waste being discharged without treatment and in excess of the above limits and any portion of the Liquid Radwaste Treatment System not in operation, prepare and submit to the Commission within 30 days, a Special Report that includes the following information: ***11/99***

a. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,

b. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

c. Summary description of action(s) taken to prevent a recurrence.

2.3.2 **Surveillance Requirements**

2.3.2.1 Doses due to liquid releases from each unit to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the following methodology when Liquid Radwaste Treatment Systems are not being fully utilized.

$$D_{31} = \left[\frac{A}{T}\right] \times 31$$

Where,

D_{31} = Projected 31 day dose

A = Cumulative dose for previous three months

T = Number of days that the cumulative dose occurred in A above

2.3.2.2 The installed Liquid Radwaste Treatment System shall be considered OPERABLE by meeting the requirements of Sections 2.1 and 2.2.

2.4 Instrumentation

The radioactive liquid effluent monitoring instrumentation channels shown in Table 2-2 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Section 2.1 are not exceeded. The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters described in Section 2.4.4.

2.4.1 Remedial Action

2.4.1.1 With a radioactive liquid effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above, immediately suspend the release of radioactive liquid effluents monitored by the affected channel, or declare the channel inoperable.

2.4.1.2 With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 2-2. Restore the inoperable instrumentation to OPERABLE status within the time specified in the ACTION, or explain in the next annual Radioactive Effluent Release Report, why this inoperability was not corrected within the time specified.

2.4.2 Surveillance Requirements

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL OPERATIONAL TEST at the frequencies shown in Table 2-3. *11/99*

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TABLE 2-2
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release		
a. Liquid Radwaste Discharge Monitor (HB-RE-18)	1	31
b. Steam Generator Blowdown Discharge Monitor (BM-RE-52)	1	32
c. Turbine Building Drain Monitor (LE-RE-59)	1	32
d. Secondary Liquid Waste System Monitor (HF-RE-45)	1	33
e. Wastewater Treatment System Influent Monitor (HF-RE-95)	1	32
2. Flow Rate Measurement Devices		
a. Liquid Radwaste Discharge Line		
1) Waste Monitor Tank A Discharge Line	1	34
2) Waste Monitor Tank B Discharge Line	1	34
b. Steam Generator Blowdown Discharge Line	1	34
c. Secondary Liquid Waste System Discharge Line	1	34

TABLE 2-2 (Continued)
ACTION STATEMENTS

Action 31 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 14 days provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Section 2.1.2, and

b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge line valving.

Otherwise, suspend release of radioactive effluents via this pathway.

Action 32 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are analyzed for principle gamma emitters and I-131 at a lower limit of detection as specified in Table 2-1.

a. At least once per 12 hours when the specific activity of the secondary coolant is greater than 0.01 microCurie/gram DOSE EQUIVALENT I-131, or

b. At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 microCurie/gram DOSE EQUIVALENT I-131.

Action 33 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 14 days provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Section 2.1.2, and

b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge line valving.

Otherwise, suspend release of radioactive effluents via this pathway.

TABLE 2-2 (Continued)
ACTION STATEMENTS

Action 34 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves generated in place may be used to estimate flow.

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TABLE 2-3

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

	INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL OPERATIONAL TEST
1.	Radioactivity Monitors providing alarm and automatic termination of release				
a.	Liquid Radwaste Discharge Monitor (HB-RE-18)	D	P	R(2)	Q(1)
b.	Steam Generator Blowdown Discharge Monitor (BM-RE-52)	D	M	R(2)	Q(1)
c.	Turbine Building Drain Monitor (LE-RE-59)	D	M	R(2)	Q(1)
d.	Secondary Liquid Waste System Monitor (HF-RE-45)	D	P	R(2)	Q(1)
e.	Wastewater Treatment System Influent Monitor (HF-RE-95)	D	M	R(2)	Q(1)
2.	Flow Rate Measurement Devices				
a.	Liquid Radwaste Discharge Line	D(3)	N.A.	R	N.A.
b.	Steam Generator Blowdown Discharge Line	D(3)	N.A.	R	N.A.
c.	Secondary Liquid Waste System Discharge Line	D(3)	N.A.	R	N.A.

TABLE 2-3 (Continued)

TABLE NOTATIONS

(1) The CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation occur as appropriate if any of the following conditions exists: *11/99*

a. Instrument indicates measured levels above the Alarm/Trip Setpoint (isolation and alarm), or

b. Circuit failure (alarm only), or

c. Instrument indicates a downscale failure (alarm only), or

d. Instrument controls not set in operate mode (alarm only).

(2) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference (gas or liquid and solid) standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range or energy, measurement range, and establish monitor response to a solid calibration source. For subsequent CHANNEL CALIBRATION, NIST traceable standard (gas, liquid, or solid) may be used; or a gas, liquid, or solid source that has been calibrated by relating it to equipment that was previously (within 30 days) calibrated by the same geometry and type of source standard traceable to NIST.

(3) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

2.4.3 Liquid Monitor Calibration Methodology

The five monitors associated with liquid releases are listed below:

Monitor ID	Description
0-BM-RE-52	Steam Generator Blowdown Discharge Monitor
0-LE-RE-59	Turbine Building Drain Monitor
0-HF-RE-45	Secondary Liquid Waste System Monitor
0-HB-RE-18	Liquid Radwaste Discharge Monitor
0-HF-RE-95	Wastewater Treatment System Influent Monitor

Liquid effluent streams are monitored by an NaI(Tl) Detector. The detector operates in a gross counting mode and is gamma sensitive.

Calibration of the liquid monitors shall be performed using three standard solutions of Cs-137. The solutions shall cover the appropriate range of the detector and have concentrations of approximately 5×10^{-7} µCi/cc, 1×10^{-5} µCi/cc, and 1×10^{-3} µCi/cc. The solutions shall be presented to the detector and the meter reading in counts per minute shall be recorded. A determination of linearity shall be produced using the counts per minute vs. concentration data.

2.4.4 Liquid Effluent Monitor Setpoints

The Alarm/Trip Setpoints for the Liquid Effluent Radiation Monitors are based on instantaneous concentration limits of 10 CFR 20, Appendix B, Table 2, Column 2 applied at the boundary of the restricted area. Specifically, the High Alarm Setpoint will correspond to the 10 CFR Part 20 limits at the Boundary of the restricted area; the Alert Alarm Setpoint is set to 80% of the High Alarm/Trip Setpoint. Since the high alarm/trip initiates isolation of the particular system and termination of the release, this setpoint represents assurance that the instantaneous liquid release limit of 10 CFR Part 20 is not exceeded. Auditable records shall be maintained indicating the actual setpoints used at all times. *11/99*

The calculated Alarm and Trip Action Setpoints for the Liquid Effluent Line Monitors must satisfy the following equation:

$$\frac{cf}{F+f} \leq C$$

Where:

C = The liquid effluent concentration limit (ECL) implementing Section 2.1 in µCi/mL. **11/99**

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 directly proportional to the Volumetric Flow of the dilution stream plus the effluent stream, represents a Value, which if exceeded would result in concentrations exceeding the limits of 10 CFR 20 in the restricted area.

f = The Pump Flow Rate as measured 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.

Thus, the expression for determining the setpoint on the Liquid Radwaste Effluent Line Monitor becomes:

$$c \leq \frac{C(F+f)}{f} \ (\mu Ci/ml)$$

If no gamma activity is detected calculate the monitor setpoint by assigning the available ECL fraction to I-131. **11/99**

2.4.4.1 Continuous Liquid Effluent Monitors

The three monitors associated with continuous liquid releases are listed below:

Monitor ID	Description
0-BM-RE-52	Stm Generator Blowdown Discharge Monitor
0-LE-RE-59	Turbine Building Drain Monitor
0-HF-RE-95	Waste Water Treatment System Influent Monitor

The Steam Generator Blowdown Discharge Effluent Monitor continuously monitors the Blowdown Discharge Pump Outlet to detect excess radioactivity due to System Demineralizer breakthrough or abnormal Primary to Secondary leakage. The Blowdown Discharge Monitor's High Alarm Setpoint initiates CLOSURE of the Blowdown Isolation Valves and the Blowdown Discharge Valve. Similarly, the High Radiation Alarm on the Turbine Building Drain Monitor and Waste Water Treatment Monitor initiates CLOSURE of the Drain Line Isolation Valves to prevent the release of radioactive effluents.

Monitor setpoints will be conservatively based on I-131, the most restrictive isotope expected to be present. This is particularly appropriate for the Turbine Building Drain Line Monitor since the most probable source is the Secondary Steam System which is expected to have negligible activity unless there is a significant Primary to Secondary leak. Due to changing activities, it will not be possible to select a radionuclide distribution on which to base the monitor setpoint. Additionally, maximum effluent flows and minimum dilution flows will normally be assumed.

The High Alarm/Trip Setpoint will be set to correspond to the I-131 ECL limit at the boundary of the restricted area from 10 CFR Part 20, Appendix B, Table 2, Column 2. The alert alarm is set one order of magnitude below the High Alarm/Trip Setpoint for release points that have dilution and to the High Alarm value for those without dilution. This High Alarm/Trip Setpoint assures the limits of Section 2.1 are not exceeded at the boundary of the restricted area. ***11/99***

In the event that an alarm is TRIPPED, an evaluation of the system will be made by taking an actual isotopic and flow analysis of the discharge.

The above continuous liquid effluents are not radioactive effluents until activity has been detected by the Liquid Effluent Monitor, a Tritium analysis of the Secondary system, or a gross Beta analysis of the Secondary system. At that time an analysis of the effluent will be made to verify activity in the system effluent. During periods of time when the above liquid effluents are not radioactive the High Alarm/Trip Setpoint may be set to 1.5 times the background count rate.

2.4.4.1.1 **Steam Generator Blowdown Discharge Monitor**

$$\text{SETPOINT}\ (\mu\text{Ci/ml}) = \text{ECL}_{\text{I-131}} \times \frac{F_m + F_B}{F_B}$$ *11/99*

where,

ECL_{I-131} = Effluent Concentration Limit of I-131, 1E-5 (10 times concentration limit of I-131) *11/99*

F_m = Dilution flow rate.

F_B = Blowdown flow rate.

The setpoint calculation is based on the minimum dilution flow rate, the maximum possible blowdown flow rate, and, due to changing conditions, I-131 which is the most restrictive isotope expected to be present.

On the event that an alarm is reached, the setpoint will be reevaluated using the actual dilution flow rate, the actual blowdown flow rate, and the actual isotopic analysis as outlined in Section 2.4.4.2. This evaluation will be used to ensure the limit of Section 2.1 was not exceeded. The setpoint will still be based on 10 times the concentration limit of I-131 due to the changing conditions of activity and I-131 being the most restrictive isotope. *11/99*

2.4.4.1.2 **Turbine Building Drain Monitor And Waste Water Treatment System Influent Monitor**

$$\text{SETPOINT}\,(\mu\text{Ci/ml}) = ECL_{I\text{-}131} \times \frac{F_m + F_T}{F_T}$$ *11/99*

ECL_{I-131} = 1E-5 (10 times concentration limit of I-131)

11/99

F_m = Dilution flow rate

F_t = Effluent flow rate

The setpoint is based on the minimum dilution flow rate, the maximum possible effluent flow rate, and the most restrictive isotope expected to be present, I-131.

On the event that an alarm is reached, the release will be evaluated to see if the limit of Section 2.1 was exceeded by using the actual Dilution Flow Rate, the actual Effluent Flow Rate, and the actual isotopic analysis as outlined in Section 2.4.4.2. The setpoint will still be based on the 10 times the ECL of I-131 due to the changing conditions of activity and I-131 being the most restrictive isotope. *11/99*

2.4.4.2 **Batch Radioactive Liquid Effluent Monitor**

The two monitors associated with liquid batch releases are listed below:

Monitor ID	Description
0-HF-RE-45	Secondary Liquid Waste System Monitor
0-HB-RE-18	Liquid Radwaste Discharge Monitor

The setpoint is a function of dilution flow rate, tank flow rate, and isotopic composition. A laboratory isotopic analysis is made of each batch prior to discharge. Based on the isotopic analysis and existing flow condition, the setpoint will be calculated and set on the appropriate monitor to ensure the concentration limits of 10 CFR 20, Appendix B, Table 2, Column 2 is not exceeded.

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The setpoints are determined using the following methodology:

1) Determine concentrations of radioactivity of the batch being considered for release.

The isotopic concentration of the batch is the sum of the concentrations for the isotopes present as determined from the analysis required in Table 2-1.

$$\sum_i C_i = \sum_g C_g + C_a + C_s + C_t + C_f$$

Where:

C_i = The concentration of nuclide i as determined by the analysis of the waste sample.

C_g = The sum of the concentrations C_g of each measured gamma emitting nuclide observed by gamma-ray spectroscopy of the waste sample.

*C_a = The measured concentration C_a of alpha emitting nuclides observed by gross alpha analysis of the monthly composite sample.

*C_s = The measured concentrations of Sr-89 and Sr-90 in liquid waste as determined by analysis of the quarterly composite sample.

*C_t = The measured concentration of H-3 in liquid waste.

*C_f = The measured concentration of Fe-55 in liquid waste as determined by analysis of the quarterly composite.

*Values for these concentrations will be based on previous composite sample analysis as required by Table 2-1.

2) The measured radionuclide concentrations are used to calculate a dilution factor, F_d, which is the ratio of total dilution flow rate to tank flow rate required to assure that the limiting concentrations of Section 2.1 are met at the point of discharge. This is referred to as the required dilution factor and is determined according to:

$$F_d = \left(\Sigma_i \frac{C_i}{ECL_i}\right) x F_s$$ *11/99*

Where:

C_i = Measured concentrations of C_g, C_a, C_s, C_t and C_f, as defined in Step 1. Terms C_a, C_s, C_t and C_f, will be included in the calculation as appropriate.

ECL_i = ECL_g, ECL_a, ECL_s, ECL_t and ECL_f, are limiting concentrations of the appropriate radionuclide from 10 CFR 20, Appendix B, Table 2, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-04, μCi/mL total activity. *11/99*

F_s = The safety factor; a conservative factor used to compensate for statistical fluctuations and errors of measurement default value is 0.5.

3) For the case $F_d < 1$, the waste tank effluent concentration meets the limits of 10 CFR 20 without dilution and the effluent may be released at any desired flow rate. For the case $F_d > 1$, a modified dilution factor, F_{dn}, must be determined so that available dilution flow may be apportioned among simultaneous discharge pathways.

$$F_{dn} = F_d / F_a$$

Where F_a is the allocation factor which will modify the required dilution factor so that simultaneous liquid releases may be made without exceeding 10 CFR 20 limits.

The most straight-forward determination of allocation factor is:

$$F_a = 1/n$$

Where:

n = The number of liquid discharge pathways for which $F_d > 1$ and which is planned for simultaneous release.

However, this value for F_a may be unnecessarily restrictive in that all release pathways are apportioned the same fraction of the available dilution stream, regardless of the relative concentrations of each of the sources.

Since the radionuclide concentration of the two continuous sources is expected to be less than that of the batch release source, it is acceptable to allocate smaller portions of the dilution stream to the continuous releases and a larger portion to the batch releases.

Therefore, F_a is defined as a flexible quantity with a default value of 1/n. Prior to initiating simultaneous release, a check will be made to assure that the sum of the allocation factors assigned to pathways for the simultaneous release is < 1.

4) The calculated maximum permissible waste tank effluent flow rate, F_{max}, is based on the modified dilution factor, F_{dn}, and the effective dilution flow rate, F_{eff}.

The cooling lake into which the effluent is discharged is also the source of the dilution stream. It is therefore necessary to take into account the recirculation of previously emitted radionuclides should they be detected by sample analysis of the cooling lake water. This is accomplished by defining an effective dilution flow rate as:

$$F_{eff} = F_m \left[1 - \sum_i \frac{LC_i}{ECL_i} \right]$$

11/99

Where:

F_m = The expected minimum dilution water flow rate.

LC_i ≐ Measured concentration of nuclide i in the cooling lake water sample.

ECL_i = Effluent concentration limit of radionuclide i from 10CFR20, Appendix B, Table 2, Column 2. ***11/99***

For the purpose of setpoint calculations the expected minimum dilution flow rate is assigned a value based upon the type and number of pumps RUNNING into the circulating water piping.

Having established the values of F_{dn} and F_{eff}, the calculated maximum permissible waste tank flow rate is given by

$$f_{max} \leq \frac{F_{eff} + f_p}{F_{dn}} \; \frac{F_{eff}}{f_{dn}} \text{ for } f_p \langle\langle Feff$$

Where f_p if the expected effluent flow rate; normally the rated capacity of the effluent pump. Thus the pump flow rate is set at or below f_{max}. Even though the value of f_{max} may be larger than the actual effluent pump capacity, f_p, it does represent the upper limit to the effluent flow rate, whereby the requirement of 10CFR20 may still be met. If $F_d \leq 1$, the effluent pump flow rate may be assigned any value since the waste tank effluent concentration meets the limits of 10CFR20 without dilution and the release may be made without regard to the setpoints for other release pathways. For those discharge pathways selected to be secured during the release under consideration, the pump flow rate should be set at as low a value as practicable to detect any inadvertent release.

A setpoint for the dilution stream flow rate is not applicable since the minimum flow rate is administratively set.

5) The liquid radiation monitor setpoint may now be determined based on the values of Σ_i, C_i, and f_{max}. The monitor response is primarily to gamma radiation, therefore, the actual setpoint is based on Σ_g, C_g. The calculated monitor setpoint concentration is determined as follows:

$$c = A \sum_i C_g \ (\mu Ci / ml)$$

Where:

A = Adjustment factor which will allow the setpoint to be established in a practical manner for convenience and to prevent spurious alarms.

$$A = \frac{f_{max}}{f_p}$$

If A > 1, calculated c and determine the maximum value for the actual monitor setpoint (μCi/mL).

If A < 1, no release may be made.

If $F_d < 1$, no further dilution is required and the release may be made without regard to available dilution or to other releases made simultaneously. However, it is necessary to establish a monitor setpoint which will provide alarm should the release concentration inadvertently exceed 10CFR20 limits. This can be accomplished by establishing the adjustment factor as follows:

$$A = 1/F_d$$

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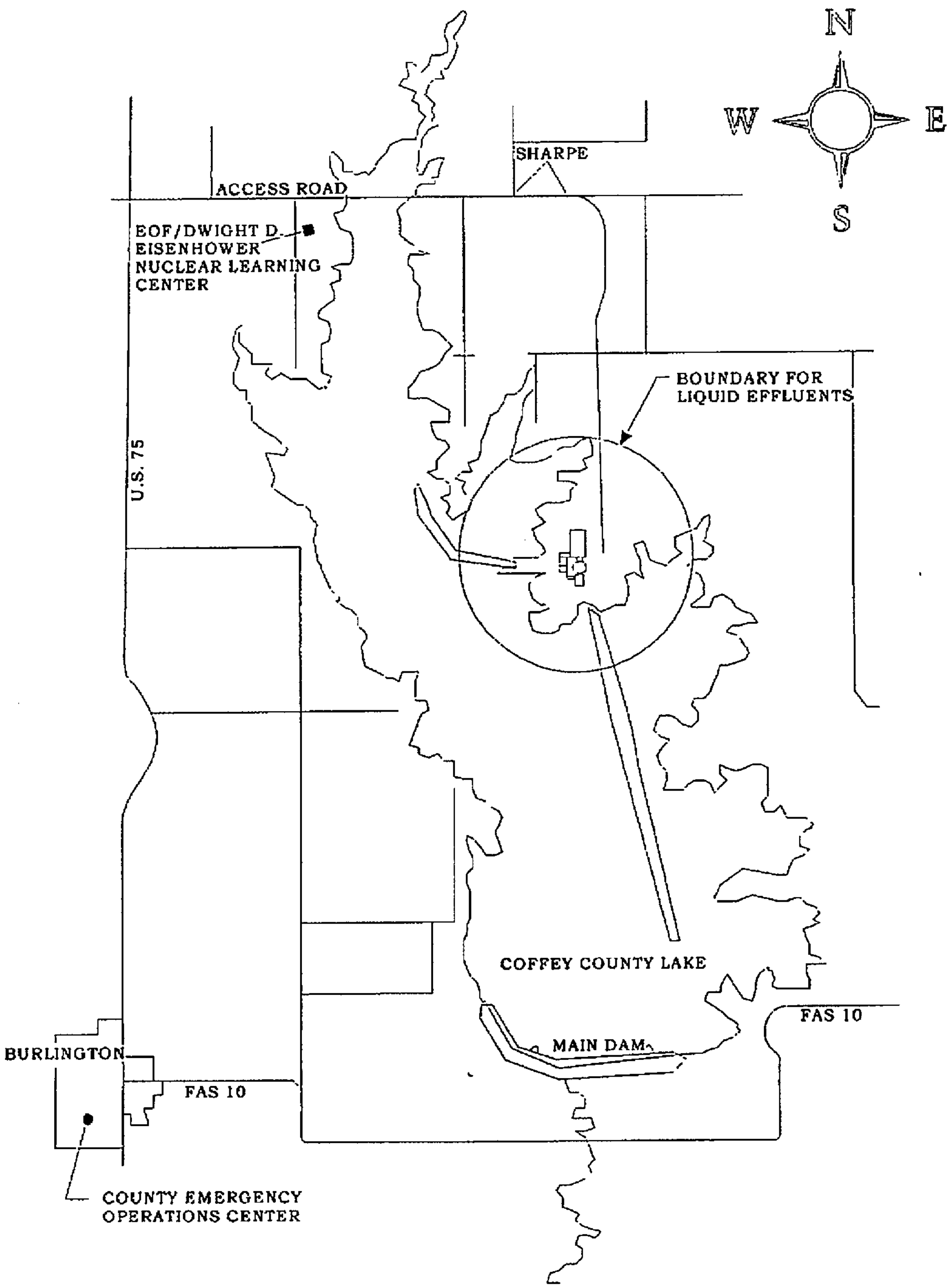
FIGURE 2.1
BOUNDARY FOR LIQUID EFFLUENTS



3.0 **Gaseous Effluents**

Gaseous effluent releases from the Unit Vent and Radwaste Building Vent are monitored continuously. The Unit Vent is the release point for the Fuel/Auxiliary Building, access control area, containment purge, and condenser air discharge. The Radwaste Building Vent is the release point for Waste Gas Decay Tanks and the Radwaste Building Ventilation System.

Waste Gas Decay Tank releases and Containment Building releases are treated as batch releases. Waste Gas Decay Tank releases are monitored by the Radwaste Building Exhaust Monitor. Containment Building releases (purges) are monitored by the Containment Purge System monitors and the Plant Unit Vent Monitor.

Monitor identifications are as follows:

Monitor ID	Release Point Description
O-GT-RE-21 A and B	Unit Vent (Fuel/Auxiliary Building, access control area, containment purge, condenser air discharge)
O-GH-RE-10 A and B	Radwaste Building vent (Radwaste Building, waste gas decay tank discharge. Acts to isolate Waste Gas Decay Tank discharge)
O-GT-RE-22 & 23	Containment Purge System Monitor (acts to isolate the purge; is not an effluent monitor)
O-GT-RE-31 & 32	Containment Atmosphere Monitor (acts to isolate purge; not an effluent monitor)

The setpoint for monitors may be determined either based on total body dose or skin dose rate. The dose rate limits are for dose rates at the unrestricted area boundary. The monitor setpoint is the lesser of the total body dose rate or skin dose rate.

3.1 Dose Rate - Compliance With 10 CFR 20

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 3.1) shall be limited to the following:

a. For noble gases: Less than or equal to 500 mrems/yr to the whole body and less than or equal to 3000 mrems/yr to the skin, and

b. For Iodine-131 and 133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrems/yr to any organ.

3.1.1 Remedial Action

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

3.1.2 Surveillance Requirements

The dose rate to radionuclides in gaseous effluents shall be determined to be within the above limits in accordance with the methodology described below by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 3-1.

Based on the methodology of NUREG-0133;

a. Release rate limit for nobles gases:

$$\sum_i K_i \left(\overline{X/Q}\right) Q_i < 500 \text{ mrem/yr for the total body,}$$

and

$$\sum_i (L_i + 1.1\, M_i)(X/Q)\, Q_i < 3000 \text{ mrem/yr for the skin}$$

Where:

K_i = Total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$, from Table A.1-2.

$\overline{(X/Q)}$ = 2.2E-06 sec/m3, the highest calculated annual average relative concentration at the restricted area boundary in the north sector.

Q_i = Release rate of radionuclide i from vent, in μCi/sec.

L_i = Skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$, from Table A.1-2.

M_i = Air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ from Table A.1-2.

1.1 = Conversion constant of air dose to skin dose.

b. Release rate limit for all radionuclides and radioactive materials in particulate form and radionuclides other than noble gases:

$$\sum_i (P_i)\,IN \times (X/Q) \times Q_i) < 1500 \text{ mrem/yr to any organ.}$$

Where:

Q_i = The release rate of radionuclides, i, in gaseous effluent from all vent releases, in μCi/sec.

$P_{(i)}IN$ = The dose parameter for radionuclides other than nobles gases for the inhalation pathway, in mrem/yr per $\mu Ci/m^3$. See Table A.5-1.

$\overline{(X/Q)}$ = 2.2E-06 sec/m3 (the highest annual average). The highest calculated annual average relative concentration for estimating the dose to any individual at the unrestricted area boundary in the N sector.

All radionuclides are assumed to be released in elemental form. The limit is applicable to the location (unrestricted area boundary or beyond), characterized by the value of X/Q which results in the maximum total body or skin dose commitment. The factors K_i, L_i, and M_i relate the radionuclide airborne concentrations to various dose rates assuming a semi-infinite cloud. These factors are taken from Table B-1 of the Regulatory Guide 1.109 and multiplied by 10^6 to convert pCi^{-1} to μCi^{-1} and listed in Table A.1-2.

The following equation for $P_{(i)IN}$ was taken from NUREG 0133:

$P_{(i)IN}$ (Inhalation);

$$P_{(i)IN} = K' (BR) DFA_i (mrem / yr \text{ per } \mu Ci / m^3)$$

Where:

K' = a constant of unit conversion, 10^6 pCi/µCi.

BR = the breathing rate of the child age group in m^3/yr

DFA_i = the maximum organ inhalation dose factor for the child age group for the i th radionuclide, in mrem/pCi. The total body is considered as an organ in the selection of DFA_i.

The age group considered is the child group. The child's breathing rate is taken as 3700 m^3/yr from Table E-5 of Regulatory Guide 1.109. The inhalation dose factors for the child, DFA_i are presented in Table E-9 of Regulatory Guide 1.109, in units of mrem/pCi.

Resolutions of the units yield:

P_i (Inhalation) = 3.7×10^9 DFA_i

The P_i value for tritium is:

P_i (Inhalation) = 3.7×10^9 DFA_i

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TABLE 3-1
RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sample Frequency	Principal Gamma Emitters	H-3 (Oxide)	I-131/ I-133	Gross Alpha	Sr-89, Sr-90
1. Unit Vent Gas LLD(1)	M	M(3)(2) 1E-4	M(4) 1E-6			
Particulate LLD(1)	Continuous(6)	W(7) 1E-11(2)			M 1E-11	Q Composite 1E-11
Charcoal LLD(1)	Continuous(6)			W(7) 1E-12/ 1E-10		
2. Radwaste Building Vent Gas LLD(1)	M	M(2) 1E-4	M 1E-6			
Particulate LLD(1)	Continuous(6)	W(7)(2) 1E-11			M 1E-11	Q (Composite) 1E-11
Charcoal LLD(1)	Continuous(6)			W(7) 1E-12/ 1E-10		
3. Containment Purge or Vent Gas LLD(1)	P(3)	P(3)(2) 1E-4	M 1E-6			
4. Waste Gas Decay Tanks Gas LLD(1)	P	P(2) 1E-4				

LLD = (μCi/ml)

TABLE 3-1 (Continued)
TABLE NOTATIONS

(1) The LLD is defined, 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:

$$LLD = \frac{4.66\ s_b}{E \times V \times (2.22E+6) \times Y \times Decay}$$

Where:

LLD = the "a priori" lower limit of detection (microCuries per unit mass or volume),

s_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate, (counts per minute), $s_b = \sqrt{B / LT}$

Where: B = background sum (counts)

LT = live time (minutes),

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22E+6 = the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

Decay = decay factor(s), There are three decay factors that may be appropriate for use depending on the nature of the sample and the half life of the nuclide. Any combination of the three may be used. The factors are as follows:

A) This decay factor corrects for decay from the time of sampling to the start of the analysis.

$e^{-\lambda \Delta t_s}$, where:

Δts = decay time = acquisition start time - sample time

TABLE 3-1 (Continued)
TABLE NOTATIONS

λ = ln2/half-life

B) This decay factor corrects for decay during the analysis.

$$\frac{1 - e^{-\lambda RT}}{\lambda \times RT}$$

λ = ln2/half-life

RT = real time of counting

C) This decay factor corrects for decay during sampling.

$$\frac{1 - e^{-\lambda \Delta td}}{\lambda \Delta td}$$

λ = ln2/half-life

Δtd = deposition time = sample time - deposition start time

NOTE

All times used in decay calculations should be in the same units.

Typical values of E, V, Y, t_s, t_d 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.

TABLE 3-1 (Continued)

TABLE NOTATIONS

(2) The principal gamma emitters for which the LLD specification applies include the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141 and Ce-144 in iodine and particulate releases. 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 annual Radioactive Effluent Release Report in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(3) Sampling and analysis shall also be performed following shutdown, startup, or a THERMAL POWER change greater than or equal to 15% of RATED THERMAL POWER within 1 hour period. *11/99*

(4) Tritium grab samples shall be taken and analyzed at least once per 24 hours when the refueling canal is flooded.

(6) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Sections 3.1, 3.2 and 3.3.

(7) Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or after removal from sampler. For unit vent, sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period, and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement to sample once per 24 hours does not apply if analysis shows that both the DOSE EQUIVALENT I-131 concentration in the reactor coolant and the unit vent noble gas monitor activity have not increased more than a factor of 3.

FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At least once per 12 hours.
D	At least once per 24 hours.
W	At least once per 7 days
M	At least once per 31 days.
Q	At least once per 92 days.
SA	At least once per 184 days.
R	At least once per 18 months.
S/U	Prior to each reactor startup.
N.A.	Not applicable.
P	Completed prior to each release.

3.2 Dose - Compliance With 10 CFR 50 Appendix I

3.2.1 Noble Gases

The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 3.1) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation, and

b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads for beta radiation.

3.2.1.1 Remedial Action

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, a special report that identifies the cause(s) for exceeding the limit(s) and 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 the above limits. ***11/99***

3.2.1.2 Surveillance Requirements

Cumulative dose contributions for the current calendar quarter and calendar year for noble gases shall be determined in accordance with the following methodology at least once per 31 days. The dose calculations for the actual releases of radioactive noble gases in gaseous effluent will be consistent with the methodology provided in Reg. Guide 1.109, Rev. 1. The following dose calculations will be performed:

a. During any calendar quarter;

For gamma radiation;

$$D = 3.17E\text{-}8 \sum_{i=1} M_i \left[\left(\overline{X/Q} \right) x\, Q_i \right] \leq 5 \text{ mrad.}$$

For beta radiation:

$$D = 3.17E\text{-}8 \sum_{i=1} N_i \left[\left(\overline{X/Q}\right) \times Q_i\right] \le 10 \text{ mrad.}$$

b. During any calendar year:

For gamma radiation;

$$D = 3.17E\text{-}8 \sum_{i=1} M_i \left[\left(\overline{X/Q}\right) \times Q_i\right] \le 10 \text{ mrad.}$$

For beta radiation:

$$D = 3.17E\text{-}8 \sum_{i=1} N_i \left[\left(\overline{X/Q}\right) \times Q_i\right] \le 20 \text{ mrad.}$$

Where:

3.17 E-8 = The inverse of the number of seconds in a year.

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ from Table A.1-2 (Reg. Guide 1.109, Table B-1, Col. 4).

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/year per $\mu Ci/m^3$ from Table A.1-2 (Reg. Guide 1.109, Table B-1, Column 2).

$\left(\overline{X/Q}\right)$ = 2.2E-06 sec/m3, the highest calculated annual average relative concentration at the restricted area boundary in the north sector.

Q_i = The release of noble gas radionuclides, 'i', in gaseous effluents, in µCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

An average monthly air dose schedule should be setup to ensure section 3.2.1 is not exceeded. The average monthly air dose should be as follows:

a. For gamma radiation ≤ 1.6 mrad/mo.

For beta radiation ≤ 3.3 mrad/mo.

If the monthly average air doses for: (a) is exceeded, it should be noted that if the release is continued at the same (or higher) frequencies or activities the quarterly limit of Section 3.2.1.A will be exceeded.

b. For gamma radiation ≤ 0.8 mrad/mo.

For beta radiation ≤ 1.6 mrad/mo.

If the monthly average air doses for: (b) is exceeded, it should be noted that if the release is continued at the same (or higher) frequencies or activities the annual limit of Section 3.2.1.B will be exceeded.

If any of the above monthly average air doses are exceeded, evaluation of the causes of the high air dose should be performed and steps should be taken to reduce the activity or frequency (e.g. delay the release of a Waste Gas Decay Tank) of the release.

3.2.2 Radioiodines, Particulates and Other Radionuclides

The dose to a MEMBER OF THE PUBLIC from Iodine-131 and 133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 3.1) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrems to any organ; and

b. During any calendar year: Less than or equal to 15 mrems to any organ.

3.2.2.1 Remedial Action

With the calculated dose from the release of Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, a special report that identifies the cause(s) for exceeding the limits and 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 the above limits. *11/99*

3.2.2.2 Surveillance Requirements

Cumulative dose contributions for the current calendar quarter and current calendar year for Iodine-131 and 133, tritium, and radionuclides in particulate form with half-lives greater than 8 days shall be determined in accordance with the following methodology at least once per 31 days. To show compliance, the dose calculations for the actual releases of the subject materials are consistent with the methodology provided in Regulation Guide 1.109, Revision 1. The following dose calculations will be performed:

a. $D(\text{mrem}) = 3.17E\text{-}8 \sum_i R_i\left[(WQ_i)\right] \leq 7.5 \text{ mrem}$

b. $D(\text{mrem}) = 3.17E\text{-}8 \sum_i R_i\left[(WQ_i)\right] \leq 15 \text{ mrem}$

Where:

3.17 E-8 = The inverse of the number of seconds in a year.

Q_i = The release of radioiodines, radioactive materials in particulate form and radionuclides other than noble gases in gaseous effluents, 'i', in µCi. Releases shall be cumulative over the calendar quarter or year as appropriate. The Q_i value shall be determined as the product of the flow rate through the release point and grab samples of the effluent analyzed in accordance with Table 3-1.

W = The annual average dispersion parameter for estimating the dose to an individual at the controlling location.

W = $(^X/Q)$, 2.2×10^{-6} sec/m^3 for the inhalation pathway.

W = $(^D/Q)$, 1.8 E-8 m^{-2}, for the food and ground plane pathways.

R_i = The dose factor for each identified radionuclide, 'i', in mrem/yr per µCi/m^3. See Table A.5-2 through Table A.5-20.

Where:

Inhalation Pathway Factor, R^I_i [X/Q]

$$R^I_i\,[X/Q] = K'\,(BR)_a (DFA_i)_a \;(\text{mrem/yr per } \mu\text{Ci/m}^3)$$

Where:

K' = a constant of unit conversion, 10^6pCi/µCi.

$(BR)_a$ = The breathing rate of the receptor of age group (a), in m^3/yr.

The breathing rates $(BR)_a$ for the various age groups are tabulated below, as given in Regulatory Guide 1.109, Table E-5.

AGE GROUP (a)	BREATHING RATE (m^3/yr)
Infant	1400
Child	3700
Teen	8000
Adult	8000

$(DFA_i)_a$ = The maximum organ inhalation dose factor for the receptor of age group (a) for the i th radionuclide, in mrem/pCi. The body is considered as an organ in the selection of $(DFA_i)_a$. See Tables A.2-1, A.2-2, A.2-3, & A.2-4. From Regulatory Guide 1.109, Tables E-7, E-8, E-9 and E-10.

Ground Plane Pathway Factor, $R^G{}_i[D/Q]$

$$R^G{}_i[D/Q] = K'K''(SF)\,DFG_i\left[\left(1-e^{-\lambda_i t}\right)/\lambda_i\right]\left(m^2 \times \text{mrem/yr per } \mu\text{Ci/sec}\right)$$

Where:

K' = A constant of unit conversion, 10^6 pCi/μCi.

K'' = A constant of unit conversion, 8760 hr/year.

λ_i = The decay constant for the i th radionuclide, sec^{-1}.

t = The exposure time, 4.73 E8 sec (15 years).

DFG_i = The ground plane dose conversion factor for the i th radionuclide (mrem/hr per pCi/m^2). See Table A.2-5. (Regulatory Guide 1.109, Table E-6).

SF = The shielding factor (dimensionless), 0.7 (Reg. Guide 1.109)

Grass-Cow-Milk Pathway Factor, $R^C{}_i[D/Q]$

$$R^C{}_i[D/Q] = K'\left(\frac{Q_F(U_{ap})}{\lambda_i+\lambda_w}\right)F_m(r)\,(DFL_i)_a\left(1/Y_p\right)\left(e^{-\lambda_i t_f}\right)\left(m^2\,\text{mrem/yr per } \mu\text{Ci/sec}\right)$$

Where:

K' = A constant of unit conversion, 10^6 pCi/μCi.

Q_F = The cow's consumption rate, in Kg/day (wet weight), 50 kg/day. (Reg. Guide 1.109, Table E-3).

U_{ap} = The receptor's milk consumption rate for age (a), in liters/yr. (Reg. Guide 1.109, Table E-5).

Infant	=	330 l/yr
Child	=	330 l/yr
Teen	=	400 l/yr
Adult	=	310 l/yr

Y_p = The agricultural productivity by unit area of pasture feed grass, in kg/m^2, 0.7 kg/m^2. (Reg. Guide 1.109, Table E-15)

F_m = The stable element transfer coefficients, in days/liter, see Table A.3-5. (Reg. Guide 1.109, Table E-1)

r = Fraction of deposited activity retained on cow's feed grass, r=1 for radioiodine and r= 0.2 for particulates. (Reg. Guide 1.109, Table E-15)

$(DFL_i)_a$ = The maximum organ ingestion dose factor for the i th radionuclide for the receptor in age group 'a', in mrem/pCi. See Tables A.3-1, A.3-2, A.3-3, and A.3-4. (Reg. Guide 1.109, Table E-11, E-12, E-13, and E-14)

λ_i = The decay constant for the i th radionuclide, in sec^{-1}.

λ_w = The decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73 E-7 sec^{-1} (corresponding to a 14 day half-life).

NOTE

The fraction of the year that the cow is on pasture and the fraction of the cow feed that is pasture grass is assumed to be 1.0, which is the most restrictive case.

t_f = The transport time from pasture to cow, to milk, to receptor, in sec, 1.73 E5 sec (2 days). (Reg. Guide 1.109, Table E-15).

Grass-Goat-Milk Pathway Factor, $R^{C}_{i}[D/Q]$

$$R^{C}_{i}[D/Q] = K'\left(\frac{Q_F(U_{ap})}{\lambda_i + \lambda_w}\right)F_m(r)\,(DFL_i)_a\left({}^{1}/Y_p\right)\left(e^{-\lambda_i t_f}\right)\left(m^2\,mrem/yr\ per\ \mu Ci/sec\right)$$

Where:

Q_F = The goat's consumption rate, in Kg/day (wet weight), 6 Kg/day. (Reg. Guide 1.109, Table E-3).

t_f = The transport time from pasture to goat, to milk, to receptor, in sec, 1.73 E5 sec (2 days). (Reg. Guide 1.109, Table E-15).

all other terms are defined under the Grass-Cow-Milk-Pathway Factor.

NOTE

The fraction of the year that the goat is on pasture and the fraction of the goat feed that is pasture grass is assumed to be 1.0, which is the most restrictive case.

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the R^{C}_{i} is based on (X/Q),

$$R^{C}_{i}[X/Q] = K'K'''F_m Q_F U_{ap}(DFL_i)_a\left[0.75\,(0.5/H)\right]\left(mrem/yr\ per\ \mu Ci/m^3\right)$$

Where:

K''' = a constant of unit conversion, 10^3 gm/Kg.

H = Absolute humidity of the atmosphere, 8 gm/m^3 (Reg. Guide 1.109).

0.75 = The fraction of total feed that is water. (NUREG 0133)

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water. (NUREG 0133)

Grass-Cow-Meat Pathway Factor, $R^{M}{}_{i}[D/Q]$

$$R^{M}{}_{i}[D/Q] = K'\left(\frac{Q_F(U_{ap})}{\lambda_i + \lambda_w}\right)F_f(r)\,(DFL_i)_a\left({}^{1}/Y_p\right)\left(e^{-\lambda_i t_f}\right)\left(m^2 mrem / yr \text{ per } mCi / sec\right)$$

Where:

F_f = The stable element transfer coefficients, in days/kg, Table A.3-5. (Reg. Guide 1.109, Table E-1).

U_{ap} = The receptor's meat consumption rate for age (a), in kg/yr. (Reg. Guide 1.109, Table E-5).

Infant	=	0
Child	=	41
Teen	=	65
Adult	=	110

t_f = The transport time from pasture to receptor, in sec., 1.73 E6 (20 days) (Reg. Guide 1,109, Table E-15).

The concentration of tritium in meat is based on its airborne concentration rather than the deposition. Therefore, the $R^{M}{}_{i}$ is based on (X/Q):

$$R^{M}{}_{i}[X/Q] = K'K'''F_f Q_F U_{ap}(DFL_i)_a\left[0.75\,(0.5/H)\right]\left(mrem/yr \text{ per } \mu Ci/m^3\right)$$

Where:

All terms defined above.

Vegetation Pathway Factor, $R^{V}{}_{i}[D/Q]$

Man is considered to consume two types of vegetation (fresh and stored) that differs only in the time period between harvest and consumption, therefore:

$$R^{V}{}_{i}[D/Q] = K'\left[\frac{r}{Y_v(\lambda_i + \lambda_w)}\right](DFL_i)_a\left[\left(U^{L}{}_{a}\right)(f_L)\left(e^{-\lambda_i t_L}\right) + \left(U^{S}{}_{a}\right)(f_g)\left(e^{-\lambda_i t_h}\right)\right]\left(m^2 \times mrem/yr \text{ per } \mu Ci/sec\right)$$

Where:

K' = A constant of unit conversion, 10^6 pCi/µCi.

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U^L_a = The consumption rate of fresh leafy vegetation by the receptor in age group (a), in kg/yr. (Reg. Guide 1.109, Table E-5).

Infant	= 0	kg/yr
Child	= 26	kg/yr
Teen	= 42	kg/yr
Adult	= 64	kg/yr

U^S_a = The consumption rate of stored vegetation by the receptor in age group (a), Kg/yr. (Reg. Guide 1.109, Table E-5).

Infant	= 0	kg/yr
Child	= 520	kg/yr
Teen	= 630	kg/yr
Adult	= 520	kg/yr

f_L = The fraction of the annual intake of fresh leafy vegetation grown locally. (default = 1.0) (Reg. Guide 1.109).

f_g = The fraction of the annual intake of stored vegetation grown locally(default = 0.76) (Reg. Guide 1.109).

t_L = The average time between harvest of leafy vegetation and its consumption, in seconds, 8.6 E4 sec (1 day). (Reg. Guide 1.109).

t_h = The average time between harvest of stored vegetation and its consumption, in seconds, 5.18 E6 sec (60 days) (Reg. Guide 1.109, Table E-15).

Y_v = The vegetation area density, 2.0 kg/m^2. (Reg. Guide 1.109, Table E-15).

All other factors previously defined.

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the R^V_i is based on (X/Q):

$$R^V_i[X/Q] = K'K''' \left[U^L_a f_L + U^S_a f_g\right](DFL_i)_a\left[0.75\,(0.5/H)\right]\left(\text{mrem/yr per } \mu\text{Ci/m}^3\right)$$

Where:

All terms defined previously. All values indicated are default values from Reg. Guide 1.109, Rev. 1.

An average monthly dose schedule should be setup to ensure Section 3.2.2 is not exceeded. The average monthly dose due to radioiodines, particulates, and other radionuclides which are included in this section should be as follows:

a. < 2.5 mrem/mo.

If the monthly average dose for (a) is exceeded, it should be noted that if the release is continued at the same (or higher) frequencies or activities the quarterly limit of Section 3.2.2.a will be exceeded.

b. < 1.25 mrem/mo.

If the monthly average dose for (b) is exceeded, it should be noted that if the release is continued at the same (or higher) frequencies or activities the yearly limit of Section 3.2.2.b will be exceeded.

If any of the above monthly doses are exceeded, evaluation of the causes should be performed and steps taken to reduce the activity or frequency of the release.

3.3 Projected Dose

The VENTILATION EXHAUST TREATMENT SYSTEM and the WASTE GAS HOLDUP SYSTEM shall be OPERABLE and appropriate portions of these systems shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 3-1) would exceed:

a. 0.2 mrad to air from gamma radiation, or

b. 0.4 mrad to air from beta radiation, or

c. 0.3 mrem to any organ of a MEMBER OF THE PUBLIC.

3.3.1 Remedial Action

With radioactive gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, a special report that includes the following information: ***11/99***

a. Identification of any inoperable equipment or subsystems, and the reason for the inoperability,

b. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

c. Summary description of action(s) taken to prevent a recurrence.

3.3.2 Surveillance Requirements

3.3.2.1 Doses due to gaseous releases from each unit to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the following methodology when Gaseous Radwaste Treatment Systems are not being fully utilized.

$$D_{31} = \left[\frac{A}{T}\right] x\, 31$$

Where:

D_{31} = Projected 31 day dose

A = Cumulative dose for previous three months

T = Number of days that the cumulative dose occurred in A above

3.3.2.2 The installed VENTILATION EXHAUST TREATMENT SYSTEM and WASTE GAS HOLDUP SYSTEM shall be considered OPERABLE by meeting Section 3.1 and 3.2 limits.

3.4 Instrumentation

The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3-2 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Section 3.1 are not exceeded. The Alarm/Trip Setpoints of these channels meeting Section 3.1 shall be determined and adjusted in accordance with the methodology and parameters of Section 3.4.4 below.

3.4.1 Remedial Action

a. With a radioactive gaseous effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above specification, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel inoperable.

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE take the ACTION shown in Table 3-2. Restore the inoperable instrumentation to OPERABLE status within the time specified in the ACTION, or explain in the next annual Radioactive Effluent Release Report, why this inoperability was not corrected within the time specified.

3.4.2 Surveillance Requirements

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL OPERATIONAL TEST at the frequencies shown in Table 3-3. ***11/99***

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TABLE 3-2

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. Unit Vent System			
a. Noble Gas Activity Monitor - Providing Alarm (GT-RE-21B)	1	*	40
b. Iodine Sampler(GT-RE-21A)	1	*	43
c. Particulate Sampler(GT-RE-21A)	1	*	43
d. Flow Rate	N.A.	*	45
e. Sampler Flow Rate Monitor	1	*	39
2. Containment Purge System			
a. Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (GT-RE-22, GT-RE-33)	1	*	41
b. Flow Rate	N.A.	*	45
3. Radwaste Building Vent System			
a. Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (GH-RE-10B)	1	*	38,40
b. Iodine Sampler(GH-RE-10A)	1	*	43
c. Particulate Sampler(GH-RE-10A)	1	*	43
d. Flow Rate	N.A.	*	45
e. Sampler Flow Rate Monitor	1	*	39

* At all times.

TABLE 3-2 (Continued)
TABLE NOTATIONS
ACTION STATEMENTS

ACTION 38 - With the number of channels OPERABLE less than required by the minimum channels OPERABLE requirement, the contents of the tank(s) may be released to the environment for up to 14 days provided that prior to initiating the release:

a. At least two independent samples of the tank's contents are analyzed, and

b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge valve lineup.

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 39 - With the number of channels OPERABLE less than required by the minimum channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours.

ACTION 40 - With the number of channels OPERABLE less than required by the minimum channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are taken at least once per 12 hours and these samples are analyzed for radioactivity within 24 hours.

ACTION 41 - With the number of channels OPERABLE less than required by the minimum channels OPERABLE requirement, immediately suspend PURGING of radioactive effluents via this pathway.

ACTION 43 - With the number of channels OPERABLE less than required by the minimum channels OPERABLE requirement, effluent releases via the affected pathway may continue for up to 30 days provided samples are continuously collected with auxiliary sample equipment as required in Table 3-1.

ACTION 45 - Flow rate for this system shall be based on fan status and operating curves or actual measurements.

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TABLE 3-3

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL OPERATIONAL TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
1. Unit Vent System					
a. Noble Gas Activity Monitor-Providing Alarm (GT-RE-21)	D	M	R(3)	Q(2)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Flow Rate	N.A.	N.A.	R(4)	N.A.	*
e. Sampler Flow Rate Monitor	D	N.A.	R	Q	*
2. Containment Purge System					
a. Noble Gas Activity Monitor-Providing Alarm and Automatic Termination of Release (GT-RE-22, GT-RE-33)	D	P	R(3)	Q(1)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Flow Rate	N.A.	N.A.	R(4)	N.A.	*
e. Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*
3. Radwaste Building Vent System					
a. Noble Gas Activity Monitor-Providing Alarm and Automatic Termination of Release (GH-RE-10)	D,P	M,P	R(3)	Q(1)	*
b. Iodine Sampler	W	N.A.	N.A.	N.A.	*
c. Particulate Sampler	W	N.A.	N.A.	N.A.	*
d. Flow Rate	N.A.	N.A.	R(4)	N.A.	*
e. Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*

*At all times.

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TABLE 3-3 (Continued)
TABLE NOTATIONS

(1) The CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and control room alarm annunciation as appropriate occur if any of the following conditions exists: *11/99*

a. Instrument indicates measured levels above the Alarm/Trip Setpoint (isolation and alarm), or

b. Circuit failure (alarm only), or

c. Instrument indicates a downscale failure (alarm only) or

d. Instrument controls not set in operate mode (alarm only).

(2) The CHANNEL OPERATIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any one or combination of the following conditions exists: *11/99*

a. Instrument indicates measured levels above the alarm setpoint

b. Circuit failure

c. Instrument indicates a downscale failure

d. Instrument controls not set in operate mode.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference (gas or liquid and solid) standards certified by the National Institute of Standards and Technology (NIST) or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy, measurement range, and establish monitor response to a solid calibration source. For subsequent CHANNEL CALIBRATION, NIST traceable standard (gas, liquid or solid) may be used; or a gas, liquid, or solid source that has been calibrated by relating it to equipment that was previously (within 30 days) calibrated by the same geometry and type of source traceable to NIST.

(4) If flow rate is determined by exhaust fan status and fan performance curves, the following surveillance operations shall be performed at least once per 18 months:

a. The specific vent flows by direct measurement, or

b. The differential pressure across the exhaust fan and vent flow established by the fan's "flow- P" curve, or

c. The fan motor horsepower measured and vent flow established by the fan's "flow-horsepower" curve.

3.4.3 Airborne Radiation Monitor Calibration Methodology

The following monitors are associated with gaseous releases

Monitor ID	Monitor Description	Monitor Type
O-GT-RE-21A	Plant Unit Vent	Particulate, Iodine
O-GH-RE-10A	Radwaste Building Effluent	Particulate, Iodine
O-GT-RE-21B	Plant Unit Vent	Wide Range Gas
O-GH-RE-10B	Radwaste Building Effluent	Wide Range Gas
O-GT-RE-22 & 33	Containment Purge Exhaust	Particulate, Iodine, Gas
O-GT-RE-31 & 32	Containment Atmosphere	Particulate, Iodine, Gas

3.4.3.1 Particulate Detector

Beta particulate is monitored by a 50 mm diameter by 0.25 mm thick plastic scintillator optically coupled to a 50 mm diameter photomultiplier tube. This detector shall be calibrated over its range of energy and rate capabilities.

For energy range calibration four sources shall be used. Each source consists of a filter paper impregnated with a beta emitting radionuclide. The radionuclides used should be Tc-99, Cs-137, Cl-36, and Rh-106. Each source shall be positioned in the filter paper retaining ring and counted separately. The count rates for each radionuclide source shall be recorded and the data plotted on a graph of cpm/μCi versus average beta energy. This curve represents the detectors response characteristics over the range of beta energies observed. The efficiency for setpoint calculations shall be based on the efficiency of the detector for Cs-137.

The detector shall be calibrated for its rate capabilities using a filter paper impregnated with standard activities of Cs-137. Increasing amounts of a standard Cs-137 solution shall be impregnated on a filter paper. The counts per minute for each Cs-137 standard shall be recorded. A determination of linearity shall be produced using the counts per minute vs. concentration data. At least three sources covering approximately ¼, ½, and ¾ of full scale shall be checked.

3.4.3.2 Iodine Detector

Iodine gas is monitored by absorbing the gas on a charcoal filter element. The charcoal filter is viewed by an NaI(Tl) integral line gamma scintillator assembly.

Because of its short half-life and the difficulty in handling gaseous iodine, barium sources shall be used for calibration. The photo peaks of interest are as follows:

a. Ba-133: 356 KeV gamma is 0.69 efficient/disintegration

b. I-131: 364 KeV gamma is 0.82 efficient/disintegration

Therefore, each iodine disintegration will produce 0.82/0.69 x barium disintegrations. Assuming that the detector efficiency for 356 KeV is the same as for the 364 KeV, the sensitivity for I-131 equals 1.19 x Ba-133 (counts/min) μCi. The standard sources shall be constructed by impregnating a standard Ba-133 solution into the charcoal filter element. The geometry shall simulate the iodine retention on the first surface of the charcoal. Sources shall be prepared to cover approximately ¼, ½ and ¾ of full scale. The barium counts per minute for each standard shall be adjusted to iodine counts per minute as described above. A determination of linearity shall be produced using the corrected counts per minute vs. concentration data.

3.4.3.3 Gas Detector

The gas detectors associated with monitors O-GT-RE-22 & 33, O-GT-RE-31 & 32 and the low-range detectors of monitors O-GT-RE-21B and O-GH-RE-10B are a plastic scintillator identical to the particulate detector. The mid-range and high-range detectors of monitors O-GT-RE-21B and O-GH-RE-10B are cadmium telluride, solid state sensors.

Sources for all gas detectors shall be produced by evacuating the sample chamber with a vacuum pump. The sample chamber then shall be backfilled to the desired pressure with a source of standard Xe-133. The source is then counted and the counts per minute recorded. A determination of linearity shall be produced using the counts per minute vs. concentration data. Sources shall be prepared to cover approximately ¼, ½ and ¾ of full scale for the detectors associated with monitors O-GT-RE-22 and 33, O-GT-RE-31 and 32 and the low-range detectors of monitors O-GT-RE-21B and O-GH-RE-10B. Sources shall be prepared for the mid/high range detector to cover two points on the mid-range scale. For ALARA purposes, response for the high-range scale shall be extrapolated using the data from the mid-range calibration.

3.4.4 Airborne Monitor Setpoints

3.4.4.1 Total Body Dose Rate Setpoint Calculations

The limit of the total body dose rate is 500 mrem/yr at the unrestricted area boundary. The monitor alarm/trip setpoint based on total body dose will be calculated as follows:

$$S_{tb} \le (SF \times AF) \times D_{tb} \times R_t$$

Where:

S_{tb} = The monitors alarm/trip setpoint based on the total body dose rate. (μCi/cc)

NOTE

If the monitor setpoint units needed are (μCi/sec), multiply (μCi/cc) calculated setpoint by the waste gas stream flow rate (cc/sec).

D_{tb} = Limit of 500 mrem/yr total body, conservatively interpreted as a continuous release over a one year period.

SF = Normally will be set to 0.85. This number is chosen since the gaseous monitors are set using Xe-133 energy level. Xe-133 comprises 85% of total noble gaseous activity expected. (See USAR Table 11.1-1). If necessary the 0.85 can be further modified to compensate for statistical fluctuations and errors of measurement.

AF = Allocation factor for each release so that simultaneous releases can be made without exceeding the limit. Normally AF is calculated as follows:

$$AF = \frac{RF}{TF}$$

Where:

RF = Release flow rate of the release point under consideration.

TF = Total flow rate of all release points including release under consideration.

R_t = monitor response per mrem/yr to the total body, determined according to:

$$R_t = \frac{c}{\left(\left(\overline{X/Q}\right)\sum_i K_i Q_i\right)}$$

Where:

c = The monitor response to the gaseous effluent noble gas (μCi/cc) corresponding to grab sample radionuclide concentrations.

$\left(\overline{X/Q}\right)$ = The highest calculated annual average atmospheric dispersion (sec/m^3) at the restricted area boundary.

K_i = The total body dose factor due to gamma emissions from isotope i (mrem/yr per μCi/m^3) from Table A.1-2.

Q_i = Rate of release of noble gas radionuclide i (μCi/sec)(concentration of radionuclide i x release flow rate)

3.4.4.2 Skin Dose Rate Calculation

The limit of the skin dose rate is 3000 mrem/yr at the restricted area boundary. The monitor alarm/trip setpoint is calculated as follows:

$$S_s \leq (SF \times AF) \times D_s \times R_s$$

Where:

S_s = The monitors alarm/trip setpoint based on the skin dose rate. (μCi/cc)

> **NOTE**
>
> **If the monitor setpoint units needed are (μCi/sec), multiply the μCi/cc), calculated setpoint by the waste gas stream flow rate (cc/sec).**

D_s = Limit of 3000 mrem/yr to the skin of the body, conservatively interpreted as a continuous release over a one year period.

R_s = Monitor response per mrem/yr to the skin of the body.

$$R_s = \frac{c}{\left(\left(\overline{X/Q}\right)\sum_i (L_i + 1.1M_i)\,Q_i\right)}$$

Where:

L_i = Skin dose factor due to beta emissions from isotope i (mrem/yr per μCi/m^3) from Table A.1-2.

1.1 = Conversion factor to mrem skin dose per mrad air dose.

M_i = Air dose factor due to gamma emissions from isotope i (mrad/yr per $\mu Ci/m^3$) from Table A.1-2.

The factors SF, AF, c, $\left(\overline{X/Q}\right)$ and Q_i are as defined in Section 3.4.4.1.

The results of equations from Sections 3.4.4.1 and 3.4.4.2 are compared to determine the smaller setpoint. The actual monitor setpoint is the lower of the two values.

A pre-release isotopic analysis is performed for batch releases from Waste Gas Decay Tanks and Containment Building purges to determine the identity and quantity of the principal radionuclides. The appropriate alarm/trip setpoint(s) are adjusted accordingly to ensure that the limits of 3.1 are not exceeded.

3.4.4.3 Alert Alarm Setpoint Calculations

The Noble Gas Alert Alarm for the Plant Unit Vent (O-GT-RE-21) and Radwaste Building Exhaust Monitor (O-GH-RE-10), is set to alert operators to that average concentration which if maintained for a full year would result in the 10 CFR 50, Appendix I Annual Dose Guidelines being reached. Section 3.2.1 limits the annual dose due to noble gases to ≤ 10 mrads for gamma radiation and ≤ 20 mrads for beta radiation. Section 3.2.2 limits the annual dose to a MEMBER OF THE PUBLIC from Iodine-131, Iodine-133, tritium and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents to ≤ 15 mrem to any organ. These two sections contain the annual dose limits due to gaseous releases found in 10 CFR 50, Appendix I.

3.4.4.3.1 Noble Gas Alert Alarm Setpoint Calculation

The alert alarm setpoint is the lesser of

$$S_\gamma \leq (SF \times AF) \times D\gamma \times R\gamma$$

$$S_\beta \leq (SF \times AF) \times D\beta \times R\beta$$

Where:

S_γ = Monitor setpoint based on gamma radiation.

D_γ = Limit of 10 mrad/yr conservatively interpreted as a continuous release over a one year period.

R_γ = Monitor response per mrad/yr determined according to:

$$R_\gamma = \frac{c}{\left(\left(\overline{X/Q}\right)\sum_i M_i \times Q_i\right)}$$

Where:

M_i = Gamma air dose factor (mrad/yr per $\mu Ci/m^3$). See Table A.1-2.

S_β = Monitor setpoint based on beta radiation.

D_β = Limit of 20 mrad/yr conservatively interpreted as a continuous release over a one year period.

R_β = Monitor response per mrad/yr determined according to:

$$R_\beta = \frac{c}{\left(\left(\overline{X/Q}\right)\sum_i N_i \times Q_i\right)}$$

Where:

N_i = Beta air dose factor (mrad/yr per $\mu Ci/m^3$). See Table A.1-2.

A semi-fixed alert alarm setpoint for the Plant Unit Vent Monitor (O-GT-RE-21) and Radwaste Building Vent Monitor (O-GH-RE-10) is calculated using the following:

$$\text{Setpoint}\ (\mu Ci/cc) = \left(\frac{(10\ \text{mrad/yr})(.85)(AF)}{\left(\left(\overline{X/Q}\right)\sum_i P_i \times M_i \times Q\right)}\right)$$

Where:

P_i = Fractional value of isotope expected, C_i/C_T, Where:

C_i = Concentration in µCi/cc of isotope.

C_T = Total Gaseous Activity from USAR Table 11.1-1

AF = Either unit vent flow or Radwaste Building vent flow divided by the combined flow of the unit vent and Radwaste Building vent.

Q = Vent flow rate in cc/sec.

Isotopes used and P_i values are as follows:

ISOTOPE	P_i
Kr-85M	.018
Kr-87	.010
Kr-88	.033
Xe-133M	.017
Xe-133	.851
Xe-135	.051

Should this semi-fixed alert alarm cause a continuous alarm condition, then actual setpoints will be calculated.

3.4.4.4 Particulate And Iodine Alarm Setpoints

Setpoints for the gaseous effluent particulate and iodine channels are set using Cs-137 MPC for particulates and I-131 MPC for iodines. The following is the calculation used:

$$\text{Setpoint}\ (\mu\text{Ci/cc}) = \frac{(MPC_i)(AF)(SF)}{(Q)\left(\overline{X/Q}\right)}$$

Where:

MPC_i = 5×10^{-10} µCi/cc for Cs-137

= 1×10^{-10} µCi/cc for I-131

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AF = as defined previously

SF = .0625 for I-131 *

= .9375 for Cs-137 *

*derived from ratio of isotope activity (either I-131 or Cs-137) to sum of activity of Cs-137 and I-131 found in USAR Table 11.1-1 for reactor coolant.

Q = Vent flow in M^3/sec

This will provide the hi alarm setpoint. The alert alarm setpoint is 10% of the hi alarm setpoint.

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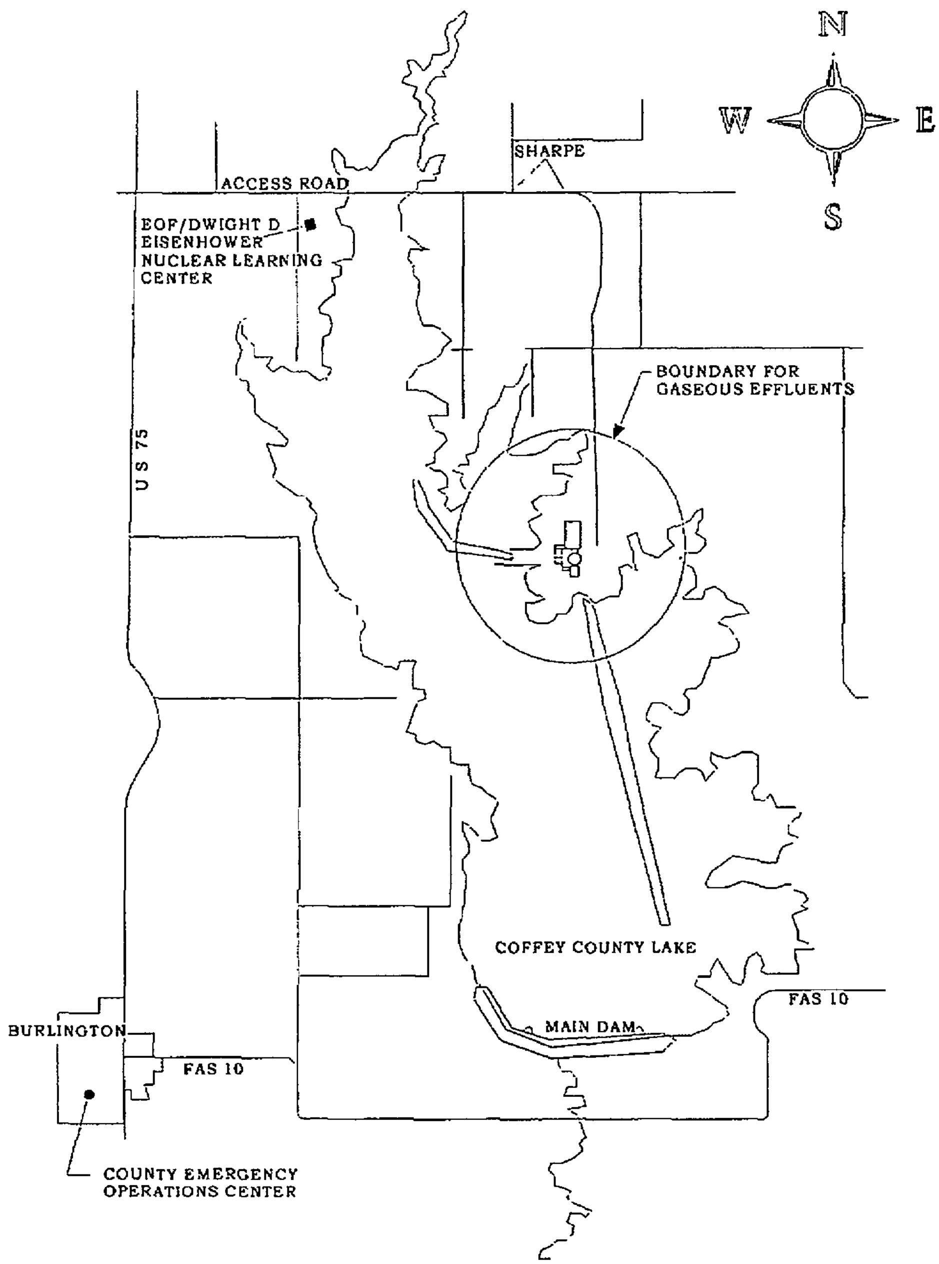
FIGURE 3.1
BOUNDARY FOR GASEOUS EFFLUENTS



4.0 Total Dose

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 less than or equal to 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

4.1 Remedial Action

With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Section 2.2a, 2.2b, 3.2.1a, 3.2.1b, 3.2.2a and 3.2.2b calculation should be made including direct radiation contributions from the units and from outside storage tanks to determine whether the above limits of Section 4.0 above has been exceeded. If such is the case, prepare and submit to the Commission within 30 days, a special report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits. This special report, as defined in 10 CFR 20.405e and 10CFR20.2203, shall include an analysis that estimates the radiation exposure (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) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved, and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits, and if the release condition resulting in violation of 40 CFR Part 190 has not already been corrected, the special report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete. *11/99*

4.2 Surveillance Requirements

4.2.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with the methodology of Sections 2.2 and 3.2 at least once per 31 days when the release of radioactive materials in liquid or gaseous effluents exceed twice the limits of Section 2.2a, 2.2b, 3.2.1a, 3.2.1b, 3.2.2a and 3.2.2b. Otherwise, no further evaluation is required.

4.2.2 Cumulative dose contribution from direct radiation from the reactor unit and from Radwaste storage tanks shall be determined utilizing the results of routine plane perimeter surveys, TLD data or a combination of both, when necessary. This requirement is applicable only under conditions set forth in the remedial action above.

6.0 Bases

The bases contained on the succeeding pages summarizes the general requirements of Section 2.0, 3.0, 4.0 and 5.0 of the ODCM.

Section 2.0 Liquid Effluents

Section 2.1 Concentration

This section is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than 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 objective of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC, and (2) the limits of 10 CFR Part 20.1301(e) to the population. The concentration limit for dissolved or entrained noble gases are based upon the assumption that Xe-135 is the controlling radioisotope and its ECL in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2. *11/99*

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).

Section 2.2 Dose

This section is provided to implement the requirements of Section II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The remedial action implements the guides set forth in Section II.A of Appendix I and provides 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." Also, for fresh water sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. The dose calculation methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I which specify 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.

Section 2.3 Liquid Radwaste Treatment System

The OPERABILITY of the Liquid Radwaste Treatment Systems ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. 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 section implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and 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 objective set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

Section 2.4 Radioactive Liquid Effluent Monitoring Instrumentation

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

Section 3.0 Gaseous Effluents

Section 3.1 Dose Rate

This section is provided to ensure that the dose at any time at and beyond the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 to UNRESTRICTED AREAS. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC in an UNRESTRICTED AREA, either within or outside the SITE BOUNDARY, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR 20.106(b)). 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 specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrems/year to the whole body or to less than or equal to 3000 mrems/year to the skin. These release rate limits also restrict, at all times the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrems/year.

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).

Section 3.2.1 Dose - Noble Gases

This section is provided to implement the requirements of Section II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The remedial action implements the guides set forth in Section II.B of Appendix I and provides 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 surveillance 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 materials 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 either the historical average or real time atmospheric conditions.

Section 3.2.2 Dose - Iodine-131 and 133, Tritium and Radioactive Material in Particulate Form

This section is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The remedial actions are the guides set forth in Section II.C of Appendix I, and 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 surveillance 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 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, "Calculational 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 either the historical average or real time conditions. The release rate limits for Iodine-131 and 133, tritium, and radionuclides in particulate form with half lives greater that 8 days are dependent upon the existing radionuclide pathways to man, in the 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, (4)deposition on the ground with subsequent exposure of man.

Section 3.3 Gaseous Radwaste Treatment System

The OPERABILITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system 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 section 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 Section II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

Section 3.4 Radioactive Gaseous Effluent Monitoring Instrumentation

The radioactive gaseous effluent instrumentation 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 Setpoints for these instruments shall be adjusted to values calculated in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50. The sensitivity of any noble gas activity monitor used to show compliance with the gaseous effluent release requirements of Section 3.2 shall be such that concentrations as low as 1×10^{-6} μCi/cc are measurable.

Section 4.0 Total Dose

This section 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 section requires the preparation and submittal of a special report whenever the calculated doses due to releases of radioactivity and the radiation from uranium fuel cycle sources exceed 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to four reactors, 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 individual reactors remain within twice the dose design objectives of Appendix I, and if direct radiation doses from the reactor Units and from outside storage tanks 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, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 km must be considered. 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, 10 CFR 20.405c, 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. 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. ***11/99***

7.2 **Annual Radioactive Effluent Release Report**

The Annual Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the Unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light Water-Cooled Nuclear Power Plants," Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof. For solid wastes, the format for Table 3 in Appendix B shall be supplemented with three additional categories: class of solid waste (as defined by 10 CFR Part 60), type of container (e.g., LSA, Type A, Type B, Large Quantity), and SOLIDIFICATION agent or absorbent (e.g., cement, urea formaldehyde).

The Annual Radioactive Effluent Release Report to be submitted before May 1 of each year shall also include 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, and atmospheric stability, and precipitation (if measured), or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.* This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the Unit or Station during the previous calendar year. This same report shall also include an assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in these reports. Historical average meteorological conditions or the meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents, as determined by sampling frequency and measurement, shall be used for determining the gaseous pathway doses. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the ODCM.

The Annual Radioactive Effluent Release Report to be submitted before May 1 of each year shall also include an assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operation." Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109, Rev. 1, October 1977.

The Annual Radioactive Effluent Release Report shall include:

a. 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.

*In lieu of submission with the Annual Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

b. Any changes made during the reporting period to the ODCM, pursuant to Technical Specification 5.5.1. ***11/99***

c. Major changes to the Radwaste Treatment Systems for the period in which the evaluation was reviewed and accepted by the PSRC. The discussion of each change shall contain:

1) A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59;

2) Sufficient detailed information to totally support the reason for the change without benefit of additional and supplemental information;

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

4) 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;

5) An evaluation of the change, which shows the expected maximum exposures to a MEMBER OF THE PUBLIC in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto;

6) 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 prior to when the changes are to be made;

7) An estimate of the exposure to plant operating personnel as a result of the change; and

8) Documentation of the fact that the change was reviewed and found acceptable by the PSRC.

d. A listing of new locations for dose calculations identified by the Land Use Census,

e. A description of the events leading to liquid holdup tanks or gas storage tanks exceeding the limits of TR 3.10.1 OR TSR 3.10.3.1. *11/99*

f. An explanation as to why the inoperability of a liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified.

g. A description of the events leading to a missed sample required by Table 2-1 or 3-1.