Callaway Energy Center 2016 Annual Radioactive Effluent Release Report

Renewed Facility Operating License NPF-30

Docket Numbers 50-483 and 72-1045

Ameren MISSOURI | Callaway Energy Center

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Abstract

The Annual Radioactive Effluent Release Report covers the operation of the Callaway Energy Center during the year 2016. The report includes a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The report also includes an annual summary of hourly meteorological data collected during the year and an assessment of radiation dose to the Member of the Public from liquid and gaseous effluents.

1. Introduction

This Annual Radioactive Effluent Release Report (ARERR) is submitted by Union Electric Co., dba Ameren Missouri, , in accordance with the requirements of 10 CFR 50.36a and 10 CFR 72.44(d)(3), Callaway Energy Center Technical Specification 5.6.3, and HI-STORM UMAX Certificate of Compliance Section 5.1.c. This report is for the period January 1, 2016 to December 31, 2016.

The doses to the Member of the Public from all liquid and gaseous effluents discharged during the reporting period were small fractions of the NRC and EPA regulatory limits and the Radioactive Effluent Control limits in the Offsite Dose Calculation Manual.

To maximize consistency, aid in the review by Members of the Public, and to allow easier industry- wide comparison of the data, this report is presented in the format recommended by Regulatory Guide 1.21, revision 2, *insofar as is practicable*.

Radionuclide concentrations in liquid and gaseous effluents were obtained by effluent sampling and radiological analysis in accordance with the requirements of FSAR-SP/ODCM Radiological Effluent Control (REC) Table 16.11-1 and Table 16.11-4. Gamma spectroscopy was the primary analysis technique used to determine the radionuclide composition and

concentration of liquid and gaseous effluents. Composite samples were analyzed for the hard to detect nuclides by an independent laboratory. Tritium and gross alpha were measured for both liquid and gaseous effluents using liquid scintillation counting and gas flow proportional counting techniques, respectively. The total radioactivity in effluent releases was determined from the measured concentrations of each radionuclide present and the total volume of effluents discharged.

The concept of average energy is not applicable to the Callaway Plant radiological effluent monitoring program since the release rate limits for fission and activation gases in gaseous effluent are not based on the average energy of the radionuclide mixture.

The Radiological Effluent Control (REC) limits applicable to the release of radioactive material in liquid and gaseous effluents are provided below.

Regulatory Limits

The Callaway regulatory limits are provided in the Radiological Effluent Controls in FSAR-SP/ODCM Chapter 16.11.

Fission and Activation Gases (Noble Gases)

The dose rate due to radioactive noble gases released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin.

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

Radioiodine, Tritium, And Particulates

The dose rate due to Iodine-131 and Iodine-133, tritium and all radionuclides in particulate form with half-lives greater than eight (8) days released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to less than or equal to 1500 mrem/yr to any organ.

The dose to a Member of the Public from Iodine-131 and Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than eight (8) days in gaseous effluents released to areas at and beyond the site boundary shall be limited to the following:

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

Liquid Effluents

The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to 10 times the concentrations specified in 10 CFR 20 Appendix B To Part 20, Table 2, Column 2 (Effluent Concentrations) for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-04 µCi/mL total activity.

The dose or dose commitment to an Individual from radioactive materials in liquid effluents released to unrestricted areas shall be limited:

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

Uranium Fuel Cycle Sources

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 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

2. Gaseous Effluents

The quantity of radioactive material released in gaseous effluents during the reporting period is summarized in Table A-1. The quarterly and annual sums of all radionuclides discharged in gaseous effluents are reported in Tables A-1A and A-1B. All gaseous effluent releases are considered to be ground level.

Gaseous Batch Releases		Q1 & Q2	Q3 & Q4
Number of batch releases:		35	30
Total time period for batch releases:	minutes	14289	2555
Max. time period for a batch release:	minutes	4601	393
Avg. time period for a batch release:	minutes	408	85
Min. time period for a batch release:	minutes	8	18

The quantity of ^{14}C released in gaseous effluents was calculated as described in EPRI Technical Report 1021106[1].

There were no radioactive effluents from the Independent Spent Fuel Storage Installation (ISFSI). The HI-STORM UMAX Canister Storage System does not create any radioactive materials or have any radioactive waste treatment systems. Specification 3.1.1, "Multi-Purpose Canister (MPC)", provides assurance that there are no radioactive effluents from the ISFSI.[2]

3. Liquid Effluents

The quantity of radioactive material released in liquid effluents during the reporting period is summarized in Table A-2. The quarterly and annual sums of all radionuclides discharged in liquid effluents are reported in Table A-2A. All liquid effluents were discharged in batch mode; there were no continuous liquid discharges

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1 *Estimation of Carbon- 14 in Nuclear Power Plant Gaseous Effluents*, Technical Report 1011106, Electric Power Research Institute, December, 2010.

2 Certificate of Compliance No. 1040, Appendix A, Technical Specifications for the HI-STORM UMAX Canister Storage System, Specification 5.1.

for the reporting period. Dilution by the Missouri River, in the form of the near- field dilution factor, is utilized in the ODCM dose calculation methodology.

Liquid Batch Releases		Q1 & Q2	Q3 & Q4
Number of batch releases:		40	28
Total time period for batch releases:	minutes	13898	10472
Max. time period for a batch release:	minutes	563	608
Avg. time period for a batch release:	minutes	347	374
Min. time period for a batch release:	minutes	17	0

4. Solid Waste Storage and Shipments

The volume and activity of solid waste shipped for disposal is provided in Table A-3. Table A-3 is presented in the format of rev. 1 to Regulatory Guide 1.21 because the data is not readily available in the format recommended by rev. 2 to Regulatory Guide 1.21.

5. Dose Assessments

The annual evaluation of dose to the Member of the Public is calculated in accordance with the methodology and parameters in the ODCM and is reported in Tables A-4 and A-5.

5.1 Table A-4, Dose Assessments, 10 CFR 50, Appendix I

The dose assessments reported in Table A-4 were calculated using the methodology and parameters in the ODCM and demonstrate compliance with 10 CFR 50, Appendix I. The gamma air dose and beta air dose were calculated at the nearest Site Boundary location with the highest value of X/Q, as described in the ODCM. The maximum organ dose from gaseous effluents was calculated for the ingestion, inhalation, and ground plane pathways at the location of the nearest resident with the highest value of D/Q, as described in the ODCM. The organ dose does not include the dose from ^{14}C, which is listed separately.

5.2 Table A-5, EPA 40 CFR 190 Individual in the Unrestricted Area

The dose assessments reported in Table A-5 are the doses to the Member of the Public from activities within the Site Boundary plus the doses at the location of the Nearest Residence. A large portion of the residual land of the Callaway Site is managed by the State of Missouri Conservation Department as the Reform Wildlife Management Area. Pursuant to the guidance provided in Regulatory Guide 1.21, rev.2, the dose reported in Table A-5 is the sum of the dose from gaseous effluents (at the Nearest Resident location and within the Site Boundary), plus the dose contribution due to activities within the Site Boundary and the organ dose from inhalation of ^{14}C (at the Nearest Resident location and within the Site Boundary). The dose assessments in Table A-5 demonstrate compliance with 10 CFR 20.1301(e) and 40 CFR 190.

6. Supplemental Information

6.1 Abnormal Releases or Abnormal Discharges

There were no abnormal releases or abnormal discharges during the reporting period.

6.2 Non- routine Planned Discharges

There were no non- routine planned discharges during the reporting period.

6.3 Radioactive Waste Treatment System Changes

There were no major changes to the liquid or gaseous radwaste treatment system during the reporting period.

6.4 Annual Land Use Census Changes

There were no changes identified in the locations for dose calculation. Changes in sample locations identified in the Land Use Census are described in the Annual Radioactive Environmental Operating Report.

6.5 Effluent Monitoring System Non- functionality

There were no effluent radiation monitors out of service for periods in excess of the Limiting Condition for Operation and associated Action statements.

6.6 Offsite Dose Calculation Manual Changes

There were changes to the Offsite Dose Calculation Manual during the reporting period. The Radiological Effluent Controls (RECs) in FSAR-SP Chapter 16.11 were revised from OPERABLE terminology to FUNCTIONAL terminology for Structure, System or Component (SSCs) functions that do not fulfill a Technical Specification (TS) specified safety function throughout FSAR-SP Chapter 16. This change, processed under LDCN 15-0007, aligns the terminology with NRC guidance provided in Inspection Manual Chapter (IMC) 0326 for use of the OPERABLE terminology, and to clarify reader understanding of the information described in the FSAR. Some additional grammatical corrections were also made. A complete copy of the revised RECs in FSAR-SP Chapter 16.11 is provided in Appendix D.

6.7 Process Control Program Changes

There were no changes to APA-ZZ-01011, "Process Control Program" during the reporting period.

6.8 Corrections to Previous Reports

Corrections to previous reports are provided in Appendix C, "Corrections to 2010- 2015 Annual Radioactive Effluent Release Reports". Callaway changed to reporting in the format recommended by Regulatory Guide 1.21, revision 2 beginning with the 2010 report. In so doing, certain information required by rev. 1 but not required by rev. 2 was left out of the report[3]. Appendix C provides the missing information for the 2010- 2015 ARERR's.

6.9 Other Information Related to Radioactive Effluents

Meteorological dispersion parameters, data recovery rate, and Joint Frequency Tables for the monitoring period are provided in Appendix B.

[3] Condition Report 201701473

Appendix A

Tables of Quantities Released in Liquid and Gaseous Radioactive Effluents and in Solid Radioactive Waste Shipments

Tables of Doses from the Discharge of Liquid and Gaseous Radioactive Effluents

Table A-1: Gaseous Effluents- Summation of All Releases

Summation of All Releases	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total	Estimated Uncertainty (%)[4]
Fission & Activation Gases	Ci	1.35E-01	5.34E-01	3.65E-02	8.97E-02	7.95E-01	20
Average Release Rate	µCi/s	1.72E-02	6.79E-02	4.59E-03	1.13E-02	2.52E-02	
% of Limit	%	N/A	N/A	N/A	N/A	N/A	
^{131}Iodine	Ci	ND[5]	2.19E-06	ND	ND	2.19E-06	23
Average Release Rate	µCi/s	ND	2.79E-07	ND	ND	6.92E-08	
% of Limit	%	N/A	N/A	N/A	N/A	N/A	
Particulates	Ci	ND	ND	ND	ND	ND	30
Average Release Rate	µCi/s	ND	ND	ND	ND	ND	
% of Limit	%	N/A	N/A	N/A	N/A	N/A	
Gross Alpha	Ci	2.55E-07	6.03E-08	2.21E-07	1.70E-07	7.06E-07	
^{3}H	Ci	4.77E00	1.48E01	1.16E01	7.59E00	3.88E01	14
Average Release Rate	µCi/s	6.07E-01	1.89E00	1.46E00	9.54E-01	1.23E00	
% of Limit	%	N/A	N/A	N/A	N/A	N/A	
^{14}C [6]	Ci	2.93E00	2.93E00	2.93E00	2.93E00	1.17E01	

[4] Safety Analysis calculation 87-063-00, January 6, 1988
[5] Not Detected
[6] ^{14}C activity is estimated based on EPRI report TR-1021106, *Estimation of ^{14}C in Nuclear Power Plant Effluents*, December, 2010 as described in Appendix A to APA-ZZ-01003, Off-site Dose Calculation Manual.

Table A-1A: Gaseous Effluents- Ground Level Release- Batch Mode						
Fission & Activation Gases	**Units**	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total for the year**
^{41}Ar	Ci	7.90E-02	5.19E-01	3.65E-02	5.95E-02	6.94E-01
^{85}Kr	Ci	5.63E-02	ND	ND	3.02E-02	8.65E-02
Total	Ci	1.35E-01	5.19E-01	3.65E-02	8.97E-02	7.81E-01
Iodines & Halogens	**Units**	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total for the year**
Total	Ci	ND	ND	ND	ND	ND
Particulates	**Units**	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total for the year**
Total	Ci	ND	ND	ND	ND	ND
^{3}H	Ci	7.16E-02	3.92E-01	1.63E-01	2.46E-01	8.73E-01
Gross α	Ci	ND	ND	ND	ND	ND
^{14}C	Ci	4.80E-01	4.80E-01	4.80E-01	4.80E-01	1.92E00

Table A-1B: Gaseous Effluents- Ground Level Release- Continuous Mode						
Fission & Activation Gases	**Units**	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total for the year**
^{133}Xe	Ci	ND	1.50E-02	ND	ND	1.50E-02
Total	Ci	ND	1.50E-02	ND	ND	1.50E-02
Iodines & Halogens	**Units**	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total for the year**
^{131}I	Ci	ND	2.19E-06	ND	ND	2.19E-06
^{132}I	Ci	1.88E-05	1.94E-04	ND	ND	2.13E-04
Total	Ci	1.88E-05	1.97E-04	ND	ND	2.16E-04
Particulates	**Units**	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total for the year**
Total	Ci	ND	ND	ND	ND	ND
^{3}H	Ci	4.70E00	1.44E01	1.14E01	7.34E00	3.78E01
Gross α	Ci	2.55E-07	6.03E-08	2.21E-07	1.70E-07	7.06E-07
^{14}C	Ci	2.45E00	2.45E00	2.45E00	2.45E00	9.78E00

Table A-2: Liquid Effluents- Summation of All Releases

Summation of All Liquid Releases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total	Est. Uncert. (%)[7]
Fission and Activation Products[8]	Ci	8.49E-03	1.30E-02	3.57E-02	9.39E-03	6.66E-02	20
Avg Diluted Conc	µCi/ml	5.80E-08	6.48E-08	2.20E-07	1.03E-07	1.11E-07	
% of Limit	%	N/A	N/A	N/A	N/A	N/A	
^{3}H	Ci	3.11E02	1.90E02	4.11E00	5.97E01	5.65E02	14
Avg Diluted Conc	µCi/ml	2.12E-03	9.48E-04	2.54E-05	6.55E-04	9.42E-04	
% of Limit	%	N/A	N/A	N/A	N/A	N/A	
Dissolved & Entrained Gases	Ci	2.02E-04	8.53E-04	0.00E+00	0.00E+00	1.06E-03	27
Avg Diluted Conc	µCi/ml	1.38E-09	4.26E-09	0.00E+00	0.00E+00	1.76E-09	
% of Limit	%	N/A	N/A	N/A	N/A	N/A	
Gross α	Ci	0.00E00	2.76E-04	2.74E-04	1.32E-04	6.82E-04	29
Avg Diluted Conc	µCi/ml	0.00E00	1.38E-09	1.69E-09	1.45E-09	1.14E-09	
Vol Liquid Effluent[9]	Liters	4.43E06	6.55E06	5.53E06	2.91E06	1.94E07	
Dilution Volume[10]	Liters	1.42E08	1.94E08	1.56E08	8.82E07	5.80E08	
Avg river flow[11]	m^3/s	2.82E03	3.62E03	2.76E03	1.70E03	2.73E03	

7 Safety Analysis calculation 87-063-00, January 6, 1988
8 Excludes ^{3}H, noble gases, and gross alpha.
9 Primary system liquid effluent plus secondary liquid effluent, prior to dilution.
10 Does not include Missouri River dilution.
11 Average Missouri River flow for the year at the Hermann, MO monitoring station as reported by the USGS.

Table A-2A: Liquid Effluents- Batch Mode

Fission & Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for the year
^{51}Cr	Ci	0.00E+00	3.37E-04	9.08E-04	6.21E-05	1.31E-03
^{58}Co	Ci	0.00E+00	6.91E-04	6.93E-05	0.00E+00	7.60E-04
^{60}Co	Ci	2.29E-03	1.68E-03	1.59E-03	3.84E-04	5.94E-03
^{63}Ni	Ci	4.42E-03	6.30E-04	2.00E-03	1.75E-04	7.22E-03
^{95}Nb	Ci	0.00E00	2.45E-05	0.00E00	0.00E00	2.45E-05
^{122}Sb	Ci	0.00E+00	1.09E-04	0.00E+00	0.00E+00	1.09E-04
^{124}Sb	Ci	0.00E+00	2.02E-03	3.00E-03	3.03E-04	5.32E-03
^{125}Sb	Ci	1.18E-03	6.96E-03	2.78E-02	8.41E-03	4.44E-02
^{126}Sb	Ci	0.00E+00	1.90E-04	0.00E+00	0.00E+00	1.90E-04
^{132}I	Ci	0.00E+00	2.92E-05	0.00E+00	0.00E+00	2.92E-05
^{134}Cs	Ci	1.74E-05	8.50E-06	0.00E+00	0.00E+00	2.59E-05
^{137}Cs	Ci	5.83E-04	3.11E-04	2.63E-04	5.33E-05	1.21E-03
^{138}Cs	Ci	0.00E+00	0.00E+00	6.84E-05	0.00E+00	6.84E-05
Total	Ci	8.49E-03	1.30E-02	3.57E-02	9.39E-03	6.66E-02
Dissolved & Entrained Gases	**Units**	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Total for the year**
^{133}Xe	Ci	2.02E-04	8.53E-04	0.00E+00	0.00E+00	1.06E-03
Total	Ci	2.02E-04	8.53E-04	0.00E+00	0.00E+00	1.06E-03
^{3}H	Ci	3.11E+02	1.90E+02	4.11E+00	5.97E+01	5.65E+02
Gross α	Ci	0.00E+00	2.76E-04	2.74E-04	1.32E-04	6.82E-04

Table A-3: Solid Waste & Irradiated Fuel Shipments

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (Not Irradiated Fuel)

1. TYPE OF WASTE	Units	Period Jan – Jun	Period Jul - Dec	Est. Total Error (%)
Spent resins, filter sludges, evaporator bottoms, etc.	m^3	2.49E+01	1.51E+01	
	Ci	1.19E+00	2.82E+02	± 25%
Dry compressible waste, contaminated equip., etc.	m^3	2.13E+02	1.14E+02	
	Ci	1.05E-01	7.72E-01	± 25%
Irradiated components, control rods, etc.	m^3	0.00E+00	0.00E+00	
	Ci	0.00E+00	0.00E+00	± 25%
Other (low level secondary resin, oily waste)	m^3	0.00E+00	0.00E+00	
	Ci	0.00E+00	0.00E+00	± 25%

2. ESTIMATE OF MAJOR NUCLIDE COMPOSITION (by Type of Waste)				
a. Spent resins, filters, evaporator bottoms, etc.				
Nuclide	% Abundance	Jan – Jun Ci	% Abundance	Jul – Dec Ci
^{60}Co	14.05%	1.71E-01	35.68%	1.02E+02
^{3}H	19.33%	2.35E-01	N/A	N/A
^{63}Ni	39.94%	4.85E-01	33.72%	9.64E+01
^{55}Fe	3.33%	4.04E-02	11.98%	3.42E+01
^{137}Cs	19.38%	2.39E-01	13.73%	3.93E+01
^{134}Cs	N/A	N/A	1.51%	4.31E+00
b. Dry compressible waste, contaminated equipment, etc.				
^{60}Co	39.21%	4.20E-02	28.33%	2.23E-01
^{63}Ni	22.66%	2.42E-02	21.79%	1.71E-01
^{137}Cs	5.10%	5.46E-03	12.82%	1.01E-01
^{55}Fe	18.58%	2.03E-02	30.37%	2.39E-01
^{134}Cs	N/A	N/A	1.89%	1.48E-02
^{3}H	1.14%	1.22E-03	1.42%	1.12E-02
^{54}Mn	1.67%	1.78E-03	1.23%	9.66E-03
^{58}Co	5.02%	5.37E-03	N/A	N/A
^{95}Nb	1.68%	1.80E-03	N/A	N/A
^{125}Sb	1.33%	1.43E-03	N/A	N/A
c. Irradiated components, control rods, etc.				
None	N/A	N/A	N/A	N/A

Table A-3: Solid Waste & Irradiated Fuel Shipments (continued)

d. Other				
Nuclide	% Abundance	Jan – Jun Ci	% Abundance	Jul – Dec Ci
None	N/A	N/A	N/A	N/A

3. SOLID WASTE DISPOSITION				
Number of Shipments	Mode of Transport	Destination	Class of Solid Waste Shipped	Type of Container
*7	Hittman Transport	Energy Solutions Services, Inc. Bear Creek, TN	A	IP-1
*1	CAST Transportation	Energy Solutions Services, Inc. Bear Creek, TN	A	IP-1
*2	Hittman Transport	Erwin Resin Solutions, LLC Erwin, TN	B	Liners in a Cask
4	Hittman Transport	Energy Solutions LLC. Clive Disposal Site - CWF	A	Liners in a Cask
*2	Hittman Transport	Alaron Corp. Wampum, PA	A, B, C, N (not classified for disposal)	Drums in a Cask

*Sent to waste processors for volume reduction before burial.

4. SOLIDIFICATION AGENT

None used.

B. IRRADIATED FUEL SHIPMENTS (Disposition)

There were no shipments of irradiated fuel during the reporting period.

Table A-4: Dose Assessments, 10 CFR 50, Appendix I					
	Quarter 1	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Yearly total**
Liquid Effluent Dose Limit, Total Body (mrem)	1.5	1.5	1.5	1.5	3
Total Body Dose (mrem)	2.52E-03	1.01E-03	5.64E-04	3.43E-04	4.29E-03
% Limit (%)	0.17%	0.07%	0.04%	0.02%	0.15%
Liquid Effluent Dose Limit, Maximum Organ (mrem)	5	5	5	5	10
Maximum Organ Dose (mrem)	3.51E-03	1.37E-03	9.76E-04	4.46E-04	6.00E-03
% Limit (%)	0.07%	0.03%	0.02%	0.01%	0.06%
Gaseous Effluent Dose Limit, Gamma Air (mrem)	5	5	5	5	10
Gamma Air Dose (mrad)	4.43E-05	2.91E-04	2.04E-05	3.34E-05	3.89E-04
% Limit (%)	0.00%	0.01%	0.00%	0.00%	0.00%
Gaseous Effluent Dose Limit, Beta Air (mrem)	10	10	10	10	20
Beta Air Dose (mrad)	2.22E-05	1.03E-04	7.21E-06	1.53E-05	1.48E-04
% Limit (%)	0.00%	0.00%	0.00%	0.00%	0.00%
Gaseous Effluent Dose Limit, Maximum Organ (mrem)	7.5	7.5	7.5	7.5	15
Maximum organ dose[12] (mrem)	1.70E-03	5.51E-03	4.14E-03	2.71E-03	1.41E-02
% Limit (%)	0.02%	0.07%	0.06%	0.04%	0.09%
^{14}C Maximum organ dose (mrem)[13]	3.65E-03	3.65E-03	3.65E-03	3.65E-03	1.46E-02

Table A-5: EPA 40 CFR 190 Individual in the Unrestricted Area			
	Whole Body	**Thyroid**	**Max Other Organ**
Dose Limit	25 mrem	75 mrem	25 mrem
Dose	1.93E-02	1.92E-02	3.25E-02
% Limit	0.08%	0.03%	0.13%

[12] Iodine, ^{3}H, and particulates with greater than an 8 day half- life.
[13] Not included in above totals

Appendix B

Joint Frequency Tables; Totals of Hours at Each Wind Speed & Direction for the period January 1, 2016- December 31, 2016

Meteorological Parameters for the Reporting Period

Nearest Resident Dispersion Parameters

Direction: NNW

Distance: 2897 meters

X/Q, Undecayed and Undepleted:	1.34E-06 sec/m^3
X/Q Decayed and Undepleted:	1.29E-06 sec/m^3
X/Q Decayed and Depleted:	1.11E-06 sec/m^3
D/Q Deposition rate:	3.31E-09 m^{-2}

Site Boundary Dispersion Parameters

Direction: NNW

Distance: 2200 meters

X/Q, Undecayed and Undepleted:	1.95E-06 sec/m^3
X/Q Decayed and Undepleted:	1.90E-06 sec/m^3
X/Q Decayed and Depleted:	1.66E-06 sec/m^3
D/Q Deposition rate:	5.31E-09 m^{-2}

Meteorological Data Recovery Rate

10 meters elevation	Hours of valid data: 8782
	Total hours in period: 8784
	Recovery rate: 99.98%
60 meters elevation	Hours of valid data: 8659
	Total hours in period: 8784
	Recovery rate: 98.58%

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
All Stabilities												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	4	50	41	64	109	92	66	29	7	1	0	463
NNE	5	38	52	56	87	59	20	9	1	0	0	327
NE	7	46	48	60	92	36	17	3	2	0	0	311
ENE	3	33	44	40	74	37	11	1	0	0	0	243
E	5	33	36	50	97	58	19	2	2	0	0	302
ESE	4	49	60	85	145	80	31	11	4	0	0	469
SE	14	82	126	193	344	145	44	14	0	0	0	962
SSE	8	47	108	174	466	207	86	34	19	0	0	1149
S	6	53	49	99	227	218	108	80	46	2	0	888
SSW	4	39	38	63	170	133	80	57	35	4	0	623
SW	1	27	49	72	134	89	49	22	18	1	0	462
WSW	5	28	40	48	83	55	27	13	10	1	0	310
W	4	31	28	42	106	105	50	29	31	0	0	426
WNW	4	48	60	74	135	114	68	42	29	0	0	574
NW	3	39	88	110	147	93	71	62	16	1	0	630
NNW	2	32	62	91	160	114	68	26	19	2	0	576
Tot	79	675	929	1321	2576	1635	815	434	239	12	0	8715
Hours of Calm 67												
Hours of Variable Direction 0												
Hours of Valid Data 8782												
Hours of Missing Data 2												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class A Extremely Unstable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	0	0	0	0	0	2	6	1	0	0	9
NNE	0	0	0	1	0	0	0	0	0	0	0	1
NE	0	0	0	1	0	1	0	0	0	0	0	2
ENE	0	0	0	0	1	0	0	0	0	0	0	1
E	0	0	0	0	0	3	0	0	0	0	0	3
ESE	0	0	0	0	0	1	1	7	0	0	0	9
SE	0	0	0	0	1	9	10	7	0	0	0	27
SSE	0	0	0	0	0	11	9	6	1	0	0	27
S	0	0	0	0	2	0	5	5	5	0	0	17
SSW	0	0	0	0	1	5	2	9	7	0	0	24
SW	0	0	0	0	1	7	9	5	6	0	0	28
WSW	0	0	0	0	3	3	0	0	0	0	0	6
W	0	0	0	0	5	6	13	3	8	0	0	35
WNW	0	0	0	0	8	9	12	8	7	0	0	44
NW	0	0	0	0	1	8	8	11	6	1	0	35
NNW	0	0	0	0	1	1	6	4	6	0	0	18
Tot	0	0	0	2	24	64	77	71	47	1	0	286
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 286												
Hours of Missing Data 2												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class B Moderately Unstable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	0	0	0	1	2	9	6	1	0	0	19
NNE	0	0	0	0	1	3	0	0	0	0	0	4
NE	0	0	0	0	3	8	1	0	0	0	0	12
ENE	0	0	0	0	4	5	1	0	0	0	0	10
E	0	0	0	0	1	4	2	0	0	0	0	7
ESE	0	0	0	0	6	4	1	1	0	0	0	12
SE	0	0	0	0	5	9	5	1	0	0	0	20
SSE	0	0	0	0	8	14	6	1	1	0	0	30
S	0	0	0	1	9	11	7	9	2	0	0	39
SSW	0	0	0	1	12	16	11	6	2	1	0	49
SW	0	0	0	0	10	9	6	4	0	1	0	30
WSW	0	0	0	0	6	6	4	0	1	0	0	17
W	0	0	0	0	9	9	7	3	2	0	0	30
WNW	0	0	0	0	1	5	7	1	2	0	0	16
NW	0	0	0	1	5	11	4	2	1	0	0	24
NNW	0	0	0	0	0	13	9	3	1	0	0	26
Tot	0	0	0	3	81	129	80	37	13	2	0	345
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 345												
Hours of Missing Data 2												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class C Slightly Unstable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	1	0	3	5	5	4	4	0	0	0	22
NNE	0	0	1	0	4	8	3	0	0	0	0	16
NE	0	1	0	1	8	5	4	0	0	0	0	19
ENE	0	0	0	0	14	7	4	0	0	0	0	25
E	0	0	0	3	8	5	0	0	0	0	0	16
ESE	0	0	0	1	8	5	0	0	0	0	0	14
SE	0	0	2	2	25	13	3	0	0	0	0	45
SSE	0	0	1	7	28	26	10	0	1	0	0	73
S	0	1	1	5	27	22	11	8	5	0	0	80
SSW	0	0	1	6	28	16	11	6	3	3	0	74
SW	0	1	2	4	14	11	6	2	3	0	0	43
WSW	0	1	1	4	6	4	2	2	2	0	0	22
W	0	1	0	5	15	16	6	4	2	0	0	49
WNW	0	0	0	6	10	10	1	2	4	0	0	33
NW	0	0	1	4	10	12	4	7	2	0	0	40
NNW	0	0	1	0	6	6	12	3	0	0	0	28
Tot	0	6	11	51	216	171	81	38	22	3	0	599
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 599												
Hours of Missing Data 2												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class D Neutral based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	7	11	18	56	64	48	13	5	1	0	223
NNE	1	6	9	20	48	36	15	9	1	0	0	145
NE	0	5	13	15	42	20	11	2	1	0	0	109
ENE	0	7	12	14	33	21	6	1	0	0	0	94
E	1	1	13	20	48	33	15	2	2	0	0	135
ESE	0	6	11	25	80	63	25	2	4	0	0	216
SE	1	6	17	43	153	70	21	3	0	0	0	314
SSE	0	4	17	38	103	69	34	10	9	0	0	284
S	0	8	10	25	57	63	25	19	18	2	0	227
SSW	0	5	9	23	44	43	32	16	15	0	0	187
SW	0	6	17	19	32	24	23	9	7	0	0	137
WSW	0	5	7	16	18	19	12	10	7	1	0	95
W	0	4	14	19	27	23	14	12	18	0	0	131
WNW	1	10	16	27	65	72	36	25	16	0	0	268
NW	0	5	14	30	75	44	52	38	7	0	0	265
NNW	0	4	11	35	80	68	38	15	12	1	0	264
Tot	4	89	201	387	961	732	407	186	122	5	0	3094
Hours of Calm 3												
Hours of Variable Direction 0												
Hours of Valid Data 3097												
Hours of Missing Data 2												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class E Slightly Stable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	9	9	18	38	20	3	0	0	0	0	97
NNE	0	9	19	23	28	12	2	0	0	0	0	93
NE	2	12	17	30	33	2	1	1	1	0	0	99
ENE	0	7	13	18	19	4	0	0	0	0	0	61
E	1	16	14	19	37	13	2	0	0	0	0	102
ESE	2	16	27	45	49	7	4	1	0	0	0	151
SE	4	24	54	100	133	43	5	3	0	0	0	366
SSE	1	8	18	57	144	62	27	17	7	0	0	341
S	0	16	18	24	75	95	59	39	16	0	0	342
SSW	1	16	10	15	53	45	24	20	8	0	0	192
SW	0	5	16	17	43	36	5	2	2	0	0	126
WSW	2	8	19	18	40	21	9	1	0	0	0	118
W	1	7	8	14	44	48	10	7	1	0	0	140
WNW	3	18	19	23	45	18	12	6	0	0	0	144
NW	1	20	30	41	41	18	3	4	0	0	0	158
NNW	0	7	22	26	51	25	3	1	0	1	0	136
Tot	18	198	313	488	873	469	169	102	35	1	0	2666
Hours of Calm 13												
Hours of Variable Direction 0												
Hours of Valid Data 2679												
Hours of Missing Data 2												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class F Moderately Stable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	3	10	14	24	8	1	0	0	0	0	0	60
NNE	0	12	14	11	5	0	0	0	0	0	0	42
NE	2	12	13	12	6	0	0	0	0	0	0	45
ENE	2	11	17	8	2	0	0	0	0	0	0	40
E	0	8	9	8	3	0	0	0	0	0	0	28
ESE	2	18	18	14	2	0	0	0	0	0	0	54
SE	4	29	42	42	27	1	0	0	0	0	0	145
SSE	3	16	42	52	148	17	0	0	0	0	0	278
S	2	16	14	31	48	24	1	0	0	0	0	136
SSW	2	10	10	15	27	8	0	0	0	0	0	72
SW	1	7	10	25	32	1	0	0	0	0	0	76
WSW	3	7	8	8	9	2	0	0	0	0	0	37
W	2	12	5	2	4	3	0	0	0	0	0	28
WNW	0	11	19	16	6	0	0	0	0	0	0	52
NW	0	9	29	29	9	0	0	0	0	0	0	76
NNW	0	17	14	15	18	0	0	0	0	0	0	64
Tot	26	205	278	312	354	57	1	0	0	0	0	1233
Hours of Calm 21												
Hours of Variable Direction 0												
Hours of Valid Data 1254												
Hours of Missing Data 2												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class G Extremely Stable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	1	23	7	1	1	0	0	0	0	0	0	33
NNE	4	11	9	1	1	0	0	0	0	0	0	26
NE	3	16	5	1	0	0	0	0	0	0	0	25
ENE	1	8	2	0	1	0	0	0	0	0	0	12
E	3	8	0	0	0	0	0	0	0	0	0	11
ESE	0	9	4	0	0	0	0	0	0	0	0	13
SE	5	23	11	6	0	0	0	0	0	0	0	45
SSE	4	19	30	20	35	8	0	0	0	0	0	116
S	4	12	6	13	9	3	0	0	0	0	0	47
SSW	1	8	8	3	5	0	0	0	0	0	0	25
SW	0	8	4	7	2	1	0	0	0	0	0	22
WSW	0	7	5	2	1	0	0	0	0	0	0	15
W	1	7	1	2	2	0	0	0	0	0	0	13
WNW	0	9	6	2	0	0	0	0	0	0	0	17
NW	2	5	14	5	6	0	0	0	0	0	0	32
NNW	2	4	14	15	4	1	0	0	0	0	0	40
Tot	31	177	126	78	67	13	0	0	0	0	0	492
Hours of Calm 30												
Hours of Variable Direction 0												
Hours of Valid Data 522												
Hours of Missing Data 2												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
All Stabilities												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	3	14	17	43	64	83	87	78	6	2	397
NNE	0	4	10	17	50	74	104	63	29	2	0	353
NE	0	6	15	23	41	83	86	46	15	3	1	319
ENE	0	3	5	9	50	82	75	41	12	0	0	277
E	0	3	6	21	48	78	86	59	9	3	0	313
ESE	0	2	10	18	64	102	128	82	29	0	3	438
SE	0	7	45	91	309	278	132	47	15	1	0	925
SSE	0	3	13	27	142	210	189	197	126	21	5	933
S	0	4	10	23	90	137	171	159	241	75	7	917
SSW	0	2	5	10	89	110	142	161	196	63	14	792
SW	0	2	9	21	63	61	74	101	164	23	15	533
WSW	0	0	3	15	39	41	44	71	91	19	9	332
W	0	2	6	15	50	51	61	85	114	36	23	443
WNW	0	3	8	13	45	62	83	137	171	54	38	614
NW	0	2	4	15	58	97	95	128	133	66	19	617
NNW	0	2	6	21	64	59	98	97	89	18	2	456
Tot	0	48	169	356	1245	1589	1651	1561	1512	390	138	8659
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 8659												
Hours of Missing Data 125												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class A Extremely Unstable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1-1.5	1.6-2	2.1-3	3.1-4	4.1-5	5.1-6	6.1-8	8.1-10	>10.00	Total
N	0	0	0	0	0	0	0	2	6	0	0	8
NNE	0	0	0	1	0	0	0	0	0	0	0	1
NE	0	0	0	1	0	0	2	0	0	0	0	3
ENE	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	2	0	0	0	0	2
ESE	0	0	0	0	0	0	2	2	5	0	0	9
SE	0	0	0	0	0	6	8	7	6	0	0	27
SSE	0	0	0	0	0	5	7	9	6	1	0	28
S	0	0	0	0	0	2	0	4	7	3	0	16
SSW	0	0	0	0	0	1	4	1	10	5	2	23
SW	0	0	0	0	0	0	6	6	12	2	4	30
WSW	0	0	0	0	0	2	2	2	0	0	0	6
W	0	0	0	0	0	1	6	9	10	5	3	34
WNW	0	0	0	0	0	2	6	9	17	7	7	48
NW	0	0	0	0	0	0	3	5	12	10	6	36
NNW	0	0	0	0	0	1	0	3	7	4	0	15
Tot	0	0	0	2	0	20	48	59	98	37	22	286
Hours of Calm	0											
Hours of Variable Direction	0											
Hours of Valid Data	286											
Hours of Missing Data	125											
Hours in Period	8784											

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class B Moderately Unstable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	0	0	0	0	1	0	6	8	1	0	16
NNE	0	0	0	0	0	2	0	0	0	0	0	2
NE	0	0	0	0	0	8	6	0	1	0	0	15
ENE	0	0	0	0	0	4	4	0	0	0	0	8
E	0	0	0	0	0	5	1	2	0	0	0	8
ESE	0	0	0	0	0	6	1	1	1	0	0	9
SE	0	0	0	0	3	10	6	2	0	0	0	21
SSE	0	0	0	0	0	11	7	8	1	1	0	28
S	0	0	0	0	6	10	9	6	10	1	0	42
SSW	0	0	0	0	2	10	10	9	8	1	1	41
SW	0	0	0	0	1	9	7	8	11	2	1	39
WSW	0	0	0	0	2	3	4	3	3	1	0	16
W	0	0	0	0	0	5	4	7	9	6	0	31
WNW	0	0	0	0	0	1	2	3	8	2	2	18
NW	0	0	0	0	0	5	6	7	6	3	1	28
NNW	0	0	0	0	0	4	8	6	3	1	0	22
Tot	0	0	0	0	14	94	75	68	69	19	5	344
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 344												
Hours of Missing Data 125												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class C Slightly Unstable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	0	0	1	3	2	3	3	5	0	0	17
NNE	0	0	0	0	0	5	6	2	0	0	0	13
NE	0	0	0	0	4	7	4	5	0	0	0	20
ENE	0	0	0	0	5	11	5	2	0	0	0	23
E	0	0	0	1	1	8	2	1	0	0	0	13
ESE	0	0	0	1	1	6	4	0	0	0	0	12
SE	0	0	0	1	17	15	7	3	0	0	0	43
SSE	0	0	0	1	21	25	15	5	3	1	0	71
S	0	0	0	1	12	14	16	11	9	5	0	68
SSW	0	0	0	3	16	25	9	5	12	4	4	78
SW	0	0	0	4	14	8	7	8	8	1	3	53
WSW	0	0	0	1	6	3	1	5	4	2	1	23
W	0	0	0	1	8	9	6	10	8	2	2	46
WNW	0	1	0	2	7	7	8	10	3	1	5	44
NW	0	0	0	1	5	7	3	7	5	7	2	37
NNW	0	0	0	0	2	2	3	9	6	1	0	23
Tot	0	1	0	18	122	154	99	86	63	24	17	584
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 584												
Hours of Missing Data 125												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class D Neutral based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	2	7	8	21	29	34	42	35	4	2	184
NNE	0	4	7	9	22	37	32	15	21	2	0	149
NE	0	2	8	16	25	29	19	12	6	2	0	119
ENE	0	1	1	4	25	24	14	11	5	0	0	85
E	0	2	3	8	30	26	26	20	6	3	0	124
ESE	0	1	5	10	36	44	50	35	16	0	3	200
SE	0	2	5	21	108	97	37	22	4	1	0	297
SSE	0	1	8	12	62	73	49	38	36	7	3	289
S	0	1	3	14	39	42	37	36	38	17	5	232
SSW	0	1	3	5	35	30	28	33	32	13	5	185
SW	0	1	6	11	28	16	16	21	31	12	5	147
WSW	0	0	3	9	16	11	12	16	22	10	8	107
W	0	1	4	8	28	16	13	16	18	13	15	132
WNW	0	2	3	6	22	32	42	52	74	29	23	285
NW	0	1	2	9	36	54	34	40	72	42	10	300
NNW	0	1	2	14	46	23	41	38	42	11	1	219
Tot	0	23	70	164	579	583	484	447	458	166	80	3054
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 3054												
Hours of Missing Data 125												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class E Slightly Stable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	0	6	4	13	20	27	22	9	0	0	101
NNE	0	0	1	2	19	10	31	24	7	0	0	94
NE	0	2	3	3	8	24	42	14	3	1	1	101
ENE	0	1	2	1	7	24	25	14	2	0	0	76
E	0	0	2	5	9	24	32	22	3	0	0	97
ESE	0	1	1	2	13	33	49	33	7	0	0	139
SE	0	2	15	28	123	128	63	12	5	0	0	376
SSE	0	1	2	5	30	51	57	66	43	11	2	268
S	0	2	5	5	17	26	39	50	126	49	2	321
SSW	0	0	1	1	21	15	30	51	94	32	2	247
SW	0	0	1	2	14	20	21	29	54	5	2	148
WSW	0	0	0	0	8	16	11	29	36	4	0	104
W	0	1	2	5	9	8	18	31	59	10	3	146
WNW	0	0	3	2	10	15	17	49	52	15	1	164
NW	0	1	0	4	12	21	37	50	27	4	0	156
NNW	0	0	3	3	11	21	30	22	18	1	1	110
Tot	0	11	47	72	324	456	529	518	545	132	14	2648
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 2648												
Hours of Missing Data 125												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class F Moderately Stable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	1	0	4	3	11	13	6	9	1	0	48
NNE	0	0	1	2	6	13	18	15	1	0	0	56
NE	0	2	4	1	4	10	6	14	3	0	0	44
ENE	0	1	1	3	9	9	17	8	4	0	0	52
E	0	1	0	2	4	11	18	11	0	0	0	47
ESE	0	0	0	1	8	7	14	9	0	0	0	39
SE	0	3	12	27	50	16	11	1	0	0	0	120
SSE	0	0	3	6	24	31	42	65	33	0	0	204
S	0	1	2	1	12	30	49	32	38	0	0	165
SSW	0	1	0	1	11	18	35	40	32	8	0	146
SW	0	1	2	1	3	7	10	19	40	1	0	84
WSW	0	0	0	5	4	4	12	11	22	1	0	59
W	0	0	0	1	4	10	10	6	8	0	0	39
WNW	0	0	0	0	1	3	6	9	12	0	0	31
NW	0	0	1	1	4	8	10	15	11	0	0	50
NNW	0	1	0	3	3	4	16	15	5	0	0	47
Tot	0	12	26	59	150	192	287	276	218	11	0	1231
Hours of Calm 0												
Hours of Variable Direction 0												
Hours of Valid Data 1231												
Hours of Missing Data 125												
Hours in Period 8784												

Joint Frequency Distribution: Hours at Wind Speed and Direction												
January- December, 2016												
Class G Extremely Stable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											
	<0.50	0.5- 1	1.1- 1.5	1.6- 2	2.1- 3	3.1- 4	4.1- 5	5.1- 6	6.1- 8	8.1- 10	>10.00	Total
N	0	0	1	0	3	1	6	6	6	0	0	23
NNE	0	0	1	3	3	7	17	7	0	0	0	38
NE	0	0	0	2	0	5	7	1	2	0	0	17
ENE	0	0	1	1	4	10	10	6	1	0	0	33
E	0	0	1	5	4	4	5	3	0	0	0	22
ESE	0	0	4	4	6	6	8	2	0	0	0	30
SE	0	0	13	14	8	6	0	0	0	0	0	41
SSE	0	1	0	3	5	14	12	6	4	0	0	45
S	0	0	0	2	4	13	21	20	13	0	0	73
SSW	0	0	1	0	4	11	26	22	8	0	0	72
SW	0	0	0	3	3	1	7	10	8	0	0	32
WSW	0	0	0	0	3	2	2	5	4	1	0	17
W	0	0	0	0	1	2	4	6	2	0	0	15
WNW	0	0	2	3	5	2	2	5	5	0	0	24
NW	0	0	1	0	1	2	2	4	0	0	0	10
NNW	0	0	1	1	2	4	0	4	8	0	0	20
Tot	0	1	26	41	56	90	129	107	61	1	0	512
Hours of Calm	0											
Hours of Variable Direction	0											
Hours of Valid Data	512											
Hours of Missing Data	125											
Hours in Period	8784											

Appendix C

Corrections to the 2010- 2015 Annual Radioactive Effluent Release Reports

Regulatory Limits

The Callaway regulatory limits are provided in the Radiological Effluent Controls in FSAR-SP/ODCM Chapter 16.11.

Fission and Activation Gases (Noble Gases)

The dose rate due to radioactive noble gases released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin.

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:

c. During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation; and
d. During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

Radioiodine, Tritium, And Particulates

The dose rate due to Iodine-131 and Iodine-133, tritium and all radionuclides in particulate form with half-lives greater than eight (8) days released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to less than or equal to 1500 mrem/yr to any organ.

The dose to a Member of the Public from Iodine-131 and Iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than eight (8) days in gaseous effluents released to areas at and beyond the site boundary shall be limited to the following:

c. During any calendar quarter: Less than or equal to 7.5 mrem to any organ; and
d. During any calendar year: Less than or equal to 15 mrem to any organ.

Liquid Effluents

The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to 10 times the concentrations specified in 10 CFR 20 Appendix B To Part 20, Table 2, Column 2 (Effluent Concentrations) for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-04 µCi/mL total activity.

The dose or dose commitment to an Individual from radioactive materials in liquid effluents released to unrestricted areas shall be limited:

c. During any calendar quarter to less than or equal to 1.5 mrem to the total body and less than or equal to 5 mrem to any organ; and
d. During any calendar year to less than or equal to 3 mrem to the whole body and to less than or equal to 10 mrem to any organ.

Uranium Fuel Cycle Sources

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 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

Measurements of Radioactivity

For the years 2010- 2015, radionuclide concentrations in liquid and gaseous effluents were obtained by effluent sampling and radiological analysis in accordance with the requirements of FSAR-SP/ODCM REC Table 16.11-1 and Table 16.11-4. Gamma spectroscopy was the primary analysis technique used to determine the radionuclide composition and concentration of liquid and gaseous effluents. Composite samples were analyzed for the hard to detect nuclides by an independent laboratory. Tritium and gross alpha were measured for both liquid and gaseous effluents using liquid scintillation counting and gas flow proportional counting techniques, respectively. The total radioactivity in effluent releases was determined from the measured concentrations of each radionuclide present and the total volume of effluents discharged.

The concept of average energy is not applicable to the Callaway Plant radiological effluent monitoring program since the release rate limits for fission and activation gases in gaseous effluent are not based on the average energy of the radionuclide mixture.

Gaseous Batch Releases 2015		Q1 & Q2	Q3 & Q4
Number of batch releases:		38	36
Total time period for batch releases:	minutes	5239	6272
Max. time period for a batch release:	minutes	932	4456
Avg. time period for a batch release:	minutes	138	174
Min. time period for a batch release:	minutes	32	27

Liquid Batch Releases 2015		Q1 & Q2	Q3 & Q4
Number of batch releases:		27	29
Total time period for batch releases:	minutes	10833	13949
Max. time period for a batch release:	minutes	571	813
Avg. time period for a batch release:	minutes	401	481
Min. time period for a batch release:	minutes	342	335

Gaseous Batch Releases 2014		Q1 & Q2	Q3 & Q4
Number of batch releases:		32	23
Total time period for batch releases:	minutes	2672	17222
Max. time period for a batch release:	minutes	414	9928
Avg. time period for a batch release:	minutes	84	749
Min. time period for a batch release:	minutes	21	27

Liquid Batch Releases 2014		Q1 & Q2	Q3 & Q4
Number of batch releases:		19	35
Total time period for batch releases:	minutes	8953	14572
Max. time period for a batch release:	minutes	870	687
Avg. time period for a batch release:	minutes	471	416
Min. time period for a batch release:	minutes	121	163

Gaseous Batch Releases 2013		Q1 & Q2	Q3 & Q4
Number of batch releases:		25	25
Total time period for batch releases:	minutes	19543	1464
Max. time period for a batch release:	minutes	9558	292
Avg. time period for a batch release:	minutes	782	59
Min. time period for a batch release:	minutes	17	25

Liquid Batch Releases 2013		Q1 & Q2	Q3 & Q4
Number of batch releases:		53	23
Total time period for batch releases:	minutes	25996	8791
Max. time period for a batch release:	minutes	1125	450
Avg. time period for a batch release:	minutes	490	382
Min. time period for a batch release:	minutes	247	256

Gaseous Batch Releases 2012		Q1 & Q2	Q3 & Q4
Number of batch releases:		29	26
Total time period for batch releases:	minutes	14212	1639
Max. time period for a batch release:	minutes	11520	308
Avg. time period for a batch release:	minutes	490	63
Min. time period for a batch release:	minutes	27	29

Liquid Batch Releases 2012		Q1 & Q2	Q3 & Q4
Number of batch releases:		27	27
Total time period for batch releases:	minutes	11474	13277
Max. time period for a batch release:	minutes	489	816
Avg. time period for a batch release:	minutes	425	492
Min. time period for a batch release:	minutes	276	266

Gaseous Batch Releases 2011		Q1 & Q2	Q3 & Q4
Number of batch releases:		31	28
Total time period for batch releases:	minutes	2468	9318
Max. time period for a batch release:	minutes	423	3797
Avg. time period for a batch release:	minutes	80	333
Min. time period for a batch release:	minutes	35	14

Liquid Batch Releases 2011		Q1 & Q2	Q3 & Q4
Number of batch releases:		28	52
Total time period for batch releases:	minutes	13929	25149
Max. time period for a batch release:	minutes	911	909
Avg. time period for a batch release:	minutes	497	484
Min. time period for a batch release:	minutes	220	2

Gaseous Batch Releases 2010		Q1 & Q2	Q3 & Q4
Number of batch releases:		30	29
Total time period for batch releases:	minutes	27307	2496
Max. time period for a batch release:	minutes	7291	1031
Avg. time period for a batch release:	minutes	910	86
Min. time period for a batch release:	minutes	43	39

Liquid Batch Releases 2010		Q1 & Q2	Q3 & Q4
Number of batch releases:		61	62
Total time period for batch releases:	minutes	33526	29125
Max. time period for a batch release:	minutes	2112	612
Avg. time period for a batch release:	minutes	550	470
Min. time period for a batch release:	minutes	375	277

Appendix D

Changes to Radiological Effluent Controls (FSAR-SP Chapter 16.11)

16.11 (ODCM 9.0) OFFSITE DOSE CALCULATION MANUAL RADIOACTIVE EFFLUENT CONTROLS

16.11.1 LIQUID EFFLUENT

16.11.1.1 LIQUID EFFLUENTS CONCENTRATION LIMITING CONDITION FOR OPERATION

(ODCM 9.3.1)

The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see Figure 16.11-1) shall be limited to 10 times the concentration values in Appendix B, Table 2, Column 2 to 10 CFR 20.1001-20.2402, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} microCurie/ml total activity.

APPLICABILITY: At all times.

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.

16.11.1.1.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.3.2)

16.11.1.1.1.a

Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 16.11-1.

16.11.1.1.1.b

The results of the radioactivity analysis shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of Section 16.11.1.1.

16.11.1.1.2 BASES

This section is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than 10 times the concentration in Appendix B, Table 2, Column 2 to 10 CFR 20.1001-20.2402. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within: (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC, and

(2) the limits of 10 CFR Part 20.1301 to the population. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLD's).

16.11.1.2 DOSE FROM LIQUID EFFLUENTS LIMITING CONDITION FOR OPERATION

(ODCM 9.4.1)

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 16.11-1) 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.

APPLICABILITY: At all times.

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: (1) the results of radiological analyses of the drinking water source, and (2) the radiological impact on finished drinking water supplies with regard to the requirements of 40 CFR Part 141, Clean Drinking Water Act.*

16.11.1.2.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.4.2)

Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

16.11.1.2.2 BASES

This section is provided to implement the requirements of Sections II.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required

* The requirements of ACTION a.(1) and (2) are applicable only if drinking water supply is taken from the receiving water body within 3 miles of the plant discharge. In the case of river-sited plants this is 3 miles downstream only.

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, "Calculations of Annual Doses to Man from Routine Releases of Reactor Effluents with 10 CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic and Dispersion of Effluents from accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I", April 1977.

The reporting requirements of Action(a) implement the requirements of 10CFR20.2203.

16.11.1.3 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION LIMITING CONDITION FOR OPERATION

(ODCM 9.1.1)

The radioactive liquid effluent monitoring instrumentation channels shown in Table 16.11-2 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of Section 16.11.1.1 are not exceeded. The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

APPLICABILITY: At all times.

ACTION:

a. 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 non-functional.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels FUNCTIONAL, take the ACTION shown in Table 16.11-2. Restore the non-functional instrumentation to FUNCTIONAL status within 30 days and, if unsuccessful, explain in the next Radioactive Effluent Release Report, pursuant to Technical Specification 5.6.3, why this non-functionality was not corrected within the time specified.

16.11.1.3.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.1.2)

Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL OPERATIONAL TEST at the frequencies shown in Table 16.11-3.

16.11.1.3.2 BASES

The radioactive liquid effluent monitoring 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 FUNCTIONALITY 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.

16.11.1.4 LIQUID RADWASTE TREATMENT SYSTEM LIMITING CONDITION FOR OPERATION

(ODCM 9.5.1)

The Liquid Radwaste Treatment System shall be FUNCTIONAL and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS (see Figure 16.11-1) would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31 day period.

APPLICABILITY: At all times.

ACTION:

With radioactive liquid waste being discharged in excess of the above limits and the Liquid Radwaste Treatment Systems are not being fully utilized, prepare and submit to the Commission within 30 days a Special Report that includes the following information:

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

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

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

16.11.1.4.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.5.2)

16.11.1.4.1.a

Doses due to liquid releases from each unit to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM.

16.11.1.4.1.b

The installed Liquid Radwaste Treatment System shall be considered FUNCTIONAL by meeting Sections 16.11.1.1 and 16.11.1.2.

16.11.1.4.2 BASES

The FUNCTIONALITY of the Liquid Radwaste Treatment System 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 the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

16.11.1.5 LIQUID HOLDUP TANKS
LIMITING CONDITION FOR OPERATION

The quantity of radioactive material contained in each of the following unprotected outdoor tanks shall be limited to less than or equal to 150 Curies, excluding tritium and dissolved or entrained noble gases:

a. Reactor Makeup Water Storage Tank,

b. Refueling Water Storage Tank,

c. Condensate Storage Tank, and

d. Outside temporary tanks, excluding demineralizer vessels and the liner being used to solidify radioactive waste.

APPLICABILITY: At all times.

ACTION:

With the quantity of radioactive material in any of the above listed tanks exceeding the above limit, immediately suspend all additions of radioactive material to the tank, within 48 hours reduce the tank contents to within the limit, and describe the events leading to this condition in the next Radioactive Effluent Release Report, pursuant to Technical Specification 5.6.3.

e.

16.11.1.5.1 SURVEILLANCE REQUIREMENTS

(4.11.1.4)

The quantity of radioactive material contained in each of the above listed tanks shall be determined to be within the above limit by analyzing a representative sample of the tank's contents at least once per 7 days when radioactive materials are being added and within 7 days following any addition of radioactive material to the tank. The provisions of Sections 16.0.2.2 and 16.0.2.3 are applicable, however the allowed surveillance interval extension beyond 25% shall not be exceeded. These tanks are also covered by Administrative Controls Section 5.5.12 of the plant Technical Specifications.

16.11.1.5.2 BASES

The tanks listed above include all those outdoor radwaste tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the Liquid Radwaste Treatment System.

Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of the tanks' contents, the resulting concentrations would be less than the limits of 10 CFR Part 20.1-20.602, Appendix B, Table II, Column 2, (redesignated at 56FR23391, May 21, 1991) at the nearest potable water supply and the nearest surface water supply in an UNRESTRICTED AREA.

16.11.2 GASEOUS EFFLUENTS

16.11.2.1 GASEOUS EFFLUENTS DOSE RATE LIMITING CONDITION OF OPERATION

(ODCM 9.6.1)

The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY (see Figure 16.11-2) 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.

APPLICABILITY: At all times.

ACTION:

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

16.11.2.1.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.6.2)

16.11.2.1.1.a

The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM.

16.11.2.1.1.b

The dose rate due to Iodine-131 and 133, tritium and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 16.11-4.

16.11.2.1.2 BASES

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 dose rate limits are the

doses associated with the concentrations of 10 CFR Part 20.1-20.601, 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 dose limits specified in 10 CFR Part 20 10 CFR 20.1301. 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. Examples of calculations for such MEMBERS OF THE PUBLIC, with the appropriate occupancy factors, shall be given in the ODCM. 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 mrem/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 (LLD's).

The requirement for additional sampling of the Unit Vent following a reactor power transient is provided to ensure that the licensee is aware of and properly accounts for any increases in the release of gaseous effluents due to spiking which may occur as a result of the power transient. Monitoring the Unit Vent for increased noble gas activity is appropriate because it is the release point for any increased activity which may result from the power transient.

Since the escape rate coefficients for the noble gas nuclides is equal to or greater than the escape rate coefficient for iodine and the particulate nuclides*,** , it is reasonable to assume that the RCS spiking behavior of the noble gas nuclides is similar to that of the particulate and iodine nuclides. Considering the effects of iodine and particulate partitioning, plateout on plant and ventilation system surfaces, and the 99% efficiency of the Unit Vent HEPA filters and charcoal absorbers, it is reasonable to assume that the relative concentrations of the noble gas nuclides will be much greater than those of the iodine and particulate nuclides. Therefore, an increase in the iodine and particulate RCS activity is not an appropriate indicator of an increase in the Unit Vent activity, and it is appropriate to monitor the Unit Vent effluent activity as opposed to the RCS activity as an indicator of the need to perform post-transient sampling. In addition, it is appropriate to monitor the noble gas activity due to its relatively greater concentration in the Unit Vent.

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* Cohen, Paul, Water Coolant Technology of Power Reactors, Table 5.19, page 198. American Nuclear Society. 1980.

** NUREG-0772, “Technical Bases for Estimating Fission Product Behavior During LWR Accidents”, Silberberg, M., editor, USNRC; Figure 4.3, page 4.22. June, 1981.

16.11.2.2 DOSE - NOBLE GASES LIMITING CONDITION OF OPERATION

(ODCM 9.7.1)

The air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY (see Figure 16.11-2) shall be limited to the following:

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

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.

APPLICABILITY: At all times.

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.

16.11.2.2.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.7.2)

Cumulative dose contributions for the current calendar quarter and current calendar year for noble gases shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

16.11.2.2.2 BASES

This section is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.B of Appendix I. The ACTION statement 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 noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases on Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors", Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

The reporting requirements of Action(a) implement the requirements of 10CFR20.2203.

16.11.2.3 DOSE - IODINE-131 AND 133, TRITIUM, AND RADIOACTIVE MATERIAL IN PARTICULATE FORM LIMITING CONDITION OF OPERATION

(ODCM 9.8.1)

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 16.11-2) 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.

APPLICABILITY: At all times.

ACTION:

a. 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.

b. The provisions of Sections 16.0.1.3 and 16.0.1.4 are not applicable.

16.11.2.3.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.8.2)

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 methodology and parameters in the ODCM at least once per 31 days.

16.11.2.3.2 BASES

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 Limiting Conditions for Operation are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the release of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept "as low as 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, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors", Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate controls for Iodine-131, and 133, tritium, and radionuclides in particulate form with half-lives greater than 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 of radionuclides onto grassy areas where milk animals and meat-producing animals graze with consumption of the milk and meat by man, and (4) deposition on the ground with subsequent exposure of man.

The reporting requirements of Action(a) implement the requirements of 10CFR20.2203.

16.11.2.4 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION LIMITING CONDITION FOR OPERATION

(ODCM 9.2.1)

The radioactive gaseous effluent monitoring instrumentation channels shown in Table 16.11-5 shall be FUNCTIONAL with their Alarm/Trip Setpoints set to ensure that the limits of Section 16.11.2.1 are not exceeded. The Alarm/Trip Setpoints of these channels meeting Section 16.11.2.1 shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

APPLICABILITY: As shown in Table 16.11-5.

ACTION:

a. With a radioactive gaseous effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above, immediately declare the channel non-functional.

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels FUNCTIONAL, take the ACTION shown in Table 16.11-5. Restore the non-functional instrumentation to FUNCTIONAL status within the time specified in the ACTION, or explain in the next Radioactive Effluent Release Report, pursuant to Technical Specification 5.6.3, why this non-functionality was not corrected within the time specified.

16.11.2.4.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.2.2)

Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL OPERATIONAL TEST at the frequencies shown in Table 16.11-6.

16.11.2.4.2 BASES

The radioactive gaseous effluent monitoring 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 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 FUNCTIONALITY 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 16.11.2.1 shall be such that concentrations as low as 1×10^{-6} μCi/cc are measurable.

The monitors GT-RE-22 and GT-RE-33 are only required for automatic containment purge isolation in MODES 1 through 4. For plant conditions during CORE ALTERATIONS and during movement of irradiated fuel within containment, the function of the monitors is to alarm only and the trip signals for automatic actuation of CPIS may be bypassed. Based on the guidance provided in Regulatory Guide 1.97 concerning monitoring requirements for containment or purge effluent, the monitors GT-RE-22 and GT-RE-33 do not need to meet the single failure criterion for an Alarm function only during CORE ALTERATIONS or during movement of irradiated fuel in containment. One instrumentation channel at a minimum is required for the alarm only function during refueling activities.

In the event that the containment mini-puge supply and exhaust valves have been closed to satisfy Action 41 of Table 16.11-5 due to non-functionality of GTRE0022 and/or GTRE0033, an allowance is provided in Action 41 to open the containment mini-purge supply and exhaust valves under administrative controls for the purpose of equalizing containment pressure. The administrative controls consist of designating a control room operator to rapidly close the valves when a need for system isolation is indicated.

16.11.2.5 GASEOUS RADWASTE TREATMENT SYSTEM LIMITING CONDITION OF OPERATION

(ODCM 9.9.1)

The VENTILATION EXHAUST TREATMENT SYSTEM and the WASTE GAS HOLDUP SYSTEM shall be FUNCTIONAL 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 16.11-2) 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.

APPLICABILITY: At all times

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:

1) Identification of any non-functional equipment or subsystems, and the reason for the non-functionality,

2) Action(s) taken to restore the non-functional equipment to FUNCTIONAL status, and

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

16.11.2.5.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.9.2)

16.11.2.5.1.a

Doses due to gaseous releases to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM.

16.11.2.5.1.b

The installed VENTILATION EXHAUST TREATMENT SYSTEM and the WASTE GAS HOLDUP SYSTEMS shall be considered FUNCTIONAL by meeting Sections 16.11.2.1 and 16.11.2.2 or 16.11.2.3.

16.11.2.5.2 BASES

The FUNCTIONALITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensures that the system will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." This control implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and the design objectives given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

16.11.2.6 EXPLOSIVE GAS MIXTURE LIMITING CONDITION FOR OPERATION

The concentration of oxygen in the WASTE GAS HOLDUP SYSTEM shall be limited to less than or equal to 3% by volume whenever the hydrogen concentration exceeds 4% by volume.

APPLICABILITY: At all times.

ACTION:

a. With the concentration of oxygen in the WASTE GAS HOLDUP SYSTEM greater than 3% by volume but less than or equal to 4% by volume, reduce the oxygen concentration to the above limit within 48 hours.

b. With the concentration of oxygen in the WASTE GAS HOLDUP SYSTEM greater than 4% by volume and the hydrogen concentration greater than 4% by volume, immediately suspend all additions of waste gases to the system and reduce the concentration on oxygen to less than or equal to 4% by volume, then take ACTION a. above.

16.11.2.6.1 SURVEILLANCE REQUIREMENTS

The concentrations of hydrogen and oxygen in the WASTE GAS HOLDUP SYSTEM shall be determined to be within the above limits by continuously monitoring the waste gases in the WASTE GAS HOLDUP SYSTEM with the hydrogen and oxygen monitors required FUNCTIONAL by Section 16.11.2.7. This system is covered by Technical Specification 5.5.12 which governs surveillance test frequencies and missed surveillances.

16.11.2.6.2 BASES

This Requirement is provided to ensure that the concentration of potentially explosive gas mixtures contained in the WASTE GAS HOLDUP SYSTEM is maintained below the flammability limits of hydrogen and oxygen. Automatic control features are included in the system to prevent the hydrogen and oxygen concentrations from reaching these flammability limits. These automatic control features include isolation of the source of hydrogen and/or oxygen. Maintaining the concentration of hydrogen and oxygen below their flammability limits provides assurance that the releases of radioactive materials will be controlled in conformance with the requirements of General Design Criterion 60 of Appendix A to 10 CFR Part 50.

16.11.2.7 WASTE GAS HOLDUP SYSTEM RECOMBINER EXPLOSIVE GAS MONITORING INSTRUMENTATION LIMITING CONDITION FOR OPERATION

At least one hydrogen and both the inlet and outlet oxygen explosive gas monitoring instrument channels for each WASTE GAS HOLDUP SYSTEM recombiner shall be FUNCTIONAL with their Alarm/Trip Setpoints (with the exception of the "FEED H2 4%/ FEED O2 3%" and "FEED H2 4%/FEED O2 4%" alarms) set to ensure that the limits of Section 16.11.2.6 are not exceeded.

APPLICABILITY: During WASTE GAS HOLDUP SYSTEM operation.

ACTION:

a. With an outlet oxygen monitor channel non-functional, operation of the system may continue provided grab samples are taken and analyzed at least once per 24 hours.

b. With both oxygen or both hydrogen channels or both the inlet oxygen and inlet hydrogen monitor channels for one recombiner non-functional, suspend oxygen supply to the recombiner. Addition of waste gas to the system may continue provided grab samples are taken and analyzed at least: 1) once per 4 hours during mechanical or chemical degassing in preparation for plant shutdown, and 2) once per 24 hours during other operations.

c. With the inlet oxygen analyzer non-functional, operation of the system may continue provided the inlet hydrogen is maintained less than 4%. If inlet hydrogen is greater than 4%, suspend oxygen to the recombiner. Addition of waste gas to the system may continue provided grab samples are taken and analyzed at least: 1) once per 4 hours during mechanical or chemical degassing operations in preparation for plant shutdown, and 2) once per 24 hours during other operations.

16.11.2.7.1 SURVEILLANCE REQUIREMENTS

This system is covered by Technical Specification 5.5.12 which governs surveillance test frequencies and missed surveillances.

Each waste gas holdup system recombiner explosive gas monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of:

a. A CHANNEL CHECK at least once per 24 hours,

b. Not used

c. A CHANNEL CALIBRATION at least once per 92 days with the use of standard gas samples containing a nominal:

1) One volume percent hydrogen, balance nitrogen and four volume percent hydrogen, balance nitrogen for the hydrogen monitor, and

2) One volume percent oxygen, balance nitrogen, and four volume percent oxygen, balance nitrogen for the inlet oxygen monitor, and

3) 10 ppm by volume oxygen, balance nitrogen and 80 ppm by volume oxygen, balance nitrogen for the outlet oxygen monitor.

16.11.2.7.2 BASES

Mechanical 'degassing operation' is defined as the transfer of gas from the Volume Control Tank (VCT) to the Waste Gas Holdup System when establishing a nitrogen blanket on the VCT in preparation for a plant shutdown. Chemical 'degassing operation' is the process of adding hydrogen peroxide to the RCS after the VCT hydrogen blanket has been replaced with nitrogen per the mechanical degassification process and the RCS has been reduced to less than 180°F. Both mechanical and chemical degassification may lead to an explosive gas mixture in the Waste Gas Holdup System, thus requiring the more restrictive 4-hour sampling. Other operations require 24-hour sampling.

The "FEED H2 4%/FEED O2 3%" AND "FEED H2 4%/FEED O2 4%" alarms are not required to be FUNCTIONAL. These alarms result from the combination of inlet hydrogen and inlet oxygen analyzer outputs while the FSAR only addresses FUNCTIONALITY of each separate analyzer. Only the individual alarms and control functions associated with each analyzer are to be used to determine its functionality. These alarms and control functions are sufficient to ensure that the limits of Section 16.11.2.6 are not exceeded.

The CHANNEL CALIBRATION includes triggering the following alarms at the analyzer and verifying that the required control board annunciators and control functions actuate:

1) Feed Gas High H_2

2) HARC-1104 OAIC-1112 Hi Hi H_2/O_2 O_2 Shutdown

3) H_2 Reactor High Oxygen O_2 Limit

4) Product Gas High H_2

5) Product Gas High Oxygen

6) Product Gas Hi Hi O_2 Shutdown

This surveillance verifies the FUNCTIONALITY of the analyzers' output relays, all interposing relays, and the annunciators. Setpoint verification consists of verifying that the correct setpoint values are entered in the analyzers' database.

16.11.2.8 GAS STORAGE TANKS LIMITING CONDITION FOR OPERATION

The quantity of radioactivity contained in each gas storage tank shall be limited to less than or equal to 2.5×10^5 Curies of noble gases (considered as Xe-133 equivalent).

APPLICABILITY: At all times.

ACTION:

With the quantity of radioactive material in any gas storage tank exceeding the above limit, immediately suspend all additions of radioactive material to the tank and, within 48 hours, reduce the tank contents to within the limit, and describe the events leading to this condition in the next Radioactive Effluent Release Report, pursuant to Technical Specification 5.6.3.

16.11.2.8.1 SURVEILLANCE REQUIREMENTS

The provisions of Sections 16.0.2.2 and 16.0.2.3 are applicable, however the allowed surveillance interval extension beyond 25% shall not be exceeded. This system is also covered by Administrative Controls Section 5.5.12 of the plant Technical Specifications.

The quantity of radioactive material contained in each gas storage tank shall be determined to be within the above limit at least once per 18 months.

16.11.2.8.2 BASES

The tanks included in this Requirement are those tanks for which the quantity of radioactivity contained is not limited directly or indirectly by another Requirement. Restricting the quantity of radioactivity contained in each gas storage tank provides assurance that in the event of an uncontrolled release of the tank's contents, the resulting whole body exposure to a MEMBER OF THE PUBLIC at the nearest SITE BOUNDARY will not exceed 0.5 rem. This is consistent with Standard Review Plan 11.3, Branch Technical Position ETSB 11-5, "Postulated Radioactive Releases Due to a Waste Gas System Leak or Failure," in NUREG-0800, July 1981. The determination of Xe-133 equivalent uses the effective dose conversion factors for air submersion listed in Table III.1 of EPA Federal Guidance Report No. 12, EPA-402-R-93-081, “External Exposure to Radionuclides in Air, Water, and Soil,” 1993.

16.11.3 TOTAL DOSE

16.11.3.1 TOTAL DOSE LIMITING CONDITION FOR OPERATION

(ODCM 9.10.1)

The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to 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 mrem.

APPLICABILITY: At all times.

ACTION:

With the calculated doses from the release of radioactive materials in gaseous effluents exceeding twice the limits of Section 16.11.2.2a, 16.11.2.2b, 16.11.2.3a, or 16.11.2.3b, calculations should be made including direct radiation contributions from the units and from outside storage tanks to determine whether the above limits of Section 16.11.3.1 have 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 release to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in 10 CFR 20.2203, 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.

16.11.3.1.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.10.2)

16.11.3.1.1.a

Cumulative dose contributions from gaseous effluents shall be determined in accordance with Sections 16.11.2.2.1, and 16.11.2.3.1, and in accordance with the methodology and parameters in the ODCM.

16.11.3.1.1.b

Cumulative dose contributions from direct radiation from the units and from radwaste storage tanks shall be determined in accordance with the methodology and parameters in the ODCM. This requirements is applicable only under conditions set forth in ACTION a. of Section 16.11.3.1.

16.11.3.1.2 BASES

This Requirement is provided to meet the dose limitations of 40 CFR Part 190 that have been incorporated into 10 CFR Part 20.1301. The control 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 Part 190.11 and 10 CFR 20.2203, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to 40 CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in Sections 16.11.1.1 and 16.11.2.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

There are three defined effluent release categories: 1.) Releases directly to the hydrosphere; 2.) noble gas releases to the atmosphere; 3.) radioiodine and particulate releases to the atmosphere. For each effluent release category, it is assumed in the dose calculations that an individual with the highest dose potential is the receptor. In general, the adult is considered to be the critical age group for liquid effluents, and the child age group is the most limiting for radioiodine and particulates in gaseous effluents. Thus, it is highly unlikely or impossible for the same individual to simultaneously receive the highest dose via all three effluent categories. For most reactor sites, it is also unlikely that all different potential dose pathways would contribute to the dose to a single real individual. Since it is difficult or impossible to continually determine actual food use patterns and critical age group, for calculational purposes, assumptions are made which tend to maximize doses. Any refinement in the assumptions would have the effect of

reducing the estimated dose. For radionuclides released to the hydrosphere, the degree of overestimation in most situations is such that no individual will receive a significant dose. These conservative assumptions generally result in an overestimation of dose by one or two orders of magnitude. Since these assumptions are reflected in the Radiological Effluent Controls limiting radionuclide releases to design objective individual doses, no offsite individual is likely to actually receive a significant dose. Since the doses from liquid releases are very conservatively evaluated, there is reasonable assurance that no real individual will receive a significant dose from radioactive liquid release pathway. Therefore, only doses to individuals via airborne pathways and dose resulting from direct radiation need to be considered in determining potential compliance to 40 CFR 190*.

The reporting requirements of Action(a) implement the requirements of 10CFR20.2203.

* NUREG-0543, “Methods for Demonstrating LWR compliance with the EPA Uranium Fuel Cycle Standard (40 CFR 190)”, Congel, F. J., Office of Nuclear Reactor Regulation, USNRC. January, 1980. pp. 5-8.

16.11.4 RADIOLOGICAL ENVIRONMENTAL MONITORING

16.11.4.1 MONITORING PROGRAM LIMITING CONDITION OF OPERATION

(ODCM 9.11.1)

The Radiological Environmental Monitoring Program shall be conducted as specified in Table 16.11-7.

APPLICABILITY: At all times.

ACTION:

a. With the Radiological Environmental Monitoring Program not being conducted as specified in Table 16.11-7, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by Technical Specification 5.6.2, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 16.11-8 when averaged over any calendar quarter, 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 to be taken to reduce radioactive effluents so that the potential annual dose* to a MEMBER OF THE PUBLIC is less than the calendar year limits of Sections 16.11.1.2, 16.11.2.2, or 16.11.2.3. When more than one of the radionuclides in Table 16.11-8 are detected in the sampling medium, this report shall be submitted if:

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

When radionuclides other than those in Table 16.11-8 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose* to A MEMBER OF THE PUBLIC from all radionuclides is equal to or greater than the calendar year limits of Sections 16.11.1.2, 16.11.2.2 or 16.11.2.3. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report, required by Technical Specification 5.6.2.

c. With milk or fresh leafy vegetable samples unavailable from one or more of the sample locations required by Table 16.11-7, identify specific locations for

* The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

obtaining replacement samples and add them within 30 days to the Radiological Environmental Monitoring Program*. The specific locations from which samples were unavailable may then be deleted from the monitoring program. In the next Annual Radiological Environmental Operating Report include the revised figure(s) and tables reflecting the new sample location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of new location(s) for obtaining samples.

d. When LLDs specified in Table 16.11-9 are unachievable due to uncontrollable circumstances such as background fluctuations, unavailable small sample sizes, the presence of interfering nuclides, etc., the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report.

16.11.4.1.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.11.2)

The radiological environmental monitoring samples shall be collected pursuant to Table 16.11-7 and shall be analyzed pursuant to the requirements of Table 16.11-7 and the detection capabilities required by Table 16.11-9.

16.11.4.1.2 BASES

The Radiological Environmental Monitoring Program provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposures of MEMBERS OF THE PUBLIC resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the Radiological Effluent Monitoring Program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for the initial monitoring program was provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLD's). The LLD's required by Table 16.11-9 are considered optimum for routine environmental measurements in industrial laboratories.

* Excluding short term or temporary unavailability.

16.11.4.2 LAND USE CENSUS LIMITING CONDITION OF OPERATION

(ODCM 9.12.1)

A Land Use Census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden* of greater than 50 m^2 (500 ft^2) producing broad leaf vegetation. The Land Use Census shall identify water intakes constructed within 10 river miles downstream of the plant discharge point.

APPLICABILITY: At all times.

ACTION:

a. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated by Section 16.11.2.3.1, identify the new location(s) in the next Radioactive Effluent Release Report, pursuant to Technical Specification 5.6.3.

b. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with Section 16.11.4.1, add the new location(s) within 30 days to the Radiological Environmental Monitoring Program except for vegetation samples which shall be added to the program before the next growing season. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this Land Use Census was conducted. In the next Annual Radiological Environmental Operating Report include the revised figure(s) and tables reflecting the new sample location(s) with information supporting the change in sample location.

c. With a Land Use Census identifying a water intake within 10 river miles downstream of the plant discharge point, implement the appropriate waterborne or ingestion sampling required by Table 16.11-7.

* Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the SITE BOUNDARY in each to two different direction sectors with the highest predicted D/Q's in lieu of the garden census. Requirements for broad leaf vegetation sampling in Table 16.11-7, Part 4.c shall be followed, including analysis of control samples.

16.11.4.2.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.12.2)

The Land Use Census shall be conducted during the growing season at least once per 12 months using that information which will provide the best results, such as, but not limited to, door-to-door survey, aerial survey, or by consulting local agriculture authorities and/or residents. The results of the Land Use Census shall be included in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2.

16.11.4.2.2 BASES

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

16.11.4.3 INTERLABORATORY COMPARISON PROGRAM LIMITING CONDITION OF OPERATION

(ODCM 9.13.1)

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that has been approved by the USNRC.

APPLICABILITY: At all times.

ACTION:

With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2.

16.11.4.3.1 SURVEILLANCE REQUIREMENTS

(ODCM 9.13.2)

The Interlaboratory Comparison Program shall be described in the plant procedures. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2.

16.11.4.3.2 BASES

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

16.11.5 ADMINISTRATIVE CONTROLS

16.11.5.1 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT (ODCM 7.1)

Routine Annual Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year.

The Annual Radiological Environmental Operating Report shall include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, with operational controls and with previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall include the results of Land Use Census required by Section 16.11.4.2. It shall also include a listing of new locations for environmental monitoring identified by the Land Use Census pursuant to Section 16.11.4.2.

The Annual Radiological Environmental Operating Report shall include the results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to Section 16.11.4.1, as well as summarized tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report. The reports shall also include the following: a summary description of the radiological environmental monitoring program; at least two legible maps* covering all sampling locations keyed to a table giving distances and directions from the midpoint between the two reactors; the results of licensee participation in the Interlaboratory Comparison Program and the corrective action being taken if the specified program is not being performed as required by Section 16.11.4.3; reasons for not conducting the Radiological Environmental Monitoring Program as required by Section 16.11.4.1 and discussion of all deviations from the sampling schedule of Table 16.11-7, discussion of environmental sample measurements that exceed the reporting levels of Table 16.11-8, but are not the result of the plant effluents, pursuant to Section 16.11.4.1; and discussion of all analyses in which the LLD required by Table 16.11-9 was not achievable.

16.11.5.1.1 BASES

The reporting requirement for the Annual Radiological Environmental Operating Report is provided to ensure compliance with Technical Specification 5.6.2. This requirement was relocated from the Offsite Dose Calculation Manual to FSAR Chapter 16.

* One map shall cover stations near the SITE BOUNDARY; a second shall include the more distant stations.

16.11.5.2 RADIOACTIVE EFFLUENT RELEASE REPORT

(ODCM 7.2)

Routine Radioactive Effluent Release Reports covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year.

The Radioactive Effluent Release Report shall include a summary of the quantities of radioactive liquid and gaseous effluents released from the unit as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases 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.

The Radioactive Effluent Release Report shall include an annual summary of hourly meteorological data collected over the previous calender year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability, and precipitation (if measured), or in the form of joint frequency distribution of wind speed, wind direction, and atmospheric stability* .

This report shall also include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit during the previous calendar year. This 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 (Figures 16.11-1 and 16.11-2) during the report period using historical average atmospheric conditions. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in these reports. 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. Assessment of radiation doses shall be performed in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

The Radioactive Effluent Release Report shall include an assessment of radiation doses to the most likely 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." Doses to the MEMBER OF THE PUBLIC shall be calculated using the methodology and parameters of the ODCM.

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* In lieu of submission with the Annual Radioactive Effluent Release Report, Union Electric 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.

As required by 10 CFR 72.44(d)(3), an annual report shall be submitted to the Commission in accordance with 10 CFR 72.4, specifying the quantity of each of the principal radionuclides released to the environment in liquid and in gaseous effluents during the previous 12 months of operation. The report must be submitted within 60 days after the end of the 12-month monitoring period.

The Radioactive Effluent Release Report shall include 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.

The Radioactive Effluent Release Report shall include a summary description of any major changes made during the year to any Liquid or Gaseous Treatment Systems, pursuant to Offsite Dose Calculation Manual. It shall also include a listing of new locations for dose calculations identified by the Land Use Census pursuant to Section 16.11.4.2.

Reporting requirements for changes to Solid Waste Treatment Systems are addressed in APA-ZZ-01011, PROCESS CONTROL PROGRAM (PCP).

The Radioactive Effluent Release Report shall also include the following information: An explanation as to why the liquid or gaseous effluent monitoring instrumentation was not restored to service within the time specified, and a description of the events leading the liquid holdup tanks or gas storage tanks exceeding the limits of Section 16.11.1.5 or 16.11.2.8.

The Radioactive Effluent Release Report shall include as part of or submitted concurrent with, a complete and legible copy of all revisions of the ODCM that occurred during the year pursuant to Technical Specification 5.5.1.

Solid Waste reporting is addressed in APA-ZZ-01011, PROCESS CONTROL PROGRAM (PCP).

16.11.5.2.1 BASES

The reporting requirement for the Radioactive Effluent Release Report is provided to ensure compliance with Technical Specification 5.6.3. This requirement was relocated from the Offsite Dose Calculation Manual implementing procedure to FSAR Chapter 16.

In addition to the above reporting requirement, an annual report shall also be submitted in compliance with the HI-STORM UMAX Certificate of Compliance (CoC), Appendix A, Section 5.1

TABLE 16.11-1 RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

1. Discharge Monitor Tanks (Batch Release) (2)			
SAMPLING FREQUENCY(7)	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LLD (1) (µCi/ml)
Prior to Each Batch	Prior to Each Batch	Principal Gamma Emitters (3)	5E-7
		I-131	1E-6
		Dissolved and Entrained Gases (Gamma Emitters)	1E-5
		H-3	1E-5
	Monthly Composite (4)	Gross Alpha	1E-7
	Quarterly Composite (4)	Sr-89, Sr-90	5E-8
		Fe-55	1E-6
		Ni-63	5E-8
		Np-237	5E-9
		Pu-238	5E-9
		Pu-239/240	5E-9
		Pu-241	5E-7
		Am-241	5E-9
		Cm-242	5E-9
		Cm-243/244	5E-9

2. Steam Generator Blowdown (Continuous Release) (5)			
SAMPLING FREQUENCY(7)	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LLD (1) (µCi/ml)
Daily Grab Sample (6)	Daily	Principal Gamma Emitters (3)	5E-7
		I-131	1E-6
		Dissolved and Entrained Gases (Gamma Emitters)	1E-5
		H-3	1E-5
	MonthlyComposite (4)	Gross Alpha	1E-7
	Quarterly Composite (4)	Sr-89, Sr-90	5E-8
		Fe-55	1E-6

TABLE NOTATIONS

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

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

$$LLD = \frac{4.66\ S_b}{E \times V \times 2.22E6 \times Y \times \exp(-\lambda \Delta t)}$$

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),

E = the counting efficiency (counts per disintegration),

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

2.22E6= the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec-1), and

TABLE 16.11-1 (Sheet 2)

Δt = the elapsed time between the midpoint of the sample collection period, and the time of counting (sec). For batch releases, $\Delta t=0$.

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

It should be recognized that the LLD is defined as a "a priori" (before the fact) limit representing the capability of a measurement system and not as an "a posteriori" (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLD's will be achieved under routine conditions.

(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 the ODCM to assure representative sampling.

(3) The principal gamma emitters for which the LLD control 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 Radioactive Effluent Release Report pursuant to Technical Specification 5.6.3, 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.

(7) Samples shall be representative of the effluent release.

TABLE 16.11-2 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

	INSTRUMENT	MINIMUM CHANNELS FUNCTIONAL	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
2.	Flow Rate Measurement Devices		
a.	Liquid Radwaste Blowdown Discharge Line (HB-FE-2017)	1	34
b.	Steam Generator Blowdown Discharge Line (BM-FE-0054)	1	34
c.	Cooling Tower Blowdown and Bypass Flow Totalizer (FYDB1017A)	1	34
3.	Discharge Monitoring Tanks (DMT's) Level		
a.	DMT A (HB-LI-2004)	1	33
b.	DMT B (HB-LI-2005)	1	33

ACTION STATEMENTS

ACTION 31 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Section 16.11.1.1.1, 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 16.11-2 (Sheet 2)

ACTION STATEMENTS

ACTION 32 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided grab samples are analyzed for principal gamma emitters and I-131 at a lower limit of detection as specified in Table 16.11-1:

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

ACTION 33 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided the volume discharged is determined by alternate means.

ACTION 34 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue 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.

TABLE 16.11-3 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)
2. Flow Rate Measurement Devices				
a. Liquid Radwaste Blowdown Discharge Line (HB-FE-2017)	D(3)	N.A.	R	N.A.
b. Steam Generator Blowdown Discharge Line (BM-FE-0054)	D(3)	N.A.	R	N.A.
c. Cooling Tower Blowdown and Bypass Flow Totalizer (FYDB1017A)	D(3)	N.A.	R	N.A.
3. Discharge Monitoring Tanks (DMT's) Level				
a. DMT A(HB-LI-2004)	Prior to release (4)	N.A.	R	N.A.
b. DMT B(HB-LI-2005)	Prior to release (4)	N.A.	R	N.A.

TABLE 16.11-3 (Sheet 2)

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:

   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 obtained from 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 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.

4. CHANNEL CHECK shall consist of verifying indication of tank level 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 from the DMT.

TABLE 16.11-4 RADIOACTIVE GASEOUS EFFLUENTS SAMPLING AND ANALYSIS PROGRAM

1. Waste Gas Decay Tank			
SAMPLING FREQUENCY (9)	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LLD (1) (μCi/ml)
Prior to each release- grab sample	Prior to each tank	Principal Gamma Emitters- particulate, iodine, noble gas (2)	1E-4
Continuous	See footnote 8		

2. Containment Purge or Vent			
SAMPLING FREQUENCY (9)	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LLD (1) (μCi/ml)
Prior to each release- grab sample	Prior to each release	Principal Gamma Emitters- particulate, iodine, noble gas (2) H-3(oxide)	1E-4 1E-6
Continuous	See footnote 8		

3. Unit Vent (3)			
SAMPLING FREQUENCY (9)	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LLD (1) (μCi/ml)
Monthly- grab sample (3)(4)	Monthly (3)(4)	Principal Gamma Emitters- noble gas (2) H-3(oxide)	1E-4 1E-6
Continuous (6)	Weekly (7)	I-131 I-133 Principal Gamma Emitters- particulate nuclides only (2)	1E-12 1E-10 1E-11
	MonthlyComposite	Gross Alpha	1E-11
	Quarterly Composite	Sr-89, Sr-90, Ni-63, Fe-55	1E-11

4. Radwaste Building Vent			
SAMPLING FREQUENCY (9)	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LLD (1) (μCi/ml)
Monthly- grab sample	Monthly	Principal Gamma Emitters- noble gas (2)	1E-4
Continuous (6)	Weekly (7)	I-131 I-133 Principal Gamma Emitters- particulate nuclides only (2)	1E-12 1E-10 1E-11
	Monthly Composite	Gross Alpha	1E-11
	Quarterly Composite	Sr-89, Sr-90, Ni-63, Fe-55	1E-11

5. Laundry Decontamination Facility Dryer Exhaust			
SAMPLING FREQUENCY (9)	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LLD (1) (μCi/ml)
Continuous (6)	Weekly (7)	Principal Gamma Emitters- particulate nuclides only (2)	1E-11
	Monthly (10) Composite	Gross Alpha	1E-11
	Quarterly (10) Composite	Sr-89, Sr-90, Ni-63, Fe-55	1E-11

TABLE 16.11-4 (Sheet 2)

6. Containment ILRT Depressurization (Post-test Vent)			
SAMPLING FREQUENCY (9)	MINIMUM ANALYSIS FREQUENCY	TYPE OF ACTIVITY ANALYSIS	LLD (1) (μCi/ml)
Prior to each release- grab sample	Prior to each release	Principal Gamma Emitters- particulate, iodine, noble gas (2) H-3(oxide)	1E-4 1E-6

TABLE NOTATIONS

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

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

$$LLD = \frac{4.66\ S_b}{E \times V \times 2.22E6 \times Y \times \exp(-\lambda \Delta t)}$$

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),

E = the counting efficiency (counts per disintegration),

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

2.22E6= the number of disintegrations per minute per microCurie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}), and

Δt = the elapsed time between the midpoint of the sample collection period, and the time of counting (sec).

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

It should be recognized that the LLD is defined as a "a priori" (before the fact) limit representing the capability of a measurement system and not as an "a posteriori" (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLD's will be achieved under routine conditions.

(2) The principal gamma emitters for which the LLD Requirement 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, 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. Any nuclide which is identified in the sample and which is also listed in the ODCM gaseous effluents dose factor tables, shall be analyzed and reported in the Radioactive Effluent Release Report.

(3) If the Unit Vent noble gas monitor (GT-RE-21B) shows that the effluent activity has increased (relative to the pre-transient activity) by more than a factor of 3 following a reactor shutdown, startup, or a thermal power change which exceeds 15% of the rated thermal power within a 1 hour period, samples shall be obtained and analyzed for noble gas, particulates and iodines. This sampling shall continue to be performed at least once per 24 hours for a period of 7 days or until the Unit Vent noble gas monitor no longer indicates a factor of 3 increase in Unit Vent noble gas activity, whichever comes first.

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

(5) Deleted.

(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 16.11.2.1, 16.11.2.2, and 16.11.2.3.

(7) Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing, or removal from the sampler. When sampling is performed in accordance with footnote 3 (above), then the LLD may be increased by a factor of 10.

(8) Continuous sampling of this batch release pathway is included in the continuous sampling performed for the corresponding continuous release pathway.

(9) Samples shall be representative of the effluent release.

(10) Required only if Mn-54, Fe-59, Co-58, Co-60, Zn-65, Cs-134, Cs-137, Ce-141, or Ce-144 are detected in principle gamma emitter analyses.

TABLE 16.11-5 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. Unit Vent System			
a. Noble Gas Activity Monitor - Providing Alarm (GT-RE-21)	1	At all times	40,46
b. Iodine Sampler	1	At all times	43
c. Particulate Sampler	1	At all times	43
d. Unit Vent Flow Rate	1	At all times	45
e. Particulate and Radioiodine Sampler Flow Rate Monitor	1	At all times	43
2. Containment Purge System			
a. Noble Gas Activity Monitor			
- Providing Alarm and Automatic Termination of Release (GT-RE-22, GT-RE-33)	2	MODES 1,2,3, and 4.	41
- Providing Alarm function only	1	During CORE ALTERATIONS or movement of irradiated fuel within the containment	42
b. Iodine Sampler	1	MODES 1,2,3,4 and during CORE ALTERATIONS or movement of irradiated fuel within the containment	43
c. Particulate Sampler	1	MODES 1,2,3,4 and during CORE ALTERATIONS or movement of irradiated fuel within the containment	43
d. Containment Purge Ventilation Flow Rate	N/A	N/A	N/A

TABLE 16.11-5 (Sheet 2)

e. Particulate and Radioiodine Sampler Flow Rate Monitor	1	MODES 1,2,3,4 and during CORE ALTERATIONS or movement of irradiated fuel within the containment	43
3. Radwaste Building Vent System			
a. Noble Gas Activity Monitor-Providing Alarm and Automatic Termination of Release (GH-RE-10)	1	At all times	38,40
b. Iodine Sampler	1	At all times	43
c. Particulate Sampler	1	At all times	43
d. Radwaste Building Vent Flow Rate	N/A	N/A	N/A
e. Particulate and Radioiodine Sampler Flow Rate Monitor	1	At all times	43
4. Laundry Decontamination Faciliy Dryer Exhaust			
a. Particulate Monitor	1	When the dryers are operating	47
b. Particulate Monitor Flow Rate Meter	1	When the dryers are operating	47
c. Dryer Exhaust Ventilation Flow Rate	NA	NA	NA

ACTION STATEMENTS

ACTION 38 - With the number of low range channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL 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.

TABLE 16.11-5 (Sheet 3)

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 39 - Deleted.

ACTION 40 - With the number of low range channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL 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 FUNCTIONAL one less than required by the Minimum Channels FUNCTIONAL requirement, restore the affected channel to FUNCTIONAL status within 4 hours. If the non-functional channel is not restored within 4 hours or with no channels FUNCTIONAL, immediately suspend the release of radioactive effluents via this pathway.

Containment mini-purge supply and exhaust valves that have been closed to satisfy this Action may be opened under administrative controls provided either:

a. one channel is FUNCTIONAL, or

b. the requirements for Table 16.11-5 Function 1.a are met and the requirements for minimum channels FUNCTIONAL for the Unit Vent Noble Gas Monitor (GT-RE-21) specified in Table 16.3-7 Function 3 are met.

The administrative controls consist of designating a control room operator to rapidly close the valves when a need for system isolation is indicated.

ACTION 42 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, and if the containment equipment hatch is open, then immediately suspend CORE ALTERATIONS and movement of irradiated fuel assemblies within containment. If the containment equipment hatch is not open, then suspend the release of radioactive effluents via this pathway or immediately suspend CORE ALTERATIONS and movement of irradiated fuel assemblies within containment.

ACTION 43 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via the affected pathway may continue for up to 30 days provided samples are continuously collected with auxiliary sampling equipment as required in Table 16.11-4.

TABLE 16.11-5 (Sheet 4)

ACTION 44 - Deleted.

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

ACTION 46 - For midrange and high range channels only - with the number of FUNCTIONAL channels less than required by the Minimum Channels FUNCTIONAL requirement, take the action specified in Section 16.3.3.4, ACTION C.

ACTION 47 - With the number of channels FUNCTIONAL less than required by the Minumum Channels FUNCTIONAL requirement, immediately suspend the release of radioactivite effluents via this pathway.

TABLE 16.11-6 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)	At all times
b. Iodine Sampler	W	N.A.	N.A.	N.A.	At all times
c. Particulate Sampler	W	N.A.	N.A.	N.A.	At all times
d. Unit Vent Flow Rate	N.A.	N.A.	R(4)	Q	At all times
e. Particulate and Radioiodine Sampler Flow Rate Monitor	D	N.A.	R	Q	At all times
2. Containment Purge System					
a. Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release (GT-RE-22, GT-RE-33)	N.A.	P	N.A.	N.A.	MODES 1,2,3,4 and during CORE ALTERATIONS or movement of irradiated fuel within the containment
b. Iodine Sampler	W	N.A.	N.A.	N.A.	MODES 1,2,3,4 and during CORE ALTERATIONS or movement of irradiated fuel within the containment
c. Particulate Sampler	W	N.A.	N.A.	N.A.	MODES 1,2,3,4 and during CORE ALTERATIONS or movement of irradiated fuel within the containment
d. Containment Purge Ventilation Flow Rate	N.A.	N.A.	R(4)	N.A.	MODES 1,2,3,4 and during CORE ALTERATIONS or movement of irradiated fuel within the containment

TABLE 16.11-6 (Sheet 2)

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL OPERATIONAL TEST	MODES FOR WHICH SURVEILLANCE IS REQUIRED
e. Particulate and Radioiodine Sampler Flow Rate Monitor	D	N.A.	R	N.A.	MODES 1,2,3,4 and during CORE ALTERATIONS or movement of irradiated fuel within the containment
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)	At all times
b. Iodine Sampler	W	N.A.	N.A.	N.A.	At all times
c. Particulate Sampler	W	N.A.	N.A.	N.A.	At all times
d. Radwaste Building Vent Flow Rate	N.A.	N.A.	R(4)	N.A.	At all times
e. Particulate and Radioiodine Sampler Flow Rate Monitor	D	N.A.	R	N.A.	At all times
4. Laundry Decontamination Facility Dryer Exhaust					
a. Particulate Monitor	NA	D	A	Q(5)	When the dryers are operating
b. Particulate Monitor Flow Rate Meter	D	NA	A	NA	When the dryers are operating
c. Dryer Exhaust Ventilation Flow Rate	NA	NA	R(4)	NA	When the dryers are operating

TABLE 16.11-6 (Sheet 3)

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:

   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 of the following conditions exists:

   a. Instrument indicates measured levels above the Alarm Setpoint, or

   b. Circuit failure, or

   c. Instrument indicates a downscale failure, or

   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 & 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 standard 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-ΔP" curve, or

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

5. The CHANNEL OPERATIONAL TEST shall also demonstrate that automatic isolation of this pathway and the shutdown of the dryers occur as appropriate if any of the following conditions exists:

   a. Instrument indicates measured levels above the Alarm/Trip Setpoint, or

   b. Monitor failure.

TABLE 16.11-7 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS (1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
1. Direct Radiation(2)	Forty routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of sixteen stations, one in each meteorological sector in the general area of the SITE BOUNDARY; Four of the stations shall be placed to monitor for gamma and neutron dose from the ISFSI; An outer ring of stations, one in each meteorological sector in the 6- to 8-km (3 to 5 mile) range from the site; and Eight stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Quarterly	Gamma dose for each sample. Neutron dose for the four samples monitoring ISFSI direct radiation.
2. Airborne Radioiodine and Particulates	Samples from five locations; Three samples from close to the SITE BOUNDARY locations, in different sectors, with high calculated annual average ground level D/Qs. One sample from the vicinity of a community located near the plant with a high calculated annual average ground level D/Q. One sample from a location in the vicinity of Fulton, MO.	Continuous sampler operation with sample collection weekly, or more frequently if required by dust loading.	Radioiodine Canister: I-131 analysis for each sample. Gamma isotopic analysis(5) for each sample.

TABLE 16.11-7 (Sheet 2)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS (1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
3. Waterborne			
a. Surface (6) (river)	One sample upstream One sample downstream	Composite sample over 1-month period (7).	Gamma Isotopic(5) and tritium analysis for each sample.
b. Surface (onsite ponds)	Water sample from on site ponds forming a ring around the plant, suitable for monitoring for plant storm water runoff and washout from plant gaseous effluents, placed as follows: Each settling pond receiving plant storm water runoff. One of the in-service sludge lagoons. Two additional on site ponds most likely to be affected by washout of radioactivity released in gaseous effluents.	Semiannually	Gamma isotopic(5) and tritium analyses for each sample. If contaminated with gamma emitting nuclides of plant origin, analyze for HTD nuclides(11).
c. Groundwater (non-drinking water)	Groundwater samples from non-drinking water shallow and deep(12) monitoring wells located as follows: Samples from one deep well located upgradient of the plant power block and one deep well located downgradient of the sludge lagoons. Samples from seven shallow wells or groundwater sumps in locations suitable to monitor for subsurface leakage from power block structures and components.	Quarterly	Gamma isotopic(5) and tritium analyses for each sample. If contaminated with gamma emitting nuclides of plant origin, analyze for HTD nuclides(11).

TABLE 16.11-7 (Sheet 3)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS (1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
c. Groundwater (non-drinking water) (continued)	Samples from three shallow wells in locations suitable to monitor for migrations of contaminated groundwater from the power block area to areas outside the Owner Controlled Area fence (one well upgradient of the plant power block and two wells in areas likely to be affected.) Samples from one shallow well located immediately downgradient of the sludge ponds. Samples from five shallow wells located along the discharge pipeline corridor in the alluvial plain. Samples from three shallow wells near the property boundary located to monitor for migration of contaminated groundwater from the discharge pipeline to the nearest potable water well. Samples from one deep well near the property boundary located to monitor for migration of contaminated groundwater from the discharge pipeline to the nearest potable water well.		

TABLE 16.11-7 (Sheet 4)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS [1]	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
d. Drinking (river water)	One sample of each of one to three of the nearest water supplies within 10 miles downstream that could be affected by its discharge. One sample from a control location.	Composite sample over 2-week period[7] when I-131 analysis is performed, monthly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of the water is greater than 1 mrem per year[9]. Composite for gross beta and gamma isotopic analyses[5] monthly. Composite for tritium analysis quarterly.
As there are no drinking water intakes within 10 miles downstream of the discharge point, the drinking water pathway is currently not included as part of the Callaway Plant Radiological Environmental Monitoring Program. Should the annual Land Use Census identify water intakes within 10 river miles downstream of the discharge point, the program will be revised to include this pathway.			
e. Drinking (potable well water)	Samples of potable well water appropriate for monitoring for radioactivity in drinking water supplies in areas most likely to be affected by a spill or leak. Two samples of potable well water from the community of Portland, MO. One sample of Callaway Plant potable water. One sample of potable well water from each resident bordering plant property along Mud Creek and Logan Creek.	Quarterly	Gamma isotopic[5] and tritium analyses for each sample. If contaminated with nuclides of plant origin, analyze for HTD nuclides[11].
f. Sediment from river shoreline	One sample from downstream area with existing or potential recreational value One sample from upstream control location.	Semiannually	Gamma isotopic analysis[5] for each sample

TABLE 16.11-7 (Sheet 5)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS (1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
g. Shoreline sediment from sludge ponds	Shoreline sediment from each on site sludge pond most likely to be affected. One sample from each in-service sludge pond. One sample from each wetlands pond.	Annually	Gamma isotopic(5) analysis for each sample.
4. Ingestion			
a. Milk	Samples from milking animals in three different meteorological sectors within 5 km (3 mile) distance having the highest dose potential. If there are none, then one sample from milking animals in each of three different meteorological sectors between 5 to 8 km (3 to 5 mile) distance where doses are calculated to be greater than 1 mrem per yr.(9) One sample from milking animals at a control location, 15 to 30 km (10 to 20 mile) distance and in the least prevalent wind direction.	Semimonthly when animals are on pasture, monthly at other times	Gamma isotopic(5) and I-131 analyses for each sample
Due to the lack of milking animals which satisfy these requirements, the milk pathway is currently not included as part of the Callaway Plant Radiological Environmental Monitoring Program. Should the Annual Land Use Census identify the existence of milking animals in locations which satisfy these requirements, then the program will be revised to include this pathway.			
b. Fish	One sample of each commercially and recreationally important species in vicinity of plant discharge area. One sample of same species in areas not influenced by plant discharge.	Sample in season, or semiannually if they are not seasonal	Gamma isotopic analysis(5) on edible portions for each sample

TABLE 16.11-7 (Sheet 6)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS (1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
c. Food Products	One sample of each principal class of food products from any area that is irrigated by water in which liquid plant wastes have been discharged.	At time of harvest(10)	Gamma isotopic analysis(5) on edible portion for each sample
As there are no areas irrigated by water in which liquid plant wastes have been discharged within 50 miles downstream of the discharge point, this sample type is not currently included as part of the Callaway Plant Radiological Environmental Monitoring Program. Should the annual Land Use Census identify irrigation water intakes within 10 river miles downstream of the discharge point, the program will be revised to include this sample type.			
	Samples of three different kinds of broad leaf vegetation if available grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q if milk sampling is not performed	Monthly when available	Gamma isotopic (5) and I-131 analyses
	One sample of each of the similar broad leaf vegetation grown 15 to 30 km (10 to 20 mile) distant in the least prevalent wind direction if milk sampling is not performed	Monthly when available	Gamma isotopic (5) and I-131 analyses
5. Soil	Surface soil samples suitable for monitoring for ground deposition if radioactivity in gaseous effluents as follows: Four ecology plots located in four quadrants surrounding the plant. One control location from an area not likely to be influenced by plant gaseous effluents.	Annually	Gamma isotopic(5) analysis for each sample.

TABLE 16.11-7 (Sheet 7)

EXPOSURE PATHWAY AND/OR SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS (1)	SAMPLING AND COLLECTION FREQUENCY	TYPE AND FREQUENCY OF ANALYSIS
6. Farm crops(13)	Farm crops from areas most likely to be affected by a break or leak in the discharge pipeline, located as follows: Three samples of each type of farm crop along the discharge pipeline corridor between manhole 8 and Katy Trail. Three samples of each type of farm crop along the discharge pipeline corridor between manhole 5 and manhole 3B. Three samples of each type of farm crop along the discharge pipeline easement between Hwy 94 and the barge loading dock access road. One sample of each type of crop sampled above, from a control location unlikely to be influenced by plant operations.	At time of harvest(10)	Gamma isotopic(5) and tritium analyses for each sample

TABLE NOTATIONS

1. Specific parameters of distance and direction sector from the centerline of one unit, and additional description where pertinent, shall be provided for each and every sample location in Table 16.11-7 in a table and figure(s) in the appropriate plant procedures. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment, and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 5.6.2.

   It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable specific alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the Radiological Environmental Monitoring Program. Submit in the next Annual Radiological Environmental Operating Report documentation for a change including the revised figure(s) and table reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples for that pathway and justifying the selection of the new location(s) for obtaining samples.

TABLE 16.11-7 (Sheet 8)

The selection of sample locations should consider accessibility of sample site, availability of power, wind direction frequency, sector population, equipment security, and the presence of potentially adverse environmental conditions (such as unusually dusty conditions, etc.).

2. One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) and/or an optically stimulated luminescent dosimeter (OSLD), are considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The number of direct radiation monitoring stations may be reduced according to geographical limitations; e.g., at an ocean site, some sectors will be over water so that the number of dosimeters may be reduced accordingly. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

3. Deleted.

4. Deleted.

5. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

6. The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area near the downstream edge of the mixing zone.

7. In this program, composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

8. Groundwater samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

9. The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.

10. If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products.

11. In this program, HTD nuclides are defined as ^{89}Sr, ^{90}Sr, ^{55}Fe, ^{63}Ni, ^{237}Np, ^{238}Pu, ^{241}Am, ^{242}Cm, and $^{243/244}Cm$.

12. In this program, a shallow well is defined as a well which extracts groundwater from the vadose zone. A deep well is defined as a well which extracts groundwater from the saturated zone.

13. Edible and non-edible farm crops from areas that could be affected by a break or leak in the discharge pipeline (including the retired discharge pipeline.)

TABLE 16.11-8 REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

REPORTING LEVELS

ANALYSIS	WATER (pCi/ℓ)[a]	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)[b]	MILK (pCi/ℓ)[a]	FOOD PRODUCTS pCi/kg, wet)[b]
H-3	20,000*				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95**	400				
I-131	2	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140**	200			300	

(a) Multiply the values in this table by 1E-9 to convert to units of μCi/ml.
(b) Multiply the values in this table by 1E-9 to convert to units of μCi/g.

* For drinking water samples. This is 40 CFR Part 141 value. For surface water samples, a value of 30,000 pCi/ℓ may be used.

** Total activity, parent plus daughter activity.

TABLE 16.11-9 DETECTION CAPABILITITES FOR ENVIRONMENTAL SAMPLE ANALYSIS

LOWER LIMIT OF DETECTION (LLD) ([1]), ([2]), ([3])

ANALYSIS	SURFACE WATER (pCi/ℓ)[a]	DRINKING WATER (pCi/ℓ)[a]	AIRBORNE PARTICULATE OR GASES (pCi/m^3)	FISH (pCi/kg, wet)[b]	MILK (pCi/ℓ)[a]	FOOD PRODUCTS (pCi/kg, wet)[b]	SEDIMENT (pCi/kg, dry)[b]
Gross Beta	4	4	0.01				
H-3	3000	2000					
Mn-54	15	15		130			
Fe-59	30	30		260			
Co-58,60	15	15		130			
Zn-65	30	30		260			
Zr-Nb-95*	15	15					
I-131	**	1	0.07		1	60	
Cs-134	15	15	0.05	130	15	60	150
Cs-137	18	18	0.06	150	18	80	180
Ba-La-140*	15	15			15		

(a) Multiply the values in this table by 1E-9 to convert to units of μCi/ml.
(b) Multiply the values in this table by 1E-9 to convert to units of μCi/g.

* Total activity, parent plus daughter activity.

** For surface water samples, the LLD of gamma isotopic analysis may be used.

TABLE 16.11-9 (Sheet 2)

TABLE NOTATIONS

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

2. Required detection capabilities for thermoluminescent dosimeters used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13, Revision 1, July 1977.

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

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

$$LLD = \frac{4.66 S_b}{E \times V \times 2.22E6 \times Y \times \exp(-\lambda \Delta t)}$$

   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),

   E = the counting efficiency (counts per disintegration),

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

   2.22E6 = the number of disintegrations per minute per microCurie,

   Y = the fractional radiochemical yield, when applicable,

   λ = the radioactive decay constant for the particular radionuclide (sec^{-1}), and

   Δt = the elapsed time between the end of the sample collection period, and the time of counting (sec).

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

It should be recognized that the LLD is defined as a "a priori" (before the fact) limit representing the capability of a measurement system and not as an "a posteriori" (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLD's will be achieved under routine conditions.