Middletown Cogeneration Facility Emission Calculations

Emission Point:	**B001 and B002**
Operating Scenario	**MWERF-2**
Description:	**Boilers Routine Emissions**

		Maximum	Expected	
Physical Characteristics:	Height of Stack above grade =		100	ft
	Diameter of Stack =		7.34	ft
Inputs shaded in Green	Stack Gas Exit Temperature =		300	F
	Operating Schedule =		8,760	hours/year (assume 100% though expected is 91.4%)
	Percent Natural Gas			Approximately 5 %
	Boilers		2	Units
	Rating, BFG EACH Unit	333.2		MMBtu/hr HHV - dry
	Natural Gas assist	18.1		MMBtu/hr HHV - dry
	Combined	351.3		From AP email - 3/9/2010
	Rating, NG EACH	370.0		MMBtu/hr HHV
	Both Units - NG	740.0	18	MMBtu/hr HHV - dry
	Both Units BFG	666.4	350	MMBtu/hr HHV - dry

Emission data:	Firing rate =	703	368	MMBtu/hr HHV dry	TOTAL
	BFG Fired =	666	350	MMBtu/hr HHV dry	BFG only
	BFG Heat Value =	127	127	Btu/SCF HHV dry	BFG only
	Heat Value =	168	168	Btu/SCF HHV wet	BFG at 117 (wet) and Nat Gas at 1019
Inputs shaded in Green	NOx Average Emission Factor =	0.100	0.100	lb/MMBtu HHV dry	Ohio RACT
	CO Average Emission Factor =	0.110	0.110	lb/MMBtu HHV dry	APCI Assessment of Vendor Quotes
	SOX Average Emission Factor =	0.120	0.120	lb/MMBtu HHV dry	Assumes 100 ppmvd S in BFG
	PM Filterable Average Emission Factor =	0.015	0.015	lb/MMBtu HHV dry	APCI Assessment of Vendor Quotes
	PM Total Average Emission Factor =	0.033	0.033	lb/MMBtu HHV	APCI Assessment of Vendor Quotes (Filterable & Condensable)
	VOC Average Emission Factor =	0.0050	0.0050	lb/MMBtu HHV dry	AP Estimate
	CO2 Emission Factor for BFG =	274.32	274.32	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	CH4 Emission Factor for BFG =	0.000022	0.000022	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	N2O Emission Factor for BFG =	0.0001	0.0001	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	CO2 Emission Factor for Nat Gas =	53.02	53.02	kg/MMBtu	GHG Reporting Rule for Nat Gas Combustion
	CH4 Emission Factor for Nat Gas =	0.0010	0.0010	kg/MMBtu	GHG Reporting Rule for Nat Gas Combustion
	N2O Emission Factor for Nat Gas =	0.00010	0.00010	kg/MMBtu	GHG Reporting Rule for Nat Gas 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

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) =	0.100	lb/MMBtu	**X**	368	MMBtu/hr	**X**	8,760	hrs/yr / 2,000 lbs/ton =	**161**	**tpy - NOx**
NOx (lb/hr) =	0.100	lb/MMBtu	**X**	368	MMBtu/hr	**=**			**37**	**lbs/hr - NOx**

CO Emissions:

CO (tpy) =	0.110	lb/MMBtu	**X**	368	MMBtu/hr	**X**	8,760	hrs/yr / 2,000 lbs/ton =	**177**	**tpy - CO**
CO (lb/hr) =	0.110	lb/MMBtu	**X**	368	MMBtu/hr	**=**			**40**	**lbs/hr - CO**

SO2 Emissions:

BFG

SO2 (tpy) =	42	lbs SO2/hr		8760	hrs/yr	***/***	2,000	lbs/ton =	**184**	**tpy - SO2 BFG**
SO2 (lb/hr) =	350	MMBtu/hr	**X**	0.120	#/MMBtu	=			**42**	**lbs/hr - SO2 BFG**

Nat Gas

SO2 (tpy) =	0.01	lbs SO2/hr		8760	hrs/yr	***/***	2,000	lbs/ton =	**0.05**	**tpy - SO2 Nat Gas**
SO2 (lb/hr) =	18	MMBtu/hr BFG	**X**	0.6	#/MMSCF	/	1,019	Btu/SCF =	**0.01**	**lbs/hr - SO2 Nat Gas**

PM Filterable Emissions:

PM_{fil} (tpy) =	0.0150	lb/MMBtu	**X**	368	MMBtu/hr	**X**	8,760	hrs/yr / 2,000 lbs/ton =	**24.1**	**tpy - PM_{fil}**
PM_{fil} (lb/hr) =	0.0150	lb/MMBtu	**X**	368	MMBtu/hr	**=**			**5.5**	**lbs/hr - PM_{fil}**

PM Total Emissions:

PM_{tot} (tpy) =	0.0330	lb/MMBtu	**X**	368	MMBtu/hr	**X**	8,760	hrs/yr / 2,000 lbs/ton =	**53.1**	**tpy - PM_{tot}**
PM_{tot} (lb/hr) =	0.0330	lb/MMBtu	**X**	368	MMBtu/hr	**=**			**12.1**	**lbs/hr - PM_{tot}**

VOC Emissions:

VOC (tpy) =	0.0050	lb/MMBtu	**X**	368	MMBtu/hr	**X**	8,760	hrs/yr / 2,000 lbs/ton =	**8.0**	**tpy - VOC (as methane)**
VOC (lb/hr) =	0.0050	lb/MMBtu	**X**	368	MMBtu/hr	**=**			**1.8**	**lbs/hr - VOC (as methane)**

CO2 Emissions:

BFG CO2 (tpy) =	350	MMBtu/hr	**X**	274.32	kg/MMBtu	**X**	1	Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2	**926,854**	**CO2 (tpy)**
BFG CH4 (tpy) =	350	MMBtu/hr	**X**	0.000022	kg/MMBtu	**X**	21	Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2	**-**	**CH4 (tpy)**
BFG N2O (tpy) =	350	MMBtu/hr	**X**	0.0001	kg/MMBtu	**X**	310	Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2	**-**	**N2) (tpy)**
Nat Gas CO2 (tpy) =	18	MMBtu/hr	**X**	53.02	kg/MMBtu	**X**	1	Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2	**-**	**CO2 (tpy)**
Nat Gas CH4 (tpy) =	18	MMBtu/hr	**X**	0.001	kg/MMBtu	**X**	21	Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2	**-**	**CH4 (tpy)**
Nat Gas N2O (tpy) =	18	MMBtu/hr	**X**	0.0001	kg/MMBtu	**X**	310	Global Warming Potential **X** 2.204 lb/kg **X** 8760 **/** 2	**-**	**N2) (tpy)**

CO2e (tpy) = BFG + Nat Gas (CO2 + CH4 + N2O) = **926,854 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) =	0.10	lb/MMBtu	**X**	703	MMBtu/hr =	**70.3**	**lbs/hr - NOx**

CO Emissions:

CO (lb/hr) =	0.110	lb/MMBtu	**X**	703	MMBtu/hr =	**77.3**	**lbs/hr - CO**

SO2 Emissions:

SO2 (lb/hr) =	666	MMBtu/hr	**X**	0.120	#/MMBtu =	**80**	**lbs/hr - SO2 (ignores Nat Gas contribution)**
						350.2	ton/yr

PM Filterable Emissions:

PM_{fil} (lb/hr) =	0.0150	lb/MMBtu	**X**	703	MMBtu/hr =	**10.5**	**lbs/hr - PM_{fil}**

PM Total Emissions:

PM_{tot} (lb/hr) =	0.0330	lb/MMBtu	**X**	703	MMBtu/hr =	**23.2**	**lbs/hr - PM_{tot}**

VOC Emissions:

VOC (lb/hr) =	0.005	lb/MMBtu	**X**	703	MMBtu/hr =	**3.5**	**lbs/hr - VOC (as methane)**