Middletown Cogeneration Emission Calculations

Emission Point:	**B001 and B002**
Operating Scenario	**MWERF2-MSS-1**
Description:	**Combined Boiler Emissions when Gas Turbine/HRSG is Down**

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 =	500	hours/year (typically 310)	
Emission data:	Additional BFG Firing rate =	666	MMBtu/hr (HHV)	BFG
	Additional Nat Gas Firing rate =	36	MMBtu/hr (HHV)	Nat Gas supplement
	Total Additional Firing Rate =	703	MMBtu/hr (HHV)	Maximum Rate for Boilers
	BFG Heat Content =	127	Btu/dscf HHV	
Inputs shaded in Green	NOx Average Emission Factor =	0.100	lb/MMBtu	Ohio RACT
	CO Average Emission Factor =	0.110	lb/MMBtu	Vendor Guarantee
	SOX Average Emission Factor =	0.120	lb/MMBtu HHV dry	Assumes 100 ppm S in BFG & ignores Nat Gas dilution
	PM Filterable Average Emission Factor =	0.0150	lb/MMBtu	Vendor Guarantee
	PM Total Average Emission Factor =	0.033	lb/MMBtu	Filterable & Condensable (Assume twice Filterable Guarantee)
	VOC Average Emission Factor =	0.0050	lb/MMBtu	Higdon Estimate
	CO2 Emission Factor for BFG =	274.32	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	CH4 Emission Factor for BFG =	0.000022	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	N2O Emission Factor for BFG =	0.0001	kg/MMBtu	GHG Reporting Rule for BFG Combustion
	CO2 Emission Factor for Nat Gas =	53.02	kg/MMBtu	GHG Reporting Rule for Nat Gas Combustion
	CH4 Emission Factor for Nat Gas =	0.0010	kg/MMBtu	GHG Reporting Rule for Nat Gas Combustion
	N2O Emission Factor for Nat Gas =	0.00010	kg/MMBtu	GHG Reporting Rule for Nat Gas Combustion
	CO2 Global Warming Potential =	1		GHG Reporting Rule
	CH4 Global Warming Potential =	21		GHG Reporting Rule
	N2O Global Warming Potential =	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**	703	MMBtu/hr	**X**	500 hrs/yr / 2,000 lbs/ton =	**18**	**tpy - NOx**
NOx (lb/hr) =	0.100	lb/MMBtu	**X**	703	MMBtu/hr	**=**		**70**	**lbs/hr - NOx**

CO Emissions:

CO (tpy) =	0.110	lb/MMBtu	**X**	703	MMBtu/hr	**X**	500 hrs/yr / 2,000 lbs/ton =	**19**	**tpy - CO**
CO (lb/hr) =	0.110	lb/MMBtu	**X**	703	MMBtu/hr	**=**		**77**	**lbs/hr - CO**

SO2 Emissions:

BFG

SO2 (tpy) =	80	lb/hr	**X**				500 hrs/yr / 2,000 lbs/ton =	**20**	**tpy - SO2 BFG**
SO2 (lb/hr) =	666	MMBtu/hr	**X**	0.120	#/MMBtu	=		**80**	**lbs/hr - SO2 BFG**

Nat Gas

SO2 (tpy) =	0.02	lbs SO2/hr	**X**				703 hrs/yr / 2,000 lbs/ton =	**0.007**	**tpy - SO2 Nat Gas**
SO2 (lb/hr) =	36	MMBtu/hr BFG	**X**	0.6	#/MMSCF	/	1,019 Btu/SCF =	**0.021**	**lbs/hr - SO2 Nat Gas**

PM Filterable Emissions:

PM_{fil} (tpy) =	0.0150	lb/MMBtu	**X**	703	MMBtu/hr	**X**	500 hrs/yr / 2,000 lbs/ton =	**2.6**	**tpy - PM_{fil}**
PM_{fil} (lb/hr) =	0.0150	lb/MMBtu	**X**	703	MMBtu/hr	**=**		**10.5**	**lbs/hr - PM_{fil}**

PM Total Emissions:

PM_{tot} (tpy) =	0.0330	lb/MMBtu	**X**	703	MMBtu/hr	**X**	500 hrs/yr / 2,000 lbs/ton =	**5.8**	**tpy - PM_{tot}**
PM_{tot} (lb/hr) =	0.0330	lb/MMBtu	**X**	703	MMBtu/hr	**=**		**23.2**	**lbs/hr - PM_{tot}**

VOC Emissions:

VOC (tpy) =	0.0050	lb/MMBtu	**X**	703	MMBtu/hr	**X**	500 hrs/yr / 2,000 lbs/ton =	**0.9**	**tpy - VOC (as methane)**
VOC (lb/hr) =	0.0050	lb/MMBtu	**X**	703	MMBtu/hr	**=**		**3.5**	**lbs/hr - VOC (as methane)**

CO2 Emissions:

BFG CO2 (tpy) =	666	MMBtu/hr	**X**	274.32	kg/MMBtu	**X**	1 Global Warming Potential **X** 2.204 lb/kg **X** 500 **/** 2000 =	**100,727**	**CO2 (tpy)**
BFG CH4 (tpy) =	666	MMBtu/hr	**X**	0.000022	kg/MMBtu	**X**	21 Global Warming Potential **X** 2.204 lb/kg **X** 500 **/** 2000 =	**0.17**	**CH4 (tpy)**
BFG N2O (tpy) =	666	MMBtu/hr	**X**	0.0001	kg/MMBtu	**X**	310 Global Warming Potential **X** 2.204 lb/kg **X** 500 **/** 2000 =	**11.4**	**N2) (tpy)**
Nat Gas CO2 (tpy) =	36	MMBtu/hr	**X**	53.02	kg/MMBtu	**X**	1 Global Warming Potential **X** 2.204 lb/kg **X** 500 **/** 2000 =	**1,058**	**CO2 (tpy)**
Nat Gas CH4 (tpy) =	36	MMBtu/hr	**X**	0.001	kg/MMBtu	**X**	21 Global Warming Potential **X** 2.204 lb/kg **X** 500 **/** 2000 =	**0.42**	**CH4 (tpy)**
Nat Gas N2O (tpy) =	36	MMBtu/hr	**X**	0.0001	kg/MMBtu	**X**	310 Global Warming Potential **X** 2.204 lb/kg **X** 500 **/** 2000 =	**0.6**	**N2) (tpy)**

CO2e (tpy) = BFG + Nat Gas (CO2 + CH4 + N2O) = **101,797 CO2e (tpy)**