

# Callaway Energy Center 2014 Annual Radioactive Effluent Release Report

Facility Operating License NPF-30

Docket Number 50-483



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## 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 Callaway Energy Center Technical Specification 5.6.3. This report is for the period January 1, 2014 to December 31, 2014.

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*. Callaway is committed to revision

## Abstract

The Annual Radioactive Effluent Release Report covers the operation of the Callaway Energy Center during the year 2014. 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 of Regulatory Guide 1.21, and some of the information is not readily available in the format recommended by revision 2.

## 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.

The quantity of  $^{14}\text{C}$  released in gaseous effluents was calculated as described in EPRI Technical Report 1021106<sup>1</sup>.

## 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 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.

## 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<sup>2</sup> and is reported in Tables A-4 and A-5. The dose to the Member of the Public was calculated using the re- evaluated long- term meteorological dispersion parameters<sup>3,4</sup>.

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

<sup>2</sup> APA-ZZ-01003, "Offsite Dose Calculation Manual", rev. 20. April 15, 2015.

<sup>3</sup> HPCI 1502, "Atmospheric Dispersion Parameters for Activities Inside the Site Boundary"

<sup>4</sup> HPCI 1503, "Calculation of Long- Term Meteorological Dispersion Parameters"

### 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  $^{14}\text{C}$ , 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  $^{14}\text{C}$  (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

The Limited Site Investigation for leakage of liquid radioactive effluent from manhole 86-2 is described in Appendix D. This issue is documented in CAR 201405071.

### 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 systems during the reporting period.

### 6.4 Annual Land Use Census Changes

Changes in sample locations identified in the Land Use Census are described in the Annual Radioactive Environmental Operating Report.

### 6.5 Effluent Monitoring System Inoperability

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 no changes to the Offsite Dose Calculation Manual during the reporting period.

## 6.7 Process Control Program Changes

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

## 6.8 Corrections to Previous Reports

Errors were discovered in the setup parameters for the VAXMET computer code used to calculate the dispersion parameters for the Annual Radioactive Effluent Release Reports for the period 1993- 2013. This apparently occurred during the 1993 computer system upgrade when the setup files were transferred to the new system. The transfer of the file with the Terrain Recirculation Correction Factors was offset by one row which affected the X/Q and D/Q calculations. During investigation of this issue it was discovered that the vent height parameter and the terrain height parameters were also in error. These issues are described in the Callaway Energy Center corrective action system.<sup>5,6,7</sup> The correct parameters were researched, reviewed, and formally documented in calculation HPCI 1503. The dispersion parameters for each year 1993- 2013 were recalculated with the NRC computer code XOQDOQ<sup>8</sup> and the parameters in HPCI 1503. The doses from gaseous effluents were recalculated using the recalculated dispersion parameters. The revised gaseous effluent doses are provided in Appendix C. The dose tables are presented in the format in which they were originally submitted.

The quantities discharged were not affected. The dose from liquid effluents and the dose from <sup>14</sup>C was not affected.

## 6.9 Other Information Related to Radioactive Effluents

Meteorological Joint Frequency Tables for the monitoring period are provided in Appendix B. The long- term meteorological data was re- evaluated using the data for the years 2009- 2013.<sup>9,10</sup> Changes were identified in the locations for dose calculation due to changes in the calculated dispersion parameters and the ODCM was revised accordingly.<sup>11</sup>

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<sup>5</sup> CAR 201309140, " Evaluate NRC Finding for ODCM Data Not Be Representative of Conditions"

<sup>6</sup> CAR 201402370, " Recirculation Factors in VAXMET and in FSAR Table are Inconsistent"

<sup>7</sup> CAR 201402623, " Small Errors in 1993-2013 ARERR Doses"

<sup>8</sup> NUREG/CR-2919, "Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations". September, 1982.

<sup>9</sup> HPCI 1502, "Atmospheric Dispersion Parameters for Activities Inside the Site Boundary"

<sup>10</sup> HPCI 1503, "Calculation of Long- Term Meteorological Dispersion Parameters"

<sup>11</sup> APA-ZZ-01003, "Offsite Dose Calculation Manual", rev. 20. April 15, 2015.

## 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 (%) <sup>12</sup>
<b>Fission &amp; Activation Gases</b>	Ci	1.69E-1	7.35E-2	3.84E-2	4.80E-1	7.61E-1	20
<i>Average Release Rate</i>	μCi/s	2.17E-2	9.34E-3	4.83E-3	6.04E-2	2.41E-2	
<i>% of Limit</i>	%	N/A	N/A	N/A	N/A	N/A	
<b><sup>131</sup>Iodine</b>	Ci	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	23
<i>Average Release Rate</i>	μCi/s	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	
<i>% of Limit</i>	%	N/A	N/A	N/A	N/A	N/A	
<b>Particulates</b>	Ci	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	30
<i>Average Release Rate</i>	μCi/s	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	
<i>% of Limit</i>	%	N/A	N/A	N/A	N/A	N/A	
<b>Gross Alpha</b>	Ci	2.36E-7	1.96E-7	1.29E-7	1.35E-7	6.96E-7	
<b><sup>3</sup>H</b>	Ci	6.49E+0	8.49E+0	1.23E+1	1.33E+1	4.06E+1	14
<i>Average Release Rate</i>	μCi/s	8.35E-1	1.08E+0	1.54E+0	1.67E+0	1.28E+0	
<i>% of Limit</i>	%	N/A	N/A	N/A	N/A	N/A	
<b><sup>14</sup>C<sup>13</sup></b>	Ci	2.9	2.9	2.9	2.9	11.6	

<sup>12</sup> Safety Analysis calculation 87-063-00, January 6, 1988

<sup>13</sup> <sup>14</sup>C activity is estimated based on EPRI report TR-1021106, *Estimation of <sup>14</sup>C in Nuclear Power Plant Effluents*, December, 2010.

<b>Table A-1A: Gaseous Effluents- Ground Level Release- Batch Mode</b>						
<b>Fission &amp; Activation Gases</b>	<b>Units</b>	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Total for the year</b>
<sup>41</sup> Ar	Ci	5.19E-2	7.35E-2	3.84E-2	4.15E-1	5.79E-1
<sup>133</sup> Xe	Ci	0.00E+0	0.00E+0	0.00E+0	2.90E-2	2.90E-2
<sup>135</sup> Xe	Ci	0.00E+0	0.00E+0	0.00E+0	4.81E-3	4.81E-3
<sup>85</sup> Kr	Ci	1.68E-1	7.35E-2	0.00E+0	0.00E+0	2.42E-1
<b>Total</b>	<b>Ci</b>	<b>1.68E-1</b>	<b>7.35E-2</b>	<b>3.84E-2</b>	<b>4.49E-1</b>	<b>7.29E-1</b>
<b>Iodines &amp; Halogens</b>	<b>Units</b>	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Total for the year</b>
		0	0	0	0	0
<b>Particulates</b>	<b>Units</b>	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Total for the year</b>
		0	0	0	0	0
<sup>3</sup> H	Ci	4.14E-2	2.05E-1	1.70E-1	1.28E+0	1.70E+0
<b>Gross α</b>	<b>Ci</b>	<b>0.00E+0</b>	<b>0.00E+0</b>	<b>0.00E+0</b>	<b>0.00E+0</b>	<b>0.00E+0</b>
<sup>14</sup> C	Ci	4.8E-1	4.8E-1	4.8E-1	4.8E-1	1.9E+0



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<b>Table A-1B: Gaseous Effluents- Ground Level Release- Continuous Mode</b>						
<b>Fission &amp; Activation Gases</b>	<b>Units</b>	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Total for the year</b>
<sup>133</sup> Xe	Ci	0.00E+0	0.00E+0	0.00E+0	3.10E-2	3.10E-2
Total	Ci	0.00E+0	0.00E+0	0.00E+0	3.10E-2	3.10E-2
<b>Iodines &amp; Halogens</b>	<b>Units</b>	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Total for the year</b>
		0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total	Ci	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
<b>Particulates</b>	<b>Units</b>	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Total for the year</b>
		0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Total	Ci	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
<sup>3</sup> H	Ci	6.45E+0	8.29E+0	1.21E+1	1.20E+1	3.88E+1
<b>Gross α</b>	Ci	2.36E-7	1.96E-7	1.29E-7	1.35E-7	6.96E-7
<sup>14</sup> C	Ci	2.4E+0	2.4E+0	2.4E+0	2.4E+0	9.7E+0

Table A-2: Liquid Effluents- Summation of All Releases							
Summation of All Liquid Releases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total	Estimated Uncert. (%) <sup>14</sup>
<b>Fission and Activation Products<sup>15</sup></b>	Ci	1.94E-3	7.84E-4	2.14E-3	5.32E-3	1.02E-2	20
<i>Avg Diluted Conc</i>	μCi/ml	1.74E-8	7.80E-9	1.43E-8	2.65E-8	1.81E-8	
<i>% of Limit</i>	%	N/A	N/A	N/A	N/A	N/A	
<b><sup>3</sup>H</b>	Ci	3.27E+2	2.95E+2	4.56E+2	3.66E+2	1.44E+3	14
<i>Avg Diluted Conc</i>	μCi/ml	2.93E-3	2.94E-3	3.04E-3	1.83E-3	2.57E-3	
<i>% of Limit</i>	%	N/A	N/A	N/A	N/A	N/A	
<b>Dissolved &amp; Entrained Gases</b>	Ci	9.31E-5	0.00E+0	6.36E-4	1.43E-3	2.16E-3	27
<i>Avg Diluted Conc</i>	μCi/ml	8.35E-10	0.00E+0	5.70E-9	1.28E-8	1.94E-8	
<i>% of Limit</i>	%	N/A	N/A	N/A	N/A	N/A	
<b>Gross α</b>	Ci	7.78E-4	0.00E+0	4.17E-4	4.53E-4	1.65E-3	29
<i>Avg Diluted Conc</i>	μCi/ml	6.98E-9	0.00E+0	2.78E-9	2.26E-9	2.93E-9	

<sup>14</sup> Safety Analysis calculation 87-063-00, January 6, 1988

<sup>15</sup> Excludes <sup>3</sup>H, noble gases, and gross alpha.

Summation of All Liquid Releases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total	
Vol Liquid Effluent <sup>16</sup>	Liters	2.10E+06	2.09E+06	2.87E+06	5.91E+06	1.30E+07	
Dilution Volume <sup>17</sup>	Liters	1.09E+08	9.84E+07	1.47E+08	1.95E+08	5.50E+08	
Avg river flow <sup>18</sup>	m <sup>3</sup> /s	1.04E+03	2.36E+03	2.47E+03	2.38E+03	2.06E+03	

Fission & Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for the year
<sup>51</sup> Cr	Ci	0.00E+0	0.00E+0	0.00E+0	5.68E-4	5.68E-4
<sup>58</sup> Co	Ci	0.00E+0	0.00E+0	0.00E+0	3.21E-4	3.21E-4
<sup>60</sup> Co	Ci	6.67E-4	4.63E-4	1.48E-3	1.41E-3	4.02E-3
<sup>137</sup> Cs	Ci	8.74E-6	1.35E-5	7.83E-5	1.79E-5	1.18E-4
<sup>124</sup> Sb	Ci	0.00E+0	0.00E+0	0.00E+0	3.48E-4	3.48E-4
<sup>125</sup> Sb	Ci	1.01E-3	1.90E-4	3.62E-4	2.22E-3	3.78E-3
<sup>95</sup> Zr	Ci	0.00E+0	0.00E+0	0.00E+0	5.53E-6	5.53E-6
<sup>95</sup> Nb	Ci	0.00E+0	0.00E+0	0.00E+0	5.96E-5	5.96E-5
Total	Ci	1.69E-3	6.67E-4	1.92E-3	4.95E-3	9.22E-3
<sup>133</sup> Xe	Ci	9.31E-5	0.00E+0	6.36E-4	1.42E-3	2.15E-3
<sup>135</sup> Xe	Ci	0.00E+0	0.00E+0	0.00E+0	8.59E-6	8.59E-6
Total	Ci	9.31E-5	0.00E+0	6.36E-4	1.43E-3	2.16E-3
<sup>3</sup> H	Ci	3.27E+2	2.95E+2	4.56E+2	3.66E+2	1.44E+3
<b>Gross α</b>	Ci	7.78E-04	0.00E+00	4.17E-04	4.53E-04	1.65E-03

<sup>16</sup> Primary system liquid effluent plus secondary liquid effluent, prior to dilution.

<sup>17</sup> Does not include Missouri River dilution.

<sup>18</sup> Average Missouri River flow for the year at the Hermann, MO monitoring station as reported by the USGS.

Table A-3: Solid Waste & Irradiated Fuel Shipments

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

<b>1. TYPE OF WASTE</b>	<b>Units</b>	<b>Period Jan – Jun</b>	<b>Period Jul - Dec</b>	<b>Est. Total Error (%)</b>
<b>Spent resins, filter sludges, evaporator bottoms, etc.</b>	m <sup>3</sup>	1.81E+1	7.22E+0	± 25%
	Ci	5.33E+0	3.71E+1	
<b>Dry compressible waste, contaminated equip., etc.</b>	m <sup>3</sup>	2.00E+2	9.44E+2	± 25%
	Ci	1.57E-2	1.80E-1	
<b>Irradiated components, control rods, etc.</b>	m <sup>3</sup>	0.00E+0	0.00E+0	± 25%
	Ci	0.00E+0	0.00E+0	
<b>Other (low level secondary resin, oily waste)</b>	m <sup>3</sup>	0.00E+0	0.00E+0	± 25%
	Ci	0.00E+0	0.00E+0	

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

<b>2. ESTIMATE OF MAJOR NUCLIDE COMPOSITION (by Type of Waste)</b>				
<b>a. Spent resins, filters, evaporator bottoms, etc.</b>				
<b>Nuclide</b>	<b>% Abundance</b>	<b>Jan – Jun Ci</b>	<b>% Abundance</b>	<b>Jul – Dec Ci</b>
<sup>60</sup> Co	45.89	2.38E+0	8.74	3.24E+0
<sup>63</sup> Ni	33.55	1.74E+0	75.82	2.81E+1
<sup>55</sup> Fe	16.87	8.75E-1	N/A	N/A
<sup>137</sup> Cs	3.68	1.91E-1	10.43	3.87E+0
<sup>134</sup> Cs	N/A	N/A	1.40	5.20E-1
<b>b. Dry compressible waste, contaminated equipment, etc.</b>				
<sup>60</sup> Co	41.79	6.57E-3	58.50	1.04E-1
<sup>63</sup> Ni	18.55	2.92E-3	11.94	2.12E-2
<sup>137</sup> Cs	17.85	2.81E-3	3.67	6.53E-3
<sup>55</sup> Fe	13.57	2.13E-3	16.48	2.93E-2
<sup>134</sup> Cs	2.25	3.54E-4	0.11	1.98E-4
<sup>58</sup> Co	1.50	2.35E-4	N/A	N/A
<sup>54</sup> Mn	1.49	2.34E-4	1.58	2.82E-3
<sup>65</sup> Zn	N/A	N/A	1.07	1.91E-3
<sup>95</sup> Nb	N/A	N/A	3.16	5.63E-3
<sup>125</sup> Sb	N/A	N/A	2.33	4.15E-3
<b>c. Irradiated components, control rods, etc.</b>				
None	N/A	N/A	N/A	N/A

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

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

<b>3. SOLID WASTE DISPOSITION</b>				
<b>Number of Shipments</b>	<b>Mode of Transport</b>	<b>Destination</b>	<b>Class of Solid Waste Shipped</b>	<b>Type of Container</b>
*20	Hittman Transport	Energy Solutions Services, Inc. Bear Creek	A	IP-1
*1	Hittman Transport	Energy Solutions Services, Inc. Bear Creek	B	Liner in an 8-120A Cask
*2	Hittman Transport	Energy Solutions Services, Inc. Bear Creek	A	Liners in a 14-215 Cask
*1	Southern Pines Trucking	Energy Solutions Services, Inc. Bear Creek	A	IP-1
*1	Hittman Transport	Energy Solutions Services, Inc. Memphis	A	IP-1
1	Miller Transfer	Energy Solutions Clive Disposal Site	A	IP-1

\*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.

<b>Table A-4: Dose Assessments, 10 CFR 50, Appendix I</b>					
	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Yearly total</b>
<b>Liquid Effluent Dose Limit, Total Body (mrem)</b>	1.5	1.5	1.5	1.5	3
Total Body Dose (mrem)	5.78E-4	5.93E-4	1.18E-3	6.06E-4	2.87E-3
% Limit (%)	0.04%	0.04%	0.08%	0.04%	0.10%
<b>Liquid Effluent Dose Limit, Maximum Organ (mrem)</b>	5	5	5	5	10
Maximum Organ Dose (mrem)	5.90E-4	6.13E-4	1.30E-3	1.22E-3	3.03E-3
% Limit (%)	0.01%	0.01%	0.03%	0.02%	0.03%
<b>Gaseous Effluent Dose Limit, Gamma Air (mrem)</b>	5	5	5	5	10
Gamma Air Dose (mrad)	2.18E-5	3.08E-5	1.61E-5	1.75E-4	2.44E-4
% Limit (%)	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Gaseous Effluent Dose Limit, Beta Air (mrem)</b>	10	10	10	10	20
Beta Air Dose (mrad)	1.79E-5	1.09E-5	5.67E-6	6.46E-5	9.91E-5
% Limit (%)	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Gaseous Effluent Dose Limit, Maximum Organ (mrem)</b>	7.5	7.5	7.5	7.5	15
Maximum organ dose <sup>19</sup> (mrem)	1.69E-3	2.21E-3	3.21E-3	3.47E-3	1.06E-2
% Limit (%)	0.02%	0.03%	0.04%	0.05%	0.07%
<sup>14</sup> C Maximum organ dose (mrem) <sup>20</sup>	3.55E-3	3.55E-3	3.55E-3	3.55E-3	1.42E-2

<sup>19</sup> Iodine, <sup>3</sup>H, and particulates with greater than an 8 day half- life.

<sup>20</sup> Not included in above totals

<b>Table A-5: EPA 40 CFR 190 Individual in the Unrestricted Area</b>			
	<b>Whole Body</b>	<b>Thyroid</b>	<b>Max Other Organ</b>
<b>Dose Limit</b>	25 mrem	75 mrem	25 mrem
<b>Dose</b>	2.00E-02	1.97E-02	4.88E-02
<b>% Limit</b>	0.08%	0.03%	0.20%



## Appendix B

*Joint Frequency Tables; Totals of Hours at Each Wind Speed & Direction for the period January 1, 2014- December 31, 2014*

## Dispersion Parameters for the Reporting Period

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 9.78E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 9.57E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 8.12E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.88E-09 m<sup>-2</sup>

### Site Boundary

Direction: NNW

Distance: 2200 meters

X/Q, Undecayed and Undepleted: 1.44E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.42E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.23E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 4.65E-09 m<sup>-2</sup>

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Joint Frequency Distribution												
January- December, 2014												
All Stabilities												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	5	14	37	65	104	93	98	72	17	4	0	509
NNE	5	24	41	60	103	74	45	19	11	0	0	382
NE	3	29	62	60	113	59	26	6	7	7	0	372
ENE	6	31	58	76	118	50	16	3	1	0	0	359
E	1	37	53	61	114	46	17	4	1	0	0	334
ESE	3	28	62	82	122	52	23	11	0	0	0	383
SE	2	55	146	162	232	113	42	11	3	0	0	766
SSE	3	47	67	129	347	213	107	52	35	6	0	1006
S	2	23	54	68	207	213	164	111	121	13	0	976
SSW	0	19	42	47	133	135	84	53	28	3	0	544
SW	3	21	41	56	114	119	74	42	13	4	1	488
WSW	1	22	37	33	61	53	49	18	16	0	2	292
W	1	28	40	59	110	94	55	47	32	1	0	467
WNW	2	26	82	75	140	105	87	66	25	0	0	608
NW	4	33	66	90	151	115	106	52	40	2	0	659
NNW	4	24	25	54	143	134	97	59	45	7	1	593
Tot	45	461	913	1177	2312	1668	1090	626	395	47	4	8738
Hours of Calm .....											18	
Hours of Variable Direction .....											0	
Hours of Valid Data .....											8756	
Hours of Missing Data .....											4	
Hours in Period .....											8760	

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Joint Frequency Distribution												
January- December, 2014												
Class A Extremely Unstable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	0	0	0	0	1	0	0	0	0	0	1
NNE	0	0	0	0	2	0	0	0	0	0	0	2
NE	0	0	0	0	0	1	0	0	0	0	0	1
ENE	0	0	0	0	1	0	0	0	0	0	0	1
E	0	0	0	0	0	0	0	0	0	0	0	0
ESE	0	0	0	0	1	1	0	0	0	0	0	2
SE	0	0	0	0	2	5	4	1	0	0	0	12
SSE	0	0	0	0	7	2	2	6	3	2	0	22
S	0	0	0	0	5	1	2	0	5	0	0	13
SSW	0	0	0	0	3	2	5	3	3	0	0	16
SW	0	0	0	0	1	5	3	9	1	2	0	21
WSW	0	0	0	0	1	0	5	4	1	0	0	11
W	0	0	0	0	0	3	1	8	1	0	0	13
WNW	0	0	0	0	0	3	4	8	1	0	0	16
NW	0	0	0	0	1	3	7	5	9	0	0	25
NNW	0	0	0	0	0	1	1	0	3	0	0	5
Tot	0	0	0	0	24	28	34	44	27	4	0	161
Hours of Calm .....	0											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	161											
Hours of Missing Data .....	4											
Hours in Period .....	8760											

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Joint Frequency Distribution												
January- December, 2014												
Class B Moderately Unstable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	0	2	1	1	4	1	2	0	0	0	11
NNE	0	0	1	1	4	1	1	3	0	0	0	11
NE	0	0	1	2	4	1	0	0	0	0	0	8
ENE	0	0	0	2	4	1	0	0	0	0	0	7
E	0	0	0	1	0	0	1	0	0	0	0	2
ESE	0	0	1	0	1	3	1	1	0	0	0	7
SE	0	0	0	1	6	5	1	1	1	0	0	15
SSE	0	0	1	2	7	14	7	4	5	1	0	41
S	0	0	0	1	10	8	6	9	7	2	0	43
SSW	0	0	0	1	7	7	10	4	6	0	0	35
SW	0	0	0	0	2	12	10	6	2	1	0	33
WSW	0	0	0	0	3	5	2	1	1	0	0	12
W	0	0	0	0	1	5	6	1	1	0	0	14
WNW	0	0	0	1	2	16	5	7	1	0	0	32
NW	0	0	0	0	2	8	12	4	2	0	0	28
NNW	0	0	0	0	1	7	8	1	3	0	0	20
Tot	0	0	6	13	55	97	71	44	29	4	0	319
Hours of Calm .....	0											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	319											
Hours of Missing Data .....	4											
Hours in Period .....	8760											

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Joint Frequency Distribution												
January- December, 2014												
Class C Slightly Unstable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	0	0	2	10	9	9	1	0	0	0	31
NNE	0	0	1	0	5	9	2	3	0	0	0	20
NE	0	0	0	2	9	3	0	0	0	0	0	14
ENE	0	0	0	4	7	3	0	0	0	0	0	14
E	0	0	1	1	6	3	0	0	1	0	0	12
ESE	0	0	1	1	4	4	3	1	0	0	0	14
SE	0	0	1	3	12	14	6	3	0	0	0	39
SSE	0	0	3	3	18	14	7	1	4	2	0	52
S	0	0	4	1	15	11	5	9	10	1	0	56
SSW	0	0	0	3	9	8	12	12	4	0	0	48
SW	0	0	2	3	5	9	10	2	1	0	0	32
WSW	0	0	0	1	6	7	7	2	3	0	0	26
W	0	0	0	2	9	5	6	2	3	0	0	27
WNW	0	0	0	5	9	11	11	9	4	0	0	49
NW	0	0	1	2	5	14	9	7	7	0	0	45
NNW	0	0	0	1	10	10	14	9	2	0	0	46
Tot	0	0	14	34	139	134	101	61	39	3	0	525
Hours of Calm .....	0											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	525											
Hours of Missing Data .....	4											
Hours in Period .....	8760											

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Joint Frequency Distribution												
January- December, 2014												
Class D Neutral based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	2	7	23	66	72	85	69	17	4	0	345
NNE	0	0	10	20	57	57	42	13	11	0	0	210
NE	0	3	17	18	67	48	22	5	5	7	0	192
ENE	0	1	13	36	82	39	13	3	1	0	0	188
E	0	5	17	25	67	31	12	4	0	0	0	161
ESE	0	2	19	39	80	32	17	5	0	0	0	194
SE	0	7	31	59	93	55	20	4	0	0	0	269
SSE	0	0	10	38	69	63	44	22	14	1	0	261
S	0	5	18	21	56	48	68	51	79	10	0	356
SSW	0	4	9	9	46	43	30	26	10	3	0	180
SW	0	2	12	15	39	41	31	22	9	1	1	173
WSW	0	2	13	5	26	22	20	9	10	0	2	109
W	0	7	7	27	43	37	28	28	26	1	0	204
WNW	0	2	17	24	74	48	58	40	19	0	0	282
NW	0	1	12	21	75	73	73	33	22	1	0	311
NNW	0	0	7	22	76	95	62	44	37	7	1	351
Tot	0	43	219	402	1016	804	625	378	260	35	4	3786
Hours of Calm .....	0											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	3786											
Hours of Missing Data .....	4											
Hours in Period .....	8760											

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Joint Frequency Distribution												
January- December, 2014												
Class E Slightly Stable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	1	4	14	23	22	7	3	0	0	0	0	74
NNE	1	6	12	23	31	7	0	0	0	0	0	80
NE	0	5	13	27	30	6	4	1	2	0	0	88
ENE	0	8	15	22	21	7	3	0	0	0	0	76
E	0	7	10	26	38	11	4	0	0	0	0	96
ESE	0	5	12	29	31	12	2	4	0	0	0	95
SE	1	8	48	68	93	34	9	1	2	0	0	264
SSE	0	8	13	26	130	92	46	19	9	0	0	343
S	0	4	10	16	76	111	76	41	20	0	0	354
SSW	0	6	6	14	43	57	24	8	5	0	0	163
SW	0	7	12	19	47	42	20	3	0	0	0	150
WSW	0	9	11	24	17	17	14	2	1	0	0	95
W	0	10	16	17	44	43	14	8	1	0	0	153
WNW	0	9	33	26	45	26	9	2	0	0	0	150
NW	0	11	15	43	58	17	5	3	0	1	0	153
NNW	0	6	14	19	42	21	12	5	0	0	0	119
Tot	3	113	254	422	768	510	245	97	40	1	0	2453
Hours of Calm .....	4											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	2457											
Hours of Missing Data .....	4											
Hours in Period .....	8760											



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Joint Frequency Distribution												
January- December, 2014												
Class F Moderately Stable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	2	1	7	12	5	0	0	0	0	0	0	27
NNE	1	5	10	10	4	0	0	0	0	0	0	30
NE	0	12	17	8	2	0	0	0	0	0	0	39
ENE	4	13	22	9	3	0	0	0	0	0	0	51
E	1	15	18	7	3	1	0	0	0	0	0	45
ESE	1	13	25	12	5	0	0	0	0	0	0	56
SE	1	25	58	29	24	0	2	1	0	0	0	140
SSE	0	15	25	51	104	22	1	0	0	0	0	218
S	1	5	12	23	40	29	6	1	0	0	0	117
SSW	0	5	19	17	22	18	3	0	0	0	0	84
SW	1	7	12	17	20	10	0	0	0	0	0	67
WSW	0	6	10	3	8	2	1	0	0	0	0	30
W	0	6	11	10	13	1	0	0	0	0	0	41
WNW	1	11	21	15	10	1	0	0	0	0	0	59
NW	2	8	26	16	9	0	0	0	0	0	0	61
NNW	0	11	0	12	11	0	0	0	0	0	0	34
Tot	15	158	293	251	283	84	13	2	0	0	0	1099
Hours of Calm .....												3
Hours of Variable Direction .....												0
Hours of Valid Data .....												1102
Hours of Missing Data .....												4
Hours in Period .....												8760

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Joint Frequency Distribution												
January- December, 2014												
Class G Extremely Stable based on lapse rate												
Elevations: Winds 10m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	2	7	7	4	0	0	0	0	0	0	0	20
NNE	3	13	7	6	0	0	0	0	0	0	0	29
NE	3	9	14	3	1	0	0	0	0	0	0	30
ENE	2	9	8	3	0	0	0	0	0	0	0	22
E	0	10	7	1	0	0	0	0	0	0	0	18
ESE	2	8	4	1	0	0	0	0	0	0	0	15
SE	0	15	8	2	2	0	0	0	0	0	0	27
SSE	3	24	15	9	12	6	0	0	0	0	0	69
S	1	9	10	6	5	5	1	0	0	0	0	37
SSW	0	4	8	3	3	0	0	0	0	0	0	18
SW	2	5	3	2	0	0	0	0	0	0	0	12
WSW	1	5	3	0	0	0	0	0	0	0	0	9
W	1	5	6	3	0	0	0	0	0	0	0	15
WNW	1	4	11	4	0	0	0	0	0	0	0	20
NW	2	13	12	8	1	0	0	0	0	0	0	36
NNW	4	7	4	0	3	0	0	0	0	0	0	18
Tot	27	147	127	55	27	11	1	0	0	0	0	395
Hours of Calm .....											11	
Hours of Variable Direction .....											0	
Hours of Valid Data .....											406	
Hours of Missing Data .....											4	
Hours in Period .....											8760	

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Joint Frequency Distribution												
January- December, 2014												
All Stabilities												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	4	5	17	52	72	91	104	106	8	4	463
NNE	0	4	12	23	62	85	91	61	50	4	2	394
NE	0	3	11	15	71	70	107	49	20	5	9	360
ENE	0	5	12	19	87	84	95	42	18	1	0	363
E	0	5	12	22	62	77	93	61	13	1	0	346
ESE	0	5	8	24	63	103	110	63	22	2	0	400
SE	0	3	35	61	169	171	171	107	45	2	1	765
SSE	0	12	16	30	115	138	175	134	166	29	7	822
S	0	4	11	23	75	92	142	152	324	133	23	979
SSW	0	2	10	10	65	82	107	119	218	47	6	666
SW	0	0	15	11	42	54	89	112	191	53	14	581
WSW	0	1	10	17	38	37	51	51	77	27	15	324
W	0	1	9	17	40	52	56	65	119	62	17	438
WNW	0	3	9	19	45	73	90	107	180	109	27	662
NW	0	6	3	13	42	63	115	163	156	77	24	662
NNW	0	4	3	23	45	83	96	108	111	41	16	530
Tot	0	62	181	344	1073	1336	1679	1498	1816	601	165	8755
Hours of Calm .....												1
Hours of Variable Direction .....												0
Hours of Valid Data .....												8756
Hours of Missing Data .....												4
Hours in Period .....												8760

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Joint Frequency Distribution												
January- December, 2014												
Class A Extremely Unstable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	0	0	0	0	0	1	0	0	1	0	2
NNE	0	0	0	0	1	1	0	0	0	0	0	2
NE	0	0	0	0	0	0	1	0	0	0	0	1
ENE	0	0	0	0	1	0	0	0	0	0	0	1
E	0	0	0	0	0	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	1	0	0	0	0	1
SE	0	0	0	0	0	7	3	2	0	0	0	12
SSE	0	0	0	0	2	6	3	2	4	4	1	22
S	0	0	0	0	3	2	1	2	2	3	0	13
SSW	0	0	0	0	0	4	1	4	2	4	0	15
SW	0	0	0	0	0	2	2	4	10	3	3	24
WSW	0	0	0	0	0	1	0	2	6	1	0	10
W	0	0	0	0	0	1	1	1	3	6	0	12
WNW	0	0	0	0	0	0	2	2	5	9	3	21
NW	0	0	0	0	0	1	1	1	6	10	2	21
NNW	0	0	0	0	0	0	1	1	2	0	0	4
Tot	0	0	0	0	7	25	18	21	40	41	9	161
Hours of Calm .....											0	
Hours of Variable Direction .....											0	
Hours of Valid Data .....											161	
Hours of Missing Data .....											4	
Hours in Period .....											8760	

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Joint Frequency Distribution												
January- December, 2014												
Class B Moderately Unstable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	0	0	2	1	1	4	1	2	0	0	11
NNE	0	0	0	1	2	2	1	0	3	0	0	9
NE	0	0	2	0	6	1	0	0	0	0	0	9
ENE	0	0	0	1	3	1	1	0	0	0	0	6
E	0	0	0	1	1	0	1	0	0	0	0	3
ESE	0	0	1	0	0	1	2	1	1	0	0	6
SE	0	0	0	1	3	6	3	2	0	0	0	15
SSE	0	0	0	1	6	10	8	5	5	5	1	41
S	0	0	0	1	2	8	7	4	12	5	1	40
SSW	0	0	0	0	3	5	5	8	6	5	1	33
SW	0	0	0	0	0	4	11	5	13	4	1	38
WSW	0	0	0	0	1	1	1	7	1	1	1	13
W	0	0	0	0	0	2	3	2	5	2	0	14
WNW	0	0	0	0	1	4	9	5	9	6	1	35
NW	0	0	0	0	0	0	7	10	7	6	1	31
NNW	0	0	0	0	0	1	3	6	2	3	0	15
Tot	0	0	3	8	29	47	66	56	66	37	7	319
Hours of Calm .....	0											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	319											
Hours of Missing Data .....	4											
Hours in Period .....	8760											

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Joint Frequency Distribution												
January- December, 2014												
Class C Slightly Unstable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	0	1	1	4	6	12	5	0	0	0	29
NNE	0	0	1	0	4	7	5	2	3	0	0	22
NE	0	0	0	1	7	2	3	0	0	0	0	13
ENE	0	0	1	3	8	2	1	0	0	0	0	15
E	0	0	0	0	5	2	2	0	0	1	0	10
ESE	0	0	0	2	2	4	2	3	0	0	0	13
SE	0	0	1	1	11	7	12	2	3	0	0	37
SSE	0	0	2	1	9	9	13	6	2	2	2	46
S	0	0	2	3	9	12	11	3	13	7	1	61
SSW	0	0	1	0	13	2	8	6	18	3	1	52
SW	0	0	0	3	1	4	8	4	9	3	0	32
WSW	0	0	1	1	3	6	3	4	9	0	3	30
W	0	0	0	2	4	2	3	3	7	2	1	24
WNW	0	0	0	2	5	7	5	7	10	15	3	54
NW	0	0	0	1	4	7	3	12	12	11	3	53
NNW	0	0	0	0	0	5	9	9	9	2	0	34
Tot	0	0	10	21	89	84	100	66	95	46	14	525
Hours of Calm .....	0											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	525											
Hours of Missing Data .....	4											
Hours in Period .....	8760											

Callaway Energy Center  
2014 Annual Radioactive Effluent Release Report

Joint Frequency Distribution												
January- December, 2014												
Class D Neutral based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	0	2	6	37	49	51	67	94	7	4	317
NNE	0	2	5	14	37	45	45	38	40	4	2	232
NE	0	1	6	8	38	39	49	26	10	4	8	189
ENE	0	2	7	11	55	50	42	16	11	1	0	195
E	0	1	7	16	35	42	23	15	7	0	0	146
ESE	0	3	5	17	48	53	26	17	13	2	0	184
SE	0	2	22	32	77	57	37	26	13	1	0	267
SSE	0	3	9	17	50	48	51	30	45	7	1	261
S	0	2	7	15	36	25	38	41	102	63	20	349
SSW	0	0	4	6	31	24	35	31	45	14	4	194
SW	0	0	8	7	21	23	20	31	47	15	10	182
WSW	0	0	7	8	12	11	17	16	28	11	10	120
W	0	0	6	11	28	20	21	26	40	32	16	200
WNW	0	1	3	10	23	34	36	38	73	73	19	310
NW	0	3	1	11	25	27	45	63	89	44	17	325
NNW	0	0	1	17	30	47	57	46	69	32	16	315
Tot	0	20	100	206	583	594	593	527	726	310	127	3786
Hours of Calm .....	0											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	3786											
Hours of Missing Data .....	4											
Hours in Period .....	8760											

Callaway Energy Center  
2014 Annual Radioactive Effluent Release Report

Joint Frequency Distribution												
January- December, 2014												
Class E Slightly Stable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	1	1	6	3	10	14	15	5	0	0	55
NNE	0	1	3	6	12	24	31	9	3	0	0	89
NE	0	1	1	2	14	20	37	13	7	1	1	97
ENE	0	3	1	2	13	14	30	11	3	0	0	77
E	0	0	0	1	13	21	32	18	5	0	0	90
ESE	0	2	0	2	6	24	53	24	7	0	0	118
SE	0	0	4	13	39	61	71	37	18	1	1	245
SSE	0	1	2	2	19	31	63	64	83	11	2	278
S	0	0	1	2	9	22	41	65	159	49	1	349
SSW	0	2	1	2	9	18	22	48	89	13	0	204
SW	0	0	1	0	11	13	28	36	77	18	0	184
WSW	0	0	0	4	14	10	14	15	27	12	1	97
W	0	0	1	1	6	18	19	25	55	19	0	144
WNW	0	0	4	3	12	18	25	34	60	6	1	163
NW	0	1	1	0	6	9	39	54	32	6	1	149
NNW	0	4	0	4	8	23	16	35	24	4	0	118
Tot	0	16	21	50	194	336	535	503	654	140	8	2457
Hours of Calm .....	0											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	2457											
Hours of Missing Data .....	4											
Hours in Period .....	8760											



Callaway Energy Center  
2014 Annual Radioactive Effluent Release Report

Joint Frequency Distribution												
January- December, 2014												
Class F Moderately Stable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	2	0	1	4	4	5	13	4	0	0	33
NNE	0	0	2	0	3	6	8	10	0	0	0	29
NE	0	1	0	1	4	5	13	6	0	0	0	30
ENE	0	0	2	1	2	9	14	8	3	0	0	39
E	0	2	1	2	2	9	19	18	0	0	0	53
ESE	0	0	1	2	5	14	18	15	0	0	0	55
SE	0	0	3	10	29	25	36	36	10	0	0	149
SSE	0	5	2	6	18	20	32	24	24	0	0	131
S	0	0	0	2	8	16	38	34	31	5	0	134
SSW	0	0	2	0	8	21	31	18	49	6	0	135
SW	0	0	3	0	6	6	16	29	32	10	0	102
WSW	0	0	0	0	4	6	10	6	6	2	0	34
W	0	1	1	2	2	6	7	7	8	1	0	35
WNW	0	1	0	2	1	7	10	17	21	0	0	59
NW	0	0	0	1	3	8	14	21	9	0	0	56
NNW	0	0	1	0	5	5	4	9	3	0	0	27
Tot	0	12	18	30	104	167	275	271	200	24	0	1101
Hours of Calm .....	1											
Hours of Variable Direction .....	0											
Hours of Valid Data .....	1102											
Hours of Missing Data .....	4											
Hours in Period .....	8760											

Callaway Energy Center  
2014 Annual Radioactive Effluent Release Report

Joint Frequency Distribution												
January- December, 2014												
Class G Extremely Stable based on lapse rate												
Elevations: Winds 60m Stability 60m												
Wind Direction Sector	Wind Speed Range (m/s)											Total
	<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	
N	0	1	1	1	3	2	4	3	1	0	0	16
NNE	0	1	1	2	3	0	1	2	1	0	0	11
NE	0	0	2	3	2	3	4	4	3	0	0	21
ENE	0	0	1	1	5	8	7	7	1	0	0	30
E	0	2	4	2	6	3	16	10	1	0	0	44
ESE	0	0	1	1	2	7	8	3	1	0	0	23
SE	0	1	5	4	10	8	9	2	1	0	0	40
SSE	0	3	1	3	11	14	5	3	3	0	0	43
S	0	2	1	0	8	7	6	3	5	1	0	33
SSW	0	0	2	2	1	8	5	4	9	2	0	33
SW	0	0	3	1	3	2	4	3	3	0	0	19
WSW	0	1	2	4	4	2	6	1	0	0	0	20
W	0	0	1	1	0	3	2	1	1	0	0	9
WNW	0	1	2	2	3	3	3	4	2	0	0	20
NW	0	2	1	0	4	11	6	2	1	0	0	27
NNW	0	0	1	2	2	2	6	2	2	0	0	17
Tot	0	14	29	29	67	83	92	54	35	3	0	406
Hours of Calm .....												0
Hours of Variable Direction .....												0
Hours of Valid Data .....												406
Hours of Missing Data .....												4
Hours in Period .....												8760

## Appendix C

### *Corrections to Prior Annual Radioactive Effluent Release Reports*

### Dispersion Parameters for 1993

#### Nearest Resident

Direction: N

Distance: 2945 meters

X/Q, Undecayed and Undepleted: 9.52E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 9.30E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 7.89E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.61E-09 m<sup>-2</sup>

#### Site Boundary

Direction: SE

Distance: 1800 meters

X/Q, Undecayed and Undepleted: 1.66E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.64E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.44E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.69E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
 TO THE NEAREST RESIDENT FROM  
 GASEOUS EFFLUENTS  
 1993**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.80 km SE		LOCATION: 2.94 km N	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	2.03E-02	0.20	1.15E-02	N/A
BETA AIR DOSE *	mrad	4.83E-02	0.24	2.74E-02	N/A
WHOLE BODY ***	mrem	1.77E-02	N/A	1.00E-02	N/A
SKIN***	mrem	4.01E-02	N/A	2.27E-02	N/A
BONE**	mrem	4.83E-06	N/A	1.73E-04	0.00
LIVER**	mrem	4.67E-03	N/A	2.33E-02	0.16
TOTAL BODY**	mrem	4.67E-03	N/A	2.32E-02	0.15
THYROID **	mrem	5.20E-03	N/A	7.54E-02	0.50
KIDNEY**	mrem	4.67E-03	N/A	2.34E-02	0.16
LUNG**	mrem	4.67E-03	N/A	2.31E-02	0.15
GI-LLI **	mrem	4.67E-03	N/A	2.31E-02	0.15

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 1993**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	6.35E-03	N/A	N/A	6.35E-03
BONE	mrem	8.49E-07	8.79E-03	1.06E-03	9.85E-03
LIVER	mrem	8.75E-04	8.79E-03	1.06E-03	1.07E-02
TOTAL BODY	mrem	3.68E-03	8.79E-03	1.06E-03	1.35E-02
THYROID	mrem	9.38E-04	8.79E-03	1.06E-03	1.08E-02
KIDNEY	mrem	8.75E-04	8.79E-03	1.06E-03	1.07E-02
LUNG	mrem	8.75E-04	8.79E-03	1.06E-03	1.07E-02
GI-LLI	mrem	8.75E-04	8.79E-03	1.06E-03	1.07E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 1993**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	1.63E-02	6.35E-03	2.26E-02	0.09
BONE	mrem	3.11E-05	9.85E-03	9.88E-03	0.04
LIVER	mrem	9.94E-03	1.07E-02	2.07E-02	0.08
TOTAL BODY	mrem	1.71E-02	1.35E-02	3.06E-02	0.12
THYROID	mrem	2.27E-02	1.08E-02	3.35E-02	0.04
KIDNEY	mrem	9.96E-03	1.07E-02	2.07E-02	0.08
LUNG	mrem	9.90E-03	1.07E-02	2.06E-02	0.08
GI-LLI	mrem	9.91E-03	1.07E-02	2.06E-02	0.08

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 1994

### Nearest Resident

Direction: WSW

Distance: 1931 meters

X/Q, Undecayed and Undepleted: 8.13E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 8.09E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 7.02E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.76E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.49E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.49E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.32E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.09E-09 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
 TO THE NEAREST RESIDENT FROM  
 GASEOUS EFFLUENTS  
 1994**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 1.93 km WSW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	2.28E-03	0.02	1.24E-03	N/A
BETA AIR DOSE *	mrad	2.64E-03	0.01	1.43E-03	N/A
WHOLE BODY ***	mrem	2.13E-03	N/A	1.16E-03	N/A
SKIN***	mrem	4.09E-03	N/A	2.22E-03	N/A
BONE**	mrem	2.41E-06	N/A	5.70E-06	0.00
LIVER**	mrem	4.19E-03	N/A	2.02E-02	0.13
TOTAL BODY**	mrem	4.19E-03	N/A	2.02E-02	0.13
THYROID **	mrem	4.21E-03	N/A	2.16E-02	0.14
KIDNEY**	mrem	4.19E-03	N/A	2.02E-02	0.13
LUNG**	mrem	4.19E-03	N/A	2.02E-02	0.13
GI-LLI **	mrem	4.19E-03	N/A	2.02E-02	0.13

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 1994**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	7.14E-04	N/A	N/A	7.14E-04
BONE	mrem	5.30E-07	8.79E-03	3.54E-04	9.14E-03
LIVER	mrem	8.58E-04	8.79E-03	3.54E-04	1.00E-02
TOTAL BODY	mrem	1.23E-03	8.79E-03	3.54E-04	1.04E-02
THYROID	mrem	8.60E-04	8.79E-03	3.54E-04	1.00E-02
KIDNEY	mrem	8.58E-04	8.79E-03	3.54E-04	1.00E-02
LUNG	mrem	8.58E-04	8.79E-03	3.54E-04	1.00E-02
GI-LLI	mrem	8.58E-04	8.79E-03	3.54E-04	1.00E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 1994**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	1.21E-03	7.14E-04	1.92E-03	0.01
BONE	mrem	1.18E-06	9.14E-03	9.15E-03	0.04
LIVER	mrem	6.33E-03	1.00E-02	1.63E-02	0.07
TOTAL BODY	mrem	6.96E-03	1.04E-02	1.73E-02	0.07
THYROID	mrem	6.58E-03	1.00E-02	1.66E-02	0.02
KIDNEY	mrem	6.33E-03	1.00E-02	1.63E-02	0.07
LUNG	mrem	6.33E-03	1.00E-02	1.63E-02	0.07
GI-LLI	mrem	6.33E-03	1.00E-02	1.63E-02	0.07

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 1995

### Nearest Resident

Direction: WSW

Distance: 1931 meters

X/Q, Undecayed and Undepleted: 7.69E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 7.64E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 6.64E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.13E-09 m<sup>-2</sup>

### Site Boundary

Direction: SE

Distance: 1800 meters

X/Q, Undecayed and Undepleted: 1.14E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.13E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 9.84E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 5.49E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
1995**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.80 km SE		LOCATION: 1.93 km WSW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	1.42E-03	0.01	9.58E-04	N/A
BETA AIR DOSE *	mrad	2.38E-03	0.01	1.61E-03	N/A
WHOLE BODY ***	mrem	3.00E-03	N/A	1.54E-03	N/A
SKIN***	mrem	4.41E-03	N/A	2.48E-03	N/A
BONE**	mrem	1.73E-03	N/A	2.79E-03	0.02
LIVER**	mrem	5.21E-03	N/A	2.43E-02	0.16
TOTAL BODY**	mrem	5.20E-03	N/A	2.24E-02	0.15
THYROID **	mrem	5.25E-03	N/A	2.51E-02	0.17
KIDNEY**	mrem	5.20E-03	N/A	2.27E-02	0.15
LUNG**	mrem	5.31E-03	N/A	2.23E-02	0.15
GI-LLI **	mrem	5.20E-03	N/A	2.21E-02	0.15

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 1995**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	6.19E-04	N/A	N/A	6.19E-04
BONE	mrem	4.08E-04	9.00E-03	2.85E-04	9.69E-03
LIVER	mrem	1.36E-03	9.00E-03	2.85E-04	1.06E-02
TOTAL BODY	mrem	1.66E-03	9.00E-03	2.85E-04	1.09E-02
THYROID	mrem	1.37E-03	9.00E-03	2.85E-04	1.07E-02
KIDNEY	mrem	1.36E-03	9.00E-03	2.85E-04	1.06E-02
LUNG	mrem	1.39E-03	9.00E-03	2.85E-04	1.07E-02
GI-LLI	mrem	1.36E-03	9.00E-03	2.85E-04	1.06E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 1995**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	1.09E-03	6.19E-04	1.70E-03	0.01
BONE	mrem	9.90E-04	9.69E-03	1.07E-02	0.04
LIVER	mrem	8.57E-03	1.06E-02	1.92E-02	0.08
TOTAL BODY	mrem	8.91E-03	1.09E-02	1.99E-02	0.08
THYROID	mrem	8.78E-03	1.07E-02	1.94E-02	0.03
KIDNEY	mrem	8.12E-03	1.06E-02	1.88E-02	0.08
LUNG	mrem	8.00E-03	1.07E-02	1.87E-02	0.07
GI-LLI	mrem	8.24E-03	1.06E-02	1.89E-02	0.08

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 1996

### Nearest Resident

Direction: WSW

Distance: 1931 meters

X/Q, Undecayed and Undepleted: 6.60E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 6.56E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 5.70E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.26E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.06E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.06E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 9.36E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 3.45E-09 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
1996**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 1.93 km WSW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	2.95E-03	0.03	1.83E-03	N/A
BETA AIR DOSE *	mrad	5.40E-03	0.03	3.34E-03	N/A
WHOLE BODY ***	mrem	2.62E-03	N/A	1.62E-03	N/A
SKIN***	mrem	5.23E-03	N/A	3.23E-03	N/A
BONE**	mrem	1.38E-06	N/A	1.87E-05	0.00
LIVER**	mrem	2.91E-03	N/A	1.60E-02	0.11
TOTAL BODY**	mrem	2.91E-03	N/A	1.60E-02	0.11
THYROID **	mrem	2.96E-03	N/A	2.19E-02	0.15
KIDNEY**	mrem	2.91E-03	N/A	1.61E-02	0.11
LUNG**	mrem	2.91E-03	N/A	1.60E-02	0.11
GI-LLI **	mrem	2.91E-03	N/A	1.60E-02	0.11

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 1996**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	1.28E-03	N/A	N/A	1.28E-03
BONE	mrem	4.27E-07	8.79E-03	2.10E-03	1.09E-02
LIVER	mrem	8.39E-04	8.79E-03	2.10E-03	1.17E-02
TOTAL BODY	mrem	1.48E-03	8.79E-03	2.10E-03	1.24E-02
THYROID	mrem	8.49E-04	8.79E-03	2.10E-03	1.17E-02
KIDNEY	mrem	8.39E-04	8.79E-03	2.10E-03	1.17E-02
LUNG	mrem	8.39E-04	8.79E-03	2.10E-03	1.17E-02
GI-LLI	mrem	8.39E-04	8.79E-03	2.10E-03	1.17E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 1996**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	2.02E-03	1.28E-03	3.30E-03	0.01
BONE	mrem	3.88E-06	1.09E-02	1.09E-02	0.04
LIVER	mrem	5.77E-03	1.17E-02	1.75E-02	0.07
TOTAL BODY	mrem	6.78E-03	1.24E-02	1.92E-02	0.08
THYROID	mrem	7.31E-03	1.17E-02	1.91E-02	0.03
KIDNEY	mrem	5.77E-03	1.17E-02	1.75E-02	0.07
LUNG	mrem	5.77E-03	1.17E-02	1.75E-02	0.07
GI-LLI	mrem	5.77E-03	1.17E-02	1.75E-02	0.07

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

### Dispersion Parameters for 1997

#### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 6.47E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 6.42E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 5.39E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.19E-09 m<sup>-2</sup>

#### Site Boundary

Direction: SE

Distance: 1800 meters

X/Q, Undecayed and Undepleted: 1.18E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.17E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.02E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.42E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
1997**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.80 km SE		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	6.21E-03	0.06	3.41E-03	N/A
BETA AIR DOSE *	mrad	1.67E-02	0.08	9.14E-03	N/A
WHOLE BODY ***	mrem	5.30E-03	N/A	2.91E-03	N/A
SKIN***	mrem	1.25E-02	N/A	6.86E-03	N/A
BONE**	mrem	1.24E-06	N/A	4.33E-06	0.00
LIVER**	mrem	2.91E-03	N/A	1.39E-02	0.09
TOTAL BODY**	mrem	2.91E-03	N/A	1.39E-02	0.09
THYROID **	mrem	2.92E-03	N/A	1.52E-02	0.10
KIDNEY**	mrem	2.91E-03	N/A	1.39E-02	0.09
LUNG**	mrem	2.91E-03	N/A	1.39E-02	0.09
GI-LLI **	mrem	2.91E-03	N/A	1.39E-02	0.09

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 1997**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	2.78E-03	N/A	N/A	2.78E-03
BONE	mrem	2.95E-07	8.79E-03	9.59E-05	8.89E-03
LIVER	mrem	7.71E-04	8.79E-03	9.59E-05	9.66E-03
TOTAL BODY	mrem	1.95E-03	8.79E-03	9.59E-05	1.08E-02
THYROID	mrem	7.73E-04	8.79E-03	9.59E-05	9.66E-03
KIDNEY	mrem	7.71E-04	8.79E-03	9.59E-05	9.66E-03
LUNG	mrem	7.71E-04	8.79E-03	9.59E-05	9.66E-03
GI-LLI	mrem	7.71E-04	8.79E-03	9.59E-05	9.66E-03

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 1997**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	4.99E-03	2.78E-03	7.76E-03	0.03
BONE	mrem	1.15E-06	8.89E-03	8.89E-03	0.04
LIVER	mrem	6.05E-03	9.66E-03	1.57E-02	0.06
TOTAL BODY	mrem	8.17E-03	1.08E-02	1.90E-02	0.08
THYROID	mrem	6.41E-03	9.66E-03	1.61E-02	0.02
KIDNEY	mrem	6.05E-03	9.66E-03	1.57E-02	0.06
LUNG	mrem	6.05E-03	9.66E-03	1.57E-02	0.06
GI-LLI	mrem	6.05E-03	9.66E-03	1.57E-02	0.06

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 1998

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 6.38E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 6.32E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 5.32E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.38E-09 m<sup>-2</sup>

### Site Boundary

Direction: S

Distance: 1300 meters

X/Q, Undecayed and Undepleted: 1.24E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.23E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.10 E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.26E-09 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
1998**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.30 km S		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	5.59E-03	0.06	2.87E-03	N/A
BETA AIR DOSE *	mrad	1.06E-02	0.05	5.45E-03	N/A
WHOLE BODY ***	mrem	9.97E-03	N/A	4.81E-03	N/A
SKIN***	mrem	1.51E-02	N/A	7.44E-03	N/A
BONE**	mrem	5.03E-03	N/A	7.89E-03	0.05
LIVER**	mrem	1.03E-02	N/A	3.19E-02	0.21
TOTAL BODY**	mrem	1.03E-02	N/A	2.66E-02	0.18
THYROID **	mrem	1.07E-02	N/A	9.09E-02	0.61
KIDNEY**	mrem	1.03E-02	N/A	2.76E-02	0.18
LUNG**	mrem	1.05E-02	N/A	2.60E-02	0.17
GI-LLI **	mrem	1.03E-02	N/A	2.55E-02	0.17

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 1998**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	2.13E-03	N/A	N/A	2.13E-03
BONE	mrem	1.24E-03	8.79E-03	8.22E-03	1.83E-02
LIVER	mrem	2.53E-03	8.79E-03	8.22E-03	1.95E-02
TOTAL BODY	mrem	3.57E-03	8.79E-03	8.22E-03	2.06E-02
THYROID	mrem	2.60E-03	8.79E-03	8.22E-03	1.96E-02
KIDNEY	mrem	2.52E-03	8.79E-03	8.22E-03	1.95E-02
LUNG	mrem	2.58E-03	8.79E-03	8.22E-03	1.96E-02
GI-LLI	mrem	2.53E-03	8.79E-03	8.22E-03	1.95E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 1998**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	3.61E-03	2.13E-03	5.74E-03	0.02
BONE	mrem	2.07E-03	1.83E-02	2.03E-02	0.08
LIVER	mrem	1.22E-02	1.95E-02	3.18E-02	0.13
TOTAL BODY	mrem	1.37E-02	2.06E-02	3.43E-02	0.14
THYROID	mrem	2.39E-02	1.96E-02	4.35E-02	0.06
KIDNEY	mrem	1.14E-02	1.95E-02	3.09E-02	0.12
LUNG	mrem	1.11E-02	1.96E-02	3.07E-02	0.12
GI-LLI	mrem	1.12E-02	1.95E-02	3.07E-02	0.12

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 1999

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 7.18E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 7.13E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 5.99E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.83E-09 m<sup>-2</sup>

### Site Boundary

Direction: NNW

Distance: 2200 meters

X/Q, Undecayed and Undepleted: 1.05E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.05E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 8.98E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 4.58E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
1999**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 2.20 km NNW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	1.56E-03	0.02	1.06E-03	N/A
BETA AIR DOSE *	mrad	1.96E-03	0.01	1.33E-03	N/A
WHOLE BODY ***	mrem	2.64E-03	N/A	1.72E-03	N/A
SKIN***	mrem	3.86E-03	N/A	2.55E-03	N/A
BONE**	mrem	1.21E-03	N/A	5.39E-03	0.04
LIVER**	mrem	3.96E-03	N/A	2.23E-02	0.15
TOTAL BODY**	mrem	3.95E-03	N/A	1.82E-02	0.12
THYROID **	mrem	3.96E-03	N/A	1.89E-02	0.13
KIDNEY**	mrem	3.95E-03	N/A	1.90E-02	0.13
LUNG**	mrem	4.00E-03	N/A	1.80E-02	0.12
GI-LLI **	mrem	3.95E-03	N/A	1.75E-02	0.12

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 1999**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	6.60E-04	N/A	N/A	6.60E-04
BONE	mrem	3.41E-04	8.79E-03	1.30E-03	1.04E-02
LIVER	mrem	1.17E-03	8.79E-03	1.30E-03	1.13E-02
TOTAL BODY	mrem	1.53E-03	8.79E-03	1.30E-03	1.16E-02
THYROID	mrem	1.17E-03	8.79E-03	1.30E-03	1.13E-02
KIDNEY	mrem	1.17E-03	8.79E-03	1.30E-03	1.13E-02
LUNG	mrem	1.18E-03	8.79E-03	1.30E-03	1.13E-02
GI-LLI	mrem	1.17E-03	8.79E-03	1.30E-03	1.13E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 1999**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	7.92E-04	6.60E-04	1.45E-03	0.01
BONE	mrem	8.24E-04	1.04E-02	1.13E-02	0.05
LIVER	mrem	5.45E-03	1.13E-02	1.67E-02	0.07
TOTAL BODY	mrem	5.65E-03	1.16E-02	1.73E-02	0.07
THYROID	mrem	4.92E-03	1.13E-02	1.62E-02	0.02
KIDNEY	mrem	4.94E-03	1.13E-02	1.62E-02	0.06
LUNG	mrem	4.78E-03	1.13E-02	1.60E-02	0.06
GI-LLI	mrem	4.75E-03	1.13E-02	1.60E-02	0.06

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2000

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 6.38E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 6.35E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 5.32E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.74E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 9.93E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 9.89E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 8.76E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 4.09E-09 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
2000**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	1.87E-03	0.02	1.20E-03	N/A
BETA AIR DOSE *	mrad	4.72E-03	0.02	3.03E-03	N/A
WHOLE BODY ***	mrem	2.25E-03	N/A	1.47E-03	N/A
SKIN***	mrem	4.30E-03	N/A	2.78E-03	N/A
BONE**	mrem	6.55E-04	N/A	4.02E-03	0.03
LIVER**	mrem	3.09E-03	N/A	1.73E-02	0.12
TOTAL BODY**	mrem	3.09E-03	N/A	1.44E-02	0.10
THYROID **	mrem	3.30E-03	N/A	5.03E-02	0.34
KIDNEY**	mrem	3.09E-03	N/A	1.51E-02	0.10
LUNG**	mrem	3.11E-03	N/A	1.42E-02	0.09
GI-LLI **	mrem	3.09E-03	N/A	1.39E-02	0.09

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2000**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	9.60E-04	N/A	N/A	9.60E-04
BONE	mrem	2.07E-04	8.79E-03	1.30E-03	1.03E-02
LIVER	mrem	9.59E-04	8.79E-03	1.30E-03	1.10E-02
TOTAL BODY	mrem	1.38E-03	8.79E-03	1.30E-03	1.15E-02
THYROID	mrem	9.99E-04	8.79E-03	1.30E-03	1.11E-02
KIDNEY	mrem	9.58E-04	8.79E-03	1.30E-03	1.10E-02
LUNG	mrem	9.62E-04	8.79E-03	1.30E-03	1.11E-02
GI-LLI	mrem	9.57E-04	8.79E-03	1.30E-03	1.10E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2000**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	1.25E-03	9.60E-04	2.21E-03	0.01
BONE	mrem	6.09E-04	1.03E-02	1.09E-02	0.04
LIVER	mrem	5.05E-03	1.10E-02	1.61E-02	0.06
TOTAL BODY	mrem	5.41E-03	1.15E-02	1.69E-02	0.07
THYROID	mrem	1.04E-02	1.11E-02	2.15E-02	0.03
KIDNEY	mrem	4.70E-03	1.10E-02	1.57E-02	0.06
LUNG	mrem	4.55E-03	1.11E-02	1.56E-02	0.06
GI-LLI	mrem	4.52E-03	1.10E-02	1.56E-02	0.06

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2001

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 6.36E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 6.29E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 5.30E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.39E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.16E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.14E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.02E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 3.51E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
2001**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	5.92E-03	0.06	3.27E-03	N/A
BETA AIR DOSE *	mrad	1.09E-02	0.05	6.02E-03	N/A
WHOLE BODY ***	mrem	5.81E-03	N/A	3.27E-03	N/A
SKIN***	mrem	1.13E-02	N/A	6.31E-03	N/A
BONE**	mrem	5.16E-04	N/A	2.70E-03	0.02
LIVER**	mrem	2.81E-03	N/A	1.37E-02	0.09
TOTAL BODY**	mrem	2.80E-03	N/A	1.16E-02	0.08
THYROID **	mrem	2.90E-03	N/A	2.34E-02	0.16
KIDNEY**	mrem	2.80E-03	N/A	1.20E-02	0.08
LUNG**	mrem	2.84E-03	N/A	1.14E-02	0.08
GI-LLI **	mrem	2.80E-03	N/A	1.12E-02	0.07

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2001**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	2.47E-03	N/A	N/A	2.47E-03
BONE	mrem	1.89E-04	8.79E-03	1.09E-02	1.99E-02
LIVER	mrem	7.96E-04	8.79E-03	1.09E-02	2.05E-02
TOTAL BODY	mrem	2.00E-03	8.79E-03	1.09E-02	2.17E-02
THYROID	mrem	8.11E-04	8.79E-03	1.09E-02	2.05E-02
KIDNEY	mrem	7.95E-04	8.79E-03	1.09E-02	2.05E-02
LUNG	mrem	8.02E-04	8.79E-03	1.09E-02	2.05E-02
GI-LLI	mrem	7.95E-04	8.79E-03	1.09E-02	2.05E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2001**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	2.94E-03	2.47E-03	5.41E-03	0.02
BONE	mrem	4.85E-04	1.99E-02	2.04E-02	0.08
LIVER	mrem	3.84E-03	2.05E-02	2.43E-02	0.10
TOTAL BODY	mrem	5.14E-03	2.17E-02	2.68E-02	0.11
THYROID	mrem	5.61E-03	2.05E-02	2.61E-02	0.03
KIDNEY	mrem	3.53E-03	2.05E-02	2.40E-02	0.10
LUNG	mrem	3.42E-03	2.05E-02	2.39E-02	0.10
GI-LLI	mrem	3.40E-03	2.05E-02	2.39E-02	0.10

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2002

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 8.35E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 8.28E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 6.96E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.90E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.42E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.41E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.25E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 4.43E-06 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
2002**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	3.49E-04	0.00	2.05E-04	N/A
BETA AIR DOSE *	mrad	4.05E-04	0.00	2.38E-04	N/A
WHOLE BODY ***	mrem	8.59E-04	N/A	5.40E-04	N/A
SKIN***	mrem	1.14E-03	N/A	7.07E-04	N/A
BONE**	mrem	5.40E-04	N/A	1.72E-03	0.01
LIVER**	mrem	3.36E-03	N/A	1.61E-02	0.11
TOTAL BODY**	mrem	3.36E-03	N/A	1.48E-02	0.10
THYROID **	mrem	3.36E-03	N/A	1.49E-02	0.10
KIDNEY**	mrem	3.36E-03	N/A	1.50E-02	0.10
LUNG**	mrem	3.40E-03	N/A	1.48E-02	0.10
GI-LLI **	mrem	3.35E-03	N/A	1.46E-02	0.10

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2002**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	1.12E-04	N/A	N/A	1.12E-04
BONE	mrem	1.57E-04	8.79E-03	9.88E-03	1.88E-02
LIVER	mrem	7.66E-04	8.79E-03	9.88E-03	1.94E-02
TOTAL BODY	mrem	8.26E-04	8.79E-03	9.88E-03	1.95E-02
THYROID	mrem	7.66E-04	8.79E-03	9.88E-03	1.94E-02
KIDNEY	mrem	7.66E-04	8.79E-03	9.88E-03	1.94E-02
LUNG	mrem	7.73E-04	8.79E-03	9.88E-03	1.94E-02
GI-LLI	mrem	7.66E-04	8.79E-03	9.88E-03	1.94E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2002**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	3.58E-04	1.12E-04	4.70E-04	0.00
BONE	mrem	6.83E-04	1.88E-02	1.95E-02	0.08
LIVER	mrem	9.53E-03	1.94E-02	2.90E-02	0.12
TOTAL BODY	mrem	9.57E-03	1.95E-02	2.91E-02	0.12
THYROID	mrem	9.12E-03	1.94E-02	2.86E-02	0.04
KIDNEY	mrem	9.18E-03	1.94E-02	2.86E-02	0.11
LUNG	mrem	9.08E-03	1.94E-02	2.85E-02	0.11
GI-LLI	mrem	9.10E-03	1.94E-02	2.85E-02	0.11

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

### Dispersion Parameters for 2003

#### Nearest Resident

Direction: WSW

Distance: 1931 meters

X/Q, Undecayed and Undepleted: 1.07E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.04E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 9.14E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.31E-09 m<sup>-2</sup>

#### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.96E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.92E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.72E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.78E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
 TO THE NEAREST RESIDENT FROM  
 GASEOUS EFFLUENTS  
 2003**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 1.93 km WSW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	1.51E-03	0.02	8.17E-04	N/A
BETA AIR DOSE *	mrad	3.39E-03	0.02	1.84E-03	N/A
WHOLE BODY ***	mrem	1.76E-03	N/A	8.88E-04	N/A
SKIN***	mrem	3.37E-03	N/A	1.76E-03	N/A
BONE**	mrem	4.57E-04	N/A	2.86E-04	0.00
LIVER**	mrem	3.54E-03	N/A	1.51E-02	0.10
TOTAL BODY**	mrem	3.54E-03	N/A	1.51E-02	0.10
THYROID **	mrem	3.68E-03	N/A	2.66E-02	0.18
KIDNEY**	mrem	3.54E-03	N/A	1.51E-02	0.10
LUNG**	mrem	3.59E-03	N/A	1.51E-02	0.10
GI-LLI **	mrem	3.54E-03	N/A	1.51E-02	0.10

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2003**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	3.95E-04	N/A	N/A	3.95E-04
BONE	mrem	1.02E-04	8.79E-03	9.21E-04	9.81E-03
LIVER	mrem	5.87E-04	8.79E-03	9.21E-04	1.03E-02
TOTAL BODY	mrem	7.64E-04	8.79E-03	9.21E-04	1.05E-02
THYROID	mrem	6.01E-04	8.79E-03	9.21E-04	1.03E-02
KIDNEY	mrem	5.87E-04	8.79E-03	9.21E-04	1.03E-02
LUNG	mrem	5.93E-04	8.79E-03	9.21E-04	1.03E-02
GI-LLI	mrem	5.87E-04	8.79E-03	9.21E-04	1.03E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2003**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	1.35E-03	3.95E-04	1.75E-03	0.01
BONE	mrem	2.38E-04	9.81E-03	1.01E-02	0.04
LIVER	mrem	7.74E-03	1.03E-02	1.80E-02	0.07
TOTAL BODY	mrem	8.33E-03	1.05E-02	1.88E-02	0.08
THYROID	mrem	1.23E-02	1.03E-02	2.26E-02	0.03
KIDNEY	mrem	7.73E-03	1.03E-02	1.80E-02	0.07
LUNG	mrem	7.71E-03	1.03E-02	1.80E-02	0.07
GI-LLI	mrem	7.81E-03	1.03E-02	1.81E-02	0.07

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2004

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 1.01E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 9.86E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 8.39E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.89E-09 m<sup>-2</sup>

### Site Boundary

Direction: NNW

Distance: 2200 meters

X/Q, Undecayed and Undepleted: 1.49E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.46E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.27E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 4.68E-09 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
 TO THE NEAREST RESIDENT FROM  
 GASEOUS EFFLUENTS  
 2004**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 2.20 km NNW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	1.71E-02	0.17	1.16E-02	N/A
BETA AIR DOSE *	mrad	4.02E-02	0.20	2.71E-02	N/A
WHOLE BODY ***	mrem	2.14E-02	N/A	1.41E-02	N/A
SKIN***	mrem	3.91E-02	N/A	2.60E-02	N/A
BONE**	mrem	6.71E-03	N/A	6.45E-02	0.43
LIVER**	mrem	8.48E-03	N/A	9.29E-02	0.62
TOTAL BODY**	mrem	8.32E-03	N/A	3.03E-02	0.20
THYROID **	mrem	1.47E-02	N/A	8.58E-01	5.72
KIDNEY**	mrem	8.37E-03	N/A	4.26E-02	0.28
LUNG**	mrem	8.34E-03	N/A	2.30E-02	0.15
GI-LLI **	mrem	8.28E-03	N/A	1.51E-02	0.10

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2004**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	5.80E-03	N/A	N/A	5.80E-03
BONE	mrem	1.83E-03	8.79E-03	3.18E-03	1.38E-02
LIVER	mrem	2.22E-03	8.79E-03	3.18E-03	1.42E-02
TOTAL BODY	mrem	4.86E-03	8.79E-03	3.18E-03	1.68E-02
THYROID	mrem	3.06E-03	8.79E-03	3.18E-03	1.50E-02
KIDNEY	mrem	2.20E-03	8.79E-03	3.18E-03	1.42E-02
LUNG	mrem	2.20E-03	8.79E-03	3.18E-03	1.42E-02
GI-LLI	mrem	2.19E-03	8.79E-03	3.18E-03	1.42E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2004**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	2.20E-02	5.80E-03	2.78E-02	0.11
BONE	mrem	1.91E-02	1.38E-02	3.29E-02	0.13
LIVER	mrem	3.89E-02	1.42E-02	5.31E-02	0.21
TOTAL BODY	mrem	4.20E-02	1.68E-02	5.88E-02	0.24
THYROID	mrem	3.04E-01	1.50E-02	3.19E-01	0.42
KIDNEY	mrem	2.10E-02	1.42E-02	3.52E-02	0.14
LUNG	mrem	1.34E-02	1.42E-02	2.76E-02	0.11
GI-LLI	mrem	1.12E-02	1.42E-02	2.53E-02	0.10

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2005

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 1.08E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.06E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 8.98E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 3.12E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.65E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.63E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.45E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.09E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
 TO THE NEAREST RESIDENT FROM  
 GASEOUS EFFLUENTS  
 2005**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	1.69E-03	0.02	1.10E-03	N/A
BETA AIR DOSE *	mrad	3.58E-03	0.02	2.33E-03	N/A
WHOLE BODY ***	mrem	3.56E-03	N/A	2.24E-03	N/A
SKIN***	mrem	6.30E-03	N/A	4.02E-03	N/A
BONE**	mrem	2.01E-03	N/A	1.74E-02	0.12
LIVER**	mrem	4.12E-03	N/A	3.32E-02	0.22
TOTAL BODY**	mrem	4.07E-03	N/A	1.67E-02	0.11
THYROID **	mrem	4.07E-03	N/A	1.30E-02	0.09
KIDNEY**	mrem	4.08E-03	N/A	1.94E-02	0.13
LUNG**	mrem	4.12E-03	N/A	1.53E-02	0.10
GI-LLI **	mrem	4.07E-03	N/A	1.31E-02	0.09

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2005**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	6.91E-04	N/A	N/A	6.91E-04
BONE	mrem	5.06E-04	8.79E-03	6.00E-03	1.53E-02
LIVER	mrem	9.00E-4	8.79E-03	6.00E-03	1.57E-02
TOTAL BODY	mrem	1.15E-03	8.79E-03	6.00E-03	1.59E-02
THYROID	mrem	8.93E-04	8.79E-03	6.00E-03	1.57E-02
KIDNEY	mrem	8.95E-04	8.79E-03	6.00E-03	1.57E-02
LUNG	mrem	9.00E-04	8.79E-03	6.00E-03	1.57E-02
GI-LLI	mrem	8.93E-04	8.79E-03	6.00E-03	1.57E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2005**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	2.82E-03	6.91E-04	3.51E-03	0.01
BONE	mrem	5.23E-03	1.53E-02	2.05E-02	0.08
LIVER	mrem	1.57E-02	1.57E-02	3.13E-02	0.13
TOTAL BODY	mrem	1.49E-02	1.59E-02	3.08E-02	0.12
THYROID	mrem	8.37E-03	1.57E-02	2.41E-02	0.03
KIDNEY	mrem	1.08E-02	1.57E-02	2.65E-02	0.11
LUNG	mrem	9.18E-03	1.57E-02	2.49E-02	0.10
GI-LLI	mrem	8.58E-03	1.57E-02	2.43E-02	0.10

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2006

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 9.46E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 9.25E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 7.85E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.85E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.43E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.40E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.25E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 3.82E-09 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
2006**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	1.05E-04	0.00	6.92E-05	N/A
BETA AIR DOSE *	mrad	3.08E-04	0.00	2.03E-04	N/A
WHOLE BODY ***	mrem	2.39E-04	N/A	1.13E-04	N/A
SKIN***	mrem	4.68E-04	N/A	2.65E-04	N/A
BONE**	mrem	1.40E-04	N/A	4.81E-05	0.00
LIVER**	mrem	1.77E-03	N/A	9.29E-03	0.06
TOTAL BODY**	mrem	1.77E-03	N/A	9.30E-03	0.06
THYROID **	mrem	1.77E-03	N/A	9.29E-03	0.06
KIDNEY**	mrem	1.77E-03	N/A	9.29E-03	0.06
LUNG**	mrem	1.77E-03	N/A	9.30E-03	0.06
GI-LLI **	mrem	1.77E-03	N/A	9.30E-03	0.06

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2006**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	6.10E-05	N/A	N/A	6.10E-05
BONE	mrem	2.19E-05	8.79E-03	6.50E-03	1.53E-02
LIVER	mrem	3.73E-04	8.79E-03	6.50E-03	1.57E-02
TOTAL BODY	mrem	3.92E-04	8.79E-03	6.50E-03	1.57E-02
THYROID	mrem	3.73E-04	8.79E-03	6.50E-03	1.57E-02
KIDNEY	mrem	3.73E-04	8.79E-03	6.50E-03	1.57E-02
LUNG	mrem	3.74E-04	8.79E-03	6.50E-03	1.57E-02
GI-LLI	mrem	3.73E-04	8.79E-03	6.50E-03	1.57E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2006**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	2.17E-04	6.10E-05	2.78E-04	0.00
BONE	mrem	4.81E-05	1.53E-02	1.54E-02	0.06
LIVER	mrem	5.68E-03	1.57E-02	2.13E-02	0.09
TOTAL BODY	mrem	5.74E-03	1.57E-02	2.14E-02	0.09
THYROID	mrem	5.68E-03	1.57E-02	2.13E-02	0.03
KIDNEY	mrem	5.68E-03	1.57E-02	2.13E-02	0.09
LUNG	mrem	5.68E-03	1.57E-02	2.13E-02	0.09
GI-LLI	mrem	5.69E-03	1.57E-02	2.13E-02	0.09

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2007

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 8.56E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 8.45E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 7.12E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.59E-09 m<sup>-2</sup>

### Site Boundary

Direction: NNW

Distance: 2200 meters

X/Q, Undecayed and Undepleted: 1.26E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.25E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.08E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 4.18E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
2007**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 2.20 km NNW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	4.40E-04	0.00	2.98E-04	N/A
BETA AIR DOSE *	mrad	9.60E-04	0.00	6.49E-04	N/A
WHOLE BODY ***	mrem	4.29E-04	N/A	2.88E-04	N/A
SKIN***	mrem	9.15E-04	N/A	6.17E-04	N/A
BONE**	mrem	3.92E-05	N/A	2.63E-05	0.00
LIVER**	mrem	1.62E-03	N/A	9.46E-03	0.06
TOTAL BODY**	mrem	1.62E-03	N/A	9.46E-03	0.06
THYROID **	mrem	1.62E-03	N/A	9.82E-03	0.07
KIDNEY**	mrem	1.62E-03	N/A	9.46E-03	0.06
LUNG**	mrem	1.62E-03	N/A	9.46E-03	0.06
GI-LLI **	mrem	1.62E-03	N/A	9.46E-03	0.06

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2007**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	1.82E-04	N/A	N/A	1.82E-04
BONE	mrem	1.22E-05	1.48E-02	2.32E-03	1.71E-02
LIVER	mrem	4.08E-04	1.48E-02	2.32E-03	1.75E-02
TOTAL BODY	mrem	4.89E-04	1.48E-02	2.32E-03	1.76E-02
THYROID	mrem	4.08E-04	1.48E-02	2.32E-03	1.75E-02
KIDNEY	mrem	4.08E-04	1.48E-02	2.32E-03	1.75E-02
LUNG	mrem	4.08E-04	1.48E-02	2.32E-03	1.75E-02
GI-LLI	mrem	4.08E-04	1.48E-02	2.32E-03	1.75E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2007**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	5.92E-04	1.82E-04	7.74E-04	0.00
BONE	mrem	2.48E-05	1.71E-02	1.72E-02	0.07
LIVER	mrem	5.77E-03	1.75E-02	2.33E-02	0.09
TOTAL BODY	mrem	6.03E-03	1.76E-02	2.36E-02	0.09
THYROID	mrem	5.89E-03	1.75E-02	2.34E-02	0.03
KIDNEY	mrem	5.77E-03	1.75E-02	2.33E-02	0.09
LUNG	mrem	5.77E-03	1.75E-02	2.33E-02	0.09
GI-LLI	mrem	5.77E-03	1.75E-02	2.33E-02	0.09

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2008

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 8.25E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 8.19E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 6.88E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 3.12E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.33E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.32E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.17E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 4.23E-09 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
 TO THE NEAREST RESIDENT FROM  
 GASEOUS EFFLUENTS  
 2008**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	1.98E-03	0.02	1.23E-03	N/A
BETA AIR DOSE *	mrad	5.12E-03	0.03	3.18E-03	N/A
WHOLE BODY ***	mrem	1.82E-03	N/A	1.14E-03	N/A
SKIN***	mrem	4.03E-03	N/A	2.51E-03	N/A
BONE**	mrem	1.27E-04	N/A	1.25E-04	0.00
LIVER**	mrem	2.18E-03	N/A	1.10E-02	0.07
TOTAL BODY**	mrem	2.18E-03	N/A	1.10E-02	0.07
THYROID **	mrem	2.20E-03	N/A	1.48E-02	0.10
KIDNEY**	mrem	2.18E-03	N/A	1.10E-02	0.07
LUNG**	mrem	2.19E-03	N/A	1.10E-02	0.07
GI-LLI **	mrem	2.18E-03	N/A	1.10E-02	0.07

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2008**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	7.68E-04	N/A	N/A	7.68E-04
BONE	mrem	3.91E-05	9.00E-03	1.43E-03	1.05E-02
LIVER	mrem	5.13E-04	9.00E-03	1.43E-03	1.09E-02
TOTAL BODY	mrem	8.47E-04	9.00E-03	1.43E-03	1.13E-02
THYROID	mrem	5.17E-04	9.00E-03	1.43E-03	1.09E-02
KIDNEY	mrem	5.13E-04	9.00E-03	1.43E-03	1.09E-02
LUNG	mrem	5.15E-04	9.00E-03	1.43E-03	1.09E-02
GI-LLI	mrem	5.13E-04	9.00E-03	1.43E-03	1.09E-02

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2008**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	2.42E-03	7.68E-04	3.19E-03	0.01
BONE	mrem	1.03E-04	1.05E-02	1.06E-02	0.04
LIVER	mrem	6.75E-03	1.09E-02	1.77E-02	0.07
TOTAL BODY	mrem	7.80E-03	1.13E-02	1.91E-02	0.08
THYROID	mrem	8.05E-03	1.09E-02	1.90E-02	0.03
KIDNEY	mrem	6.75E-03	1.09E-02	1.77E-02	0.07
LUNG	mrem	6.75E-03	1.09E-02	1.77E-02	0.07
GI-LLI	mrem	6.77E-03	1.09E-02	1.77E-02	0.07

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2009

### Nearest Resident

Direction: WSW

Distance: 1931 meters

X/Q, Undecayed and Undepleted: 8.97E-07 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 8.69E-07 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 7.68E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.65E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 2.32E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 2.25E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 2.03E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.28E-06 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
2009**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 1.93 km WSW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	6.74E-03	0.07	2.60E-03	N/A
BETA AIR DOSE *	mrad	1.67E-02	0.08	6.46E-03	N/A
WHOLE BODY ***	mrem	5.80E-03	N/A	2.24E-03	N/A
SKIN***	mrem	1.31E-02	N/A	5.07E-03	N/A
BONE**	mrem	2.24E-07	N/A	3.49E-05	0.00
LIVER**	mrem	2.52E-03	N/A	8.62E-03	0.06
TOTAL BODY**	mrem	2.52E-03	N/A	8.62E-03	0.06
THYROID **	mrem	2.52E-03	N/A	8.79E-03	0.06
KIDNEY**	mrem	2.52E-03	N/A	8.62E-03	0.06
LUNG**	mrem	2.52E-03	N/A	8.62E-03	0.06
GI-LLI **	mrem	2.52E-03	N/A	8.62E-03	0.06

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2009**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	1.52E-03	N/A	N/A	1.52E-03
BONE	mrem	1.52E-08	8.79E-03	1.35E-04	8.93E-03
LIVER	mrem	3.35E-04	8.79E-03	1.35E-04	9.26E-03
TOTAL BODY	mrem	1.01E-03	8.79E-03	1.35E-04	9.93E-03
THYROID	mrem	3.35E-04	8.79E-03	1.35E-04	9.26E-03
KIDNEY	mrem	3.35E-04	8.79E-03	1.35E-04	9.26E-03
LUNG	mrem	3.35E-04	8.79E-03	1.35E-04	9.26E-03
GI-LLI	mrem	3.35E-04	8.79E-03	1.35E-04	9.26E-03

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2009**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	4.99E-03	1.52E-03	6.51E-03	0.03
BONE	mrem	1.22E-05	8.93E-03	8.94E-03	0.04
LIVER	mrem	5.02E-03	9.26E-03	1.43E-02	0.06
TOTAL BODY	mrem	7.23E-03	9.93E-03	1.72E-02	0.07
THYROID	mrem	5.08E-03	9.26E-03	1.43E-02	0.02
KIDNEY	mrem	5.02E-03	9.26E-03	1.43E-02	0.06
LUNG	mrem	5.02E-03	9.26E-03	1.43E-02	0.06
GI-LLI	mrem	5.02E-03	9.26E-03	1.43E-02	0.06

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2010

### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 1.17E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.14E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 9.71E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 3.20E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.75E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.72E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.54E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.26E-09 m<sup>-2</sup>



**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
2010**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 2.93 km NNW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	3.92E-03	0.04	2.59E-03	N/A
BETA AIR DOSE *	mrad	1.00E-02	0.05	6.63E-03	N/A
WHOLE BODY ***	mrem	3.42E-03	N/A	2.26E-03	N/A
SKIN***	mrem	7.71E-03	N/A	5.10E-03	N/A
BONE**	mrem	6.91E-05	N/A	1.07E-04	0.00
LIVER**	mrem	1.90E-03	N/A	1.05E-02	0.07
TOTAL BODY**	mrem	1.90E-03	N/A	1.05E-02	0.07
THYROID **	mrem	1.96E-03	N/A	1.78E-02	0.12
KIDNEY**	mrem	1.90E-03	N/A	1.05E-02	0.07
LUNG**	mrem	1.91E-03	N/A	1.05E-02	0.07
GI-LLI **	mrem	1.90E-03	N/A	1.05E-02	0.07

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2010**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	1.15E-03	N/A	N/A	1.15E-03
BONE	mrem	1.70E-05	8.79E-03	5.13E-04	9.32E-03
LIVER	mrem	3.38E-04	8.79E-03	5.13E-04	9.64E-03
TOTAL BODY	mrem	8.45E-04	8.79E-03	5.13E-04	1.01E-02
THYROID	mrem	3.44E-04	8.79E-03	5.13E-04	9.65E-03
KIDNEY	mrem	3.38E-04	8.79E-03	5.13E-04	9.64E-03
LUNG	mrem	3.39E-04	8.79E-03	5.13E-04	9.64E-03
GI-LLI	mrem	3.38E-04	8.79E-03	5.13E-04	9.64E-03

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2010**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	5.06E-03	1.15E-03	6.22E-03	0.02
BONE	mrem	6.31E-05	9.32E-03	9.38E-03	0.04
LIVER	mrem	6.41E-03	9.64E-03	1.60E-02	0.06
TOTAL BODY	mrem	8.63E-03	1.01E-02	1.88E-02	0.08
THYROID	mrem	8.93E-03	9.65E-03	1.86E-02	0.02
KIDNEY	mrem	6.41E-03	9.64E-03	1.61E-02	0.06
LUNG	mrem	6.40E-03	9.64E-03	1.60E-02	0.06
GI-LLI	mrem	6.41E-03	9.64E-03	1.61E-02	0.06

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2011

### Nearest Resident

Direction: WSW

Distance: 1931 meters

X/Q, Undecayed and Undepleted: 1.06E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.02E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 9.09E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.49E-09 m<sup>-2</sup>

### Site Boundary

Direction: SSW

Distance: 1400 meters

X/Q, Undecayed and Undepleted: 1.74E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.69E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.53E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 4.25E-09 m<sup>-2</sup>

**DOSE AT THE SITE BOUNDARY AND  
TO THE NEAREST RESIDENT FROM  
GASEOUS EFFLUENTS  
2011**

		SITE BOUNDARY		NEAREST RESIDENT	
		LOCATION: 1.40 km SSW		LOCATION: 1.93 km WSW	
		AGE GROUP: CHILD		AGE GROUP: CHILD	
Organ	Unit	Dose	% Limit <sup>(a)</sup>	Dose	% Limit <sup>(b)</sup>
GAMMA AIR DOSE *	mrad	8.77E-04	0.01	5.29E-04	N/A
BETA AIR DOSE *	mrad	1.60E-03	0.01	9.63E-04	N/A
WHOLE BODY ***	mrem	8.06E-04	N/A	4.87E-04	N/A
SKIN***	mrem	1.84E-03	N/A	1.11E-03	N/A
BONE**	mrem	1.90E-06	N/A	1.10E-05	0.00
LIVER**	mrem	2.31E-03	N/A	1.24E-02	0.08
TOTAL BODY**	mrem	2.31E-03	N/A	1.24E-02	0.08
THYROID **	mrem	2.32E-03	N/A	1.32E-02	0.09
KIDNEY**	mrem	2.31E-03	N/A	1.24E-02	0.08
LUNG**	mrem	2.31E-03	N/A	1.24E-02	0.08
GI-LLI **	mrem	2.31E-03	N/A	1.24E-02	0.08

\* Dose from Noble Gases only

\*\*Dose from Tritium, Radioiodines, and Particulates only

\*\*\*Dose from Noble Gases plus Ground Plane dose

(a) Annual dose limits of Offsite Dose Calculation Manual of 10 mrad gamma air dose and 20 mrad beta air dose.

(b) Annual dose limits of Offsite Dose Calculation Manual of 15 mrem to any organ from <sup>131</sup>I, <sup>133</sup>I, <sup>3</sup>H and particulate radionuclides with half-lives greater than 8 days.

**DOSE TO THE MEMBER OF THE PUBLIC FROM ACTIVITIES WITHIN THE SITE  
 BOUNDARY  
 2011**

<b>Organ</b>	<b>Unit</b>	<b>Effluent Dose within the Site Boundary</b>	<b>Direct Radiation from the Unit</b>	<b>Direct Radiation from Outdoor Storage Tanks</b>	<b>Total Dose for the Year</b>
SKIN	mrem	2.82E-04	N/A	N/A	2.82E-04
BONE	mrem	5.63E-07	8.79E-03	1.00E-07	8.79E-03
LIVER	mrem	4.07E-04	8.79E-03	1.00E-07	9.20E-03
TOTAL BODY	mrem	5.31E-04	8.79E-03	1.00E-07	9.32E-03
THYROID	mrem	4.08E-04	8.79E-03	1.00E-07	9.20E-03
KIDNEY	mrem	4.07E-04	8.79E-03	1.00E-07	9.20E-03
LUNG	mrem	4.07E-04	8.79E-03	1.00E-07	9.20E-03
GI-LLI	mrem	4.07E-04	8.79E-03	1.00E-07	9.20E-03

**TOTAL DOSE DUE TO THE URANIUM FUEL CYCLE  
 (MEMBER OF THE PUBLIC)  
 2011**

<b>Organ</b>	<b>Unit</b>	<b>Dose at the Residence Location</b>	<b>Dose from Activities within the Site Boundary</b>	<b>Total Dose to the Member of the Public</b>	<b>% Limit*</b>
SKIN	mrem	8.71E-04	2.82E-04	1.15E-03	0.00
BONE	mrem	4.74E-06	8.79E-03	8.80E-03	0.04
LIVER	mrem	5.67E-03	9.20E-03	1.49E-02	0.06
TOTAL BODY	mrem	6.05E-03	9.32E-03	1.54E-02	0.06
THYROID	mrem	5.98E-03	9.20E-03	1.52E-02	0.02
KIDNEY	mrem	5.67E-03	9.20E-03	1.49E-02	0.06
LUNG	mrem	5.67E-03	9.20E-03	1.49E-02	0.06
GI-LLI	mrem	5.67E-03	9.20E-03	1.49E-02	0.06

\*Annual dose limits from 40CFR190.10(a) of 25 mrem whole body, 75 mrem to the thyroid, and 25 mrem to any other organ.

## Dispersion Parameters for 2012

### Nearest Resident

Direction: WSW

Distance: 1931 meters

X/Q, Undecayed and Undepleted: 1.17E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.11E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 9.97E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 2.07E-09 m<sup>-2</sup>

### Site Boundary

Direction: S

Distance: 1300 meters

X/Q, Undecayed and Undepleted: 1.92E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.87E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.69E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 5.20E-09 m<sup>-2</sup>



2012 Dose Assessments, 10 CFR 50, Appendix I					
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly total
<b>Liquid Effluent Dose Limit, Total Body (mrem)</b>	*	*	*	*	*
Total Body Dose (mrem)	*	*	*	*	*
% Limit (%)	*	*	*	*	*
<b>Liquid Effluent Dose Limit, Maximum Organ (mrem)</b>	*	*	*	*	*
Maximum Organ Dose (mrem)	*	*	*	*	*
% Limit (%)	*	*	*	*	*
<b>Gaseous Effluent Dose Limit, Gamma Air (mrem)</b>	5	5	5	5	10
Gamma Air Dose (mrad)	4.15E-05	8.05E-05	2.42E-05	2.84E-05	1.75E-04
% Limit (%)	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Gaseous Effluent Dose Limit, Beta Air (mrem)</b>	10	10	10	10	20
Beta Air Dose (mrad)	3.29E-04	8.55E-05	3.05E-05	2.71E-05	4.72E-04
% Limit (%)	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Gaseous Effluent Dose Limit, Maximum Organ (mrem)</b>	7.5	7.5	7.5	7.5	15
Maximum organ dose <sup>21</sup> (mrem)	1.43E-03	2.58E-03	2.96E-03	2.02E-03	8.99E-03
% Limit (%)	0.02%	0.03%	0.04%	0.035	0.06%
<sup>14</sup> C Maximum organ dose (mrem) <sup>22</sup>	*	*	*	*	*

\* Liquid dose and <sup>14</sup>C dose did not change.

<sup>21</sup> Iodine, <sup>3</sup>H, and particulates with greater than an 8 day half- life.

<sup>22</sup> Not included in above totals

<b>2012 EPA 40 CFR 190 Individual in the Unrestricted Area</b>			
	<b>Whole Body</b>	<b>Thyroid</b>	<b>Max Other Organ</b>
<b>Dose Limit</b>	25 mrem	75 mrem	25 mrem
<b>Dose (mrem)</b>	1.12E-02	1.12E-02	1.96E-02
<b>% Limit</b>	0.04%	0.01%	008%

### Dispersion Parameters for 2013

#### Nearest Resident

Direction: NNW

Distance: 2929 meters

X/Q, Undecayed and Undepleted: 1.08E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.04E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 8.89E-07 sec/m<sup>3</sup>

D/Q Deposition rate: 3.23E-09 m<sup>-2</sup>

#### Site Boundary

Direction: NNW

Distance: 2200 meters

X/Q, Undecayed and Undepleted: 1.52E-06 sec/m<sup>3</sup>

X/Q Decayed and Undepleted: 1.48E-06 sec/m<sup>3</sup>

X/Q Decayed and Depleted: 1.29E-06 sec/m<sup>3</sup>

D/Q Deposition rate: 4.88E-09 m<sup>-2</sup>

<b>2013 Dose Assessments, 10 CFR 50, Appendix I</b>					
	<b>Quarter 1</b>	<b>Quarter 2</b>	<b>Quarter 3</b>	<b>Quarter 4</b>	<b>Yearly total</b>
<b>Liquid Effluent Dose Limit, Total Body (mrem)</b>	*	*	*	*	*
Total Body Dose (mrem)	*	*	*	*	*
% Limit (%)	*	*	*	*	*
<b>Liquid Effluent Dose Limit, Maximum Organ (mrem)</b>	*	*	*	*	*
Maximum Organ Dose (mrem)	*	*	*	*	*
% Limit (%)	*	*	*	*	*
<b>Gaseous Effluent Dose Limit, Gamma Air (mrem)</b>	5	5	5	5	10
Gamma Air Dose (mrad)	5.40E-05	1.69E-04	1.15E-05	2.20E-05	2.56E-04
% Limit (%)	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Gaseous Effluent Dose Limit, Beta Air (mrem)</b>	10	10	10	10	20
Beta Air Dose (mrad)	7.56E-05	1.03E-04	1.43E-05	7.77E-06	2.01E-04
% Limit (%)	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Gaseous Effluent Dose Limit, Maximum Organ (mrem)</b>	7.5	7.5	7.5	7.5	15
Maximum organ dose <sup>23</sup> (mrem)	1.08E-03	4.49E-03	3.05E-03	2.23E-03	1.08E-02
% Limit (%)	0.01%	0.06%	0.04%	0.03%	0.07%
<sup>14</sup> C Maximum organ dose (mrem) <sup>24</sup>	*	*	*	*	*

\* Liquid dose and <sup>14</sup>C dose did not change

<sup>23</sup> Iodine, <sup>3</sup>H, and particulates with greater than an 8 day half- life.

<sup>24</sup> Not included in above totals

<b>2013 EPA 40 CFR 190 Individual in the Unrestricted Area</b>			
	<b>Whole Body</b>	<b>Thyroid</b>	<b>Max Other Organ</b>
<b>Dose Limit</b>	25 mrem	75 mrem	25 mrem
<b>Dose (mrem)</b>	1.30E-02	1.30E-02	2.07E-02
<b>% Limit</b>	0.05%	0.02%	0.08%

## Appendix D

### Leakage from Manhole 86-2 Limited Site Investigation

#### *Event Description*<sup>25</sup>

The original Techite<sup>26</sup> plant discharge line was replaced in 2007 with a new high density polyethylene (HDPE) line constructed approximately parallel to the old line. This pipeline carries cooling tower blowdown and liquid radioactive effluent to the Missouri River. The discharge point is ~400 feet downstream of the plant intake structure. The Techite piping that connected the cooling tower blowdown to the new HDPE plant discharge pipeline was not replaced at that time.

The Techite piping that connected the cooling tower blowdown to the plant discharge pipeline was replaced in 2010 with 18" HDPE and connected to the HDPE plant discharge line. The connection was made via new manhole 86-2 (MH86-2). MH86-2 also provides a connection with the 6" stainless steel (SS) liquid radwaste discharge pipe. The liquid radwaste discharges into MH86-2 where it mixes with the cooling tower blowdown prior to being transported to the river by the ~6 mile long plant discharge line. The HDPE piping penetrations were installed with an anchor/ water stop, essentially a collar or ring, cast in place with the concrete manhole to prevent leakage from the penetration. MH86-2 is coated with a waterproofing elastomeric polyurethane bonded geotextile system. The coating system has a waterproofing function to protect the concrete and it provides a secondary barrier to prevent leakage through the concrete structure. The coating was applied to the interior and exterior surfaces of the manhole. The coating was not intended to provide primary waterproofing of the piping penetrations.

Issues with shredding of the waterproof coating inside MH86-2 were first identified on November 1, 2012 while troubleshooting reduced plant discharge pipeline flow rate. An October, 2013 self-assessment of Callaway's groundwater protection program by a team of EPRI experts, an industry peer and Callaway personnel identified the degraded coating in MH86-2 as a gap with respect to NEI 07-07, "Industry Groundwater Protection Initiative- Final Guidance" and recommended installation of a sentinel well to monitor for possible leaks.

On July 22, 2014, monitoring well U1MW-031 was installed as a sentinel well to monitor for possible leakage from MH86-2. Well development was completed on July 25, 2014 and the first sample was taken the same day. On July 31, 2014, the vendor lab notified Callaway that the <sup>3</sup>H concentration in the sample was 1.6E6 pCi/L and <sup>60</sup>Co was present at 12 pCi/L. Subsequent samples showed only <sup>3</sup>H.

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<sup>25</sup> CAR 201405071, "<sup>3</sup>H and <sup>60</sup>Co in Monitoring Well U1MW-031"

<sup>26</sup> Techite is a registered trademark of Amoco Reinforced Plastics Company, a former subsidiary of Amoco Chemicals.

All liquid radwaste discharges were suspended. A four hour voluntary notification was made to the NRC Operations Center pursuant to NEI 07-07. Notifications were also made to the Missouri Department of Natural Resources, NRC Resident Inspector, NRC Region IV Office, Callaway County Presiding Commissioner, Nuclear Energy Institute, and American Nuclear Insurers.

The manhole was visually inspected on August 1, 2014. The inspection revealed a failure of the seals around the HDPE plant discharge piping penetration and the 6" SS radwaste discharge line penetration. Hydrophobic polyurethane foam (Blome Sealant 78<sup>27</sup>) was injected into injection ports drilled around the HDPE plant discharge piping penetration and also behind the link seals on the 6" SS radwaste discharge line penetration.

Four different fluorescent dye tests were performed to demonstrate that the seal repairs were effective. Liquid radwaste discharges recommenced on August 15, 2015 and two additional dye tests were performed. On August 28, 2014, the 6" SS radwaste discharge piping was extended through the manhole and about 65" down the HDPE plant discharge line, thus bypassing MH86-2.

### *Cause Analysis*

A formal root cause evaluation was performed for this event. The gaps between the HDPE plant discharge pipeline and the concrete wall of the manhole are the result of inadequate bearing capacity of the bedding material. The HDPE plant discharge pipeline was inserted into the manhole before the bedding material was fully in place resulting in the challenge of placing and compacting the bedding material under the pipe. The bedding material is more critical than in typical applications due to close proximity to the rigid manhole wall penetration seals that are intolerant to movement and the ~25' bury depth results in significant overburden loading. The inadequate bedding compaction and significant overburden loading allowed for settlement and rotation of the pipe which sheared the water stops, deformed the pipe, and caused gaps to develop. The 6" SS radwaste discharge pipe experienced similar issues due to inadequate bedding and significant overburden loading resulting in compression of the rubber portion of the Link-Seals<sup>28</sup>.

### *Activity Concentration*

It is assumed the leakage began at the time of construction and lasted until discovery so that the duration of the leakage is assumed to be approximately 4 years. The volume of leakage is unknown therefore the total activity leaked is unknown. The average <sup>3</sup>H concentration in the leakage can be obtained from the Annual Radioactive Effluent Release Report for the subject years as shown in TABLE 1.

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<sup>27</sup> Registered trademark of Blome International

<sup>28</sup> Registered trademark of GPT/ EnPro Industries, Inc.

**TABLE 1: AVERAGE <sup>3</sup>H CONCENTRATION IN LIQUID EFFLUENTS**

<b>Year</b>	<b>Average <sup>3</sup>H Concentration (μCi/ml)</b>
2010	6.61E-4
2011	1.60E-3
2012	7.72E-4
2013	1.45E-3
2014	2.57E-3

*Hydrogeology*<sup>29,30</sup>

The Callaway Energy Center is located on a topographic plateau approximately 350' above the Missouri River underlain by low permeability silty- clay soils of glacial and post- glacial origin. The soils are underlain by weathered sedimentary rocks with horizontal to sub- horizontal fracture orientations.

Across the plateau, the Graydon Chert Formation is considered to be the shallow aquifer. There are localized areas where the overlying material may be included in this aquifer, but in general the saturated groundwater is confined within the chert. The chert is a moderate water-bearing unit, with the glacial till acting as the confining unit above the chert and the Burlington Limestone acting as the confining unit and top of the aquitard beneath the chert. The Graydon Chert lies unconformably atop the Burlington Limestone and unconformably below the glacial till, therefore, its elevation and thickness vary. Across the plateau, the depth of the Graydon Chert ranges from 15' to 39' below ground surface (bgs) and averages approximately 27' bgs. Its thickness ranges from 16' to 61' and averages approximately 38'.

Groundwater within the Graydon Chert conglomerate flows radially outwards in the vicinity of the plant towards the nearby drainage basins that surround the plateau. The impact of the discharge lines bedding material on the overall groundwater flow directions within this hydrogeologic unit cannot be quantified but is likely to be limited. Localized variations in groundwater flow directions are anticipated within the conglomerate when it is in direct contact with the bedding material. In the vicinity of the plant discharge pipeline and the abandoned

<sup>29</sup> "Final Groundwater Model Report Callaway Nuclear Power Plant", rev. 1, October 31, 2008. Paul C. Rizzo Associates, Inc.

<sup>30</sup> "Tritium Investigation Report Callaway Energy Center Fulton, Missouri", March 9, 2015. GZA GeoEnvironmental, Inc.



Techite pipeline, hereinafter collectively called "pipelines", groundwater elevations in the conglomerate are generally greater than the groundwater levels in the bedding material for the Techite pipeline down line. Therefore, convergent flow from the conglomerate into the bedding material for the Techite pipeline is anticipated.

Beneath the shallow aquifer there is a leaky, confining aquitard. The top of the aquitard begins with the top of the Burlington Limestone and extends through the Bushberg Sandstone, Snyder Creek Formation (shale), Callaway Limestone, and upper portion of the Cotter-Jefferson City (CJC) Dolomitic Limestone. The depth to the top of the aquitard averages 68' bgs across the plateau, and its thickness is approximately 290' in the central portion of the plateau.

Beneath the aquitard is the CJC aquifer. The depth to the CJC aquifer is approximately 350' bgs in the central portion of the plateau. The thickness of the CJC aquifer beneath the plateau is approximately 300'. Regionally, the CJC aquifer is considered to be a minor aquifer and represents the top of the Cambrian-Ordovician aquifer system, which consists of intervals of minor aquifers and major aquifers with intermittent aquitards to depths up to 2,000' bgs.

Groundwater within the CJC aquifer flows radially outwards from the plateau to the nearby drainage basins that surround the plateau. The hydraulic head within the CJC aquifer are approximately 250' lower than the shallower overburden and Graydon Chert conglomerate hydrogeologic units. As such, the groundwater elevation data, as well as the sub- horizontal fracture orientations, indicate that the communication between the shallower groundwater and the CJC aquifer is limited. The pipelines bedding material is not likely to influence the groundwater flow directions with the CJC aquifer.

The well yield for the chert aquifer is less than 1 gallon per minute (gpm) and for the CJC aquifer is approximately 5 to 10 gpm. Two pumping tests were performed successfully in the CJC aquifer, and the relatively low estimates of storativity are consistent with mildly fractured bedrock aquifers where the small size of fractures and low degree of interconnectedness limits the amount of water in storage and the amount of water to potentially yield to a well. A step-drawdown test at a pumping well in the chert aquifer resulted in a dry well after a short period of time, which made the pumping test unviable.

Groundwater primarily flows within bedrock along fractures and bedding/ joint planes. Therefore, the magnitude of vertical flow within bedrock is directly related to the interconnection of multiple fractures, as well as fracture orientations. The fractures orientations near Callaway are sub- horizontal and the Rock Quality Designation (RQD) Index of the deeper core runs were typically greater than 70%. This information, coupled with the groundwater elevation data collected during the recent Limited Site Investigation (LSI) as well as historical data, suggest that a good hydraulic communication does not exist between the shallow sedimentary bedrock and the deeper CJC aquifer. The numerous springs which are located near

the base of the plateau and along the slope of the plateau indicate that groundwater preferentially flows along the sub- horizontal fractures in shallow bedrock and discharges at these spring locations, prior to reaching the CJC aquifer. Therefore the amount of vertical flow between the shallow and deeper rock is limited.

Within the Missouri River flood plain, the upper 10'- 15' of the overburden sediments consists of mottled brown and red silty clay alluvial deposits. These fine grained soils were underlain by fine to coarse sand and gravel. Groundwater within the alluvial floodplain deposits flows to the south- southeast, towards the Missouri River. The groundwater elevation data indicate that the shallow groundwater in the northeastern portion of the flood plain discharges into Logan Creek, a small tributary of the Missouri River. Because the hydraulic conductivity of the native alluvial sediments is similar to the bedding material, the influence of the pipelines trenches on overall groundwater flow directions is minimal. As such, dissimilar to conditions on the plateau, groundwater within the bedding material may potentially exfiltrate into the native sand and gravel sediments.

#### *Limited Site Investigation<sup>31</sup>*

A Limited Site Investigation (LSI) was performed to determine the migration pathway and fate of the <sup>3</sup>H contamination. The LSI concluded that, on the plateau, the <sup>3</sup>H impacted water has not migrated beyond the confines of the HDPE plant discharge pipeline trench and the abandoned Techite pipeline trenches. Other than the pipeline bedding, <sup>3</sup>H was not detected in any of the monitoring wells screened in the overburden or bedrock on the plateau. Water exfiltrating from the abandoned Techite pipeline in the Missouri River alluvial floodplain follows natural groundwater flow paths through both the sand and bedding before discharging to the river.

Twenty eight (28) wells were installed during the LSI. The LSI concluded that the <sup>3</sup>H leaked from the damaged seals in MH86-2 flows down the bedding of the HDPE discharge pipeline for approximately 1000'. At that point, the <sup>3</sup>H impacted water followed the bedding material of an abandoned 12" pipe which is hydraulically connected to the bedding material of the abandoned Techite plant discharge line.

The Techite discharge pipeline was abandoned in 2007 when the new HDPE plant discharge pipeline was installed, however the abandoned Techite pipeline was not filled in or plugged. Some of the <sup>3</sup>H impacted water enters the Techite pipeline at abandoned manhole 86-4A through unsealed penetrations for the abandoned 12" pipe; the rest migrates down pipe through the bedding material of the abandoned Techite pipeline. Continued infiltration of <sup>3</sup>H impacted water through the leaky bell and spigot joints into the Techite pipeline likely occurs

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<sup>31</sup> "Tritium Investigation Report Callaway Energy Center Fulton, Missouri", March 9, 2015. GZA GeoEnvironmental, Inc.

over approximately the next mile and then migrates within the Techite pipeline to the edge of the plateau.

An inward hydraulic gradient into the pipeline bedding material effectively confines the  $^3\text{H}$  impacted water to the bedding material and interior of the abandoned Techite pipeline and likely prevents it from leaking out through the leaky joints. As a result, clean overburden water continues to flow into the bedding material from the surrounding soil.

Near the plant, the HDPE and Techite pipelines were constructed in separate trenches excavated through the low permeability soil. The sides and bottom of the trenches are therefore in this portion of the alignment. In portions of the alignment near the edge of the plateau, the pipelines were installed in trenches over or excavated within shallow bedrock.

On the plateau, water inside the abandoned Techite pipeline remains in the pipe because the water level in the pipe is lower than the surrounding groundwater elevation. Thus, the hydraulic gradient is from the surrounding overburden towards the abandoned Techite discharge line and the surrounding bedding material. The  $^3\text{H}$  impacted water has not migrated significantly beyond the confines of the discharge pipeline trenches on the plateau. Other than the discharge pipeline bedding,  $^3\text{H}$  was not detected in any of the monitoring wells screened in the overburden or bedrock on the plateau.

Within the Missouri River valley deposits, the gate valve on the abandoned Techite pipeline is permanently closed and the downstream pipe is cut and capped. As such, the  $^3\text{H}$  impacted water exfiltrates through the leaky bell and spigot joints of the abandoned Techite pipeline within the Missouri River floodplain when the water level in the abandoned Techite pipeline is higher than the groundwater elevation of the surrounding bedding material. Once the water exfiltrates from the pipe, it flows through the overburden to the river along the natural groundwater flow paths. In the pipeline corridor, those natural groundwater flow paths would likely be influenced by the bedding of the pipeline (i.e., localized convergent flow towards the bedding may exist) when the water level is above the bottom of the pipeline trench. However, the water level may be below the bottom of the bedding in portions of the floodplain. As such, the natural groundwater flow paths are likely through both the sand and bedding before discharging at the river. The abandoned Techite pipeline valve vault is ~340' from the Missouri River shoreline and is ~500' from the normal liquid effluent discharge point.

### *Monitoring Results*

The monitoring results are summarized in Table 2. The  $^3\text{H}$  analytical results for each sample are presented in Table 3. The gamma spectroscopy results and drawings showing the well locations are provided in the 2014 Annual Radiological Environmental Operating Report.

**TABLE 2: SUMMARY OF <sup>3</sup>H ACTIVITY IN MONITORING WELLS<sup>32</sup>**

Location	Sample Designation/ <sup>3</sup> H Activity Concentration (pCi/L)		
	HDPE Pipeline Bedding	Abandoned Techite Pipeline Bedding	Manhole/ Other
Adjacent to MH86-2	U1MW-031 1,500- 1,650,000	N/A	Inside MH86-2 during liquid radwaste release (diluted effluent)  2,000,000-,3,000,000
400' downpipe of MH86-2	U1MW-034 8,000- 12,000	U1MW-035 <MDA	N/A
1,000' downpipe of MH86-2	U1MW-036 14,000- 18,500	N/A	MH86-4A seepage 3,500
¼ to ½ miles downpipe of MH86-2	U1MW-038 <MDA	N/A	MH86-5 (inside Techite pipeline) 6,200
Start of shallow bedrock area	U1MW-040 <MDA	U1MW-059 <MDA	N/A
Southern edge of plateau/ hill between floodplain	U1MW-045 <MDA	U1MW-060 <MDA	Inside Techite pipeline on hillside 1,800

**Land Use**

The land traversed by the pipelines is wholly owned by Ameren Corporation. Farming is allowed in the pipelines corridor in the Missouri River alluvial floodplain however the groundwater is not used for irrigation.

<sup>32</sup> "Tritium Investigation Report Callaway Energy Center Fulton, Missouri", March 9, 2015. GZA GeoEnvironmental, Inc.

### *Dose to the Member of the Public*

The dose to the Member of the Public was calculated for each discharge and was reported in the Annual Radioactive Effluents Release Report for the respective year. As described above, the portion of each release that leaked from MH86-2 into the pipelines trenches was conveyed by the abandoned Techite pipeline to the Missouri River alluvial floodplain to a location ~340 feet from the Missouri River shoreline where it followed natural groundwater flow patterns to the Missouri River. The highest measured  $^3\text{H}$  concentration in the Missouri River floodplain (U1MW-047) was 8,512 pCi/L, which, if it were the sole source of drinking water for a year, would deliver a dose of approximately 1.7 mrem. However, the groundwater in the Missouri River floodplain is not a drinking water source. The original dose calculations bound the dose to the Member of the Public from this discharge.

Ameren owns ~7,200 acres surrounding the plant site and extending to the northern bank of the Missouri River. The site groundwater including the groundwater in the pipelines corridor is not used for irrigation and there are no drinking water wells in the Missouri River alluvial floodplain for at least a mile downstream. There are no new dose pathways created by this discharge.

The CJC aquifer and the deeper Derby- Doe Run aquifer are important sources of area drinking water. Callaway has been monitoring these aquifers and drinking water from the town of Portland, MO for over 30 years. Callaway installed an additional well at the base of the plateau in 2006 to provide additional monitoring for the CJC aquifer.  $^3\text{H}$  has never been detected in any of these samples, including during the monitoring events conducted since the release occurred.

Callaway has been monitoring drinking water wells from adjoining properties since 2006 and the monitoring frequency of these wells was increased for the period of the study after the tritium was detected in the groundwater samples from well U1 MW-031.  $^3\text{H}$  has never been detected in any of the samples collected from these drinking water wells.

Sentinel wells were installed between the pipelines corridor and adjoining properties in 2006.  $^3\text{H}$  has never been detected in any of these samples.

A network of monitoring wells was installed along the pipelines corridor in 2006- 2010 to monitor for leakage from the pipelines.  $^3\text{H}$  has never been detected in any of these samples, other than those wells used in the monitoring of the natural attenuation of a  $^3\text{H}$  contaminated area discovered in 2006.<sup>33</sup> Callaway is currently monitoring the natural attenuation of that area. That contamination is due to normal operation of the air release valves from when the abandoned Techite discharge line was in operation.

Based on the hydrogeologic conditions within the travel pathway of the release, it is highly unlikely that the impacted water migrated downwards and impacted the much deeper CJC aquifer or other water supply sources near the plant. This conclusion is further supported by the

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<sup>33</sup> CAR 200602748, "Vulnerabilities to Unplanned, Unmonitored Releases Offsite"

recent and historical groundwater quality monitoring data for the on- site monitoring wells and off- site water supply wells.

#### ***Remedial Actions***

Following discovery of the leak, all liquid radioactive effluent discharges were suspended until the manhole leaks were repaired. The gaps between the concrete wall of the manhole and the pipe were injected with expanding hydrophobic polyurethane which sealed the leaks. The repairs were tested with fluorescent dye prior to restarting the liquid radioactive effluent discharges.

#### ***Actions to Prevent Recurrence***

The leaks were repaired and tested as described above. In addition, the 6" SS liquid radioactive effluent pipe was extended 65" down the HDPE discharge pipe thus completely bypassing the manhole. Additional testing was performed to ensure these actions are sufficient to prevent leaks.

**TABLE 3: <sup>3</sup>H RESULTS FOR SAMPLES DURING THE LSI**

U1MW-031		U1MW-031		U1MW-031	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
25-Jul-14	1,644,880 1,569,566	25-Aug-14	165,440	28-Oct-14	5,703
01-Aug-14	296,323	26-Aug-14	163,544	10-Oct-14	9,476
08-Aug-14	110,120	27-Aug-14	159,459	04-Nov-14	9,024
11-Aug-14	111,262	28-Aug-14	171,980	11-Nov-14	9,233
13-Aug-14	102,716	02-Sep-14	189,259	18-Nov-14	2,435
15-Aug-14	100,448	09-Sep-14	213,378	24-Nov-14	1,477
16-Aug-14	105,979	16-Sep-14	121,001	3-Dec-14	3,782
20-Aug-14	142,203	23-Sep-14	88,573	8-Dec-14	6,507
21-Aug-14	155,603	30-Sep-14	43,326	22-Dec-14	7,615
22-Aug-14	157,542	07-Oct-14	29,693	12-Jan-15	6,269
23-Aug-14	154,238	14-Oct-14	9,125	13-Feb-15	4,553
24-Aug-14	157,665	21-Oct-14	7,927		

U1MW -047		U1MW -058		U1MW -032	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
04-Nov-14	5,152	25-Nov-14	5,721	14-Nov-15	<179
11-Nov-14	4,374	22-Dec-14	8,512		
18-Nov-14	4,415	12-Jan-15	7,121		
24-Nov-14	4,846				
3-Dec-14	5,491				
8-Dec-14	5,050				

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U1MW -034		U1MW -036	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
28-Oct-14	10,451	28-Oct-14	18,674
30-Oct-14	10,304	30-Oct-14	18,195
04-Nov-14	11,086	07-Nov-14	18,577
11-Nov-14	11,727	11-Nov-14	18,698
18-Nov-14	9,968	18-Nov-14	17,697
24-Nov-14	9,902	24-Nov-14	17,222
3-Dec-14	8,318	3-Dec-14	16,094
8-Dec-14	8,226	8-Dec-14	15,143
22-Dec-14	8,950	22-Dec-14	13,849
12-Jan-15	7,748	12-Jan-15	13,295
13-Feb-15	6,701	13-Feb-15	12,732

U1MW -033		U1MW -035		U1MW -037	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
14-Nov-15	<179	28-Oct-14	<174	28-Oct-14	<174
		30-Oct-14	229	30-Oct-14	<136
		04-Nov-14	<175		



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U1MW -038		U1MW -039		U1MW -040	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
04-Nov-14	<181	31-Oct-14	<167	31-Oct-14	<167

U1MW -041		U1MW -045		U1MW -046	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
04-Nov-14	<181	04-Nov-14	<181	04-Nov-14	<181

U1MW -048		U1MW -049		U1MW -050	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
04-Nov-14	<181	04-Nov-14	<181	04-Nov-14	240

U1MW -051		U1MW -053		U1MW -054	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
04-Nov-14	<181	11-Nov-14	<171	12-Nov-14	<184

U1MW -052		U1MW -052(12-15)*		U1MW -052(30-32)*	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
14-Nov-14	<185	07-Nov-14	18,369	07-Nov-14	17,917

\*Grab samples taken prior to completion of drilling activities and well development

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U1MW -053		U1MW -054		U1MW -055S	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
11-Nov-14	<171	12-Nov-14	<184	24-Nov-14	<177

U1MW -055D		U1MW -056S		U1MW -056D	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
20-Nov-14	<177	24-Nov-14	<179	24-Nov-14	<179

U1MW -057		U1MW -059		U1MW -060	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
21-Nov-14	<177	10-Dec-14	<190	10-Dec-14	<190

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Brandt Seep		Lawrence School	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
07-Nov-14	<176	07-Nov-14	<176

Inside MH86-2*		Inside Abandoned MH86-4A	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
17-Oct-14	<150	13-Nov-14	3,577
13-Nov-14	<176		
23-Nov-14	<179		
10-Dec-14	<190		

\*Following installation of bypass piping. Demonstrates there is no backflow into the manhole.

Inside Abandoned MH86-5		Inside Abandoned MH86-6*		Inside Abandoned MH11*	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
25-Nov-14	6,247	25-Nov-14	<173	25-Nov-14	<173

\* Standing groundwater inside manhole

Inside Techite Pipeline Upper Exposed Section		Gate Valve Vault HDPE Discharge Pipeline*		Gate Valve Vault Techite Discharge Pipeline*	
Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)	Sample Date	<sup>3</sup> H Conc. (pCi/L)
09-Dec-14	1,761	19-Sep-14	4,128	26-Nov-14	355
		20-Oct-14	540		
		18-Nov-14	349		

\* Standing groundwater inside manhole