B-1 Combustion Turbine/Duct Burner Emissions Calculations - Unit 10 (VIC10)

EPN:	VIC10

Turbine:	GE 7FA

Specifications

Parameter		Value	Unit
Fuel Type : Natural Gas			
		1,024	Btu/scf
Annual Average Firing Rate:	Turbine	1,816	mmBtu/hr (HHV)
	Duct Burners	483	mmBtu/hr (HHV)
	Factor Basis	**Emission Factor**	
CO2 Emission Factor	Part 75 App G	118.9	lb/mmBtu
CH4 Emission Factor	Part 98, App C	0.001	kg/mmBtu
N2O Emission Factor	Part 98, App C	0.0001	kg/mmBtu
Operating Hours	Turbine Full Load	7,760	hr/yr
	Duct Burners	4,375	hr/yr
	MSS	1,000	hr/yr

Note: All mmBtu values are HHV

Emission Rates

Pollutant	tpy	GWP* Factor	CO_2e tpy
Full Load			
CO2	962,956	1	962,956
CH4	18	25	447
N20	2	298	532
Total CO2e	N/A	N/A	**963,935**
MSS			
CO2	107,924	1	107,924
CH4	5	25	135
N20	0.2	298	60
Total CO2e	N/A	N/A	**108,118**
Total VIC10			
CO2	1,070,879	1	1,070,879
CH4	23	25	581
N20	2	298	592
Total CO2e	N/A	N/A	**1,072,053**

* Table A -1 to Subpart A of Part 98--Global Warming Potentials

Sample Calculations:

CO2 emission factor calculated from constants in Section 2.3 of Appendix G to 40 CFR Part 75 as follows:

CO2 (lb/mmBtu) = 1040 scf/mmbtu x 1 mole/385 scf x 44 lb CO2/mole = 118.9 lb/mmBtu

CO2 (Full Load) = (1,816 mmBtu/hr * 7,760 hr/yr + 483 mmBtu/hr * 4,375 hr/yr) * 118.9 lb/mmBtu * 1ton/2000lb = 962,956 tpy

CO2 (MSS) = 1,816 mmBtu/hr * 1,000 hr/yr * 118.9 lb/mmBtu * 1ton/2000lb = 107,924 tpy

CO2 (Total) = 962,956 tpy + 107,924 tpy = 1,070,879 tpy

CH4 (Full Load) = (1,816 mmBtu/hr * 7,760 hr/yr + 483 mmBtu/hr * 4,375 hr/yr) * 0.001 kg/mmBtu * 1000g/kg * 1lb/453.6g * 1ton/2000lb = 18 tpy

CH4 (MSS) = 3.4 tpy + (1,816 mmBtu/hr * 1,000 hr/yr * 0.001 kg/mmBtu * 1000g/kg * 1lb/453.6g * 1ton/2000lb) = 5 tpy (includes shutdown and maintenance purging)

CH4 (Total) = 18 tpy + 5 tpy = 23 tpy

N2O (Full Load) = (1,816 mmBtu/hr * 7,760 hr/yr + 483 mmBtu/hr * 4,375 hr/yr) * 0.0001 kg/mmBtu * 1000g/kg * 1lb/453.6g * 1ton/2000lb = 2 tpy

N2O (MSS) = 1,816.0 mmBtu/hr * 1,000 hr/yr * 0.0001 kg/mmBtu * 1000g/kg * 1lb/453.6g * 1ton/2000lb = 0.2 tpy

N2O (Total) = 2 tpy + 0.2 tpy = 2 tpy

Total CO2e = 1,070,879 tpy * 1 + 23 tpy * 25 + 2 tpy * 298 = 1,072,053 tpy

Summary of CH_4 Purging Emissions

Purging Event	GHG Annual Emission Rate (tpy)	CO_2e Annual Emission Rate (tpy)
Shutdown CH_4 Purging (1)	2.9	73.0
Maintenance CH_4 Purging (2)	0.5	11.6
Total	**3.4**	**84.6**

Notes:

(1) Shutdown process requires limited amounts of CH_4 to be purged via an automatic double block and bleed valve at the CTG and DB System

(2) Prior to any maintenance event at the CT, the CT and DB lines are vented to the atmosphere, and consequently CH_4 is released.

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Turbine:	GE 7FA

Shutdown CH_4 Purging

Vented System	Volume Purged (cf/event) (1)	Operating Pressure (psig)	Operating Temperature (Degrees F)	Volume Purged (scf/event) (2)	CH_4 Vented (lb/event) (3)	No. Shutdowns (events/yr) (4)	Global Warming Potential (5)	GHG Annual Emission Rate (tpy) (6)	CO_2e Annual Emission Rate (tpy) (7)
Combustion Turbine	4.36	425.00	100.00	121.33	5.13	305	25	0.78	19.56
Duct Burner	58.65	30.00	100.00	165.82	7.01	610	25	2.14	53.46

Notes:

(1) Per physical piping measurements of the CTG Main/Pilot Gas Headers and John Zink isometric drawing of the duct burners system

(2) $Volume_{stand\ cond}$ (scf/event) = $Volume_{operating\ cond}$ (cf/event) * $P_{operating\ cond}$ (psia) / 14.67 psia * 519.67 R / $T_{operating\ cond}$ (R)

(3) CH_4 Vented (lb/event) = Volume (scf/event) * 1/Standard Molar Volume (scf/lbmole) * MW_{CH4} (lb/lbmole)

Standard Molar Volume = 379 scf/lbmole

CH_4 Molecular Weight = 16.0 lb/lbmole

(4) Maximum number of shutdowns requested to be authorized.

(5) Global Warming Potential per 40 CFR Part 98, Table A-1 to Subpart A.

(6) GHG Annual Emission Rate (tpy) = CH4 Vented (lb/event) * No. Shutdowns (events/yr) * 1 ton/2,000 lb

GHG Annual Emission Rate for CT = 5.13 lb/event * 305 events/yr * 1 ton / 2,000 lb = 0.78 tpy

(7) CO_2e Annual Emission Rate = GHG Annual Emission Rate (tpy) * Global Warming Potential

CO2e Annual Emission Rate for CT = 0.78 tpy * 25 = 19.56 tpy

Maintenance CH_4 Purging

Vented System	Volume Purged (scf/event) (1)	CH_4 Vented (lb/event) (2)	No. Maintenance Events (events/yr) (3)	Global Warming Potential (4)	GHG Annual Emission Rate (tpy) (5)	CO_2e Annual Emission Rate (tpy) (6)
Combustion Turbine	4,206.96	177.86	5	25	0.44	11.12
Duct Burner	441.47	18.66	2	25	0.02	0.47

Notes:

(1) Process engineering knowledge

(2) CH_4 Vented (lb/event) = Volume (scf/event) * 1/Standard Molar Volume (scf/lbmole) * MW_{CH4} (lb/lbmole)

Standard Molar Volume = 379 scf/lbmole

CH_4 Molecular Weight = 16.0 lb/lbmole

(3) Maximum expected maintenance events per year

(4) Global Warming Potential per 40 CFR Part 98, Table A-1 to Subpart A.

(5) GHG Annual Emission Rate (tpy) = CH4 Vented (lb/event) * No. Shutdowns (events/yr) * 1 ton/2,000 lb

GHG Annual Emission Rate for CT = 177.86 lb/event * 5 events/yr * 1 ton / 2,000 lb = 0.44 tpy

(6) CO_2e Annual Emission Rate = GHG Annual Emission Rate (tpy) * Global Warming Potential

CO2e Annual Emission Rate for CT = 0.44 tpy * 25 = 11.12 tpy