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Trinity Consultants

March 19, 2014

Mr. Randy Hamilton
Texas Commission on Environmental Quality
Air Permits Division
12100 Park 35 Circle, Mail Code 163
Building C, Third Floor
Austin, TX 78753

RE: Revisions to GHG PSD Permit Application
Tenaska Brownsville Partners, LLC – Tenaska Brownsville Generating Station
TCEQ Permit No. 108411, PSDTX1350
RN106579600, CN604252627

Dear Mr. Hamilton:

Tenaska Brownsville Partners, LLC (Tenaska) is proposing to construct the Tenaska Brownsville Generating Station (TBGS), a combined cycle electric power generation facility located on a 263-acre greenfield tract of land situated in Cameron County, Texas, inside the City of Brownsville, TX. Tenaska submitted a Prevention of Significant Deterioration (PSD) permit application for greenhouse gases to the U.S. Environmental Protection Agency (EPA) on February 14, 2013. Since submitting the application, Tenaska has elected to modify the design of the plant with the following changes:

- The turbine configuration will now incorporate de-superheaters which will allow for decreased startup and shutdown (SUSD) duration.
- The gas-fired dew point heater represented in the original application will be replaced with an electric heater, and will consequently have no emissions.
- Aqueous Ammonia will be used at the TBGS in place of Anhydrous Ammonia for the Selective Catalytic Reduction system.

In addition to the design changes mentioned above, the global warming potentials (GWPs) used to calculate carbon dioxide equivalent (CO_2e) emissions, as well as the emission factor for carbon dioxide (CO_2) have been revised per Federal Register 71948, Vol. 78, No. 230, dated November 29, 2013.

With the enclosure, Tenaska is submitting revisions to the application to reflect these changes. As only portions of the application were affected by the updates, only the following revised portions of the application are included in this submittal:

- Section 1: Executive Summary
  - Table 1.2-1
- Section 7: Emissions Data
  - Table 7-1
- Section 8: Emission Point Summary (TCEQ Table (A))
- Section 9: Federal Regulatory Requirements
  - Table 9.1-1
- Section 10: Best Available Control Technology
  - Table 10.1 Proposed GHG BACT Limits for the Brownsville Generating Station

    - Section 10.5.2.3: Selection of Efficient CCCT
- Appendix A: GHG Emission Calculations

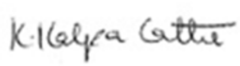
Additionally, please note the following changes which apply throughout the application but are not included in the enclosed revisions:

- Removal of the fuel gas heater
- Replacement of anhydrous ammonia with aqueous ammonia
- The overall CO2e limit for the turbines in normal operating mode is now proposed to be 1,584,989 tpy
- GWP values stated in the application should be revised as follows:
    - Methane (CH_4): 25
    - Nitrous Oxide (N_2O): 298
    - Sulfur Hexafluoride (SF_6): 22,800

If you have any questions regarding these updates to the application or the original application, please feel free to contact me at (972) 661-8100 or Mr. Larry Carlson (Tenaska) at (402) 938-1661.

Sincerely,

TRINITY CONSULTANTS



Latha Kambham
Senior Consultant

cc: Mr. Jeff Robinson, USEPA Region 6
Ms. Jaime A. Garza, TCEQ Region 15
Mr. Larry Carlson, Tenaska
Mr. Paul Greywall, Trinity Consultants

Enclosure

Table 1.2-1. Brownsville Generating Station- Proposed Project GHG Emissions

EPN	Emission Point Description	GHG Emission Rates (short tons per year)				
		CO_2	CH_4	N_2O	SF_6	Total CO_2e
1	Combustion Turbine 1/ Duct Burner (Normal Operations)	1,570,399.36	105.57	40.10	-	1,584,988.36
2	Combustion Turbine 2/ Duct Burner (Normal Operations)	1,570,399.36	105.57	40.10	-	1,584,988.36
4	Fire Pump Engine	31.20	1.27E-03	2.52E-04	-	31.31
5	Emergency Generator	155.10	6.29E-03	1.26E-03	-	155.63
7	Auxiliary Boiler	23,056.00	0.43	0.04	-	23,079.86
12	Fugitive SF_6 Circuit Breaker Emissions	-	-	-	0.005	116.68
12	Components Fugitive Leak Emissions	-	1.02	-	-	25.41
1 and 2	CCCT MSS Emissions		8,544.00	-	-	213,600.00
	Total (1 on 1 Scenario)	**1,593,641.66**	**4,379.02**	**40.14**	**0.005**	**1,715,197.25**
	Total (2 on 1 Scenario)	**3,164,041.02**	**8,756.59**	**80.24**	**0.005**	**3,406,985.61**

1.3. PERMIT APPLICATION

All required supporting documentation for the permit application is provided in the following sections. The TCEQ Form PI-1 is included in Section 2 and a TCEQ Core Data form is found in Section 3 of this application. An area map indicating the site location and a plot plan identifying the location of various emission units at the site are included in Sections 4 and 5 of the report, respectively. A project description and process flow diagram are presented in Section 6. A summary of the emission calculations and the TCEQ Table 1(a) can be found in Sections 7 and 8 of this application.

Detailed federal regulatory requirements are provided in Section 9 and discussions of Best Available Control Technology (BACT) are provided in Section 10.

This section summarizes the GHG emission calculation methodologies and provides emission calculations for the emission sources of GHGs at the proposed Brownsville Generating Station. Detailed emission calculation spreadsheets, including example calculations, are included in Appendix B. These emission estimates reflect the emission limits and controls proposed as BACT in Section 10.

Potential GHG emissions from the proposed project will result from the following emission units:

- Combustion Turbines, Duct Burners and SUSD emissions (EPNs: 1 and 2);
- One Diesel Fire Pump Engine (EPN: 4);
- One Emergency Generator (EPN: 5);
- One Auxiliary Boiler (EPN: 7);
- Fugitive Emissions from Fuel Piping Components and SF_6 Circuit Breaker Fugitive Emissions (EPN: FUG_GHG)

Table 7-1 provides a summary of the annual potential to emit emissions of GHGs for the proposed project.

Table 7-1. Proposed Project Potential GHG Emissions

		GHG Emission Rates (short tons per year)				
EPN	**Emission Point Description**	**CO_2**	**CH_4**	**N_2O**	**SF_6**	**Total CO_2e**
1	Combustion Turbine 1/ Duct Burner (Normal Operations)	1,570,399.36	105.57	40.10	-	1,584,988.36
2	Combustion Turbine 2/ Duct Burner (Normal Operations)	1,570,399.36	105.57	40.10	-	1,584,988.36
4	Fire Pump Engine	31.20	1.27E-03	2.52E-04	-	31.31
5	Emergency Generator	155.10	6.29E-03	1.26E-03	-	155.63
7	Auxiliary Boiler	23,056.00	0.43	0.04	-	23,079.86
12	Fugitive SF_6 Circuit Breaker Emissions	-	-	-	0.005	116.68
12	Components Fugitive Leak Emissions	-	1.02	-	-	25.41
1 and 2	CCCT MSS Emissions		8,544.00	-	-	213,600.00
	Total (1 on 1 Scenario)	**1,593,641.66**	**4,379.02**	**40.14**	**0.005**	**1,715,197.25**
	Total (2 on 1 Scenario)	**3,164,041.02**	**8,756.59**	**80.24**	**0.005**	**3,406,985.61**

GHG emissions for the CCCTs (for both normal and MSS operations), were based on emission levels proposed as BACT and equipment specifications provided by the equipment manufacturer. For all other combustion sources, the GHG emissions for each emission unit were based on emission levels and controls proposed as BACT, proposed equipment

8. EMISSION POINT SUMMARY (TCEQ TABLE 1(A))

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Table 1(a) Emission Point Summary

Date:	**Revised March 2014**	**Permit No.:**	**108411**
Regulated Entity No.:	**106579600**		
Area Name:	**Tenaska Brownsville Generating Station**	**Customer Reference No.:**	**604252627**

Review of applications and issuance of permits will be expedited by supplying all necessary information requested on this Table.

AIR CONTAMINANT DATA					
1. Emission Point			**2. Component or Air Contaminant Name**	**3. Air Contaminant Emission Rate**	
(A) EPN	**(B) FIN**	**(C) NAME**		**(A) Pound Per Hour**	**(B) TPY**
1	1	Combustion Turbine 1/Duct Burner	CH_4 (Normal Operations)	25.70	4,377.57
			CH_4 (MSS Operations)[1]	See Note 1	
			N_2O	9.46	40.10
			CO_2	370,435.00	1,570,399.36
			CO_2e (Normal operations)	373,896.58	1,691,788.36
			CO_2e (MSS operations)	See Note 1	
2	2	Combustion Turbine 2/Duct Burner	CH_4 (Normal Operations)	25.70	4,377.57
			CH_4 (MSS Operations)[1]	See Note 1	
			N_2O	9.46	40.10
			CO_2	370,435.00	1,570,399.36
			CO_2e (Normal operations)	373,896.58	1,691,788.36
			CO_2e (MSS operations)	See Note 1	
4	4	Fire Pump Engine	CH_4	0.03	<0.01
			N_2O	0.01	<0.01
			CO_2	623.24	31.20
			CO_2e	626.97	31.31
5	5	Emergency Generator	CH_4	0.13	0.01
			N_2O	0.03	<0.01
			CO_2	3,102.97	155.10
			CO_2e	3,115.16	155.63

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Table 1(a) Emission Point Summary

Date:	Revised March 2014	Permit No.:	108411	Regulated Entity No.:	106579600
Area Name:	Tenaska Brownsville Generating Station			Customer Reference No.:	604252627

Review of applications and issuance of permits will be expedited by supplying all necessary information requested on this Table.

AIR CONTAMINANT DATA					
1. Emission Point			2. Component or Air Contaminant Name	3. Air Contaminant Emission Rate	
(A) EPN	(B) FIN	(C) NAME		(A) Pound Per Hour	(B) TPY
7	7	Auxiliary Boiler	CH_4	0.20	0.43
			N_2O	0.02	0.04
			CO_2	10,527.85	23,056.00
			CO_2e	10,538.81	23,079.86
FUG_GHG	FUG_GHG	Fugitive Emissions - GHGs	SF_6 (from circuit breakers)	<0.01	0.005
			CO_2e (from circuit breakers)	26.64	116.68
			CH_4 (from fuel piping components)	0.23	1.02
			CO_2e (from fuel piping components)	5.80	25.41

EPN = Emission Point Number
FIN = Facility Identification Number

[1] **Unburned CH_4 emisions during MSS operations are provided for the annual emission limits.**

Table 9.1-1. Proposed Potential Emissions Compared with PSD Thresholds and PSD SERs

PSD Applicability Summary (1 on 1 Scenario)

	CO	**NO_x**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**VOC**	**H_2SO_4 Mist**	**CO_2e**
Site-wide Emissions (tpy)	1,146	164	100	39	35	9	432	7.2	1,715,197
PSD Major Source Threshold (tpy)	100	100	100	100	100	100	100	100	100,000
Is the site above PSD limits?	**YES**	**YES**	NO	NO	NO	NO	**YES**	NO	**YES**
Significant Emission Rates (SER) (tpy)	100	40	25	15	10	40	40	7	75,000
Is the site above SER?	**YES**	**YES**	**YES**	**YES**	**YES**	NO	**YES**	**YES**	**YES**

PSD Applicability Summary (2 on 1 Scenario)

	CO	**NO_x**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**VOC**	**H_2SO_4 Mist**	**CO_2e**
Site-wide Emissions (tpy)	2,275	325	134	73	69	19	863	14	3,406,986
PSD Major Source Threshold (tpy)	100	100	100	100	100	100	100	100	100,000
Is the site above PSD limits?	**YES**	**YES**	NO	NO	NO	NO	**YES**	NO	**YES**
Significant Emission Rates (SER) (tpy)	100	40	25	15	10	40	40	7	75,000
Is the site above SER?	**YES**	**YES**	**YES**	**YES**	**YES**	NO	**YES**	**YES**	**YES**

1. PSD and Title V Permitting Guidance For Greenhouse Gases (hereafter referred to as General GHG Permitting Guidance)[22]
2. Report of the Interagency Task Force on Carbon Capture & Storage (hereafter referred to as CCS Task Force Report)[23]

10.4. GHG BACT EVALUATION FOR PROPOSED EMISSION SOURCES

The following is an analysis of BACT for the control of GHG emissions from the proposed Brownsville Generating Station following the EPA's five-step "top-down" BACT process. Tenaska is proposing the use of good combustion, operating and maintenance practices together with other BACT controls described below for all the stationary combustion sources at the proposed facility.

Table 10.1 provides a summary of the proposed BACT limits discussed in the following sections.

Table 10.1. Proposed GHG BACT Limits for the Brownsville Generating Station

EPN	Description	Proposed BACT Limit[a] (CO_2e tpy)	Proposed BACT Limit[b] (lbs of CO_2/MW-hr$_{gross}$)
1	Combustion Turbine 1/ Duct Burner (Normal Operations)	1,584,989	914
2	Combustion Turbine 2/ Duct Burner (Normal Operations)	1,584,989	914
4	Fire Pump Engine	Work Practice Standards	
5	Emergency Generator	Work Practice Standards	
7	Auxiliary Boiler	23,080	
1 and 2	MSS Operations for CCCTs	Work Practice Standards	
FUG_GHG	Fugitive emissions from equipment leaks	Work Practice Standards	

[a] The BACT limits are represented in short tons

[b] The BACT limits are represented at ISO conditions (Standard pressure at 14.696 psia and temperature at 60 degree F), at base load, and at plant elevation.

A detailed BACT analysis is conducted for the two combustion turbines, MSS emissions from the combustion turbines, the fire water pump, emergency generator, auxiliary boiler, fugitive emissions from fuel piping components, and the circuit breaker equipment leaks.

10.5. COMBUSTION TURBINES

GHG emissions from the proposed combustion turbines consist of CO_2, CH_4, and N_2O and result from the combustion of natural gas. The following section presents a GHG BACT evaluation for the proposed CCCTs.

[22] U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Research Triangle Park, NC: March 2011). http://www.epa.gov/nsr/ghgdocs/ghgpermittingguidance.pdf

[23] Report of the Interagency Task Force on Carbon Capture & Storage, August 2010, http://www.epa.gov/climatechange/downloads/CCS-Task-Force-Report-2010.pdf

leftover water droplets, and is then directed into the compressor inlet. Cooling the combustion air increases the density and, therefore, results in a higher mass-flow rate and pressure ratio, resulting in increased turbine output and efficiency. The two CCCTs will employ evaporative cooling when ambient temperatures are high enough to render it effective.

10.5.2.3. Selection of Efficient CCCT

Tenaska conducted a comprehensive evaluation of the available CCCTs that could be installed at the proposed Brownsville Generating Station while remaining consistent with the project definition. Several advanced heavy duty frame type combustion turbine technologies were considered and evaluated such as General Electric's 7FA.05, Siemens SGT6-5000F5ee, Siemens SGT6-8000H, Mitsubishi 501GAC, Mitsubishi 501J. Evaluation criteria included plant size, market considerations, heat rate, operating experience, capital and O&M costs, and all-in levelized cost of energy. Each of the aforementioned combustion turbine models were evaluated solely in a combined cycle configuration.

Table 10.2 below includes a comparison of the CCCTs evaluated based on the efficiency of the turbines (e.g., Btu input per kWh output) and net plant output in 2x1 configuration. In general, GHG emissions are proportional to heat rate.

Table 10.2. CCCTs Evaluated

CCCT Description	Combined Cycle Unfired Net Plant Heat Rate (Btu/kW-hr) LHV[38]	Net Plant Output 2x1 Configuration
MHI 501GAC	5,744	810.7
Siemens SGT6-5000F	5,970	620.0
GE 7FA.05	5,831	647.8
Siemens SGT6-8000H	5,691	822.0
MHI 501J	5,531	942.9

As shown in Table 10.2, the GE 7FA.05 and Siemens SGT6-5000F have significantly lower output rates than the desired nominal plant output and have higher heat rates compared to the other models. The MHI 501J model exceeds the desired nominal 400 MW or 800 MW plant output. Although Table 10.2 indicates the Mitsubishi 501J and Siemens SGT6-8000H exhibit a slightly better net plant design heat rate (approximately 1%), either a single unit or two-unit combined cycle configuration utilizing those turbines exceeds the desired nominal 400 MW or 800 MW plant output. Based on the evaluation criteria above, the Mitsubishi 501GAC was selected as best meeting Tenaska's project scope, since the output for this model is the closest to the desired plant output for normal operations.

In addition, Tenaska proposes to use duct burners to provide additional power during peak demand periods. A detailed project analysis including alternative options considered for the duct burners is provided in Appendix B. As

[38] Gas Turbine World 2012 Performance Specs 28th Ed.; ISO Conditions

shown in this analysis, use of duct burners is the only economically reasonable option to meet Tenaska's project scope.

In order for the Brownsville Generating Station to provide flexible, baseload capacity to "balance" other intermittent generation such as wind it must have the ability to start and stop as dictated by dispatch. Therefore, a conservative approach has been taken with respect to the estimated annual number of startups and shutdowns, by assuming that a total of 356 startups and 356 shutdowns will occur annually. Each SUSD event is expected to take less than 1 hour (approximately 25 minutes). While the number of each type of start is not proposed as a permit limit, nor would that be appropriate, the emissions calculated according to this schedule will be included in the annual permit limits.

The Brownsville Generating Station will primarily be a base loaded, combined cycle plant, as market allows. For this reason, as well as performance and maintenance considerations, the higher-performing standard Mitsubishi 501GAC was selected.

The Brownsville Generating Station will strive to minimize the duration of startup and shutdown events, as these are less efficient modes of operation. In order to minimize the duration of startup events, the Brownsville Generating Station will incorporate de-superheaters to control steam temperatures to levels required for warming the steam turbine and other downstream components. This will allow the combustion turbines to ramp up to 50% load more quickly, similarly to simple cycle turbines. Once the turbine is at 50% load, it will continue to be ramped up to full load at the dispatched rate, according to the length of time since the plant last operated. However, once the turbine has reached 50% load (i.e., minimum load), the emission concentrations will be equivalent to those occurring during normal operation. Therefore, the duration of the steam turbine downtime will not affect the startup scenario from an emissions standpoint.

The proposed auxiliary boiler will be used to facilitate commissioning and pre-commercial operation plant startup activities, as well as post-commercial operation maintenance activities. With the use of de-superheaters as discussed above, use of the auxiliary boiler to warm steam piping, balance plant systems and provide steam for steam turbine seals during startups will be minimized.

10.5.2.4. Fuel Selection

Tenaska proposes the use of pipeline quality natural gas as the sole fuel source for the two CCCTs being proposed as part of this project. Table C-1 of 40 CFR Part 98 shows CO_2 emissions per unit heat input (in terms of kg/MMBtu) for a wide variety of industrial fuel types. As shown in this table, Natural gas has the lowest carbon intensity of any available fuel for the combustion turbines. The proposed combustion turbines will be fired with only pipeline quality natural gas fuel.

APPENDIX A

GHG Emission Calculations

SITE-WIDE EMISSIONS SUMMARY FOR GHG EMISSIONS

Annual Potential GHG Emissions

EPN	Emission Point Description	Pontentual GHG Emissions (short tons per year) CO_2	CH_4	N_2O	SF_6	Total CO_2e [1]
1	Combustion Turbine 1/Duct Burner - Normal Operations	1,570,399.36	105.57	40.10	-	1,584,988.36
1	Combustion Turbine 1/Duct Burner - MSS Operations	-	4,272.00	-	-	106,800.00
2	Combustion Turbine 2/Duct Burner - Normal Operations	1,570,399.36	105.57	40.10	-	1,584,988.36
2	Combustion Turbine 2/Duct Burner - MSS Operations	-	4,272.00	-	-	106,800.00
4	Fire Pump Engine	31.20	1.27E-03	2.52E-04	-	31.31
5	Emergency Generator	155.10	6.29E-03	1.26E-03	-	155.63
7	Auxiliary Boiler	23,056.00	0.43	0.04	-	23,079.86
FUG_GHG	Fugitive SF_6 Circuit Breaker Emissions	-	-	-	0.005	116.68
FUG_GHG	Components Fugitive Leak Emissions	-	1.02	-	-	25.41
	Total GHG Emissions - 1 on 1 Scenario	**1,593,641.66**	**4,379.02**	**40.14**	**0.005**	**1,715,197.25**
	Total GHG Emissions - 2 on 1 Scenario	**3,164,041.02**	**8,756.59**	**80.24**	**0.005**	**3,406,985.61**

[1] Per 40 CFR 98 - Mandatory Greenhouse Gas Reporting, Subpart A, Table A-1 (Federal Register 71948 / Vol. 78, No. 230, November 29, 2013). Total CO_2e emissions are calculated based on the following Global Warming Potentials.

CO_2	1
CH_4	25
N_2O	298
SF_6	22,800

[2] Percent Contribution (%) = Total CO_2e for each EPN (tpy) / Total CO_2e (tpy) * 100

[3] Proposed BACT limits are rounded upto the nearest digit.

GHG EMISSION CALCULATIONS FOR COMBUSTION TURBINES - NORMAL OPERATIONS

FIN: 1 & 2
EPN: 1 & 2
Mitsubishi MHI 501GAC Combustion Turbines in 1x1 or 2x1 Combined-Cycle Configuration

Input Data[1]

Parameter	Value	Units
Annual Hours of Operation per Turbine[1]	8,760	hr/yr
Annual Maximum Hours of Operation w/o Duct Burner[1]	3,560	hr/yr
Annual Maximum Hours of Operation w/ Duct Burner[1]	5,200	hr/yr
Rated Output of Each Combustion Turbine at 20 deg F, Unfired[2]	305	MW
Rated Output for Steam Turbine, 1x1 Fired Configuration[2]	174	MW
Rated Output of 1x1 Combined Cycle Configuration, Fired at 20 ^oF[2]	479	MW
Combustion Turbine Capacity (HHV basis)[2]	2,903	MMBtu/hr/turbine
Duct Burner Capacity (HHV basis)[2]	250	MMBtu/hr
Total Combustion Turbine Capacity (HHV basis, each turbine)[2]	3,153	MMBtu/hr/turbine
Natural Gas High Heat Value, Site-Info (HHV) [2]	1,027	btu/scf
Number of Turbines	2	(for 2 x 1 scenario)

[1] Hours of operation data provided by Mr. Larry Carlson (Tenaska) via email to Ms. Latha Kambham (Trinity Consultants) on October 24, 2012.
[2] Turbine and duct burner capacity and site-specific natural gas HHV are based on MHI 501GAC model data provided by Mr. Larry Carlson (Tenaska) via email to Ms. Latha Kambham (Trinity Consultants) on January 17, 2013, February 5, 2013 and February 11, 2013.

Proposed Hourly and Annual Emissions - GHG Pollutants - Based on Vendor Data

Pollutant	Hourly Emissions per Turbine[1] Without Duct Burner (lb/hr)	Hourly Emissions per Turbine[1] With Duct Burner (lb/hr)	Annual Emissions for 1x1 Scenario[2] (metric tpy)	Annual Emissions for 2x1 Scenario (metric tpy)	Annual Emissions for 1x1 Scenario[3] (short tpy)	Annual Emissions for 2x1 Scenario (short tpy)
CO_2	341,162.00	370,435.00	1,424,656.95	2,849,313.90	1,570,399.36	3,140,798.7
CH_4	21.77	25.70	95.77	191.54	105.57	211.14
N_2O	8.71	9.46	36.38	72.76	40.10	80.20
CO_{2e}	344,301.83	373,896.58	1,437,892.01	2,875,784.02	1,584,988.36	3,169,976.72

[1] Emissions data for combustion turbines provided by Mr. Larry Carlson (Tenaska) via email to Ms. Latha Kambham (Trinity Consultants) on February 5, 2013. Emission data are based on MHI 501 GAC combustion turbine.
[2] Annual emissions are calculated based on the maximum hourly emissions and hours of operation with and without duct burner, as follows:
Annual Emissions (tpy) =
[Hourly Emission Rate w/o Duct Burner (lb/hr) x Hours of Operation w/o Duct Burner (hrs/yr) + Hourly Emission Rate w/ Duct Burner (lb/hr) x Hours of Operation w/ Duct Burner (hrs/yr)] x (1 ton /2,000 lb) x (1 metric ton/1.1023 short ton)

$$\text{Annual Emissions of } CH_4 \text{ (tpy)} = \left(\frac{21.77 \text{ lb}}{\text{hr}} \Big| \frac{3{,}560 \text{ hr}}{\text{yr}} + \frac{25.70 \text{ lb}}{\text{hr}} \Big| \frac{5{,}200 \text{ hr}}{\text{yr}} \right) * \frac{1 \text{ short ton}}{2{,}000 \text{ lb}} * \frac{\text{metric ton}}{1.1023 \text{ short tor}} = 95.77 \text{ tpy}$$

metric ton to short ton 1.1023 short ton/metric ton
Per 40 CFR 98 - Mandatory Greenhouse Gas Reporting, Subpart A, Table A-1 (Federal Register 71948 / Vol. 78, No. 230, November 29, 2013). Total CO_2e emissions are calculated based on the following Global Warming Potentials.

CO_2	1
CH_4	25
N_2O	298

[3] Annual Emissions (short tpy) = Annual Emission (metric tpy) * 1.1023 (short ton/metric ton)
To be consistent with the reporting format in GHG Mandatory Reporting Rule, the emissions rounded as follows: CO_2 - 1 decimal place, CH_4 - 2 decimal places, N_2O - 3 decimal places, and CO_2e - rounded to nearest digit.

GHG CALCULATIONS FOR COMBUSTION TURBINES - STARTUP & SHUTDOWN ACTIVITIES

FINs: 1 & 2
EPNs: 1 & 2

Proposed Startup/Shutdown Events, Duration, and Emissions

Parameter	Value (per CT)	Units
Max Annual Starts Per Unit	356	events/yr
Startup Duration[1]	24	mins/event
Shutdown Duration	25	mins/event
Max. Hourly Emission Rates during Startup [2]		
CH_4	12,000	lb/hr

[1] Information provided by Mr. Larry Carlson (Tenaska) via email to Ms. Latha Kambham (Trinity Consultants) on July 11, 2013.
Startup period is defined as the period from the first fire to the time combustion turbine achieves 50% load.
[2] Emission rates provided by Mr. Larry Carlson (Tenaska) via email to Ms. Latha Kambham (Trinity Consultants) on August 14, 2013.

Proposed SUSD Emissions per Combustion Turbine

Pollutant	Max. Hourly Emissions [1]	Potential Annual Emissions [2,3]	
		1x1 Scenario	2x1 Scenario
	(lb/hr/turbine)	(tpy)	(tpy)
CH_4	12,000	4,272.00	8,544.00
	Annual CO_2e (tpy) [4]	106,800.00	213,600.00

[1] Hourly emissions during a shutdown event are lower than the startup event. However, to be conservative, it is assumed that emission rates from startup and shutdown events are the same.
In addition, it is assumed that only one type of event (i.e., startup or shutdown) will occur in an hour.
[2] Annual emissions are estimated based on the maximum hourly emission rate and the total number of startup and shutdown events per year.
Maximum number of annual shutdowns is assumed to be the same as the number of annual startups.
Annual Emissions (tpy) = Hourly Emission Rate (lb/hr) x (No. of startup events/yr + No. of shutdown events/yr) x (1 ton /2,000 lb)

$$\text{Annual Emissions of } CH_4\text{, per Combustion Turbine (tpy)} = \frac{12{,}000 \text{ lb}}{\text{hr}} \left| \frac{(356 \text{ startups} + 356 \text{ shutdowns})}{\text{yr}} \right| \frac{1 \text{ ton}}{2{,}000 \text{ lb}} = 4{,}272 \text{ tpy}$$

[3] Annual emissions for 2 x1 scenario = 2 * Annual emissions for 1 x 1 scenario

GHG EMISSION CALCULATIONS FOR OTHER COMBUSTION SOURCES

FINs: 4, 5 & 7
EPNs: 4, 5 & 7

Combustion Sources of GHG Emissions

Parameter	Units	Fire Pump Engine	Emergency Generator	Auxiliary Boiler
EPN	-	4	5	7
Rated Capacity (HHV) [1]	MMBtu/hr	3.82	19.03	90
Hours of Operation per Year [2]	hrs/yr	100	100	4,380
Natural Gas Potential Throughput [3]	scf/yr	--	--	383,747,167
Diesel Potential Throughput [4]	gal/yr	2,789.80	13,890.51	--
Natural Gas High Heat Value (HHV) [5]	MMBtu/scf	--	--	1.027E-03
Diesel Fuel High Heat Value (HHV) [6]	MMBtu/gal	0.137	0.137	--

[1] Rated Capacity for ancillary equipment provided by Mr. Larry Carlson (Tenaska) to Ms. Latha Kambham (Trinity Consultants) on October 22, 2012 and on February 4, 2013.
[2] Annual hours of operation for ancillary equipment provided by Mr. Larry Carlson (Tenaska) to Ms. Latha Kambham (Trinity Consultants) on October 22, 2012.
[3] Natural gas throughput is based on heat capacity of the unit, hours of operation and the fuel's high heating value.
[4] Diesel Potential Throughput (gal/yr) = Rated Capacity (MMBtu/hr) * Hours of Operation Per Year (hrs/yr) / Diesel Fuel HHV (MMBtu/gal)

$$\text{Diesel Potential Throughput for Fire Pump Engine (gal/yr)} = \frac{3.82\ \text{MMBtu}}{\text{hr}} \left| \frac{100\ \text{hrs}}{\text{yr}} \right| \frac{1\ \text{gal}}{0.137\ \text{MMBtu}} = 2789.80\ \text{gal/yr}$$

[5] High Heating Value for Natural Gas represents the site specific HHV.
[6] High Heating Value for Diesel Fuel Oil No.2 is obtained from 40 CFR Part 98, Subpart C, Table C-1.

GHG Emission Factors for Diesel Engine

Pollutant	Emission Factor	Emission Factor Units
CO_2 [1]	73.960	kg CO_2/MMBtu
CH_4 [2]	0.003	kg CH_4/MMBtu
N_2O [2]	0.0006	kg N_2O/MMBtu

[1] Emission factors from 40 CFR Part 98, Subpart C, Table C-1 for Distillate Fuel Oil No. 2.
[2] Emission factors Per 40 CFR Part 98, Subpart C, Table C-2 for petroleum fuel.

GHG Emission Factors for Natural Gas

Pollutant	Emission Factor	Emission Factor Units
CO_2 [1]	53.060	kg CO_2/MMBtu
CH_4 [2]	0.001	kg CH_4/MMBtu
N_2O [2]	0.0001	kg N_2O/MMBtu

[1] Emission factors from 40 CFR Part 98, Subpart C, Table C-1 for Natural Gas (Federal Register 71948 / Vol. 78, No. 230, November 29, 2013).
[2] Emission factors Per 40 CFR Part 98, Subpart C, Table C-2 for Natural Gas.

GHG EMISSION CALCULATIONS FOR OTHER COMBUSTION SOURCES

FINs: 4, 5 & 7
EPNs: 4, 5 & 7

GHG Potential Emission Calculations

				Hourly Emissions[1] (lb/hr)				Annual Emissions[3,4] (metric tons/yr)				Annual Emissions[5] (short tons/yr)			
EPN	**Description**	**Fuel Type**	**Tier Used**	**CO_2**	**CH_4**	**N_2O**	**CO_2e[2]**	**CO_2**	**CH_4**	**N_2O**	**CO_2e[2]**	**CO_2**	**CH_4**	**N_2O**	**CO_2e[2]**
4	Fire Pump Engine	No.2 Fuel Oil	Tier I	623.24	0.03	0.01	626.97	28.27	1.15E-03	2.29E-04	28.37	31.2	1.27E-03	2.52E-04	31.31
5	Emergency Generator	No.2 Fuel Oil	Tier I	3,102.97	0.13	0.03	3,115.16	140.75	5.71E-03	1.14E-03	141.23	155.1	6.29E-03	1.26E-03	155.63
7	Auxiliary Boiler	Natural Gas	Tier I	10,527.85	0.20	0.02	10,538.81	20,916.25	0.39	0.04	20937.92	23,056.0	0.43	0.044	23079.86
			Total	14,254.06	0.36	0.06	14,280.94	21,085.27	0.40	0.04	21,107.52	23,242.3	0.44	0.046	23,266.80

[1] Hourly Emission Rates are calculated based on Annual Emission Rates.

Example Calculation:

Hourly Emissions of CO_2 for Fire Pump Engine (lb/hr) =	28.27 metric tons / yr	1.1023 short ton / metric ton	2,000 lb / 1 short ton	yr / 100 hr	= 623.24 lb/hr

tons to lb 2000 lb/ton

metric ton to short ton 1.1023 short ton/metric ton

[2] Per 40 CFR 98 - Mandatory Greenhouse Gas Reporting, Subpart A, Table A-1 (Federal Register 71948 / Vol. 78, No. 230, November 29, 2013). Total CO_2e emissions are calculated based on the following Global Warming Potentials.

CO_2	1
CH_4	25
N_2O	298

[3] CO_2 emissions from No.2 Fuel Oil and Natural Gas combustion calculated per Equation C-1 and Tier I methodology provided in 40 CFR Part 98, Subpart C.

$$CO_2 = 1x\,10^{-3} * Fuel * HHV * EF \qquad \text{(Eq. C-1)}$$

Where:
CO_2= Annual CO_2 mass emissions for the specific fuel type (metric tons).
Fuel = Mass or volume of fuel combusted per year.
HHV = Default high heat value of the fuel.
EF = Fuel-specific default CO_2 emission factor.
1×10^{-3}= Conversion factor from kilograms to metric tons.

[4] CH_4 and N_2O emissions No.2 Fuel Oil and Natural Gas combustion calculated per Equation C-8 provided in 40 CFR Part 98, Subpart C.

$$CH_4 \;or\; N_2O = 1x\,10^{-3} * Fuel * HHV * EF \qquad \text{(Eq. C-8)}$$

Where:
CH_4 or N_2O = Annual CH_4 or N_2O emissions from the combustion of natural gas (metric ton).
Fuel = Mass or volume of the fuel combusted.
HHV = Default high heat value of the fuel.
EF = Fuel-specific default emission factor for CH_4 or N_2O, from Table C–2 of this subpart (kg CH_4 or N_2O per mmBtu).
1×10^{-3}= Conversion factor from kilograms to metric tons.

[5] Annual Emissions (short tpy) = Annual Emission (metric tpy) * 1.1023 (short ton/metric ton)

To be consistent with the reporting format in GHG Mandatory Reporting Rule, the emissions rounded as follows: CO_2 - 1 decimal place, CH_4 - 2 decimal places, N_2O - 3 decimal places, and CO_2e - rounded to nearest digit.

SF_6 EMISSION CALCULATIONS FOR CIRCUIT BREAKERS

FIN: FUG_GHG
EPN: FUG_GHG

SF_6 Emission Rates

EPN	Description	Model Name [1] (kV)	Total Number of Circuit Breakers for Brownsville Station	Amount of SF_6 in Full Charge [1] (lb)	SF_6 Leak Rate [2] (%/yr)	Annual SF_6 Emission Rate [3] (short tons /yr)	Annual CO_2e Emission Rate [4] (short tons/yr)
FUG_GHG	Transmission / Switchyard Breakers	345 kV ABB 362 PM or similar	6	300	0.50	4.50E-03	102.60
	Generator Breakers	Alstom FKG1N G1 or similar	2	66	0.50	3.30E-04	7.52
	Bottle Storage	Large Bottle	1	115	0.50	2.88E-04	6.56
Total						**5.12E-03**	**116.68**

[1] Information provided by Mr. Larry Carlson (Tenaska) to Ms. Latha Kambham (Trinity Consultants) on October 22, 2012.

[2] From EPA's technical paper titled, "SF6 Leak Rates from High Voltage Circuit Breakers - U.S. EPA Investigates Potential Greenhouse Gas Emission Source - by J. Blackman, Program Manager, U.S. EPA and M. Averyt, ICF Consulting, and Z. Taylor, ICF Consulting". Used the worst-case estimate of 0.5% per year.

[3] Annual Emission Rate (tpy) = Number of Circuit Breakers * Amount of SF_6 in Full Charge (lb) * SF_6 Leak Rate (%/yr) * 1/2000 (ton/lb)

[4] Global Warming Potential (GWP) of SF_6 = 22,800 per 40 CFR 98, Subpart A, Table A-1 (Federal Register 71948 / Vol. 78, No. 230, November 29, 2013)

To be consistent with the reporting format in GHG Mandatory Reporting Rule, the CO_2e emissions are rounded to nearest digit.

FUGITIVE GHG EMISSION CALCULATIONS FOR NATURAL GAS SERVICES

FIN: FUG_GHG
EPN: FUG_GHG

Fugitive GHG Emissions Rates in Natural Gas Services

EPN	Components	Component Count [1]	Emission Factors [2] (lb/hr-component)	Control Efficiency [3] (%)	CH_4 Emissions [4, 5,6] (tons/yr)	Annual CO_2e Emissions [7] (short tons/yr)
FUG_GHG	Valves	624	0.00992	97%	0.79	19.72
	Pressure Relief Valves	12	0.0194	97%	0.03	0.74
	Flanges	1752	0.000860	97%	0.19	4.80
	Pumps	4	0.00529	93%	5.66E-03	0.14
				Total Emissions	**1.02**	**25.41**

[1] Component counts provided from Mr. Larry Carlson (Tenaska) to Ms. Latha Kambham (Trinity Consultants) on October 22,2012. A 20% safety factor is also included in the fugitive component counts.

[2] Emission factors obtained from Table 4 for Oil and Gas Production Operations from Addendum to RG-360A, *Emission Factors for Equipment Leak Fugitive Components,* TCEQ, January 2008, Gas factors.

[3] The Brownsville Generating Station will implement Audio/Visual/Olfactory (AVO) program to minimize emissions. Control efficiencies are obtained from October 2000 Draft TCEQ Technical Guidance Package.

[4] The methane content in the gas is conservatively assumed to be 97 %.

[5] The annual hours of operation are 8,760 hrs/yr.

[6] Annual Emission Rate (tpy) = Component Count * Emission Factor (lb/hr-component) * Methane Content (%) * Annual Hours of Operation (hrs/yr) * 1/2000 (ton/lb)

$$CH_4 \text{ Annual Emissions from Valves (tpy)} = 624 \text{ components} \times \frac{0.00992 \text{ lb}}{\text{hr - component}} \times \frac{97\ \%}{100} \times \frac{8{,}760 \text{ hrs}}{\text{yr}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lb}} = 0.79 \text{ tpy}$$

[7] Global Warming Potential of CH_4 = 25 per 40 CFR 98, Subpart A, Table A-1 (Federal Register 71948 / Vol. 78, No. 230, November 29, 2013)