Middletown Cogeneration Facility Emission Calculations

Emission Point:	**P001**
Operating Scenario	**MWERF-1**
Description:	**Gas Turbine/HRSG Routine Emissions**

		Maximum	Expected		
Physical Characteristics:	Height of Stack above grade =		125	ft	
	Diameter of Stack =		16.5	ft	
Inputs shaded in Green	Stack Gas Exit Temperature =		317	F	
	Operating Schedule =	504	8,760	hours/year (assume 100% though expected is 91.4%)	
Emission data:	BFG Firing rate =	1100	1000	MMBtu/hr HHV (dry)	GE Rev 6 Emission Input File for Max Firing of 1,006 LHV, Average Firing of 944 LHV
	BFG Heat Value =	127	127	Btu/SCF HHV (dry)	GE Rev 6 Emission Input File at Average Ambient conditions, 119 LHV
	Exhaust Mass Rate (wet) =	3,090,060	2,901,377	lb/hr Wet	GE Rev 6 Emission Input File of exhaust flow times Firing Rate adjustment
	Exhaust Molar Rate (dry) @ 15% O2=	132,418	124,332	lbmole/hr Dry @15% O2	
Inputs shaded in Green	Exhaust Molar Rate (dry) =	99,156	93,101	lbmole/hr Dry	
	Exhaust Molar Rate (wet) =	103,395	97,081	lbmole/hr Wet	
	NOx Average Emission Factor =	12	12	ppmvd@15%O2	SCR performance guarantee (assumes 25 ppm Inlet)
	CO Average Emission Factor =	25	25	ppmvd @ exhaust conditions	Gas Turbine performance guarantee
	SO2 =	0.120	0.120	#/MMBtu HHV (dry)	100 ppm
	PM Filterable Average Emission Factor =	21	21	#/hr	Gas Turbine performance guarantee
	PM Total Average Emission Factor =	35	35	#/hr (Filterable & Condensable)	Gas Turbine performance guarantee
	VOC Average Emission Factor =	1.4	1.4	ppmvw @ exhaust conditions	Gas Turbine performance guarantee (as methane)
	NH3 Average Slip Concentration =	5	5	ppmvd @ 15% 02	SCR performance guarantee
	CO2 Emission Factor =	274.32	274.32	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	CH4 Emission Factor =	0.000022	0.000022	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	N2O Emission Factor =	0.0001	0.0001	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	CO2 Global Warming Potential =	1	1		GHG Reporting Rule
	CH4 Global Warming Potential =	21	21		GHG Reporting Rule
	N2O Global Warming Potential =	310	310		GHG Reporting Rule
	Supplemental NG Flow Rate =	0	0	#/MMBtu	Gas Turbine manufacturer

Exhaust Stack %mole	
ARGON	1%
NITROGEN	72%
OXYGEN	13%
CARBON DIOXIDE	10%
WATER	4%
Mole. Wt. Dry	29.1
Mole. Wt. Wet	29.9
%O2 dry	13.0%

Average Emission Rate Calculations:

Average Concentration (PPMV) **X** Molar Flow Rate (lbmole/hr) **X** Operating Hours X Molecular Weight (lbs/lbmole) / 2,000 lbs/ton X 1,000,000 **=** Tons/Year

Component Specific Emission Factor (lbs/MMBtu) **X** Firing Rate (MMBtu/hr) X Operating Hours / 2,000 lbs/ton = Tons/Year

NOx Emissions:

NOx (tpy) = 12 ppmv avg **X** 124,332 lbmole/hr **X** 8,760 hrs/yr **X** 46 lbs/lbmole **/** (2,000 **X** 1,000,000) = **301 tpy - NOx**

NOx (lb/hr) = 12 ppmv avg **X** 124,332 lbmole/hr **X** 46 lbs/lbmole / 1,000,000 lbs/ppm = **69 lbs/hr - NOx**
0.069 lb/MMBtu

CO Emissions:

CO (tpy) = 25 ppmv avg **X** 93,101 lbmole/hr **X** 8,760 hrs/yr **X** 28 lbs/lbmole **/** (2,000 **X** 1,000,000) = **285 tpy - CO**

CO (lb/hr) = 25 ppmv avg **X** 93,101 lbmole/hr **X** 28 lbs/lbmole / 1,000,000 lbs/ppm = **65 lbs/hr - CO**
0.065 lb/MMBtu

SO2 Emissions:

SO2 (tpy) = 120 lbs SO2/hr 8760 hrs/yr **/** 2,000 lbs/ton = **525 tpy - SO2**

SO2 (lb/hr) = 1,000 MMBtu/hr **X** 0.120 #/MMBtu = **120 lbs/hr - SO2**

PM Filterable Emissions:

PM_{fil} (tpy) = 21 lb/hr **X** 8,760 hrs/yr / 2,000 lbs/ton = **93 tpy - PM_{fil}**

PM_{fil} (lb/hr) = 21 lb/hr **21 lbs/hr - PM_{fil}**

PM Total Emissions:

PM_{tot} (tpy) = 35 lb/hr **X** 8,760 hrs/yr / 2,000 lbs/ton = **154 tpy - PM_{tot}**

PM_{tot} (lb/hr) = 35 lb/hr **35 lbs/hr - PM_{tot}**

VOC Emissions:

VOC (tpy) = 1.4 ppmv avg **X** 97,081 lbmole/hr **X** 8,760 hrs/yr **X** 16 lbs/lbmole **/** (2,000 **X** 1,000,000) = **10 tpy - VOC (as methane)**

VOC (lb/hr) = 1.4 ppmv avg **X** 97,081 lbmole/hr **X** 16 lbs CH4/lbmole / 1,000,000 lbs/ppm = **2 lbs/hr - VOC (as methane)**

NH3 Emissions:

NH3 (tpy) = 5 ppmv avg **X** 124,332 lbmole/hr **X** 8,760 hrs/yr **X** 17 lbs/lbmole **/** (2,000 **X** 1,000,000) = **46 tpy - NH3**

NH3 (lb/hr) = 5 ppmv avg **X** 124,332 lbmole/hr **X** 17 lbs/lbmole / 1,000,000 lbs/ppm = **11 lbs/hr - NH3**

CO2 Emissions:

CO2 (tpy) = 1,000 MMBtu/hr **X** 274.32 kg/MMBtu **X** 1 Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2000 = **2,648,154 CO2 (tpy)**
CH4 (tpy) = 1,000 MMBtu/hr **X** 0.000022 kg/MMBtu **X** 21 Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2000 = **0 CH4 (tpy)**
N2O (tpy) = 1,000 MMBtu/hr **X** 0.0001 kg/MMBtu **X** 310 Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2000 = **17 N2) (tpy)**

CO2e (tpy) = CO2 + CH4 + N2O = **2,648,171 CO2e (tpy)**

Maximum Emission Rate Calculations:

Maximum Component Specific Emission Factor (lbs/MMBtu) **X** Firing Rate (MMBtu/hr) **=** lbs per hour of the specific component

Maximum Concentration (PPMV) **X** Molar Flow Rate (lbmole/hr) **X** Molecular Weight (lbs/lbmole) / 1,000,000 **=** Pounds per hour

NOx Emissions:

NOx (lb/hr) = 12 ppmv avg **X** 132,418 lbmole/hr X 46 lbs/lbmole / 1,000,000 lbs/ppm = **73 lbs/hr - NOx**

CO Emissions:

CO (lb/hr) = 25 ppmv avg **X** 99,156 lbmole/hr X 28 lbs/lbmole / 1,000,000 lbs/ppm = **69 lbs/hr - CO**

SO2 Emissions:

SO2 (lb/hr) = 1,100 MMBtu/hr **X** 0.12 #/MMBtu = **132 lbs/hr - SO2**

PM Filterable Emissions:

PM_{fil} (lb/hr) = 21 lb/hr = **21 lbs/hr - PM_{fil}**

PM Total Emissions:

PM_{tot} (lb/hr) = 35 lb/hr = **35 lbs/hr - PM_{tot}**

VOC Emissions:

VOC (lb/hr) = 1.4 ppmv avg **X** 103,395 lbmole/hr X 16 lbs/lbmole / 1,000,000 lbs/ppm = **2 lbs/hr - VOC (as methane)**

NH3 Emissions:

NH3 (lb/hr) = 5 ppmdv @ 15 % avg **X** 132,418 lbmole/hr X 17 lbs/lbmole / 1,000,000 lbs/ppm = **11 lbs/hr - NH3**