

Great River Energy
 Elk River Station - Peaking Turbine Project
 Appendix A - Emission Calculations
 Table A-1: Limited Potential to Emit Summary

SV #	Emission Unit ID	Source Description	PM tons/year	PM10 tons/year	SO2 tons/year	NOx tons/year	VOC tons/year	CO tons/year	Total HAPs tons/year	Largest HAP (Formaldehyde) tons/year
012	EU010	Turbine 1	37.6	37.6	2.1	179.5	34.8	124.2	9.9	5.21
012	ISA	Preheater	0.07	0.07	0.01	0.46	0.05	0.77	0.02	6.8E-04
Tank	ISA	846,000 Gallon CT Fuel Oil Tank					0.21		0.02	
TOTAL			37.7	37.7	2.1	180.0	35.0	125.0	9.9	5.21

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Appendix A - Emission Calculations

Table A-2: Turbine 1 Project Emissions

											Limited Operation		
Unit ID	Unit Name	Fuel	Pollutant	Maximum Heat Input (units/hr)	Emission Factor (lb/units) (Ref.No.)		Emission Rate (lb/hr)	Maximum Potential to Emit (PTE) (ton/yr)	Actual Operating Hours (hr/yr)	Limited Potential to Emit (PTE) (ton/yr)	Max ton/yr	Limited Potential to Emit (PTE) (ton/yr)	
EU010	Turbine 1	Natural Gas	VOC	2169	MMBtu	-	1	10.3	45.0	6765	34.8	y	34.8
EU010	Turbine 1	Natural Gas	PM	2169	MMBtu	-	1	8.0	35.0	6765	27.1	n	
EU010	Turbine 1	Natural Gas	PM ₁₀	2169	MMBtu	-	1	8.0	35.0	6765	27.1	n	
EU010	Turbine 1	Natural Gas	CO	2169	MMBtu	-	1	471.9	2067.1	526	124.2	n	
EU010	Turbine 1	Natural Gas	SO ₂	2169	MMBtu	9.1E-05	2	0.2	0.9	6765	0.7	n	
EU010	Turbine 1	Natural Gas	NOx	2169	MMBtu	-	1	53.1	232.4	6765	179.5	n	
EU010	Turbine 1	Natural Gas	H ₂ SO ₄ Mist	2169	MMBtu	1.8E-06	3	4.0E-03	1.7E-02	6765	1.3E-02	n	
EU010	Turbine 1	Natural Gas	1,3-Butadiene	2169	MMBtu	4.3E-07	4	9.3E-04	4.1E-03	6765	3.2E-03	n	
EU010	Turbine 1	Natural Gas	2,2,4-Trimethylpentane	2169	MMBtu	1.2E-06	7	2.6E-03	1.1E-02	6765	8.8E-03	-	8.8E-03
EU010	Turbine 1	Natural Gas	Acetaldehyde	2169	MMBtu	4.0E-05	4	8.7E-02	3.8E-01	6765	2.9E-01	y	2.9E-01
EU010	Turbine 1	Natural Gas	Acrolein	2169	MMBtu	6.4E-06	4	1.4E-02	6.1E-02	6765	4.7E-02	n	
EU010	Turbine 1	Natural Gas	Benzene	2169	MMBtu	1.2E-05	4	2.6E-02	1.1E-01	6765	8.8E-02	y	8.8E-02
EU010	Turbine 1	Natural Gas	Ethyl benzene	2169	MMBtu	3.2E-05	4	6.9E-02	3.0E-01	6765	2.3E-01	-	2.3E-01
EU010	Turbine 1	Natural Gas	Formaldehyde	2169	MMBtu	7.1E-04	4	1.5E+00	6.7E+00	6765	5.2E+00	y	5.2E+00
EU010	Turbine 1	Natural Gas	Hexane	2169	MMBtu	1.8E-05	7	3.9E-02	1.7E-01	6765	1.3E-01	-	1.3E-01
EU010	Turbine 1	Natural Gas	Naphthalene	2169	MMBtu	1.3E-06	4	2.8E-03	1.2E-02	6765	9.5E-03	n	
EU010	Turbine 1	Natural Gas	N-Nitrosodimethylamine (NDMA)	2169	MMBtu	2.3E-07	7	5.1E-04	2.2E-03	6765	1.7E-03	-	1.7E-03
EU010	Turbine 1	Natural Gas	N-Nitrosomorpholine (NMOR)	2169	MMBtu	1.6E-07	7	3.5E-04	1.5E-03	6765	1.2E-03	-	1.2E-03
EU010	Turbine 1	Natural Gas	PAH	2169	MMBtu	2.2E-06	4	4.8E-03	2.1E-02	6765	1.6E-02	n	
EU010	Turbine 1	Natural Gas	Propylene oxide	2169	MMBtu	2.9E-05	4	6.3E-02	2.8E-01	6765	2.1E-01	-	2.1E-01
EU010	Turbine 1	Natural Gas	Toluene	2169	MMBtu	1.3E-04	4	2.8E-01	1.2E+00	6765	9.5E-01	y	9.5E-01
EU010	Turbine 1	Natural Gas	Trimethoxyamphetamines (TMA)	2169	MMBtu	2.2E-07	7	4.7E-04	2.1E-03	6765	1.6E-03	-	1.6E-03
EU010	Turbine 1	Natural Gas	Xylenes	2169	MMBtu	6.4E-05	4	1.4E-01	6.1E-01	6765	4.7E-01	n	
EU010	Turbine 1	Natural Gas	Arsenic	2169	MMBtu	7.7E-08	7	1.7E-04	7.3E-04	6765	5.7E-04	n	
EU010	Turbine 1	Natural Gas	Cadmium	2169	MMBtu	2.7E-06	7	5.8E-03	2.5E-02	6765	2.0E-02	y	2.0E-02
EU010	Turbine 1	Natural Gas	Lead	2169	MMBtu	5.1E-05	7	1.1E-01	4.9E-01	6765	3.8E-01	y	3.8E-01
EU010	Turbine 1	Natural Gas	Manganese	2169	MMBtu	5.1E-06	7	1.1E-02	4.9E-02	6765	3.8E-02	n	
EU010	Turbine 1	Natural Gas	Mercury	2169	MMBtu	7.0E-07	7	1.5E-03	6.6E-03	6765	5.1E-03	y	5.1E-03
EU010	Turbine 1	Distillate Oil	VOC	2132	MMBtu	-	1	183.1	802.0	130	11.9	n	
EU010	Turbine 1	Distillate Oil	PM	2132	MMBtu	-	1	58.4	255.8	1288	37.6	y	37.6
EU010	Turbine 1	Distillate Oil	PM ₁₀	2132	MMBtu	-	1	58.4	255.8	1288	37.6	y	37.6
EU010	Turbine 1	Distillate Oil	CO	2132	MMBtu	-	1	1918.2	8401.8	130	124.2	y	124.2
EU010	Turbine 1	Distillate Oil	SO ₂	2132	MMBtu	1.5E-03	2	3.2	14.1	1288	2.1	y	2.1
EU010	Turbine 1	Distillate Oil	NOx	2132	MMBtu	-	1	278.8	1221.3	1288	179.5	y	179.5
EU010	Turbine 1	Distillate Oil	H ₂ SO ₄ Mist	2132	MMBtu	3.0E-05	3	6.5E-02	2.8E-01	1288	4.2E-02	y	4.2E-02
EU010	Turbine 1	Distillate Oil	1,3-Butadiene	2132	MMBtu	1.6E-05	5	3.4E-02	1.5E-01	1288	2.2E-02	y	2.2E-02
EU010	Turbine 1	Distillate Oil	Acetaldehyde	2132	MMBtu	1.0E-05	7	2.2E-02	9.6E-02	1288	1.4E-02	n	
EU010	Turbine 1	Distillate Oil	Acrolein	2132	MMBtu	8.3E-05	7	1.8E-01	7.7E-01	1288	1.1E-01	y	1.1E-01
EU010	Turbine 1	Distillate Oil	Benzene	2132	MMBtu	5.5E-05	5	1.2E-01	5.1E-01	1288	7.5E-02	n	
EU010	Turbine 1	Distillate Oil	Carbon tetrachloride	2132	MMBtu	1.7E-05	7	3.7E-02	1.6E-01	1288	2.4E-02	-	2.4E-02
EU010	Turbine 1	Distillate Oil	Chlorobenzene	2132	MMBtu	1.3E-05	7	2.7E-02	1.2E-01	1288	1.7E-02	-	1.7E-02
EU010	Turbine 1	Distillate Oil	Chloroform	2132	MMBtu	1.4E-05	7	2.9E-02	1.3E-01	1288	1.9E-02	-	1.9E-02
EU010	Turbine 1	Distillate Oil	Dichlorobenzene	2132	MMBtu	1.7E-05	7	3.5E-02	1.6E-01	1288	2.3E-02	-	2.3E-02
EU010	Turbine 1	Distillate Oil	Dioxins/Furans (as 2,3,7,8-TCDD equiv.)	2132	MMBtu	3.9E-10	7	8.4E-07	3.7E-06	1288	5.4E-07	-	5.4E-07
EU010	Turbine 1	Distillate Oil	Ethylene dichloride	2132	MMBtu	1.1E-05	7	2.4E-02	1.0E-01	1288	1.5E-02	-	1.5E-02
EU010	Turbine 1	Distillate Oil	Formaldehyde	2132	MMBtu	2.8E-04	5	6.0E-01	2.6E+00	1288	3.8E-01	n	
EU010	Turbine 1	Distillate Oil	Methylene chloride	2132	MMBtu	9.6E-06	7	2.0E-02	9.0E-02	1288	1.3E-02	-	1.3E-02
EU010	Turbine 1	Distillate Oil	Naphthalene	2132	MMBtu	3.5E-05	5	7.5E-02	3.3E-01	1288	4.8E-02	y	4.8E-02
EU010	Turbine 1	Distillate Oil	PAH	2132	MMBtu	4.0E-05	5	8.5E-02	3.7E-01	1288	5.5E-02	y	5.5E-02

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Appendix A - Emission Calculations

Table A-2: Turbine 1 Project Emissions

											Limited Operation		
Unit ID	Unit Name	Fuel	Pollutant	Maximum Heat Input (units/hr)	Emission Factor (lb/units) (Ref.No.)	Emission Rate (lb/hr)	Maximum Potential to Emit (PTE) (ton/yr)	Actual Operating Hours (hr/yr)	Limited Potential to Emit (PTE) (ton/yr)	Max ton/yr	Limited Potential to Emit (PTE) (ton/yr)		
EU010	Turbine 1	Distillate Oil	Tetrachloroethylene	2132	MMBtu	1.9E-05	7	4.0E-02	1.8E-01	1288	2.6E-02	-	2.6E-02
EU010	Turbine 1	Distillate Oil	Toluene	2132	MMBtu	5.4E-04	7	1.1E+00	5.0E+00	1288	7.4E-01	n	
EU010	Turbine 1	Distillate Oil	Trichloroethylene	2132	MMBtu	1.5E-05	7	3.2E-02	1.4E-01	1288	2.0E-02	-	2.0E-02
EU010	Turbine 1	Distillate Oil	Vinyl chloride	2132	MMBtu	3.5E-05	7	7.5E-02	3.3E-01	1288	4.9E-02	-	4.9E-02
EU010	Turbine 1	Distillate Oil	Vinylidene chloride	2132	MMBtu	3.5E-05	7	7.5E-02	3.3E-01	1288	4.9E-02	-	4.9E-02
EU010	Turbine 1	Distillate Oil	Xylenes	2132	MMBtu	5.3E-04	7	1.1E+00	4.9E+00	1288	7.2E-01	y	7.2E-01
EU010	Turbine 1	Distillate Oil	Arsenic	2132	MMBtu	1.1E-05	6	2.3E-02	1.0E-01	1288	1.5E-02	y	1.5E-02
EU010	Turbine 1	Distillate Oil	Beryllium	2132	MMBtu	3.1E-07	6	6.6E-04	2.9E-03	1288	4.3E-04	-	4.3E-04
EU010	Turbine 1	Distillate Oil	Cadmium	2132	MMBtu	4.8E-06	6	1.0E-02	4.5E-02	1288	6.6E-03	n	
EU010	Turbine 1	Distillate Oil	Chromium	2132	MMBtu	1.1E-05	6	2.3E-02	1.0E-01	1288	1.5E-02	-	1.5E-02
EU010	Turbine 1	Distillate Oil	Lead	2132	MMBtu	1.4E-05	6	3.0E-02	1.3E-01	1288	1.9E-02	n	
EU010	Turbine 1	Distillate Oil	Manganese	2132	MMBtu	7.9E-04	6	1.7E+00	7.4E+00	1288	1.1E+00	y	1.1E+00
EU010	Turbine 1	Distillate Oil	Mercury	2132	MMBtu	1.2E-06	6	2.6E-03	1.1E-02	1288	1.6E-03	n	
EU010	Turbine 1	Distillate Oil	Nickel	2132	MMBtu	4.6E-06	6	9.8E-03	4.3E-02	1288	6.3E-03	-	6.3E-03
EU010	Turbine 1	Distillate Oil	Selenium	2132	MMBtu	2.5E-05	6	5.3E-02	2.3E-01	1288	3.4E-02	-	3.4E-02
ISA	Preheater	Natural Gas	VOC	2.75	MMBtu	5.4E-03	9	1.5E-02	6.5E-02	6765	0.050	-	0.050
ISA	Preheater	Natural Gas	PM	2.75	MMBtu	7.5E-03	9	2.0E-02	9.0E-02	6765	0.069	-	0.069
ISA	Preheater	Natural Gas	PM ₁₀	2.75	MMBtu	7.5E-03	9	2.0E-02	9.0E-02	6765	0.069	-	0.069
ISA	Preheater	Natural Gas	CO	2.75	MMBtu	8.2E-02	8	2.3E-01	9.9E-01	6765	0.766	-	0.766
ISA	Preheater	Natural Gas	SO ₂	2.75	MMBtu	5.9E-04	9	1.6E-03	7.1E-03	6765	0.005	-	0.005
ISA	Preheater	Natural Gas	H ₂ SO ₄ Mist	2.75	MMBtu	1.2E-05	3	3.2E-05	1.4E-04	6765	1.1E-04	-	1.1E-04
ISA	Preheater	Natural Gas	NOx	2.75	MMBtu	4.9E-02	8	1.3E-01	5.9E-01	6765	0.456	-	0.456
ISA	Preheater	Natural Gas	Benzene	2.75	MMBtu	2.1E-06	10	5.7E-06	2.5E-05	6765	1.9E-05	-	1.9E-05
ISA	Preheater	Natural Gas	Dichlorobenzene	2.75	MMBtu	1.2E-06	10	3.2E-06	1.4E-05	6765	1.1E-05	-	1.1E-05
ISA	Preheater	Natural Gas	Formaldehyde	2.75	MMBtu	7.4E-05	10	2.0E-04	8.9E-04	6765	6.8E-04	-	6.8E-04
ISA	Preheater	Natural Gas	Hexane	2.75	MMBtu	1.8E-03	10	4.9E-03	2.1E-02	6765	1.6E-02	-	1.6E-02
ISA	Preheater	Natural Gas	Naphthalene	2.75	MMBtu	6.0E-07	10	1.6E-06	7.2E-06	6765	5.6E-06	-	5.6E-06
ISA	Preheater	Natural Gas	Toluene	2.75	MMBtu	3.3E-06	10	9.2E-06	4.0E-05	6765	3.1E-05	-	3.1E-05
ISA	Preheater	Natural Gas	PAH	2.75	MMBtu	8.6E-08	10	2.4E-07	1.0E-06	6765	8.0E-07	-	8.0E-07
ISA	Preheater	Natural Gas	Arsenic	2.75	MMBtu	2.0E-07	11	5.4E-07	2.4E-06	6765	1.8E-06	-	1.8E-06
ISA	Preheater	Natural Gas	Beryllium	2.75	MMBtu	1.2E-08	11	3.2E-08	1.4E-07	6765	1.1E-07	-	1.1E-07
ISA	Preheater	Natural Gas	Cadmium	2.75	MMBtu	1.1E-06	11	3.0E-06	1.3E-05	6765	1.0E-05	-	1.0E-05
ISA	Preheater	Natural Gas	Chromium	2.75	MMBtu	1.4E-06	11	3.8E-06	1.7E-05	6765	1.3E-05	-	1.3E-05
ISA	Preheater	Natural Gas	Cobalt	2.75	MMBtu	8.2E-08	11	2.3E-07	9.9E-07	6765	7.7E-07	-	7.7E-07
ISA	Preheater	Natural Gas	Lead	2.75	MMBtu	4.9E-07	11	1.3E-06	5.9E-06	6765	4.6E-06	-	4.6E-06
ISA	Preheater	Natural Gas	Manganese	2.75	MMBtu	3.7E-07	11	1.0E-06	4.5E-06	6765	3.5E-06	-	3.5E-06
ISA	Preheater	Natural Gas	Mercury	2.75	MMBtu	2.5E-07	11	7.0E-07	3.1E-06	6765	2.4E-06	-	2.4E-06
ISA	Preheater	Natural Gas	Molybdenum	2.75	MMBtu	1.1E-06	11	3.0E-06	1.3E-05	6765	1.0E-05	-	1.0E-05
ISA	Preheater	Natural Gas	Nickel	2.75	MMBtu	2.1E-06	11	5.7E-06	2.5E-05	6765	1.9E-05	-	1.9E-05
ISA	Preheater	Natural Gas	Selenium	2.75	MMBtu	2.4E-08	11	6.5E-08	2.8E-07	6765	2.2E-07	-	2.2E-07
ISA	846,000 Gallon CT Fuel Oil Tank	N/A	VOC	-	-	-	12	4.7E-02	2.1E-01	8760	2.1E-01	-	2.1E-01
ISA	846,000 Gallon CT Fuel Oil Tank	N/A	Benzene	-	-	-	12	1.1E-04	4.9E-04	8760	4.9E-04	-	4.9E-04
ISA	846,000 Gallon CT Fuel Oil Tank	N/A	Ethyl benzene	-	-	-	12	1.5E-04	6.5E-04	8760	6.5E-04	-	6.5E-04
ISA	846,000 Gallon CT Fuel Oil Tank	N/A	Hexane	-	-	-	12	2.3E-05	1.0E-04	8760	1.0E-04	-	1.0E-04
ISA	846,000 Gallon CT Fuel Oil Tank	N/A	Toluene	-	-	-	12	1.2E-03	5.1E-03	8760	5.1E-03	-	5.1E-03
ISA	846,000 Gallon CT Fuel Oil Tank	N/A	Xylenes	-	-	-	12	2.7E-03	1.2E-02	8760	1.2E-02	-	1.2E-02

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Unit ID	Unit Name	Fuel	Pollutant	Maximum Heat Input (units/hr)	Emission Factor (lb/units) (Ref.No.)	Emission Rate (lb/hr)	Maximum Potential to Emit (PTE) (ton/yr)	Limited Operation		
								Actual Operating Hours (hr/yr)	Limited Potential to Emit (PTE) (ton/yr)	Max ton/yr
TOTAL VOC EMISSIONS										35.0
TOTAL PM EMISSIONS										37.7
TOTAL PM ₁₀ EMISSIONS										37.7
TOTAL CO EMISSIONS										125.0
TOTAL SO ₂ EMISSIONS										2.08
TOTAL H ₂ SO ₄ Mist EMISSIONS										0.04
TOTAL NO _x EMISSIONS										180.0
TOTAL HAP EMISSIONS										9.9
LARGEST SINGLE HAP EMISSIONS (Formaldehyde)										5.21

REFERENCES:

- Information provided by Siemens Westinghouse for Estimated 5000F Gas Turbine Performance
- AP-42 Table 3.1-2a. EMISSION FACTORS FOR CRITERIA POLLUTANTS AND GREENHOUSE GASES FROM STATIONARY GAS TURBINES
 NNG Data:

$$\begin{array}{l}
 \text{Sulfur content} = < 0.032 \text{ grains/100 scf} \\
 \text{Heat Content (gross)} = 999.500 \text{ Btu/scf} \\
 \text{s\%} = \frac{0.032 \text{ grains S}}{100 \text{ scf}} \times \frac{1 \text{ lb}}{7000 \text{ grains}} \times \frac{\text{cf}}{999.5 \text{ Btu}} \times \frac{1000000 \text{ Btu}}{\text{MMBtu}} \times \frac{2 \text{ lb SO}_2}{\text{lb S}} = 9.15\text{E-}05 \frac{\text{lb SO}_2}{\text{MMBtu}}
 \end{array}$$

Fuel Oil Data:

Sulfur content (given): 0.0015 %S

- Assumes a 1-2% conversion of SO₂ to SO₃ and, conservatively, 100% conversion of SO₃ to H₂SO₄. (ref: Reising, B.; Siemens-Westinghouse; Review of Air Toxics from Combustion Sources; Power Gen 2003 - Las Vegas; December 2003)
- AP-42 Table 3.1-3. EMISSION FACTORS FOR HAZARDOUS AIR POLLUTANTS FROM NATURAL GAS-FIRED STATIONARY GAS TURBINES
- AP-42 Table 3.1-4. EMISSION FACTORS FOR HAZARDOUS AIR POLLUTANTS FROM DISTILLATE OIL-FIRED STATIONARY GAS TURBINES
- AP-42 Table 3.1-5. EMISSION FACTORS FOR METALLIC HAZARDOUS AIR POLLUTANTS FROM DISTILLATE OIL-FIRED STATIONARY GAS TURBINES
- EPA. Technology Transfer Network Air Toxics Website, Stationary Combustion Turbines NESHAP, Combustion Turbine Emissions Database v.5, 10/15/02. <http://www.epa.gov/ttn/atw/turbine/turbinepg.html#TECH>
- AP-42 Table 1.4-1. EMISSION FACTORS FOR NITROGEN OXIDES (NO_x) AND CARBON MONOXIDE (CO) FROM NATURAL GAS COMBUSTION
- AP-42 TABLE 1.4-2. EMISSION FACTORS FOR CRITERIA POLLUTANTS AND GREENHOUSE GASES FROM NATURAL GAS COMBUSTION
- AP-42 TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM NATURAL GAS COMBUSTION
- AP-42 TABLE 1.4-4. EMISSION FACTORS FOR METALS FROM NATURAL GAS COMBUSTION
- Emission rate calculated using EPA TANKS 4.0.9d.

**Great River Energy
Elk River Power Station - Peaking Turbine Project
Appendix A - Emission Calculations**

Table A-3: Turbine Criteria Pollutant Worst-Case Determination from Manufacturer Data

% Load	Fuel	Estimated Hours of Operation	Maximum NOx Emission Rate (lb/hr)	Annual NOx Emissions (tons/yr)	Maximum CO Emission Rate (lb/hr)	Annual CO Emissions (tons/yr)	Maximum PM Emission Rate (lb/hr)	Annual PM Emissions (tons/yr)	Maximum VOC Emission Rate (lb/hr)	Annual VOC Emissions (tons/yr)
50%	Nat Gas	526.2	129.2	34.0	471.9	124.2	12.9	3.4	36.0	9.5
	Distillate	130	262.5	17.0	1918.2	124.2	69.2	4.5	183.1	11.9
60%	Nat Gas	6765	53.1	179.5	35.9	121.4	8.0	27.1	10.3	34.8
	Distillate	275	296.6	40.8	903.0	124.2	62.9	8.7	10.3	1.4
70%	Nat Gas	6051	59.3	179.5	16.1	48.6	8.0	24.2	2.3	7.0
	Distillate	1288	278.8	179.5	40.4	26.0	58.4	37.6	2.3	1.5
80%	Nat Gas	5475	65.6	179.5	17.7	48.6	8.0	22.0	2.5	7.0
	Distillate	1155	310.7	179.5	45.0	26.0	54.7	31.6	2.6	1.5
90%	Nat Gas	4997	71.8	179.5	19.4	48.6	8.7	21.7	2.8	7.0
	Distillate	1055	340.2	179.5	49.3	26.0	52.4	27.6	2.8	1.5
Base	Nat Gas	4898	73.3	179.5	19.8	48.6	8.8	21.6	2.8	7.0
	Distillate	1002	358.3	179.5	51.9	26.0	49.3	24.7	3.0	1.5

Worst Case Summary (Maximum tons/yr)

Pollutant	Fuel	Load	Hours of Operation	Emission Rate (lb/hr)	Emission Rate (tons/yr)
NOx	Nat Gas	60%	6765	53.1	179.5
	Distillate	70%	1288	278.8	179.5
CO	Nat Gas	50%	526	471.9	124.2
	Distillate	50%	130	1918.2	124.2
PM	Nat Gas	60%	6765	8.0	27.1
	Distillate	70%	1288	58.4	37.6
VOC	Nat Gas	60%	6765	10.3	34.8
	Distillate	50%	130	183.1	11.9

Great River Energy
Elk River Station - Peaking Turbine Project
Appendix A - Emission Calculations
Table A-4: Turbine Manufacturer Data Used for Emission Estimates

SITE CONDITIONS:

FUEL TYPE
LOAD LEVEL
AMBIENT DRY BULB TEMPERATURE, °F

Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil
BASE	90%	80%	70%	60%	50%
90.0	90.0	90.0	90.0	90.0	90.0

GAS TURBINE INFORMATION:

HEAT INPUT, MMBtu/hr (HHV)
EXHAUST TEMPERATURE, °F
EXHAUST FLOW, lb_m/hr
EXHAUST FLOW, MACFM

1,733	1,537	1,415	1,278	1,151	1,031
1,072	1,080	1,080	1,080	1,080	1,080
3,687,390	3,343,606	3,132,804	2,926,628	2,717,587	2,514,602
2.49	2.27	2.13	1.98	1.84	1.70

NET EMISSIONS (Based on USEPA Test Methods):

NO_x, ppmvd @ 15% O₂
NO_x, lb_m/hr as NO₂
CO, ppmvd @ 15% O₂
CO, lb_m/hr
VOC, ppmvd @ 15% O₂
VOC, lb_m/hr as CH₄
PARTICULATES, lb_m/hr

42	42	42	42	50	50
291	258	238	215	230	206
10	10	10	10	250	600
42	37	34	31	700	1,505
1	1	1	1	5	100
2	2.1	2.0	1.8	8	144
41	41	44	47	51	56

SITE CONDITIONS:

FUEL TYPE
LOAD LEVEL
AMBIENT DRY BULB TEMPERATURE, °F

Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
BASE	90%	80%	70%	60%	50%
90.0	90.0	90.0	90.0	90.0	90.0

GAS TURBINE INFORMATION:

HEAT INPUT, MMBtu/hr (HHV)
EXHAUST TEMPERATURE, °F
EXHAUST FLOW, lb_m/hr
EXHAUST FLOW, MACFM

1,828	1,620	1,490	1,356	1,223	1,092
1,107	1,115	1,115	1,115	1,115	1,115
3,645,647	3,301,147	3,089,533	2,873,747	2,661,337	2,454,852
2.55	2.32	2.17	2.02	1.87	1.72

NET EMISSIONS (Based on USEPA Test Methods):

NO_x, ppmvd @ 15% O₂
NO_x, lb_m/hr as NO₂
CO, ppmvd @ 15% O₂
CO, lb_m/hr
VOC, ppmvd @ 15% O₂
VOC, lb_m/hr as CH₄
PARTICULATES, lb_m/hr

9	9	9	9	9	25
62	55	50	46	41	102
4	4	4	4	10	150
17	15	14	12	28	374
1	1	1	1	5	20
2.4	2.1	2.0	1.8	8	29
8	8	8	8	8	8

**Great River Energy
Elk River Station - Peaking Turbine Project
Appendix A - Emission Calculations
Table A-4: Turbine Manufacturer Data Used for Emission Estimates**

SITE CONDITIONS:

FUEL TYPE
LOAD LEVEL
AMBIENT DRY BULB TEMPERATURE, °F

Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil
BASE	90%	80%	70%	60%	50%
59.0	59.0	59.0	59.0	59.0	59.0

GAS TURBINE INFORMATION:

HEAT INPUT, MMBtu/hr (HHV)
EXHAUST TEMPERATURE, °F
EXHAUST FLOW, lb_m/hr
EXHAUST FLOW, MACFM

1,837	1,683	1,545	1,390	1,248	1,113
1,047	1,047	1,047	1,047	1,047	1,047
3,926,968	3,642,073	3,399,732	3,164,524	2,928,863	2,700,806
2.59	2.40	2.24	2.08	1.93	1.78

NET EMISSIONS (Based on USEPA Test Methods):

NO_x, ppmvd @ 15% O₂
NO_x, lb_m/hr as NO₂
CO, ppmvd @ 15% O₂
CO, lb_m/hr
VOC, ppmvd @ 15% O₂
VOC, lb_m/hr as CH₄
PARTICULATES, lb_m/hr

42	42	42	42	50	50
309	283	260	233	249	222
10	10	10	10	250	600
45	41	38	34	759	1,625
1	1	1	1	5	100
2.6	2.3	2.2	1.9	9	155
44	45	48	51	55	61

SITE CONDITIONS:

FUEL TYPE
LOAD LEVEL
AMBIENT DRY BULB TEMPERATURE, °F

Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
BASE	90%	80%	70%	60%	50%
59.0	59.0	59.0	59.0	59.0	59.0

GAS TURBINE INFORMATION:

HEAT INPUT, MMBtu/hr (HHV)
EXHAUST TEMPERATURE, °F
EXHAUST FLOW, lb_m/hr
EXHAUST FLOW, MACFM

1,937	1,772	1,626	1,475	1,325	1,178
1,082	1,082	1,082	1,082	1,082	1,082
3,882,803	3,594,973	3,353,580	3,109,020	2,868,912	2,636,310
2.65	2.45	2.29	2.12	1.96	1.80

NET EMISSIONS (Based on USEPA Test Methods):

NO_x, ppmvd @ 15% O₂
NO_x, lb_m/hr as NO₂
CO, ppmvd @ 15% O₂
CO, lb_m/hr
VOC, ppmvd @ 15% O₂
VOC, lb_m/hr as CH₄
PARTICULATES, lb_m/hr

9	9	9	9	9	25
65	60	55	50	45	110
4	4	4	4	10	150
18	16	15	13	30	404
1	1	1	1	5	20
2.5	2.3	2.1	1.9	9	31
8	8	8	8	8	8

Great River Energy
Elk River Station - Peaking Turbine Project
Appendix A - Emission Calculations
Table A-4: Turbine Manufacturer Data Used for Emission Estimates

SITE CONDITIONS:

FUEL TYPE
 LOAD LEVEL
 AMBIENT DRY BULB TEMPERATURE, °F

Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil	Dist. Oil
96%	90%	80%	70%	60%	50%
-30.0	-30.0	-30.0	-30.0	-30.0	-30.0

GAS TURBINE INFORMATION:

HEAT INPUT, MMBtu/hr (HHV)
 EXHAUST TEMPERATURE, °F
 EXHAUST FLOW, lb_m/hr
 EXHAUST FLOW, MACFM

2,132	2,024	1,849	1,660	1,484	1,313
997	997	997	997	997	997
4,375,169	4,180,350	3,877,887	3,599,268	3,316,016	3,033,673
2.78	2.66	2.46	2.28	2.10	1.92

NET EMISSIONS (Based on USEPA Test Methods):

NO_x, ppmvd @ 15% O₂
 NO_x, lb_m/hr as NO₂
 CO, ppmvd @ 15% O₂
 CO, lb_m/hr
 VOC, ppmvd @ 15% O₂
 VOC, lb_m/hr as CH₄
 PARTICULATES, lb_m/hr

42	42	42	42	50	50
358	340	311	279	297	263
10	10	10	10	250	600
52	49	45	40	903	1,918
1	1	1	1	5	100
3.0	2.8	2.6	2.3	10	183
49	52	55	58	63	69

SITE CONDITIONS:

FUEL TYPE
 LOAD LEVEL
 AMBIENT DRY BULB TEMPERATURE, °F

Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
92%	90%	80%	70%	60%	50%
-30.0	-30.0	-30.0	-30.0	-30.0	-30.0

GAS TURBINE INFORMATION:

HEAT INPUT, MMBtu/hr (HHV)
 EXHAUST TEMPERATURE, °F
 EXHAUST FLOW, lb_m/hr
 EXHAUST FLOW, MACFM

2,169	2,126	1,941	1,756	1,571	1,378
1,031	1,031	1,031	1,031	1,031	991
4,197,970	4,124,536	3,822,082	3,534,582	3,245,871	3,053,199
2.76	2.71	2.51	2.32	2.13	1.95

NET EMISSIONS (Based on USEPA Test Methods):

NO_x, ppmvd @ 15% O₂
 NO_x, lb_m/hr as NO₂
 CO, ppmvd @ 15% O₂
 CO, lb_m/hr
 VOC, ppmvd @ 15% O₂
 VOC, lb_m/hr as CH₄
 PARTICULATES, lb_m/hr

9	9	9	9	9	25
73	72	66	59	53	129
4	4	4	4	10	150
20	19	18	16	36	472
1	1	1	1	5	20
2.8	2.8	2.5	2.3	10	36
9	9	8	8	8	13