NRG Energy, Inc.
910 Louisiana Street.
Houston, TX 77002

CERTIFIED MAIL -- RETURN RECEIPT REQUESTED

July 3, 2020

Texas Commission on Environmental Quality
Ms. Ruth Alvirez
Air Permits Division- MC-163
P.O. Box 13087
Austin, Texas 78711-3087

Subject: **Response to Deficiency Letter Dated April 30, 2020, Cedar Bayou 5 Permit Nos. 160538, PSDTX1582, and GHGPSDTX204**
NRG Cedar Bayou 5 LLC
TCEQ Account ID Number: LI-0027-L
Customer Reference Number: CN605766492
Regulated Entity Reference Number: RN100825371
TCEQ Project Number: 313800

Dear Ms. Alvirez:

Attached to this letter is the NRG Cedar Bayou 5 LLC (NRG) response to your letter of April 30, 2020 concerning deficiencies noted for the Electric Generating Unit 5 initial air permit application submitted on March 20, 2020. The Electric Generating Unit 5 is located at 7705 West Bay Road, Baytown, Chambers County, Texas. NRG comments are noted in italics in the response. Also included are all other attachments noted in the NRG responses to provide for the necessary updates in representations.

In addition to the deficiency response, NRG is also requesting the following updates to the application:

1. Revised combined cycle description and calculations;
2. Updated emergency engine process description and BACT.

If you have any questions or require any additional information, please do not hesitate to contact myself or Colleen Krenek, of my staff, at (713) 537-3284 or by email at colleen.krenek@nrg.com.

Sincerely,

Craig R. Eckberg
Sr. Director, Environmental Services

cc: Air Section Manager, Region 12 - Houston
Air Permits Section Chief, New Source Review Section (6PD-R), U.S. Environmental Protection Agency, Region 6, Dallas

1. The duct burners (DBs), on page 21 is rated at 780 MMBtu/h. In the DB emission calculation, the emission rates are based on 643 MMBtu/hr. Please confirm that 643 MMBtu/hr is the correct maximum heat input for the DBs.

    a. *The 780 MMBtu/hr duct burner firing rate is from a preliminary combined cycle turbine performance heat balance; please disregard. In the final performance data, the highest duct burner firing rate is 784 MMBtu/h-HHV, which occurs in Firing Case 1 (97° ambient temperature, 45% relative humidity). Firing Case 24 (10° ambient temperature, 75% relative humidity), with a turbine firing rate of 733 MMBtu/hr, is provided in the emission calculations. The max duct burner heat input is 784 and the heat input associated with Case 24 (as used in the emission calculations) is 733 MMBtu/hr.*

2. Maintenance Activities (page 22). Refractory repair/replacement is listed as planned maintenance activity; however, there is a not corresponding calculation page. Please provide the calculation and adjust the FUG-MSS emission rate accordingly.

    a. *NRG is removing the refractory repair/replacement planned maintenance activity. The updated application attached reflects this.*

3. Startup/Shutdown definitions. The endpoint described as "steady state in low NO_x operating mode" and the SCR and OC have achieved steady state operation" are not definitive enough to determine when the CTG meets the emission standards. Please revisit the definition and provide a clearer definition of the endpoint.

    b. *Startup is defined as the period from first combustion of fuel to compliance with the NOx and CO emissions limits for the CTG, not to exceed 120 minutes. Shutdown is the period from minimum emissions-compliant load to flame out, but no more than 60 minutes.*

4. Please provide the heat rate for the turbine.

    c. *In an email on May 6, 2020 it was determined that NRG did not need to provide the heat rate for the turbine and respectfully recommends that this request be voided.*

5. Please provide startup and shutdown definitions for the boiler.

    NRG will be adhering to the definitions of startup and shutdown for boilers from the Environmental Protection Agency (EPA) 40 CFR § 63.11237.

    "Startup means:

    - *Either the first-ever firing of fuel in a boiler for the purpose of supplying useful thermal energy (such as steam or hot water) for heating and/or producing electricity, or for any other purpose, or the firing of fuel in a boiler after a shutdown event for any purpose. Startup ends when any of the useful thermal energy (such as steam or hot water) from the boiler is supplied for heating and/or producing electricity, or for any other purpose, or the period in which operation of a boiler is initiated for any purpose. Startup begins with either the first-ever firing of fuel in a boiler for the purpose of supplying useful thermal energy (such as steam or hot water) for heating, cooling or process purposes or producing electricity, or the firing of fuel in a boiler for any purpose after a shutdown event. Startup ends 4 hours after when the boiler supplies useful thermal energy (such as steam or hot water) for heating, cooling, or process purposes or generates electricity, whichever is earlier."*
        - *For NRG's Auxiliary Boiler, startup ends when any of the steam from the boiler is supplied for heating or process purposes.*
    - *"Shutdown means the period in which cessation of operation of a boiler is initiated for any purpose. Shutdown begins when the boiler no longer supplies useful thermal energy (such as steam or hot water) for heating, cooling, or process purposes or generates electricity, or when no fuel is being fed to the boiler, whichever is earlier. Shutdown ends when the boiler no longer supplies useful thermal energy (such as steam or hot water) for*

heating, cooling, or process purposes or generates electricity, and no fuel is being combusted in the boiler."

VI. APPLICATION MATERIALS (PROCESS DESCRIPTION; EMISSION CALCULATIONS; BACT)

EMISSION POINT INFORMATION

EPN CBY51 Combustion Turbine Generator and Heat Recovery Steam Generator (Combined Cycle Option)

EPN CBY51 Process Description

CB5 is seeking authorization to construct and operate either a simple cycle turbine electric generating unit or a combined cycle turbine electric generating unit. CB5 has selected the Mitsubishi MHI 501JAC turbine with a nominal gross base-load electric power output of approximately 420 MW at ISO conditions in simple cycle configuration. In combined cycle configuration, the unit will produce approximately 710 MW.

The main components of the CTG unit consist of a compressor, combustor, turbine, and generator. Filtered ambient air is drawn into the compressor section of the CTG. Natural gas is mixed with the compressed inlet air and combusted in the combustor section of the CTG. Lean premix combustors are used to reduce the NO_x emissions generated in the combustion process. Hot exhaust gases then enter the expansion turbine where the gases expand across the turbine, which generates torque that causes rotation of the turbine shaft. The shaft drives the compressor section of the unit and spins a dedicated electric generator, producing electricity. The temperature of the inlet air to the CTG proposed for the project may occasionally be lowered using evaporative cooling to increase the mass air flow through the turbines and achieve maximum turbine power output on days of most urgent ERCOT needs.

In the combined cycle configuration, exhaust from the combustion turbine then passes through a HRSG where boiler feed water is converted into high pressure steam. Natural gas-fired duct burners increase the temperature of the exhaust as the exhaust passes through the HRSG. The duct burners will have a maximum heat input capacity of 784 million British thermal units per hour (MMBtu/hr) higher heating value (HHV). Emissions from the turbine are further controlled using a SCR unit and an oxidation catalyst that is installed within the HRSG at a location where the exhaust gas is at the optimum temperature for the catalyst. The SCR process includes injection of ammonia into the exhaust gas stream within the HRSG and exposure of the exhaust to a catalyst bed where a series of reactions between the NO_x in the exhaust and the added ammonia converts most of the NO_x to nitrogen and oxygen. The exhaust stream is then released to the atmosphere through the unit's stack (EPN: CBY51).

A steam turbine generator receives the steam from the HRSG. The expansion of the high-pressure steam across the steam turbine causes rotation of the steam turbine shaft, producing approximately an additional 280 MW of electricity. Electricity produced at the Plant is exported to the Texas wholesale electric market.

A conventional SCR system, using a 19-percent solution of aqueous ammonia as the reagent, will be used to control NOx emissions from the proposed combined cycle turbine configurations. The systems will be comprised of aqueous ammonia storage and handling equipment, ammonia injection grids, and catalyst beds. In the combined cycle configuration, the ammonia injection grids and the SCR catalyst beds will be installed downstream of the turbine and downstream of the duct burners at a location in the HRSG housings where the flue gas temperature will allow for SCR NOx reduction reactions.

EMISSION POINT INFORMATION

EPN EMGEN: Emergency Diesel Generator and EPN DSL-TNK: Emergency Diesel Generator Tank

EPN EMGEN and DSL-TNK Process Description

One diesel engine-driven emergency generator will be installed to provide electric power to essential service users during emergencies and to operate during periods of economic dispatch. The engine will operate up to 500 hours per year. Emissions from the emergency engine will be exhausted either through a stack that runs alongside the combustion turbine stack (EPN: EMGEN) or will be exhausted into the combustion turbine stack. The combined cycle option will utilize a 2,000 hp emergency generator and the simple cycle option will utilize an 1,800 hp emergency generator. A 750-gallon diesel storage tank is included within the emergency generator housing. Emissions from this diesel storage tank will be exhausted through vent EPN: DSL-TNK.

EPN EMGEN and DSL-TNK Criteria Pollutant Emission Calculation Methodology

Operation of the emergency generator will be limited to 500 hours per year for testing and maintenance purposes and for economic dispatch purposes. The exhaust emissions from the diesel fuel-fired equipment were calculated using the Tier 4 Exhaust Standards for Generator Sets after the 2014 Model Year, 40 CFR 1039.101(b) and vendor emission factors for VOC emissions. SO_2 emissions are based on firing with ultra-low sulfur diesel with a maximum sulfur content of 15 parts per million by weight. The estimated emissions are calculated in Table A-12A for the 2,000 hp engine and Table A-12B for the 1,800 hp engine. A diesel storage tank (EPN: DSL-TNK) are included within the generator and pump housings. The estimated emissions from the diesel storage tank are calculated in Table A-13 of Appendix A.

EPN EMGEN Greenhouse Gas Emissions Calculation Methodology

CO_2 emissions from the diesel-fired emergency generator are calculated using the emission factors (kg/MMBtu) for Distillate Fuel Oil No. 2 from Table C-1 of the Mandatory Greenhouse Gas Reporting Rules. CH_4 and N_2O emissions from the diesel-fired engines are calculated using the emission factors (kg/MMBtu) for Petroleum from Table C-2 of the Mandatory Greenhouse Gas Reporting Rules. The global warming potential factors used to calculate CO_2e emissions are based on Table A-1 of the Mandatory Greenhouse Gas Reporting Rules. Calculations of GHG emissions from the combined cycle option emergency engine are presented on Table B-8A. Calculations of GHG emissions from the simple cycle option emergency engine are presented on Table B-8B.

EPN EMGEN Criteria Pollutant BACT

BACT for the diesel-fired generator engine will be achieved through the installation of an engine that meets the Tier 4 Exhaust Standard for Generator Sets after the 2014 Model Year, 40 CFR 1039.101(b), through the proper operation and maintenance of the engines, and through the burning of diesel fuels meeting the sulfur requirements of 40 CFR 80.510(c).

EPN DSL-TNK Criteria Pollutant BACT

TCEQ Tier I BACT for storage tanks with a capacity less than 25,000 gallons or containing a material with a true vapor pressure of less than 0.5 psia is listed as fixed roof tank with submerged fill. Uninsulated exterior surfaces exposed to the sun shall be white or aluminum. The diesel storage tank is provided as part of the emergency engine installation. Tanks that are smaller than 1,000 gallons typically are not constructed with a submerged fill pipe. There are no NSPS or Chapter 115 requirements that apply to the diesel storage tank because the storage capacity is less than 1,000 gallons. Therefore, CB5 proposes that BACT is satisfied for the diesel tank based upon the very low vapor pressure of diesel (0.01 psia) and the size of the tank (750 gallons).

EPN EMGEN Greenhouse Gas Emissions BACT

The emergency generator will provide electricity to the facility in case of power failure. The following technologies were identified as potential control options for emergency engines:

- Use of low carbon fuel
- Use of good operating and maintenance practices
- Low annual capacity factor.

Engine options include engines powered with electricity, natural gas, or liquid fuel, such as gasoline or fuel oil. Good operating and maintenance practices for the engines include the following:

- Operating with recommended fuel to air ratio recommended by the manufacturer and
- Appropriate maintenance of equipment, including periodic readiness testing.

Each emergency engine will be limited to 500 hours of non-emergency operation per year for purposes of maintenance checks and readiness testing and operation during economic dispatch.

The purpose of the emergency engine is to provide a power source during emergencies, which includes outages of the transmission system, combustion turbine, natural gas supply outages, and natural disasters, such as floods and hurricanes. As such, the engine must be available during emergencies. Electricity and natural gas may not be available during an emergency and therefore cannot be used as an energy source for the emergency engines.

The engine must be powered by a liquid fuel that can be stored on-site in a tank and supplied to the engines on demand, such as gasoline or diesel fuels. The default CO_2 emission factors for gasoline and diesel are very similar, 70.22 kg/MMBtu for gasoline and 73.96 kg/MMBtu for diesel. Diesel fuel has a much lower volatility than gasoline and can be stored for longer periods of time. Therefore, diesel is typically the chosen fuel for emergency engines. Because of the need to store the emergency engine fuel on-site and the ability to store diesel for longer periods of time than gasoline, it is technically infeasible to utilize a lower carbon fuel than diesel.

The use of good operating and maintenance practices is technically feasible for the emergency engines. Also, a low annual capacity factor for the engines is technically feasible since the engine will only be operated up to 500 hours per year. As a result of this analysis, appropriate operation of the engine through proper fuel to air ratios and maintenance based on recommended readiness testing and low annual hours of operation are selected as BACT for the proposed engines.

Table A-2
Emission Calculations - Maximum Hourly Turbine
Normal Operating Conditions
M501JAC Combined Cycle - Single Unit
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

OPERATING CONDITIONS:		Case 1	Case 13	Case 14	Case 16	Case 18	Case 24	Case 25	Case 26	Case 28
		Fired Base Evap On	Fired Base Evap On	Base Evap On	75% Load Evap Off	MECL 35% Load Evap Off	Fired Base Evap Off	Base Evap Off	75% Load Evap Off	MECL 41.9% Load Evap Off
		Input	Input	Input	Input	Input				
Ambient Dry Bulb Temperature	ºF	97	59	59	59	59	10	10	10	10
Ambient Relative Humidity	%	45	60	60	60	60	75	75	75	75
Ambient Pressure	psia	14.685431	14.685431	14.685431	14.685431	14.685431	14.685431	14.685431	14.685431	14.685431
NATURAL GAS FUEL PROPERTIES:										
Natural Gas Fuel	BTU/lb - HHV	23,643	23,643	23,643	23,643	23,643	23,643	23,643	23,643	23,643
Heating Value, Natural Gas	BTU/scf - HHV	1022	1022	1022	1022	1022	1022	1022	1022	1022
Natural Gas MW	lb/lbmole	16.41	16.41	16.41	16.41	16.41	16.41	16.41	16.41	16.41
Sulfur Content, Natural Gas 1-Hr	grains S/100 scf	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sulfur Content, Natural Gas Annual	grains S/100 scf	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
CTG EFFECTS:										
Evaporative cooler On/Off		On	On	On	Off	Off	Off	Off	Off	Off
Evaporative cooler effectiveness	%	90	90	90	0	0	0	0	0	0
Gross Plant output power	kW	687,486	710,439	630,254	488,079	290,559	724,202	642,564	520,658	346,175
Heat Input	MMBTU/hr - HHV	3,657.0	3,794.8	3,797.1	3,003.5	2,044.4	3,885.5	3,889.0	3,238.9	2,395.9
DUCT BURNER EFFECTS:										
Duct Burner Heat Input	MMBTU/hr - HHV	784	694	0	0	0	733	0	0	0
DB Fuel Flow	lb/hr	33,139	29,359	0	0	0	30,991	0	0	0
DB Fuel Flow	scf/hr	766,733	679,270	0	0	0	717,036	0	0	0
DB Fuel Flow	mol/hr	2,019	1,789	0	0	0	1,888	0	0	0
CTG & DUCT BURNER COMBINED EXHAUST:										
HRSG stack exhaust gas mass flow	lb_m/hr	5,812,205	5,997,649	5,971,080	4,854,180	3,919,860	6,016,626	5,989,440	5,220,360	4,303,380
HRSG stack gas temperature	°F	171.9	169.0	178.0	171.7	165.3	162.7	176.2	174.4	169.3
HRSG stack gas N2 volume percentage	%	71.50	72.98	73.54	73.80	74.29	73.67	74.25	74.43	74.74
HRSG stack gas O2 volume percentage	%	8.58	9.01	10.63	10.95	12.38	8.87	10.53	11.00	11.95
HRSG stack gas CO2 volume percentage	%	5.35	5.35	4.61	4.49	3.84	5.51	4.75	4.53	4.10
HRSG stack gas H2O volume percentage	%	13.66	11.74	10.29	9.83	8.55	11.03	9.54	9.10	8.27
HRSG stack gas Ar volume percentage	%	0.90	0.92	0.93	0.93	0.94	0.92	0.93	0.94	0.94
HRSG stack gas O2 volume percentage - Dry Basis	%	9.94	10.21	11.85	12.14	13.54	9.97	11.64	12.10	13.03
HRSG stack gas molecular weight		27.95	28.17	28.26	28.30	28.38	28.26	28.35	28.38	28.43
HRSG stack PM	lb/hr	24.19	24.22	14.95	12.01	8.85	24.78	15.16	12.96	6.76
Exit Flow Rate	lb_{mol}/hr	207,914	212,942	211,305	171,540	138,121	212,932	211,257	183,944	151,356
Exit Flow Rate	lb_{mol}/hr - dry	179,510	187,937	189,562	154,678	126,312	189,440	191,103	167,205	138,838
Exit Flow Rate	scf/hr	80,150,963	82,089,297	81,458,239	66,128,787	53,245,820	82,085,250	81,439,525	70,910,348	58,347,569
Exit Flow Rate	scf/hr - dry	69,200,928	72,449,745	73,076,186	59,628,327	48,693,302	73,029,205	73,670,195	64,457,506	53,522,225
CTG & DUCT BURNER COMBINED EXHAUST:										
NO_X	ppmvd@15%O_2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
NO_X	ppmvd	3.71631	3.62492	3.06804	2.96823	2.49578	3.70473	3.13881	2.98264	2.66869
NO_X as NO_2	lb/hr	30.69	31.34	26.76	21.12	14.50	32.29	27.60	22.94	17.05
CO	ppmvd@15%O_2	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
CO	ppmvd	6.50	6.34	5.37	5.19	4.37	6.48	5.49	5.22	4.67
CO	lb/hr	32.70	33.39	28.51	22.51	15.45	34.40	29.40	24.45	18.16
VOC, as CH_4	ppmvd@15%O_2	1	1	0.9	0.9	0.9	1	0.9	0.9	0.9
VOC, as CH_4	ppmvd	1.86	1.81	1.38	1.34	1.12	1.85	1.41	1.34	1.20
VOC, as CH_4	lb/hr	5.35	5.46	4.20	3.31	2.28	5.63	4.33	3.60	2.67
H_2CO	ppmvd@15%O_2	91.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0
H_2CO	ppmvd	169.09	164.93	139.60	135.05	113.56	168.57	142.82	135.71	121.43
H_2CO	lb/hr	0.91	0.93	0.79	0.63	0.43	0.96	0.82	0.68	0.51
NH_3	ppmvd@15%O_2	7	7	7	7	7	7	7	7	7
NH_3	ppmvd	13.01	12.69	10.74	10.39	8.74	12.97	10.99	10.44	9.34
NH_3	lb/hr	39.76	40.61	34.67	27.37	18.79	41.83	35.75	29.73	22.08
SO_2, Maximum Hourly	lb/hr	12.40	12.54	10.61	8.39	5.71	12.90	10.86	9.05	6.69
SO_2, Annual Average	lb/hr	6.20	6.27	5.30	4.19	2.86	6.45	5.43	4.52	3.35
SO_2 to SO_3 Conversion in Turbine	%	5	5	5	5	5	5	5	5	5
SO_2 to SO_3 Conversion in Duct Burner	%	10	10	0	0	0	10	0	0	0
SO_2 to SO_3 Conversion in Catalyst Beds	%	40	40	40	40	40	40	40	40	40
H_2SO_4, Maximum Hourly (100% converted SO_3)	lb/hr	8.92	9.06	6.98	5.52	3.76	9.31	7.15	5.96	4.41
H_2SO_4, Annual Average (100% converted SO_3)	lb/hr	4.46	4.53	3.49	2.76	1.88	4.66	3.58	2.98	2.20
$(NH_4)_2SO_4$, Maximum Hourly (100% converted SO_3)	lb/hr	12.02	12.20	9.41	7.44	5.07	12.55	9.63	8.02	5.94
$(NH_4)_2SO_4$, Annual Average (100% converted SO_3)	lb/hr	6.01	6.10	4.70	3.72	2.53	6.27	4.82	4.01	2.97
PM FH+BH, Maximum Hourly (including Sulfates)	lb/hr	36.21	36.42	24.36	19.45	13.91	37.33	24.79	20.98	12.69
PM FH+BH, Annual Average (including Sulfates)	lb/hr	30.20	30.32	19.66	15.73	11.38	31.06	19.97	16.97	9.72

Revised 06/29/2020

Table A-3
Sample Emission Calculations
M501JAC Combined Cycle Turbine
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Case 24		
Exhaust Flow Rate	6,016,626	lb/hr
Exhaust Flow MW	28.26	lb/lbmole
CTG Heat Input	3,886	MMBtu / hr, HHV
DB Heat Input.	733	MMBtu / hr, HHV
Natural Gas	1,021.9	Btu / scf, HHV
Exhaust Content	8.87	% O2 wet
Exhaust Content	11.03	% H2O

Exhaust Flow = $\frac{6{,}016{,}626 \text{ lb exhaust}}{\text{hr}} \left| \frac{\text{lbmole}}{28.26 \text{ lb}} \right| \frac{1}{1 - (11.03\% \text{ H2O})/100)}$ = 189,440.2 lbmole/hr (dry)

Convert Oxygen Concentration to Dry Basis

$O_2 = \frac{8.87 \text{ \% O2 wet}}{(1 - (11.03 \text{ \% H20}) /100))}$ = 9.97 % dry

Natural Gas Usage

CTG NG Flow = $\frac{3{,}886 \text{ MMBtu HHV}}{\text{hr}} \left| \frac{1{,}000{,}000 \text{ Btu}}{\text{MMBtu}} \right| \frac{\text{scf}}{1{,}021.9 \text{ MMBtu HHV}}$ = 3,802,397.2 scfh

DB NG Flow = $\frac{733 \text{ MMBtu HHV}}{\text{hr}} \left| \frac{1{,}000{,}000 \text{ Btu}}{\text{MMBtu}} \right| \frac{\text{scf}}{1{,}021.9 \text{ MMBtu HHV}}$ = 717,036.4 scfh

Total NG Flow = 3,802,397.2 scfh + 717,036.4 scfh = 4,519,433.7 scfh

Gaseous Pollutant Sample Calculation - Oxides of Nitrogen (NOx)

Emission Factor 2.0 ppmvd NOx @ 15% O_2

NO_2 MW 46.01 lb / lb_{mole}

Emission Factor Corrected for Actual Oxygen Concentration - Oxides of Nitrogen

Emission Factor = $\frac{2.0 \text{ ppmd @ 15\%}}{} \left| \frac{(20.9 - 9.97 \text{ O2\% dry})}{(20.9 - 15)} \right.$ = 3.7 ppmvd NOx

Emission Rate Calculation - Oxides of Nitrogen

ST Emissions = $\frac{3.7 \text{ lbmole NOx}}{1{,}000{,}000 \text{ lbmole exhaust}} \left| \frac{189{,}440 \text{ lbmole exhaust}}{\text{hr}} \right| \frac{46.01 \text{ lb NOx/lb mole}}{\text{lbmole NOx}}$ = 32.29 lb/hr NOx as NO2

Gaseous Pollutant Sample Calculation - Carbon Monoxide (CO)

Emission Factor 3.5 ppmvd CO @ 15% O_2

CO MW 28.01 lb / lb_{mole}

Emission Factor Corrected for Actual Oxygen Concentration - Carbon Monixide

Emission Factor = $\frac{3.5 \text{ ppmd @ 15\%}}{} \left| \frac{(20.9 - 9.97 \text{ O2\% dry})}{(20.9 - 15)} \right.$ = 6.48 ppmvd CO

Emission Rate Calculation - Carbon Monoxide

ST Emissions = $\frac{6.48 \text{ lbmole CO}}{1{,}000{,}000 \text{ lbmole exhaust}} \left| \frac{189{,}440 \text{ lbmole exhaust}}{\text{hr}} \right| \frac{28.01 \text{ lb CO/lb mole}}{\text{lbmole CO}}$ = 34.4 lb/hr CO

Gaseous Pollutant Sample Calculation - Volatile Organic Compound (VOC)

Emission Factor 1.0 ppmvd VOC @ 15% O_2

VOC MW 16.04 lb / lb_{mole}

Emission Factor Corrected for Actual Oxygen Concentration - VOC

Emission Factor = $\frac{1.0 \text{ ppmd @ 15\%}}{} \left| \frac{(20.9 - 9.97 \text{ O2\% dry})}{(20.9 - 15)} \right.$ = 1.85 ppmvd VOC

Emission Rate Calculation - VOC

ST Emissions = $\frac{1.85 \text{ lbmole VOC}}{1{,}000{,}000 \text{ lbmole exhaust}} \left| \frac{189{,}440 \text{ lbmole exhaust}}{\text{hr}} \right| \frac{16.04 \text{ lb VOC/lb mole}}{\text{lbmole VOC}}$ = 5.63 lb/hr VOC

Table A-3
Sample Emission Calculations
M501JAC Combined Cycle Turbine
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Sample Calculation - Sulfur Dioxide (SO_2), Sulfuric Acid (H_2SO_4) and Ammonium Sulfate $(NH_4)_2SO_4$

Emission Factor	1	grain S / 100 scf, Natural Gas, Max Hourly
Emission Factor	0.5	grain S / 100 scf, Natural Gas, Annual Average
S MW	32.06	lb / lb_{mole}
SO_2 MW	64.06	lb / lb_{mole}
H_2SO_4 MW	98.07	lb / lb_{mole}
$(NH_4)_2SO_4$ MW	132.13	lb / lb_{mole}

Sample Calculation - Sulfur Dioxide (SO_2)

CTG/DB ST Emissions = (1 grain S / 100 scf) × (lb / 7000 grain) × (4,519,434 Total NG scf / hr) × (64.06 lbmole SO2 / 32.06 lbmole S) = 12.9 lb/hr SO2

Sample Calculation - Sulfuric Acid (H_2SO_4)

SO2 to SO3 Conversion in Turbine	5	%
SO2 to SO3 Conversion in Duct Burner	10	%
SO2 to SO3 Conversion in Catalyst Beds	40	%

Turbine Conversion = (1 grain S / 100 scf) × (lb S / 7000 grain) × (3,802,397 scf NG to CGT / hr) × (lbmole SO2 / 32.06 lb S)

(5/100) lbmole SO3 / lbmole SO2 × lbmole H2SO4 / lbmole SO3 × 98.07 lb H2SO4 / lbmole H2SO4 = 0.8 lb/hr H2SO4

Duct Burner Conversion = (1 - (5/100)) × (3,802,397 scf NG to CGT / hr) × (1 grain S / 100 scf) × (lb S / 7000 grain) × (lbmole SO2 / 32.06 lb S)

(10/100) lbmole SO3 / lbmole SO2 × lbmole H2SO4 / lbmole SO3 × 98.07 lb H2SO4 / lbmole H2SO4 = 1.6 lb/hr H2SO4

Catalyst Bed Conversion = ((1 - (5 + 10)/100)) * 3,802,397) scf NG to CGT + 717,036 scf NG to DB / hr × (1 grain S / 100 scf) × (lb S / 7000 grain)

lbmole SO2 / 32.06 lb S × (40/100) lbmole SO3 / lbmole SO2 × lbmole H2SO4 / lbmole SO3 × 98.07 lb H2SO4 / lbmole H2SO4 = 6.9 lb/hr H2SO4

Total H2SO4 = 0.8 lb/hr + 1.6 lb/hr +6.9 lb/hr = 9.3 lb/hr H2SO4

Sample Calculation - Ammonium Sulfate ($(NH_4)_2SO_4$)

Assume 100% of H_2SO_4.converts to $(NH_4)_2SO_4$.

ST Emissions = (9.3 lb H2SO4 / hr) × (lbmole H2SO4 / 98 lb H2SO4) × (lbmole (NH4)2SO4 / lbmole H2SO4) × (132 lb (NH4)2SO4 / lbmole (NH4)2SO4)

= 12.55 lb/hr (NH4)2(SO4) lb/hr

Sample Calculation - Particulate Matter ($PM_{10}/PM_{2.5}$)

CTG Emission Rate =	24.78	lb/hr, front and back half, vendor supplied
(NH4)2SO4 Emissions =	12.55	lb/hr
Total PM =	37.33	lb/hr

Table A-6
Hourly Emission Summary
Normal Operating Conditions
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

M501JAC Combined Cycle

Pollutant	Maximum For Averaging Period	Single Turbine (lb/hr)					
		Maximum Hourly	MSS Max Hourly (Cold Start)			Annual	Annual
		Case 24 Fired Base Evap Off 10 °F lb/hr	MSS Emissions lbs	MSS Duration minutes	First Hour Emissions MSS/Routine lb/hr	Case 13 Duct Fired Base Evap On 59 °F lb/hr	Case 14 No Duct Firing Base Evap On 59 °F lb/hr
NO_X	1-Hour	32.29	22	19	43.96		
	Annual					31.34	26.76
CO	1-Hour	34.40	510	19	533.39		
	Annual					33.39	28.51
VOC	1-Hour	5.630	73	19	76.83		
	Annual					5.46	4.20
SO_2	1-Hour	12.90					
	Annual					6.27	5.30
Particulates (FH&BH)	1-Hour	37.33					
	Annual					30.32	19.66
H_2SO_4	1-Hour	9.31					
	Annual					4.53	3.49
NH_3	1-Hour	41.83					
	Annual					40.61	34.67
$(NH_4)_2SO_4$	1-Hour	12.55					
	Annual					6.10	4.70

M501JAC Simple Cycle

Pollutant	Maximum For Averaging Period	Single Turbine				
		Maximum Hourly	MSS Max Hourly (Cold Start)			Annual
		Case 22 Base Load; 10 F lb/hr	MSS Emissions lbs	MSS Duration minutes	First Hour Emissions MSS/Routine lb/hr	Case 13 Base Load; 59 F lb/hr
NO_X	1-Hour	34.65	15	20	38.10	
	Annual					33.56
CO	1-Hour	29.54	237	20	256.69	
	Annual					28.60
VOC	1-Hour	7.250	58	20	62.83	
	Annual					7.02
SO_2	1-Hour	10.81				
	Annual					5.28
Particulates (FH&BH)	1-Hour	19.28				
	Annual					14.28
H_2SO_4	1-Hour	7.12				
	Annual					3.48
NH_3	1-Hour	51.31				
	Annual					49.69
$(NH_4)_2SO_4$	1-Hour	9.59				
	Annual					4.68

Notes:
1. VOCs are non-methane, non-ethane as CH_4.
2. Particulates are front and back half by EPA Method 5/202 and include condensables.

Table A-7
Gas Turbine Annual Emission Summary
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Annual Emissions for M501JAC Combined Cycle

Annual Operating Hours with Duct Firing[1]: 1910.0
Annual Operating Hours without Duct Firing: 6819.9
Annual SS Operating Hours[1]: 30.1

Pollutant	Annual Emissions Based on 1,910.0 hrs/yr of Normal Operations with Duct Firing tons/yr	Annual Emissions Based on 6,819.9 hrs/yr of Normal Operations without Duct Firing tons/yr	Estimated Annual Emissions From SS Operations tons/yr	Estimated SS Annual Operating Hours[1,2] hrs/yr	Combined Routine/MSS Annual Emissions tons/yr
NO_X	29.93	91.24	1.69	30.1	122.86
CO	31.89	97.21	21.19	30.1	150.29
VOC	5.22	14.32	4.75	30.1	24.28
SO_2	5.99	18.08	---	---	24.07
$PM/PM_{10}/PM_{2.5}$	28.96	67.03	---	---	95.99
H_2SO_4	4.32	11.90	---	---	16.23
$(NH_4)_2SO_4$	5.83	16.04	---	---	21.87
NH_3	38.78	118.21	---	---	157

Notes:

1. The annual hours used in these calculations are estimates for purposes of calculating annual emissions. They are not represente as being the maximum operating hours for each of the three operating modes. The total annual combined cycle combustion turbir firing rate is represented to be 34,538,193 MMBtu/yr
2. Only emissions of NOx, CO, and VOC are shown in the startup/shutdown columns as emissions of other pollutants are expected to be less than during normal operation.

Annual Emissions for M501JAC Simple Cycle

Annual Operating Hours[1]: 3850

Pollutant	Annual Emissions Based on 3,850 hrs/yr of Normal Operations tons/yr	Estimated Annual Emissions From SS Operations tons/yr	Estimated SS Annual Operating Hours[1,2] hrs/yr	Combined Routine/MSS Annual Emissions tons/yr
NO_X	64.59	1.84	77	65.14
CO	55.06	59.57	77	113.53
VOC	13.52	11.09	77	24.33
SO_2	10.16	---	---	10.16
$PM/PM_{10}/PM_{2.5}$	27.49	---	---	27.49
H_2SO_4	6.69	---	---	6.69
$(NH_4)_2SO_4$	9.01	---	---	9.01
NH_3	95.64	---	---	95.64

Notes:

1. The annual hours used in these calculations are estimates for purposes of calculating annual emissions. They are not represente as being the maximum operating hours for each of the two operating modes. The total annual simple cycle combustion turbine firing rate is represented to be 14,552,539 MMBtu/yr
2. Only emissions of NOx, CO, and VOC are shown in the startup/shutdown columns as emissions pollutants are expected to be less than during normal operation.

Table A-12A
Diesel-Fired Emergency Generator (Combined Cycle Option) - Emission Calculations
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Assumptions:

Max Daily Operating Schedule	1	hours/day
Annual Operating Schedule	500	hours/year
Power Rating	2,000	bhp
Fuel Consumption	104.90	gal/hr
Density of No. 2 Fuel Oil:	7.67	lb/gal
Max Fuel Consumption	804.9	lb fuel/hr
Heating Value of No. 2 Fuel Oil:	0.138	MMBtu/gal
Max Heat Input:	14.48	MMBtu/hr
Maximum Sulfur Content (S)	15.00	ppmw

Calculations:

Emission Rate = Emission Factor * Power rating * hours of operation / averaging period

Pollutant	Emission	Units	Max Hourly Emission Rate lb/hr	Max. Annual Emission Rate ton/yr
NO_x [1]	0.50	g/HP-hr	2.20	0.55
CO [1]	2.61	g/HP-hr	11.51	2.88
VOC [2]	0.04	g/HP-hr	0.18	0.04
PM/PM_{10} [1]	0.022	g/HP-hr	0.10	0.02
SO_2 [2]	Mass Balance		0.0241	0.0060

Sample Calculations:

NO_x lb/hr = 0.499819841057291 g/HP-hr * 2,000 bhp * lb/453.6g = 2.20 lb/hr

CO lb/hr = 2.61099916970226 g/HP-hr * 2,000 bhp * lb/453.6g = 11.51 lb/hr

VOC lb/hr = 0.04 g/HP-hr * 2,000 bhp * lb/453.6g = 0.18 lb/hr

PM lb/hr = 0.0223799928831623 g/HP-hr * 2,000 bhp * lb/453.6g = 0.10 lb/hr

SO_2 lb/hr = 805 lb fuel/hr * 15 lb S/1,000,000 lb fuel * lbmol S/32 lb S * 64 lb SO2/lbmol SO2

SO_2 lb/hr = 0.024 lb/hr

Notes:

1. Tier 4 Exhaust Standard for Generator Sets after the 2014 Model Year, 40 CFR 1039.101(b)
2. Manufacturer specifications
3. Calculated based on maximum fuel sulfur content and max fuel consumption.

Stack Parameters			
Stack diameter ft	Exhaust Flow acfm wet	Temperature °F	Velocity ft/sec
1.00	12,105.0	965	256.88

Table A-12B
Diesel-Fired Emergency Generator (Simple Cycle Option) - Emission Calculations
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Assumptions:

Max Daily Operating Schedule	1	hours/day
Annual Operating Schedule	500	hours/year
Power Rating	1,800	bhp
Fuel Consumption	93.9	gal/hr
Density of No. 2 Fuel Oil	7.67	lb/gal
Max Fuel Consumption	720.5	lb fuel/hr
Heating Value of No. 2 Fuel Oil	0.138	MMBtu/gal
Max Heat Input	12.96	MMBtu/hr
Maximum Sulfur Content (S)	15.00	ppmw

Calculations:

Emission Rate = Emission Factor * Power rating * hours of operation / averaging period

Pollutant	Emission	Units	Max Hourly Emission Rate lb/hr	Max. Annual Emission Rate ton/yr
NO_x [1]	0.50	g/HP-hr	1.98	0.50
CO [1]	2.61	g/HP-hr	10.36	2.59
VOC [1]	0.04	g/HP-hr	0.16	0.040
PM/PM_{10} [1]	0.022	g/HP-hr	0.09	0.022
SO_2 [2]	Mass Balance		0.0216	0.0054

Sample Calculations:

NO_x lb/hr = 0.499819841057291 g/HP-hr * 1,800 bhp * lb/453.6g = 1.98 lb/hr

CO lb/hr = 2.61099916970226 g/HP-hr * 1,800 bhp * lb/453.6g = 10.36 lb/hr

VOC lb/hr = 0.04 g/HP-hr * 1,800 bhp * lb/453.6g = 0.16 lb/hr

PM lb/hr = 0.0223799928831623 g/HP-hr * 1,800 bhp * lb/453.6g = 0.09 lb/hr

SO_2 lb/hr = 721 lb fuel/hr * 15 lb S/1,000,000 lb fuel * lbmol S/32 lb S * 64 lb SO2/lbmol SO2

SO_2 lb/hr = 0.022 lb/hr

Notes:

1. Manufacturer specifications
2. Calculated based on maximum fuel sulfur content and max fuel consumption.

Stack Parameters			
Stack diameter ft	Exhaust Flow acfm wet	Temperature °F	Velocity ft/sec
1.00	10,894.5	965	231.19

Table B-1
Project GHG Emission Summary
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Combined Cycle Turbine Option

Name	EPN	CO_2 ton/yr	CH_4 ton/yr	N_2O ton/yr	SF_6 ton/yr	Total GHG Mass Emissions ton/yr	Total CO_2e ton/yr
Combustion Turbine 1 (Combined Cycle)	CBY51	2,052,555.5	38.1	3.8		2,052,597.3	2,054,641.8
Auxiliary Boiler	AUX-BLR	10,414.7	0.2	0.0		10,414.9	10,425.5
Gas Heater	GAS-HTR	4,966.1	0.1	0.0		4,966.2	4,971.2
Natural Gas Component Fugitives	FUG-NGAS	0.005	2.2			2.2	55.2
Planned Maintenance Activities Fugitives	FUG-MSS	0.0002	0.11			0.11	2.7
Emergency Diesel Generator	EMGEN	590.1	0.0239	0.0048		590.1	592.1
SF_6 Insulated Equipment	SF6FUG				0.00103	0.00103	23.4
Sitewide Emissions		2,068,526.4	40.7	3.8	0.00103	2,068,570.9	**2,070,711.9**

Simple Cycle Turbine Option

Name	EPN	CO_2 ton/yr	CH_4 ton/yr	N_2O ton/yr	SF_6 ton/yr	Total GHG Mass Emissions ton/yr	Total CO_2e ton/yr
Combustion Turbine 1 (Simple Cycle)	CBY51	864,836.6	16.0	1.6		864,854.2	865,715.7
Gas Heater	GAS-HTR	4,966.1	0.1	0.009		4,966.2	4,971.2
Natural Gas Component Fugitives	FUG-NGAS	0.005	2.2			2.2	55.2
Planned Maintenance Activities Fugitives	FUG-MSS	0.0002	0.11			0.11	2.7
Emergency Diesel Generator	EMGEN	528.2	0.0030	0.0043		528.3	530.1
SF_6 Insulated Equipment	SF6FUG				0.00103	0.00103	23.4
Sitewide Emissions		870,331.0	18.5	1.6	0.00103	870,351.0	**871,298.2**

Table B-2
GHG Annual Emission Calculations - M501JAC Combined Cycle Combustion Turbine
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

EPN	Average Heat Input MMBtu/hr	Hours Per Year	Annual Heat Input MMBtu/yr	Pollutant	Emission Factor lb/MMBtu[4]	GHG Mass Emissions[5] ton/yr	Global Warming Potential[6]	CO_2e ton/yr
CBY51[1] (Duct Burner Firing)	4,489	1,910	8,573,867	CO_2	118.86	509,532.6	1	509,532.6
				CH_4	2.2E-03	9.5	25	236.3
				N_2O	2.2E-04	0.9	298	281.6
CBY51[2] (No Duct Burner Firing)	3797.1	6,819.9	25,895,837	CO_2	118.86	1,538,952.6	1	1,538,952.6
				CH_4	2.2E-03	28.5	25	713.6
				N_2O	2.2E-04	2.9	298	850.6
CBY51[3] (Startup/Shutdown)	2274.1	30.1	68,489	CO_2	118.86	4,070.2	1	4,070.2
				CH_4	2.2E-03	0.1	25	1.9
				N_2O	2.2E-04	0.01	298	2.2
CBY51 Total		8,760	34,538,193	CO_2		2,052,555.5	1	2,052,555.5
				CH_4		38.1	25	951.8
				N_2O		3.8	298	1,134.5
					TOTAL	**2,052,597.3**		**2,054,641.8**

Notes:

1. The average heat input for the M501JAC duct burner firing scenario is based on the HHV heat input at 100% load, with duct burner firing, at 59°F ambient temperature (Operating Case 13).
2. The average heat input for the M501JAC non-duct burner firing scenario is based on the HHV heat input at 100% load, with no duct burner firing, at 59°F ambient temperature (Operating Case 14).
3. The average heat input for the M501JAC startup-shutdown scenario is based on the HHV heat input at 50% load, with no duct burner firing, at 59°F ambient temperature (Operating Case 17).
4. CH_4 and N_2O GHG factors based on Table C-2 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.
5. CO_2 emissions based on 40 CFR Part 75, Appendix G, Equation G-4

$W_{CO2} = (F_c \times H \times U_f \times MW_{CO2})/2000$

W_{CO2} = CO_2 emitted from combustion, tons/yr

F_c = Carbon based F-factor,1040 scf/MMBtu

H = Heat Input (MMBtu/yr)

U_f = 1/385 scf CO_2/lbmole at 14.7 psia and 68°F

MW_{CO2} = Molecule weight of CO_2, 44.0 lb/lb-mole

6. Global Warming Potential factors based on Table A-1 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.

Table B-8A

GHG Emission Calculations - Diesel Combustion in Emergency Engines (Combined Cycle Option)

Cedar Bayou Electric Generating Station

NRG Cedar Bayou 5 LLC

Assumptions:

Annual Operating Schedule:	500	hours/year
Power Rating:	2,000	hp
Max Hourly Fuel Use:	104.9	gal/hr
Heating Value of No. 2 Fuel Oil:	0.138	MMBtu/gal
Max Hourly Heat Input:	14.5	MMBtu/hr
Annual Heat Input:	7,238.1	MMBtu/yr

EPN	Heat Input (MMBtu/yr)	Pollutant	Emission Factor (kg/MMBtu)[2]	GHG Mass Emissions (tpy)	Global Warming Potential[3]	CO_2e (tpy)
EMGEN	7238.1	CO_2	73.96	590.1	1	590.1
		CH_4	3.0E-03	0.0239	25	0.6
		N_2O	6.0E-04	0.0048	298	1.4
			Total:	**590.12**		**592.1**

Notes:

1. Default high heat value based on Table C-1 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.
2. GHG factors based on Tables C-1 and C-2 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.
3. Global Warming Potential factors based on Table A-1 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.

Sample Calculation:

Annual Emission Rate = Annual Heat Input X Emission Factor X 2.2 lbs/kg X Global Warming Potential / 2,000 lbs/ton

Table B-8B
GHG Emission Calculations - Diesel Combustion in Emergency Engines (Simple Cycle Option)
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Assumptions:

Annual Operating Schedule:	500	hours/year
Power Rating:	1,800	hp
Max Hourly Fuel Use:	93.9	gal/hr
Heating Value of No. 2 Fuel Oil:	0.138	MMBtu/gal
Max Hourly Heat Input:	13.0	MMBtu/hr
Annual Heat Input:	6,479.5	MMBtu/yr

EPN	Heat Input (MMBtu/yr)	Pollutant	Emission Factor (kg/MMBtu)[2]	GHG Mass Emissions (tpy)	Global Warming Potential[3]	CO_2e (tpy)
EMGEN	6479.5	CO_2	73.96	528.2	1	528.2
		CH_4	3.0E-03	0.0214	25	0.5
		N_2O	6.0E-04	0.0043	298	1.3
			Total:	**528.27**		**530.1**

Notes:

1. Default high heat value based on Table C-1 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.
2. GHG factors based on Tables C-1 and C-2 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.
3. Global Warming Potential factors based on Table A-1 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.

Sample Calculation:

Annual Emission Rate = Annual Heat Input X Emission Factor X 2.2 lbs/kg X Global Warming Potential / 2,000 lbs/ton

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	06/29/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	32.29	---
		(Normal Operating Emissions)	CO	34.40	---
			SO_2	12.90	---
			VOC	5.63	---
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	37.33	---
			H_2SO_4 [(a)]	9.31	---
			NH_3	41.83	---
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	43.96	---
		(Maximum Short-Term	CO	533.4	---
		Startup/Shutdown Emissions)	SO_2	76.83	---
			VOC	76.83	---
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	37.33	---
			H_2SO_4 [(a)]	9.31	---
			NH_3	41.83	---
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	---	122.86
		(Normal Operating and	CO	---	150.29
		Startup/Shutdown Emissions)	SO_2	---	24.07
			VOC	---	24.28
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	---	95.99
			H_2SO_4 [(a)]	---	16.23
			NH_3	---	156.99

NOX lb/hr represents a maximum hourly emission rate over a three-hour average.

(a) $PM / PM_{10} / PM_{2.5}$ from both front-half and back-half.

(b) $PM / PM_{10} / PM_{2.5}$ values include $(NH_4)_2SO_4$ emissions.

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	**06/29/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
C-TOWER1	C-TOWER1	Cooling Tower	PM	24.21	106.03
			PM_{10}	0.08	0.33
			$PM_{2.5}$	<0.01	<0.01
AUX-BLR	AUX-BLR	Auxiliary Boiler	NO_X	0.89	0.89
			CO	3.29	3.29
			SO_2	0.25	0.12
			VOC	0.48	0.48
			PM / PM_{10} / $PM_{2.5}$	0.66	0.66
GAS-HTR	GAS-HTR	Gas Heater	NO_X	0.12	0.51
			CO	0.36	1.57
			SO_2	0.027	0.06
			VOC	0.03	0.14
			PM / PM_{10} / $PM_{2.5}$	0.05	0.21
EMGEN	EMGEN	Emergency Diesel Generator	NO_X	2.20	0.55
			CO	11.51	2.88
			SO_2	0.02	<0.01
			VOC	0.18	0.04
			PM / PM_{10} / $PM_{2.5}$	0.10	0.02

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	**06/29/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
DSL-TNK	DSL-TNK	Emergency Diesel Generator Tank	VOC	0.02	< 0.01
FUG-SCR	FUG-SCR	Ammonia Component Fugitives	NH_3	0.02	0.0993
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	VOC	0.0024	0.0103
CBY51-LOV	CBY51-LOV	Unit 1 Lube Oil Vent	VOC	0.003	0.01
			$PM / PM_{10} / PM_{2.5}$	0.003	0.01
CBYST1-LOV	CBYST1-LOV	Steam Turbine 1 Lube Oil Vent	VOC	0.003	0.01
			$PM / PM_{10} / PM_{2.5}$	0.003	0.01
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	NO_X	<0.01	<0.01
			CO	<0.01	<0.01
			VOC	0.12	<0.01
			PM	0.05	<0.01
			PM_{10}	0.05	<0.01
			$PM_{2.5}$	0.05	<0.01
			NH_3	<0.01	<0.01

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	06/29/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	CO_2e		2,054,641.77
			CO_2		2,052,555.45
			CH_4		38.07
			N_2O		3.81
AUX-BLR	AUX-BLR	Auxiliary Boiler	CO_2e		10,425.48
			CO_2		10,414.71
			CH_4		0.20
			N_2O		0.02
GAS-HTR	GAS-HTR	Gas Heater	CO_2e		4,971.23
			CO_2		4,966.10
			CH_4		0.09
			N_2O		0.01
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	CO_2e		55.21
			CO_2		0.0050
			CH_4		2.21
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	CO_2e		2.69
			CO_2		0.0002
			CH_4		0.11

EPN = Emission Point Number
FIN = Facility Identification Number

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	06/29/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
EMGEN	EMGEN	Emergency Diesel Generator	CO_2e		592.12
			CO_2		590.09
			CH_4		0.02
			N_2O		0.005
SF6FUG	SF6FUG	SF6 Insulated Equipment	CO_2e		23.37
			SF_6		0.0010

EPN = Emission Point Number
FIN = Facility Identification Number

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	06/29/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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

AIR CONTAMINANT DATA			EMISSION POINT DISCHARGE PARAMETERS										
1. Emission Point			4. UTM Coordinates of Emission Point (NAD83)			Source 5. Building Height (ft)	6. Height Above Ground (ft)	7. Stack Exit Data			8. Fugitives		
EPN (A)	FIN (B)	NAME (C)	Zone	East (Meters)	North (Meters)			Diameter (ft) (A)	Velocity (fps) (B)	Temperature (°F) (C)	Length (ft) (A)	Width (ft) (B)	Axis Degrees (C)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	15	314,225	3,292,887		200	23	64.7	163			
C-TOWER1	C-TOWER1	Cooling Tower	15	314,275	3,292,865		45	20	15.0	100			
AUX-BLR	AUX-BLR	Auxiliary Boiler	15	314,224	3,292,891		200	4	36.0	299			
GAS-HTR	GAS-HTR	Gas Heater	15	314,149	3,292,824		50	2	23.5	250			
EMGEN	EMGEN	Emergency Diesel Generator	15	314,225	3,292,887		200	1	256.9	965			
DSL-TNK	DSL-TNK	Emergency Diesel Generator Tank	15	314,197	3,292,754		10	1	0.003	Ambient			
FUG-SCR	FUG-SCR	Ammonia Component Fugitives	15	314,206	3,292,858						161	201	4
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	15	314,215	3,292,802						266	207	1
CBY51-LOV	CBY51-LOV	Unit 1 Lube Oil Vent	15	314,236	3,292,832		30	0.003	0.003	Ambient			
CBYST1-LOV	CBYST1-LOV	Steam Turbine 1 Lube Oil Vent	15	314,192	3,292,798		30	0.003	0.003	Ambient			
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	15	314,169	3,292,734						633	460	8

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Simple Cycle Option

Date:	06/29/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
CBY51	CBY51	Combustion Turbine 1 (Simple Cycle)	NO_X	34.65	---
		(Normal Operating Emissions)	CO	29.54	---
			SO_2	10.81	---
			VOC	7.25	---
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	19.28	---
			H_2SO_4 [(a)]	7.12	---
			NH_3	51.31	---
CBY51	CBY51	Combustion Turbine 1 (Simple Cycle)	NO_X	38.10	---
		(Maximum Short-Term	CO	256.7	---
		Startup/Shutdown Emissions)	SO_2	10.81	---
			VOC	62.83	---
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	19.28	---
			H_2SO_4 [(a)]	7.12	---
			NH_3	51.31	---
CBY51	CBY51	Combustion Turbine 1 (Simple Cycle)	NO_X	---	65.14
		(Normal Operating and	CO	---	113.53
		Startup/Shutdown Emissions)	SO_2	---	10.16
			VOC	---	24.33
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	---	27.49
			H_2SO_4 [(a)]	---	6.69
			NH_3	---	95.64

NOX lb/hr represents a maximum hourly emission rate over a three-hour average.

(a) $PM / PM_{10} / PM_{2.5}$ from both front-half and back-half.

(b) $PM / PM_{10} / PM_{2.5}$ values include $(NH_4)_2SO_4$ emissions.

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Simple Cycle Option

Date:	**06/29/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
GAS-HTR	GAS-HTR	Gas Heater	NO_X	0.12	0.51
			CO	0.36	1.57
			SO_2	0.027	0.06
			VOC	0.03	0.14
			PM / PM_{10} / $PM_{2.5}$	0.05	0.21
EMGENSC	EMGENSC	Emergency Diesel Generator	NO_X	1.98	0.50
			CO	10.36	2.59
			SO_2	0.02	<0.01
			VOC	0.16	0.04
			PM / PM_{10} / $PM_{2.5}$	0.09	0.022
DSL-TNK	DSL-TNK	Emergency Diesel Generator Tank	VOC	0.02	< 0.01
FUG-SCR	FUG-SCR	Ammonia Component Fugitives	NH_3	0.02	0.0993
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	VOC	0.0024	0.0103
CBY51-LOV	CBY51-LOV	Unit 1 Lube Oil Vent	VOC	0.003	0.01
			PM / PM_{10} / $PM_{2.5}$	0.003	0.01

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Simple Cycle Option

Date:	**06/29/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	NO_X	<0.01	<0.01
			CO	<0.01	<0.01
			VOC	0.12	<0.01
			PM	0.05	<0.01
			PM_{10}	0.05	<0.01
			$PM_{2.5}$	0.05	<0.01
			NH_3	<0.01	<0.01

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Simple Cycle Option

Date:	**06/29/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
CBY51	CBY51	Combustion Turbine 1 (Simple Cycle)	CO_2e		865,715.66
			CO_2		864,836.60
			CH_4		16.04
			N_2O		1.60
GAS-HTR	GAS-HTR	Gas Heater	CO_2e		4,971.23
			CO_2		4,966.10
			CH_4		0.09
			N_2O		0.009
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	CO_2e		55.21
			CO_2		0.005
			CH_4		2.21
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	CO_2e		2.69
			CO_2		0.0002
			CH_4		0.11
EMGENSC	EMGENSC	Emergency Diesel Generator	CO_2e		530.06
			CO_2		528.25
			CH_4		0.003
			N_2O		0.004

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Simple Cycle Option

Date:	**06/29/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
SF6FUG	SF6FUG	SF6 Insulated Equipment	CO_2e		23.37
			SF_6		0.0010

EPN = Emission Point Number
FIN = Facility Identification Number

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Simple Cycle Option

Date:	06/29/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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

AIR CONTAMINANT DATA			EMISSION POINT DISCHARGE PARAMETERS											
1. Emission Point			4. UTM Coordinates of Emission Point (NAD83)			Source								
						5. Building Height (ft)	6. Height Above Ground (ft)	7. Stack Exit Data			8. Fugitives			
EPN (A)	FIN (B)	NAME (C)	Zone	East (Meters)	North (Meters)			Diameter (ft) (A)	Velocity (fps) (B)	Temperature (°F) (C)	Length (ft) (A)	Width (ft) (B)	Axis Degrees (C)
CBY51	CBY51	Combustion Turbine 1 (Simple Cycle)	15	314,227	3,292,889		200	31.33	108.6	825			
GAS-HTR	GAS-HTR	Gas Heater	15	314,149	3,292,824		50	2	23.5	250			
EMGENSC	EMGENSC	Emergency Diesel Generator	15	314,227	3,292,889		200	1	231.2	965			
DSL-TNK	DSL-TNK	Emergency Diesel Generator Tank	15	314,264	3,292,778		10	1	0.003	Ambient			
FUG-SCR	FUG-SCR	Ammonia Component Fugitives	15	314,191	3,292,856						160	279	8
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	15	314,196	3,292,796						275	300	5
CBY51-LOV	CBY51-LOV	Unit 1 Lube Oil Vent	15	314,191	3,292,856		30	0.003	0.003				
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	15	314,169	3,292,734						633	460	8

EPN = Emission Point Number
FIN = Facility Identification Number

TABLE 1F
AIR QUALITY APPLICATION SUPPLEMENT

Permit No.:	160538/PSDTX1582/GHGPSDTX204	Application Submittal Date:	06/29/2020
Company	NRG Cedar Bayou 5 LLC		
RN:	RN100825371	Facility Location:	7705 West Bay Road
City	Baytown	County:	Chambers
Permit Unit I.D.:	CBY51	Permit Name:	Cedar Bayou Electric Generating Station
Permit Activity:	☐ New Major Source	☑ Modification	
Project or Process Description: Addition of one combined cycle turbine			

Complete for all pollutants with a project emission increase.	**POLLUTANTS**								
	Ozone		**CO**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**H_2SO_4**	**CO_2e**
	VOC	**NOx**							
Nonattainment? (yes or no)	Yes	Yes	No	No	No	No	No	No	No
Existing site PTE (tpy)									
Proposed project increases (tpy from 2F)[3]	24.99	124.81	158.03	202.95	97.25	96.92	24.26	16.23	2,070,712
Is the existing site a major source?[2]	No								
If not, is the project a major source by itself? (yes or no)	Yes								
If site is major, is project increase significant? (yes or no)	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
If netting required, estimated start of construction:	12/31/20								
5 years prior to start of construction:	12/31/15	Contemporaneous							
Estimated start of operation:	6/1/22	Period							
Net contemporaneous change, including proposed project, from Table 3F (tpy)	24.99	124.81	158.03	202.95	97.25	96.92	24.26	16.23	2,070,711.86
FNSR applicable? (yes or no)	No	No (within PAL limit)	Yes	Yes	Yes	Yes	No	Yes	Yes

1. Other PSD pollutants
2. Nonattainment major source is defined in Table 1 in 30 TAC 116.12(11) by pollutant and county. PSD thresholds are found in 40 CFR §51.166(b)(1).

3. Sum of proposed emissions minus baseline emissions, increases only. Nonattainment thresholds are found in Table 1 in 30 TAC 116.12(11) and PSD thresholds in 40 CFR §51.166(b)(23).

The presentations made above and on the accompanying tables are true and correct to the best of my knowledge.

Signature Title Date

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]:	VOC	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

					A	B				
	Affected or Modified Facilities[2]		**Permit No.**	**Actual Emissions[3]**	**Baseline Emissions[4]**	**Proposed Emissions[5]**	**Projected Actual Emissions**	**Difference (B - A) [6]**	**Correction[7]**	**Project Increase[8]**
	FIN	**EPN**								
1	CBY51	CBY51	160538			24.28		24.28		24.28
2	AUX-BLR	AUX-BLR	160538			0.48		0.48		0.48
3	GAS-HTR	GAS-HTR	160538			0.14		0.14		0.14
4	EMGEN	EMGEN	160538			0.04		0.04		0.04
5	DSL-TNK	DSL-TNK	160538			0.0001		0.0001		0.0001
6	FUG-NGAS	FUG-NGAS	160538			0.01		0.01		0.01
7	CBY51-LOV	CBY51-LOV	160538			0.01		0.013		0.013
8	CBYST1-LOV	CBYST1-LOV	160538			0.01		0.01		0.01
9	FUG-MSS	FUG-MSS	160538			0.003		0.003		0.003
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			24.99

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]:	NOx	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	A Actual Emissions[3]	B Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			122.86		122.86		122.86
2	AUX-BLR	AUX-BLR	160538			0.89		0.89		0.89
3	GAS-HTR	GAS-HTR	160538			0.51		0.51		0.51
4	EMGEN	EMGEN	160538			0.55		0.55		0.55
5	FUG-MSS	FUG-MSS	160538			0.000001		0.000001		0.000001
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			124.81

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]:	CO	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	A Actual Emissions[3]	B Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			150.29		150.29		150.29
2	AUX-BLR	AUX-BLR	160538			3.29		3.29		3.29
3	GAS-HTR	GAS-HTR	160538			1.57		1.57		1.57
4	EMGEN	EMGEN	160538			2.88		2.88		2.88
5	FUG-MSS	FUG-MSS	160538			0.000001		0.000001		0.000001
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			158.03

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]:	PM	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3]	Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
				A	B					
1	CBY51	CBY51	160538			95.99		95.99		95.99
2	C-TOWER1	C-TOWER1	160538			106.03		106.03		106.03
3	AUX-BLR	AUX-BLR	160538			0.66		0.66		0.66
4	GAS-HTR	GAS-HTR	160538			0.21		0.21		0.21
5	EMGEN	EMGEN	160538			0.02		0.02		0.02
6	CBY51-LOV	CBY51-LOV	160538			0.01		0.01		0.01
7	CBYST1-LOV	CBYST1-LOV	160538			0.01		0.01		0.01
8	FUG-MSS	FUG-MSS	160538			0.001		0.001		0.001
9										
10										
11										
12										
13										
14										
15										
16										
							Page Subtotal[9]			202.95

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]: PM_{10}	**Permit:** 160538/PSDTX1582/GHGPSDTX204
Baseline Period: N/A **to**	

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3]	Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
				A	B					
1	CBY51	CBY51	160538			95.99		95.99		95.99
2	C-TOWER1	C-TOWER1	160538			0.33		0.33		0.33
3	AUX-BLR	AUX-BLR	160538			0.66		0.66		0.66
4	GAS-HTR	GAS-HTR	160538			0.21		0.21		0.21
5	EMGEN	EMGEN	160538			0.025		0.025		0.025
6	CBY51-LOV	CBY51-LOV	160538			0.01		0.01		0.01
7	CBYST1-LOV	CBYST1-LOV	160538			0.01		0.01		0.01
8	FUG-MSS	FUG-MSS	160538			0.001		0.001		0.001
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			97.25

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]:	$PM_{2.5}$	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	A Actual Emissions[3]	B Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			95.99		95.99		95.99
2	C-TOWER1	C-TOWER1	160538			0.001		0.001		0.001
3	AUX-BLR	AUX-BLR	160538			0.66		0.66		0.66
4	GAS-HTR	GAS-HTR	160538			0.21		0.21		0.21
5	EMGEN	EMGEN	160538			0.025		0.025		0.025
6	CBY51-LOV	CBY51-LOV	160538			0.01		0.01		0.01
7	CBYST1-LOV	CBYST1-LOV	160538			0.01		0.01		0.01
8	FUG-MSS	FUG-MSS	160538			0.001		0.001		0.001
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			96.92

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]:	SO_2	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3] A	Baseline Emissions[4] A	Proposed Emissions[5] B	Projected Actual Emissions B	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			24.07		24.07		24.07
2	AUX-BLR	AUX-BLR	160538			0.12		0.12		0.12
3	GAS-HTR	GAS-HTR	160538			0.06		0.06		0.06
4	EMGEN	EMGEN	160538			0.0060		0.0060		0.0060
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			24.26

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]: H_2SO_4	**Permit:** 160538/PSDTX1582/GHGPSDTX204
Baseline Period: N/A **to**	

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	A Actual Emissions[3]	B Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			16.23		16.23		16.23
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			16.23

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]:	CO_2e	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3] A	Baseline Emissions[4] A	Proposed Emissions[5] B	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			2,054,642		2,054,642		2,054,642
2	AUX-BLR	AUX-BLR	160538			10,425		10,425		10,425
3	GAS-HTR	GAS-HTR	160538			4,971.23		4,971.23		4,971.23
4	EMGEN	EMGEN	160538			592.12		592.12		592.12
5	FUG-NGAS	FUG-NGAS	160538			55.21		55.21		55.21
6	FUG-MSS	FUG-MSS	160538			2.69		2.69		2.69
7	SF6FUG	SF6FUG	160538			23.37		23.37		23.37
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			2,070,712

TABLE 1F
AIR QUALITY APPLICATION SUPPLEMENT

Permit No.:	160538/PSDTX1582/GHGPSDTX204	Application Submittal Date:	06/29/2020
Company	NRG Cedar Bayou 5 LLC		
RN:	RN100825371	Facility Location:	7705 West Bay Road
City	Baytown	County:	Chambers
Permit Unit I.D.:	CBY51	Permit Name:	Cedar Bayou Electric Generating Station
Permit Activity:	☐ New Major Source	☑ Modification	
Project or Process Description: Addition of one simple cycle turbine			

Complete for all pollutants with a project emission increase.	**POLLUTANTS**								
	Ozone		**CO**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**H_2SO_4**	**CO_2e**
	VOC	**NOx**							
Nonattainment? (yes or no)	Yes	Yes	No	No	No	No	No	No	No
Existing site PTE (tpy)									
Proposed project increases (tpy from 2F)[3]	24.54	66.14	117.69	27.74	27.74	27.74	10.23	6.69	871,298
Is the existing site a major source?[2]	No								
If not, is the project a major source by itself? (yes or no)	Yes								
If site is major, is project increase significant? (yes or no)	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes
If netting required, estimated start of construction:	12/31/20								
5 years prior to start of construction:	12/31/15	Contemporaneous							
Estimated start of operation:	6/1/22	Period							
Net contemporaneous change, including proposed project, from Table 3F (tpy)	24.54	66.14	117.69	27.74	27.74	27.74	10.23	6.69	871,298
FNSR applicable? (yes or no)	No	No (within PAL limit)	Yes	Yes	Yes	Yes	No	No	Yes

1. Other PSD pollutants
2. Nonattainment major source is defined in Table 1 in 30 TAC 116.12(11) by pollutant and county. PSD thresholds are found in 40 CFR §51.166(b)(1).

3. Sum of proposed emissions minus baseline emissions, increases only. Nonattainment thresholds are found in Table 1 in 30 TAC 116.12(11) and PSD thresholds in 40 CFR §51.166(b)(23).

The presentations made above and on the accompanying tables are true and correct to the best of my knowledge.

Signature Title Date

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	VOC	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3] A	Baseline Emissions[4] A	Proposed Emissions[5] B	Projected Actual Emissions B	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			24.33		24.33		24.33
2	GAS-HTR	GAS-HTR	160538			0.14		0.14		0.14
3	EMGEN	EMGEN	160538			0.04		0.04		0.04
4	DSL-TNK	DSL-TNK	160538			0.0001		0.0001		0.0001
5	FUG-NGAS	FUG-NGAS	160538			0.01		0.01		0.01
6	CBY51-LOV	CBY51-LOV	160538			0.01		0.013		0.013
7	FUG-MSS	FUG-MSS	160538			0.003		0.003		0.003
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			24.54

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	NOx	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	A Actual Emissions[3]	B Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			65.14		65.14		65.14
3	GAS-HTR	GAS-HTR	160538			0.51		0.51		0.51
4	EMGEN	EMGEN	160538			0.50		0.50		0.50
5	FUG-MSS	FUG-MSS	160538			0.000001		0.000001		0.000001
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			66.14

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	CO	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3] A	Baseline Emissions[4] A	Proposed Emissions[5] B	Projected Actual Emissions B	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			113.53		113.53		113.53
3	GAS-HTR	GAS-HTR	160538			1.57		1.57		1.57
4	EMGEN	EMGEN	160538			2.59		2.59		2.59
5	FUG-MSS	FUG-MSS	160538			0.000001		0.000001		0.000001
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			117.69

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	PM	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3]	Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
				A	B					
1	CBY51	CBY51	160538			27.49		27.49		27.49
4	GAS-HTR	GAS-HTR	160538			0.21		0.21		0.21
5	EMGEN	EMGEN	160538			0.022		0.022		0.022
6	CBY51-LOV	CBY51-LOV	160538			0.01		0.01		0.01
8	FUG-MSS	FUG-MSS	160538			0.001		0.001		0.001
9										
10										
11										
12										
13										
14										
15										
16										
							Page Subtotal[9]			27.74

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	PM_{10}	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	A Actual Emissions[3]	B Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			27.49		27.49		27.49
2	GAS-HTR	GAS-HTR	160538			0.21		0.21		0.21
3	EMGEN	EMGEN	160538			0.022		0.022		0.022
4	CBY51-LOV	CBY51-LOV	160538			0.01		0.01		0.01
5	FUG-MSS	FUG-MSS	160538			0.001		0.001		0.001
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			27.74

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	$PM_{2.5}$	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	A Actual Emissions[3]	B Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			27.49		27.49		27.49
2	GAS-HTR	GAS-HTR	160538			0.21		0.21		0.21
3	EMGEN	EMGEN	160538			0.022		0.022		0.022
4	CBY51-LOV	CBY51-LOV	160538			0.01		0.01		0.01
5	FUG-MSS	FUG-MSS	160538			0.001		0.001		0.001
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			27.74

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	SO_2	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3]	Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
				A	B					
1	CBY51	CBY51	160538			10.16		10.16		10.16
3	GAS-HTR	GAS-HTR	160538			0.06		0.06		0.06
4	EMGEN	EMGEN	160538			0.0054		0.0054		0.0054
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			10.23

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	H_2SO_4	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3]	Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
				A	B					
1	CBY51	CBY51	160538			6.69		6.69		6.69
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			6.69

TABLE 2F
PROJECT EMISSION INCREASE
SIMPLE CYCLE OPTION

Pollutant[1]:	CO_2e	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	Actual Emissions[3] A	Baseline Emissions[4] A	Proposed Emissions[5] B	Projected Actual Emissions B	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			865,716		865,716		865,716
3	GAS-HTR	GAS-HTR	160538			4,971.23		4,971.23		4,971.23
4	EMGEN	EMGEN	160538			530.06		530.06		530.06
5	FUG-NGAS	FUG-NGAS	160538			55.21		55.21		55.21
6	FUG-MSS	FUG-MSS	160538			2.69		2.69		2.69
7	SF6FUG	SF6FUG	160538			23.37		23.37		23.37
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			871,298

Krenek, Colleen

From: Ruth Alvirez <ruth.alvirez@tceq.texas.gov>
Sent: Wednesday, May 6, 2020 11:33 AM
To: Krenek, Colleen
Subject: RE: NOD Letter

Colleen,

This is a hold over from when EPA wrote the GHG permits which we incorporated into our permits. However, while it is mentioned in the rule but doesn't seem to require monitoring, so if NRG would like I can removed it.

Ruth

Ruth Alvirez
TCEQ/OA/APD/Working Hard
Ruth.Alvirez@TCEQ.Texas.Gov
MC-163
(512)239-5220

From: Krenek, Colleen <Colleen.Krenek@nrg.com>
Sent: Tuesday, May 5, 2020 10:54 AM
To: Ruth Alvirez <ruth.alvirez@tceq.texas.gov>
Subject: NOD Letter

Ruth,

Could you please provide some clarification on what you want on item number 4? It just says, "Please provide the heat rate for the turbine."

Thanks!

Colleen Krenek
Environmental Specialist
910 Lousiana
Houston, TX 77002
Office: 713-537-5742
Cell: 979-533-2470

POWER ENGINEERS

POWER ENGINEERS, INC.
2600 VIA FORTUNA
SUITE 450
AUSTIN, TX 78746 USA

PHONE 512-329-5544
FAX 512-329-8253

August 6, 2020

Mr. Robert Scalise via email
Texas Commission on Environmental Quality
Air Dispersion Modeling Team, Air Permits Division
Air Permits Initial Review Team (MC 161)
12100 Park 35 Circle
Austin, TX 78753

Subject: Response to Modeling Comments
Permit Nos. 160538 / PSD-TX-1582
NRG Cedar Bayou 5 LLC
Cedar Bayou Electric Generating Station
Regulated Entity Number RN100825371

Dear Mr. Scalise:

On behalf of NRG Cedar Bayou 5 LLC (CB5), POWER Engineers, Inc. (POWER) submits the enclosed responses to your questions regarding the July 2020 Air Quality Analysis (AQA) received in your July 30, 2020, email message. A response to these comments follows.

If you have any further questions concerning the modeling protocol, please contact me at 512-579- 3820 or at david.castro@powereng.com.

Sincerely,
POWER Engineers, Inc.

David L. Castro
Senior Air Quality Specialist

Enclosure

c: Mr. Craig Eckberg, NRG Power
Ms Colleen Krenek, NRG Power
Mr. Larry Moon, P.E., POWER Engineers, Inc.
EPA Region 6, Dallas, Texas (via email to R6AirPermitsTX@epa.gov)

Texas Commission on Environmental Quality
August 6, 2020

Responses to TCEQ Comments

1. Please provide detailed calculations of the intermittent emission rates used in the SO2 and NO2 analyses for the modeled emergency equipment. There is a tab for this in the EMEW.

   Response: A single diesel-fired engine is proposed as part of this project (combined cycle EPN EMGEN or simple cycle EPN EMGENSC). This engine has been labeled as an emergency engine on the Table 1a. However, this engine will be able of operating continuously for lengthy periods. It is not assumed to be an intermittent source in this AQA.

   There are three existing diesel fuel-fired emergency generators on site (EPNs CBY1EDG, CBY2EDG and BS-GEN). $PM_{2.5}$ emissions associated with the emergency readiness testing of these engines were modeled in the full-impact NAAQS and PSD increment consumption analyses. The hourly SO_2 emissions associated with readiness testing was also modeled in the state property line analysis. Hourly SO_2 and NO_2 emissions associated with intermittent operations were not included in any of the required analyses. Therefore, detailed hourly SO_2 and NO_2 emission rate calculations corresponding to intermittent operations are not required for this AQA.

2. The plot plan identifies several large area sources that were not included in the modeling. Please explain.

   Response: The plot plans for each turbine scenario illustrate three fugitive sources: FUG-NG, FUG-SCR and FUG-MSS. As customary, these sources are illustrated using areas representing possible locations for these fugitive emissions might occur. Following TCEQ modeling guidance, these fugitives were not modeled as being emitted equally across the entire fugitive area. Instead, these fugitives were modeled using conservative assumptions correspond to possible exhaust scenarios.

   The modeling of these fugitives is described in AQA Section 6.4.2.4. The modeling IDs utilized for each of these fugitive sources are summarized in the table included as AQA Appendix Y. Note that the only emissions associated with EPN FUG-NG are natural gas.

3. Building IDs BOIL1_2 and BOIL3 appear to correspond to porous structures that would not inhibit airflow. In addition, several structures in the vicinity of these building IDs and the surrounding point sources, such as tanks on the north side and several buildings on the east and south sides, were not included in the modeling. Please verify that all applicable buildings were included in modeling and revise the analysis if necessary.

   Response: The equipment within that area is not porous and includes the following equipment:

   - Two boilers, each 57 ft wide x 36 ft deep x 200 ft height;
   - SCR Duct from each boiler, 150 ft in length, 24 ft wide, 45 ft tall;
   - Two horizontal deaerator tanks, each 8 ft. diameter x 39.33 ft length
   - Two horizontal boiler feed tanks, each 12 ft diameter x 54 ft length

- Steam turbine, 154 ft long x 22 ft wide x18 ft height
- Condenser, 65 ft long x 30 ft wide x 40 ft tall
- Steam piping with outside diameters of either 2 ft, 3.2 ft or 3.3 ft.

These boiler structures have been recognized as major downwash structures in the modeling of electrical generating facilities for several decades. Additionally, these identical structures were approved by the TCEQ as appropriate downwash structures in the most recent PSD AQA submitted by this facility (NRG Texas Power LLC) on March 3, 2014.

The boiler structures are extremely large and are the dominant downwash structure for all sources within (approximately) 300 meters. Only the proposed CB5 sources fall outside of these structures' downwash zone. The deaerator tanks, boiler feed water tanks and other structures (buildings) are much smaller in size. The BPIP-calculated downwash parameters for Unit 1 and Unit 2 sources would not be significantly affected by the inclusion of these minor structures.

4. Modeled emission rates and parameters were reported for point source IDs CBYMSS41, CBYMSS42, CCBY51SS, CMSSCEMS, FUG_NH31, and FUG_NH34, however these sources were not included in the modeling. Please explain.

Response: Each of the tables provided in the AQA Appendix include the proposed and existing sources at the Cedar Bayou Station. The modeled emission rates are listed only on the tables provided as Appendix Q, R, S, and T. Additionally, the modeled emissions for State NSR analysis pollutants are summarized within the two EMEWs.
In response to this question, POWER has reviewed the modeling input data files and confirmed that the applicable emissions associated with these sources have been modeled. Specifically:

- SCBY51SS and CCBY51SS correspond to NO_X and CO emissions associated with startup/shutdown operations for the proposed electric generating Unit 5. These emissions are included in the preliminary modeling runs (Runs 104, 108, 109-118, 119 and 120). Project-related NO_X and CO impacts were less than the SIL. No additional NO_X or CO modeling was required.
- SMSSCEMS (and SMSSCEMS) correspond to NO_X and CO emissions associated with CEMS maintenance testing. These emissions are included in preliminary modeling runs (Runs 101-122). Project-related NO_X and CO impacts were less than the SIL. No additional NO_X or CO modeling was required.
- CBYMSS41 and CBYMSS42 correspond to NO_X and CO emissions associated with startup/shutdown operations for the existing electric generating Unit 4. Project-related NO_X and CO impacts were less than the SIL. Therefore, these emissions were not required to be included in any modeling.
- FUG_NH31 and FUG_NH34 correspond to ammonia fugitive emissions associated with existing Units 1 and 2 and existing Unit 4. Project-related ammonia emissions met the MERA guidance conditions. No additional ammonia modeling was required. Therefore, these emissions were not required to be included in any modeling.

Table A-2
Emission Calculations - Maximum Hourly Turbine
Normal Operating Conditions
M501JAC Combined Cycle - Single Unit
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

OPERATING CONDITIONS:		Case 1	Case 13	Case 14	Case 16	Case 18	Case 24	Case 25	Case 26	Case 28
		Fired Base Evap On	Fired Base Evap On	Base Evap On	75% Load Evap Off	MECL 35% Load Evap Off	Fired Base Evap Off	Base Evap Off	75% Load Evap Off	MECL 41.9% Load Evap Off
		Input	Input	Input	Input	Input				
Ambient Dry Bulb Temperature	ºF	97	59	59	59	59	10	10	10	10
Ambient Relative Humidity	%	45	60	60	60	60	75	75	75	75
Ambient Pressure	psia	14.685431	14.685431	14.685431	14.685431	14.685431	14.685431	14.685431	14.685431	14.685431
NATURAL GAS FUEL PROPERTIES:										
Natural Gas Fuel	BTU/lb - HHV	23,643	23,643	23,643	23,643	23,643	23,643	23,643	23,643	23,643
Heating Value, Natural Gas	BTU/scf - HHV	1022	1022	1022	1022	1022	1022	1022	1022	1022
Natural Gas MW	lb/lbmole	16.41	16.41	16.41	16.41	16.41	16.41	16.41	16.41	16.41
Sulfur Content, Natural Gas 1-Hr	grains S/100 scf	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sulfur Content, Natural Gas Annual	grains S/100 scf	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
CTG EFFECTS:										
Evaporative cooler On/Off		On	On	On	Off	Off	Off	Off	Off	Off
Evaporative cooler effectiveness	%	90	90	90	0	0	0	0	0	0
GT output power	kW	687,485	710,427	630,237	488,077	290,662	724,203	642,646	520,656	346,229
Heat Input	MMBTU/hr - HHV	3,657.0	3,794.8	3,797.1	3,003.5	2,044.4	3,885.5	3,889.0	3,238.9	2,395.9
DUCT BURNER EFFECTS:										
Duct Burner Heat Rate	MMBTU/hr - HHV	784	694	0	0	0	733	0	0	0
DB Fuel Flow	lb/hr	33,139	29,359	0	0	0	30,991	0	0	0
DB Fuel Flow	scf/hr	766,733	679,270	0	0	0	717,036	0	0	0
DB Fuel Flow	mol/hr	2,019	1,789	0	0	0	1,888	0	0	0
CTG & DUCT BURNER COMBINED EXHAUST:										
HRSG stack exhaust gas mass flow	lb_m/hr	5,810,739	5,997,649	5,971,080	4,854,180	3,919,860	6,016,626	5,989,440	5,220,360	4,303,380
HRSG stack gas temperature	°F	171.9	169.0	178.0	171.7	165.3	162.7	176.2	174.4	169.3
HRSG stack gas N2 volume percentage	%	71.50	72.98	73.54	73.80	74.29	73.67	74.25	74.43	74.74
HRSG stack gas O2 volume percentage	%	8.58	9.01	10.63	10.95	12.38	8.87	10.53	11.00	11.95
HRSG stack gas CO2 volume percentage	%	5.35	5.35	4.61	4.49	3.84	5.51	4.75	4.53	4.10
HRSG stack gas H2O volume percentage	%	13.66	11.74	10.29	9.83	8.55	11.03	9.54	9.10	8.27
HRSG stack gas Ar volume percentage	%	0.90	0.92	0.93	0.93	0.94	0.92	0.93	0.94	0.94
HRSG stack gas O2 volume percentage - Dry Basis	%	9.94	10.21	11.85	12.14	13.54	9.97	11.64	12.10	13.03
HRSG stack gas molecular weight		27.95	28.17	28.26	28.30	28.38	28.26	28.35	28.38	28.43
HRSG stack PM	lb/hr	24.19	24.22	14.95	12.01	8.85	24.78	15.16	12.96	6.76
Exit Flow Rate	lb_{mol}/hr	207,862	212,942	211,305	171,540	138,121	212,932	211,257	183,944	151,356
Exit Flow Rate	lb_{mol}/hr - dry	179,464	187,937	189,562	154,678	126,312	189,440	191,103	167,205	138,838
Exit Flow Rate	scf/hr	80,130,750	82,089,297	81,458,239	66,128,787	53,245,820	82,085,250	81,439,525	70,910,348	58,347,569
Exit Flow Rate	scf/hr - dry	69,183,477	72,449,745	73,076,186	59,628,327	48,693,302	73,029,205	73,670,195	64,457,506	53,522,225
CTG & DUCT BURNER COMBINED EXHAUST:										
NO_X	ppmvd@15%O_2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
NO_X	ppmvd	3.71631	3.62492	3.06804	2.96823	2.49578	3.70473	3.13881	2.98264	2.66869
NO_X as NO_2	lb/hr	30.68	31.34	26.76	21.12	14.50	32.29	27.60	22.94	17.05
CO	ppmvd@15%O_2	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
CO	ppmvd	6.50	6.34	5.37	5.19	4.37	6.48	5.49	5.22	4.67
CO	lb/hr	32.69	33.39	28.51	22.51	15.45	34.40	29.40	24.45	18.16
VOC, as CH_4	ppmvd@15%O_2	1	1	0.9	0.9	0.9	1	0.9	0.9	0.9
VOC, as CH_4	ppmvd	1.86	1.81	1.38	1.34	1.12	1.85	1.41	1.34	1.20
VOC, as CH_4	lb/hr	5.35	5.46	4.20	3.31	2.28	5.63	4.33	3.60	2.67
H_2CO	ppmvd@15%O_2	91.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0	91.0
H_2CO	ppmvd	169.09	164.93	139.60	135.05	113.56	168.57	142.82	135.71	121.43
H_2CO	lb/hr	0.91	0.93	0.79	0.63	0.43	0.96	0.82	0.68	0.51
NH_3	ppmvd@15%O_2	7	7	7	7	7	7	7	7	7
NH_3	ppmvd	13.01	12.69	10.74	10.39	8.74	12.97	10.99	10.44	9.34
NH_3	lb/hr	39.75	40.61	34.67	27.37	18.79	41.83	35.75	29.73	22.08
SO_2, Maximum Hourly	lb/hr	12.40	12.54	10.61	8.39	5.71	12.90	10.86	9.05	6.69
SO_2, Annual Average	lb/hr	6.20	6.27	5.30	4.19	2.86	6.45	5.43	4.52	3.35
SO_2 to SO_3 Conversion in Turbine	%	5	5	5	5	5	5	5	5	5
SO_2 to SO_3 Conversion in Duct Burner	%	10	10	0	0	0	10	0	0	0
SO_2 to SO_3 Conversion in Catalyst Beds	%	40	40	40	40	40	40	40	40	40
H_2SO_4, Maximum Hourly (100% converted SO_3)	lb/hr	8.92	9.06	6.98	5.52	3.76	9.31	7.15	5.96	4.41
H_2SO_4, Annual Average (100% converted SO_3)	lb/hr	4.46	4.53	3.49	2.76	1.88	4.66	3.58	2.98	2.20
$(NH_4)_2SO_4$, Maximum Hourly (100% converted SO_3)	lb/hr	12.02	12.20	9.41	7.44	5.07	12.55	9.63	8.02	5.94
$(NH_4)_2SO_4$, Annual Average (100% converted SO_3)	lb/hr	6.01	6.10	4.70	3.72	2.53	6.27	4.82	4.01	2.97
PM FH+BH, Maximum Hourly (including Sulfates)	lb/hr	36.21	36.42	24.36	19.45	13.91	37.33	24.79	20.98	12.69
PM FH+BH, Annual Average (including Sulfates)	lb/hr	30.20	30.32	19.66	15.73	11.38	31.06	19.97	16.97	9.72

Revised 06/29/2020

Table A-3
Sample Emission Calculations
M501JAC Combined Cycle Turbine
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Case 24		
Exhaust Flow Rate	6,016,626	lb/hr
Exhaust Flow MW	28.26	lb/lbmole
CTG Heat Input	3,886	MMBtu / hr, HHV
DB Heat Input.	733	MMBtu / hr, HHV
Natural Gas	1,021.9	Btu / scf, HHV
Exhaust Content	8.87	% O2 wet
Exhaust Content	11.03	% H2O

Exhaust Flow = $\frac{6{,}016{,}626 \text{ lb exhaust}}{\text{hr}} \left| \frac{\text{lbmole}}{28.26 \text{ lb}} \right| \frac{1}{1 - (11.03\% \text{ H2O})/100)}$ = 189,440.2 lbmole/hr (dry)

Convert Oxygen Concentration to Dry Basis

$O_2 = \frac{8.87 \text{ \% O2 wet}}{(1 - (11.03 \text{ \% H20}) /100))}$ = 9.97 % dry

Natural Gas Usage

CTG NG Flow = $\frac{3{,}886 \text{ MMBtu HHV}}{\text{hr}} \left| \frac{1{,}000{,}000 \text{ Btu}}{\text{MMBtu}} \right| \frac{\text{scf}}{1{,}021.9 \text{ MMBtu HHV}}$ = 3,802,397.2 scfh

DB NG Flow = $\frac{733 \text{ MMBtu HHV}}{\text{hr}} \left| \frac{1{,}000{,}000 \text{ Btu}}{\text{MMBtu}} \right| \frac{\text{scf}}{1{,}021.9 \text{ MMBtu HHV}}$ = 717,036.4 scfh

Total NG Flow = 3,802,397.2 scfh + 717,036.4 scfh = 4,519,433.7 scfh

Gaseous Pollutant Sample Calculation - Oxides of Nitrogen (NOx)

Emission Factor 2.0 ppmvd NOx @ 15% O_2

NO_2 MW 46.01 lb / lb_{mole}

Emission Factor Corrected for Actual Oxygen Concentration - Oxides of Nitrogen

Emission Factor = $\frac{2.0 \text{ ppmd @ 15\%}}{} \left| \frac{(20.9 - 9.97 \text{ O2\% dry})}{(20.9 - 15)} \right.$ = 3.7 ppmvd NOx

Emission Rate Calculation - Oxides of Nitrogen

ST Emissions = $\frac{3.7 \text{ lbmole NOx}}{1{,}000{,}000 \text{ lbmole exhaust}} \left| \frac{189{,}440 \text{ lbmole exhaust}}{\text{hr}} \right| \frac{46.01 \text{ lb NOx/lb mole}}{\text{lbmole NOx}}$ = 32.29 lb/hr NOx as NO2

Gaseous Pollutant Sample Calculation - Carbon Monoxide (CO)

Emission Factor 3.5 ppmvd CO @ 15% O_2

CO MW 28.01 lb / lb_{mole}

Emission Factor Corrected for Actual Oxygen Concentration - Carbon Monixide

Emission Factor = $\frac{3.5 \text{ ppmd @ 15\%}}{} \left| \frac{(20.9 - 9.97 \text{ O2\% dry})}{(20.9 - 15)} \right.$ = 6.48 ppmvd CO

Emission Rate Calculation - Carbon Monoxide

ST Emissions = $\frac{6.48 \text{ lbmole CO}}{1{,}000{,}000 \text{ lbmole exhaust}} \left| \frac{189{,}440 \text{ lbmole exhaust}}{\text{hr}} \right| \frac{28.01 \text{ lb CO/lb mole}}{\text{lbmole CO}}$ = 34.4 lb/hr CO

Gaseous Pollutant Sample Calculation - Volatile Organic Compound (VOC)

Emission Factor 1.0 ppmvd VOC @ 15% O_2

VOC MW 16.04 lb / lb_{mole}

Emission Factor Corrected for Actual Oxygen Concentration - VOC

Emission Factor = $\frac{1.0 \text{ ppmd @ 15\%}}{} \left| \frac{(20.9 - 9.97 \text{ O2\% dry})}{(20.9 - 15)} \right.$ = 1.85 ppmvd VOC

Emission Rate Calculation - VOC

ST Emissions = $\frac{1.85 \text{ lbmole VOC}}{1{,}000{,}000 \text{ lbmole exhaust}} \left| \frac{189{,}440 \text{ lbmole exhaust}}{\text{hr}} \right| \frac{16.04 \text{ lb VOC/lb mole}}{\text{lbmole VOC}}$ = 5.63 lb/hr VOC

Table A-3
Sample Emission Calculations
M501JAC Combined Cycle Turbine
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Sample Calculation - Sulfur Dioxide (SO_2), Sulfuric Acid (H_2SO_4) and Ammonium Sulfate $(NH_4)_2SO_4$

Emission Factor	1	grain S / 100 scf, Natural Gas, Max Hourly
Emission Factor	0.5	grain S / 100 scf, Natural Gas, Annual Average
S MW	32.06	lb / lb_{mole}
SO_2 MW	64.06	lb / lb_{mole}
H_2SO_4 MW	98.07	lb / lb_{mole}
$(NH_4)_2SO_4$ MW	132.13	lb / lb_{mole}

Sample Calculation - Sulfur Dioxide (SO_2)

CTG/DB ST Emissions = (1 grain S / 100 scf) × (lb / 7000 grain) × (4,519,434 Total NG scf / hr) × (64.06 lbmole SO2 / 32.06 lbmole S) = 12.9 lb/hr SO2

Sample Calculation - Sulfuric Acid (H_2SO_4)

SO2 to SO3 Conversion in Turbine	5	%
SO2 to SO3 Conversion in Duct Burner	10	%
SO2 to SO3 Conversion in Catalyst Beds	40	%

Turbine Conversion = (1 grain S / 100 scf) × (lb S / 7000 grain) × (3,802,397 scf NG to CGT / hr) × (lbmole SO2 / 32.06 lb S)

(5/100) lbmole SO3 / lbmole SO2 × lbmole H2SO4 / lbmole SO3 × 98.07 lb H2SO4 / lbmole H2SO4 = 0.8 lb/hr H2SO4

Duct Burner Conversion = (1 - (5/100)) × (3,802,397 scf NG to CGT / hr) × (1 grain S / 100 scf) × (lb S / 7000 grain) × (lbmole SO2 / 32.06 lb S)

(10/100) lbmole SO3 / lbmole SO2 × lbmole H2SO4 / lbmole SO3 × 98.07 lb H2SO4 / lbmole H2SO4 = 1.6 lb/hr H2SO4

Catalyst Bed Conversion = ((1 - (5 + 10)/100)) * 3,802,397) scf NG to CGT + 717,036 scf NG to DB / hr × (1 grain S / 100 scf) × (lb S / 7000 grain)

lbmole SO2 / 32.06 lb S × (40/100) lbmole SO3 / lbmole SO2 × lbmole H2SO4 / lbmole SO3 × 98.07 lb H2SO4 / lbmole H2SO4 = 6.9 lb/hr H2SO4

Total H2SO4 = 0.8 lb/hr + 1.6 lb/hr +6.9 lb/hr = 9.3 lb/hr H2SO4

Sample Calculation - Ammonium Sulfate ($(NH_4)_2SO_4$)

Assume 100% of H_2SO_4.converts to $(NH_4)_2SO_4$.

ST Emissions = (9.3 lb H2SO4 / hr) × (lbmole H2SO4 / 98 lb H2SO4) × (lbmole (NH4)2SO4 / lbmole H2SO4) × (132 lb (NH4)2SO4 / lbmole (NH4)2SO4)

= 12.55 lb/hr (NH4)2(SO4) lb/hr

Sample Calculation - Particulate Matter ($PM_{10}/PM_{2.5}$)

CTG Emission Rate =	24.78	lb/hr, front and back half, vendor supplied
(NH4)2SO4 Emissions =	12.55	lb/hr
Total PM =	37.33	lb/hr

Table A-6
Hourly Emission Summary
Normal Operating Conditions
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

M501JAC Combined Cycle

Pollutant	Maximum For Averaging Period	Single Turbine (lb/hr)					
		Maximum Hourly	MSS Max Hourly (Cold Start)			Annual	Annual
		Case 24 Fired Base Evap Off 10 °F lb/hr	MSS Emissions lbs	MSS Duration minutes	First Hour Emissions MSS/Routine lb/hr	Case 13 Duct Fired Base Evap On 59 °F lb/hr	Case 14 No Duct Firing Base Evap On 59 °F lb/hr
NO_X	1-Hour	32.29	22	19	43.96		
	Annual					31.34	26.76
CO	1-Hour	34.40	510	19	533.39		
	Annual					33.39	28.51
VOC	1-Hour	5.630	73	19	76.83		
	Annual					5.46	4.20
SO_2	1-Hour	12.90					
	Annual					6.27	5.30
Particulates (FH&BH)	1-Hour	37.33					
	Annual					30.32	19.66
H_2SO_4	1-Hour	9.31					
	Annual					4.53	3.49
NH_3	1-Hour	41.83					
	Annual					40.61	34.67
$(NH_4)_2SO_4$	1-Hour	12.55					
	Annual					6.10	4.70

M501JAC Simple Cycle

Pollutant	Maximum For Averaging Period	Single Turbine				
		Maximum Hourly	MSS Max Hourly (Cold Start)			Annual
		Case 22 Base Load; 10 F lb/hr	MSS Emissions lbs	MSS Duration minutes	First Hour Emissions MSS/Routine lb/hr	Case 13 Base Load; 59 F lb/hr
NO_X	1-Hour	34.65	15	20	38.10	
	Annual					33.56
CO	1-Hour	29.54	237	20	256.69	
	Annual					28.60
VOC	1-Hour	7.250	58	20	62.83	
	Annual					7.02
SO_2	1-Hour	10.81				
	Annual					5.28
Particulates (FH&BH)	1-Hour	19.28				
	Annual					14.28
H_2SO_4	1-Hour	7.12				
	Annual					3.48
NH_3	1-Hour	51.31				
	Annual					49.69
$(NH_4)_2SO_4$	1-Hour	9.59				
	Annual					4.68

Notes:
1. VOCs are non-methane, non-ethane as CH_4.
2. Particulates are front and back half by EPA Method 5/202 and include condensables.

Table A-7
Gas Turbine Annual Emission Summary
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Annual Emissions for M501JAC Combined Cycle

Annual Operating Hours with Duct Firing[1]: 1910.0
Annual Operating Hours without Duct Firing: 6819.9
Annual SS Operating Hours[1]: 30.1

Pollutant	Annual Emissions Based on 1,910.0 hrs/yr of Normal Operations with Duct Firing tons/yr	Annual Emissions Based on 6,819.9 hrs/yr of Normal Operations without Duct Firing tons/yr	Estimated Annual Emissions From SS Operations tons/yr	Estimated SS Annual Operating Hours[1,2] hrs/yr	Combined Routine/MSS Annual Emissions tons/yr
NO_X	29.93	91.24	1.69	30.1	122.86
CO	31.89	97.21	21.19	30.1	150.29
VOC	5.22	14.32	4.75	30.1	24.28
SO_2	5.99	18.08	---	---	24.07
$PM/PM_{10}/PM_{2.5}$	28.96	67.03	---	---	95.99
H_2SO_4	4.32	11.90	---	---	16.23
$(NH_4)_2SO_4$	5.83	16.04	---	---	21.87
NH_3	38.78	118.21	---	---	157

Notes:

1. The annual hours used in these calculations are estimates for purposes of calculating annual emissions. They are not represente as being the maximum operating hours for each of the three operating modes. The total annual combined cycle combustion turbir firing rate is represented to be 34,538,193 MMBtu/yr
2. Only emissions of NOx, CO, and VOC are shown in the startup/shutdown columns as emissions of other pollutants are expected to be less than during normal operation.

Annual Emissions for M501JAC Simple Cycle

Annual Operating Hours[1]: 3850

Pollutant	Annual Emissions Based on 3,850 hrs/yr of Normal Operations tons/yr	Estimated Annual Emissions From SS Operations tons/yr	Estimated SS Annual Operating Hours[1,2] hrs/yr	Combined Routine/MSS Annual Emissions tons/yr
NO_X	64.59	1.84	77	65.14
CO	55.06	59.57	77	113.53
VOC	13.52	11.09	77	24.33
SO_2	10.16	---	---	10.16
$PM/PM_{10}/PM_{2.5}$	27.49	---	---	27.49
H_2SO_4	6.69	---	---	6.69
$(NH_4)_2SO_4$	9.01	---	---	9.01
NH_3	95.64	---	---	95.64

Notes:

1. The annual hours used in these calculations are estimates for purposes of calculating annual emissions. They are not represente as being the maximum operating hours for each of the two operating modes. The total annual simple cycle combustion turbine firing rate is represented to be 14,552,539 MMBtu/yr
2. Only emissions of NOx, CO, and VOC are shown in the startup/shutdown columns as emissions pollutants are expected to be less than during normal operation.

Table A-12A
Diesel-Fired Emergency Generator (Combined Cycle Option) - Emission Calculations
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Assumptions:

Max Daily Operating Schedule	1	hours/day
Annual Operating Schedule	500	hours/year
Power Rating	2,000	bhp
Fuel Consumption	104.90	gal/hr
Density of No. 2 Fuel Oil:	7.67	lb/gal
Max Fuel Consumption	804.9	lb fuel/hr
Heating Value of No. 2 Fuel Oil:	0.138	MMBtu/gal
Max Heat Input:	14.48	MMBtu/hr
Maximum Sulfur Content (S)	15.00	ppmw

Calculations:

Emission Rate = Emission Factor * Power rating * hours of operation / averaging period

Pollutant	Emission	Units	Max Hourly Emission Rate lb/hr	Max. Annual Emission Rate ton/yr
NO_x [1]	0.50	g/HP-hr	2.20	0.55
CO [1]	2.61	g/HP-hr	11.51	2.88
VOC [2]	0.04	g/HP-hr	0.18	0.04
PM/PM_{10} [1]	0.022	g/HP-hr	0.10	0.02
SO_2 [2]	Mass Balance		0.0241	0.0060

Sample Calculations:

NO_x lb/hr = 0.499819841057291 g/HP-hr * 2,000 bhp * lb/453.6g = 2.20 lb/hr

CO lb/hr = 2.61099916970226 g/HP-hr * 2,000 bhp * lb/453.6g = 11.51 lb/hr

VOC lb/hr = 0.04 g/HP-hr * 2,000 bhp * lb/453.6g = 0.18 lb/hr

PM lb/hr = 0.0223799928831623 g/HP-hr * 2,000 bhp * lb/453.6g = 0.10 lb/hr

SO_2 lb/hr = 805 lb fuel/hr * 15 lb S/1,000,000 lb fuel * lbmol S/32 lb S * 64 lb SO2/lbmol SO2

SO_2 lb/hr = 0.024 lb/hr

Notes:

1. Tier 4 Exhaust Standard for Generator Sets after the 2014 Model Year, 40 CFR 1039.101(b)
2. Manufacturer specifications
3. Calculated based on maximum fuel sulfur content and max fuel consumption.

Stack Parameters			
Stack diameter ft	Exhaust Flow acfm wet	Temperature °F	Velocity ft/sec
1.00	12,105.0	965	256.88

Table A-12B
Diesel-Fired Emergency Generator (Simple Cycle Option) - Emission Calculations
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Assumptions:

Max Daily Operating Schedule	1	hours/day
Annual Operating Schedule	500	hours/year
Power Rating	1,800	bhp
Fuel Consumption	93.9	gal/hr
Density of No. 2 Fuel Oil	7.67	lb/gal
Max Fuel Consumption	720.5	lb fuel/hr
Heating Value of No. 2 Fuel Oil	0.138	MMBtu/gal
Max Heat Input	12.96	MMBtu/hr
Maximum Sulfur Content (S)	15.00	ppmw

Calculations:

Emission Rate = Emission Factor * Power rating * hours of operation / averaging period

Pollutant	Emission	Units	Max Hourly Emission Rate lb/hr	Max. Annual Emission Rate ton/yr
NO_x [1]	0.50	g/HP-hr	1.98	0.50
CO [1]	2.61	g/HP-hr	10.36	2.59
VOC [1]	0.04	g/HP-hr	0.16	0.040
PM/PM_{10} [1]	0.022	g/HP-hr	0.09	0.022
SO_2 [2]	Mass Balance		0.0216	0.0054

Sample Calculations:

NO_x lb/hr = 0.499819841057291 g/HP-hr * 1,800 bhp * lb/453.6g = 1.98 lb/hr

CO lb/hr = 2.61099916970226 g/HP-hr * 1,800 bhp * lb/453.6g = 10.36 lb/hr

VOC lb/hr = 0.04 g/HP-hr * 1,800 bhp * lb/453.6g = 0.16 lb/hr

PM lb/hr = 0.0223799928831623 g/HP-hr * 1,800 bhp * lb/453.6g = 0.09 lb/hr

SO_2 lb/hr = 721 lb fuel/hr * 15 lb S/1,000,000 lb fuel * lbmol S/32 lb S * 64 lb SO2/lbmol SO2

SO_2 lb/hr = 0.022 lb/hr

Notes:

1. Manufacturer specifications
2. Calculated based on maximum fuel sulfur content and max fuel consumption.

Stack Parameters			
Stack diameter ft	Exhaust Flow acfm wet	Temperature °F	Velocity ft/sec
1.00	10,894.5	965	231.19

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	09/01/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	32.29	---
		(Normal Operating Emissions)	CO	34.40	---
			SO_2	12.90	---
			VOC	5.63	---
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	37.33	---
			H_2SO_4 [(a)]	9.31	---
			NH_3	41.83	---
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	43.96	---
		(Maximum Short-Term	CO	533.4	---
		Startup/Shutdown Emissions)	SO_2	12.90	---
			VOC	76.83	---
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	37.33	---
			H_2SO_4 [(a)]	9.31	---
			NH_3	41.83	---
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	---	122.86
		(Normal Operating and	CO	---	150.29
		Startup/Shutdown Emissions)	SO_2	---	24.07
			VOC	---	24.28
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	---	95.99
			H_2SO_4 [(a)]	---	16.23
			NH_3	---	156.99

NOX lb/hr represents a maximum hourly emission rate over a three-hour average.

(a) $PM / PM_{10} / PM_{2.5}$ from both front-half and back-half.

(b) $PM / PM_{10} / PM_{2.5}$ values include $(NH_4)_2SO_4$ emissions.

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	**09/01/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
C-TOWER1	C-TOWER1	Cooling Tower	PM	24.21	106.03
			PM_{10}	0.08	0.33
			$PM_{2.5}$	<0.01	<0.01
AUX-BLR	AUX-BLR	Auxiliary Boiler	NO_X	0.89	0.89
			CO	3.29	3.29
			SO_2	0.25	0.12
			VOC	0.48	0.48
			PM / PM_{10} / $PM_{2.5}$	0.66	0.66
GAS-HTR	GAS-HTR	Gas Heater	NO_X	0.12	0.51
			CO	0.36	1.57
			SO_2	0.027	0.06
			VOC	0.03	0.14
			PM / PM_{10} / $PM_{2.5}$	0.05	0.21
EMGEN	EMGEN	Emergency Diesel Generator	NO_X	2.20	0.55
			CO	11.51	2.88
			SO_2	0.02	<0.01
			VOC	0.18	0.04
			PM / PM_{10} / $PM_{2.5}$	0.10	0.02
					09/01/2020

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	**09/01/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
DSL-TNK	DSL-TNK	Emergency Diesel Generator Tank	VOC	0.02	< 0.01
FUG-SCR	FUG-SCR	Ammonia Component Fugitives	NH_3	0.02	0.0993
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	VOC	0.0024	0.0103
CBY51-LOV	CBY51-LOV	Unit 1 Lube Oil Vent	VOC	0.003	0.01
			$PM / PM_{10} / PM_{2.5}$	0.003	0.01
CBYST1-LOV	CBYST1-LOV	Steam Turbine 1 Lube Oil Vent	VOC	0.003	0.01
			$PM / PM_{10} / PM_{2.5}$	0.003	0.01
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	NO_X	<0.01	<0.01
			CO	<0.01	<0.01
			VOC	0.12	<0.01
			PM	0.05	<0.01
			PM_{10}	0.05	<0.01
			$PM_{2.5}$	0.05	<0.01
			NH_3	<0.01	<0.01

EPN = Emission Point Number
FIN = Facility Identification Number

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	09/01/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	CO_2e		2,054,641.77
			CO_2		2,052,555.45
			CH_4		38.07
			N_2O		3.81
AUX-BLR	AUX-BLR	Auxiliary Boiler	CO_2e		10,425.48
			CO_2		10,414.71
			CH_4		0.20
			N_2O		0.02
GAS-HTR	GAS-HTR	Gas Heater	CO_2e		4,971.23
			CO_2		4,966.10
			CH_4		0.09
			N_2O		0.01
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	CO_2e		55.21
			CO_2		0.0050
			CH_4		2.21
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	CO_2e		2.69
			CO_2		0.0002
			CH_4		0.11

EPN = Emission Point Number
FIN = Facility Identification Number

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	09/01/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
EMGEN	EMGEN	Emergency Diesel Generator	CO_2e		592.12
			CO_2		590.09
			CH_4		0.02
			N_2O		0.005
SF6FUG	SF6FUG	SF6 Insulated Equipment	CO_2e		23.37
			SF_6		0.0010

EPN = Emission Point Number
FIN = Facility Identification Number

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	09/01/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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

AIR CONTAMINANT DATA			EMISSION POINT DISCHARGE PARAMETERS										
1. Emission Point			4. UTM Coordinates of Emission Point (NAD83)			Source 5. Building Height (ft)	6. Height Above Ground (ft)	7. Stack Exit Data			8. Fugitives		
EPN (A)	FIN (B)	NAME (C)	Zone	East (Meters)	North (Meters)			Diameter (ft) (A)	Velocity (fps) (B)	Temperature (°F) (C)	Length (ft) (A)	Width (ft) (B)	Axis Degrees (C)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	15	314,225	3,292,887		200	23	64.7	163			
C-TOWER1	C-TOWER1	Cooling Tower	15	314,275	3,292,865		45	20	15.0	100			
AUX-BLR	AUX-BLR	Auxiliary Boiler	15	314,224	3,292,891		200	4	36.0	299			
GAS-HTR	GAS-HTR	Gas Heater	15	314,149	3,292,824		50	2	23.5	250			
EMGEN	EMGEN	Emergency Diesel Generator	15	314,225	3,292,887		200	1	256.9	965			
DSL-TNK	DSL-TNK	Emergency Diesel Generator Tank	15	314,197	3,292,754		10	1	0.003	Ambient			
FUG-SCR	FUG-SCR	Ammonia Component Fugitives	15	314,206	3,292,858						161	201	4
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	15	314,215	3,292,802						266	207	1
CBY51-LOV	CBY51-LOV	Unit 1 Lube Oil Vent	15	314,236	3,292,832		30	0.003	0.003	Ambient			
CBYST1-LOV	CBYST1-LOV	Steam Turbine 1 Lube Oil Vent	15	314,192	3,292,798		30	0.003	0.003	Ambient			
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	15	314,169	3,292,734						633	460	8

EPN = Emission Point Number
FIN = Facility Identification Number

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	09/28/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	32.29	---
		(Normal Operating Emissions)	CO	34.40	---
			SO_2	12.90	---
			VOC	5.63	---
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	37.33	---
			H_2SO_4 [(a)]	9.31	---
			NH_3	41.83	---
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	43.96	---
		(Maximum Short-Term	CO	533.4	---
		Startup/Shutdown Emissions)	SO_2	12.90	---
			VOC	76.83	---
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	37.33	---
			H_2SO_4 [(a)]	9.31	---
			NH_3	41.83	---
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	NO_X	---	122.86
		(Normal Operating and	CO	---	150.29
		Startup/Shutdown Emissions)	SO_2	---	24.07
			VOC	---	24.28
			$PM / PM_{10} / PM_{2.5}$ [(a) (b)]	---	95.99
			H_2SO_4 [(a)]	---	16.23
			NH_3	---	156.99

NOX lb/hr represents a maximum hourly emission rate over a three-hour average.

(a) $PM / PM_{10} / PM_{2.5}$ from both front-half and back-half.

(b) $PM / PM_{10} / PM_{2.5}$ values include $(NH_4)_2SO_4$ emissions.

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	09/28/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
C-TOWER1	C-TOWER1	Cooling Tower	PM	24.21	106.03
			PM_{10}	0.08	0.33
			$PM_{2.5}$	<0.01	<0.01
AUX-BLR	AUX-BLR	Auxiliary Boiler	NO_X	3.25	3.25
			CO	3.29	3.29
			SO_2	0.25	0.12
			VOC	0.48	0.48
			PM / PM_{10} / $PM_{2.5}$	0.66	0.66
GAS-HTR	GAS-HTR	Gas Heater	NO_X	0.12	0.51
			CO	0.36	1.57
			SO_2	0.027	0.06
			VOC	0.03	0.14
			PM / PM_{10} / $PM_{2.5}$	0.05	0.21
EMGEN	EMGEN	Emergency Diesel Generator	NO_X	2.20	0.55
			CO	11.51	2.88
			SO_2	0.02	<0.01
			VOC	0.18	0.04
			PM / PM_{10} / $PM_{2.5}$	0.10	0.02

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	**09/28/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
DSL-TNK	DSL-TNK	Emergency Diesel Generator Tank	VOC	0.02	< 0.01
FUG-SCR	FUG-SCR	Ammonia Component Fugitives	NH_3	0.02	0.0993
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	VOC	0.0024	0.0103
CBY51-LOV	CBY51-LOV	Unit 1 Lube Oil Vent	VOC	0.003	0.01
			$PM / PM_{10} / PM_{2.5}$	0.003	0.01
CBYST1-LOV	CBYST1-LOV	Steam Turbine 1 Lube Oil Vent	VOC	0.003	0.01
			$PM / PM_{10} / PM_{2.5}$	0.003	0.01
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	NO_X	<0.01	<0.01
			CO	<0.01	<0.01
			VOC	0.12	<0.01
			PM	0.05	<0.01
			PM_{10}	0.05	<0.01
			$PM_{2.5}$	0.05	<0.01
			NH_3	<0.01	<0.01

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	**09/28/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	FIN (B)	NAME (C)		Pounds per Hour (A)	TPY (B)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	CO_2e		2,054,641.77
			CO_2		2,052,555.45
			CH_4		38.07
			N_2O		3.81
AUX-BLR	AUX-BLR	Auxiliary Boiler	CO_2e		10,425.48
			CO_2		10,414.71
			CH_4		0.20
			N_2O		0.02
GAS-HTR	GAS-HTR	Gas Heater	CO_2e		4,971.23
			CO_2		4,966.10
			CH_4		0.09
			N_2O		0.01
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	CO_2e		55.21
			CO_2		0.0050
			CH_4		2.21
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	CO_2e		2.69
			CO_2		0.0002
			CH_4		0.11

EPN = Emission Point Number
FIN = Facility Identification Number

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	**09/28/2020**	Permit No.:	**160538/PSDTX1582/GHGPSDTX204**	Regulated Entity No.:	**RN100825371**
Area Name:	**Cedar Bayou Electric Generating Station**			Customer Reference No.:	**CN605766492**

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 #	
EPN (A)	**FIN (B)**	**NAME (C)**		Pounds per Hour (A)	TPY (B)
EMGEN	EMGEN	Emergency Diesel Generator	CO_2e		592.12
			CO_2		590.09
			CH_4		0.02
			N_2O		0.005
SF6FUG	SF6FUG	SF6 Insulated Equipment	CO_2e		23.37
			SF_6		0.0010

EPN = Emission Point Number
FIN = Facility Identification Number

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Table 1(a) Emission Point Summary
Combined Cycle Option

Date:	09/28/2020	Permit No.:	160538/PSDTX1582/GHGPSDTX204	Regulated Entity No.:	RN100825371
Area Name:	Cedar Bayou Electric Generating Station			Customer Reference No.:	CN605766492

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

AIR CONTAMINANT DATA			EMISSION POINT DISCHARGE PARAMETERS										
1. Emission Point			4. UTM Coordinates of Emission Point (NAD83)			Source 5. Building Height (ft)	6. Height Above Ground (ft)	7. Stack Exit Data			8. Fugitives		
EPN (A)	FIN (B)	NAME (C)	Zone	East (Meters)	North (Meters)			Diameter (ft) (A)	Velocity (fps) (B)	Temperature (°F) (C)	Length (ft) (A)	Width (ft) (B)	Axis Degrees (C)
CBY51	CBY51	Combustion Turbine 1 (Combined Cycle)	15	314,225	3,292,887		200	23	64.7	163			
C-TOWER1	C-TOWER1	Cooling Tower	15	314,275	3,292,865		45	20	15.0	100			
AUX-BLR	AUX-BLR	Auxiliary Boiler	15	314,224	3,292,891		200	4	36.0	299			
GAS-HTR	GAS-HTR	Gas Heater	15	314,149	3,292,824		50	2	23.5	250			
EMGEN	EMGEN	Emergency Diesel Generator	15	314,225	3,292,887		200	1	256.9	965			
DSL-TNK	DSL-TNK	Emergency Diesel Generator Tank	15	314,197	3,292,754		10	1	0.003	Ambient			
FUG-SCR	FUG-SCR	Ammonia Component Fugitives	15	314,206	3,292,858						161	201	4
FUG-NGAS	FUG-NGAS	Natural Gas Component Fugitives	15	314,215	3,292,802						266	207	1
CBY51-LOV	CBY51-LOV	Unit 1 Lube Oil Vent	15	314,236	3,292,832		30	0.003	0.003	Ambient			
CBYST1-LOV	CBYST1-LOV	Steam Turbine 1 Lube Oil Vent	15	314,192	3,292,798		30	0.003	0.003	Ambient			
FUG-MSS	FUG-MSS	Planned Maintenance Activities Fugitives	15	314,169	3,292,734						633	460	8

EPN = Emission Point Number
FIN = Facility Identification Number

TABLE 1F
AIR QUALITY APPLICATION SUPPLEMENT

Permit No.:	160538/PSDTX1582/GHGPSDTX204	Application Submittal Date:	09/28/2020
Company	NRG Cedar Bayou 5 LLC		
RN:	RN100825371	Facility Location:	7705 West Bay Road
City	Baytown	County:	Chambers
Permit Unit I.D.:	CBY51	Permit Name:	Cedar Bayou Electric Generating Station
Permit Activity:	☐ New Major Source	☑ Modification	
Project or Process Description: Addition of one combined cycle turbine			

Complete for all pollutants with a project emission increase.	**POLLUTANTS**								
	Ozone		**CO**	**PM**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**H_2SO_4**	**CO_2e**
	VOC	**NOx**							
Nonattainment? (yes or no)	Yes	Yes	No	No	No	No	No	No	No
Existing site PTE (tpy)									
Proposed project increases (tpy from 2F)[3]	24.99	127.16	158.03	202.95	97.25	96.92	24.26	16.23	2,070,712
Is the existing site a major source?[2]	No								
If not, is the project a major source by itself? (yes or no)	Yes								
If site is major, is project increase significant? (yes or no)	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
If netting required, estimated start of construction:	12/31/20								
5 years prior to start of construction:	12/31/15	Contemporaneous							
Estimated start of operation:	6/1/22	Period							
Net contemporaneous change, including proposed project, from Table 3F (tpy)	24.99	127.16	158.03	202.95	97.25	96.92	24.26	16.23	2,070,711.86
FNSR applicable? (yes or no)	No	No (within PAL limit)	Yes	Yes	Yes	Yes	No	Yes	Yes

1. Other PSD pollutants
2. Nonattainment major source is defined in Table 1 in 30 TAC 116.12(11) by pollutant and county. PSD thresholds are found in 40 CFR §51.166(b)(1).

3. Sum of proposed emissions minus baseline emissions, increases only. Nonattainment thresholds are found in Table 1 in 30 TAC 116.12(11) and PSD thresholds in 40 CFR §51.166(b)(23).

The presentations made above and on the accompanying tables are true and correct to the best of my knowledge.

Signature Title Date

TABLE 2F
PROJECT EMISSION INCREASE
COMBINED CYCLE OPTION

Pollutant[1]:	NOx	**Permit:**	160538/PSDTX1582/GHGPSDTX204
Baseline Period:	N/A **to**		

	Affected or Modified Facilities[2] FIN	EPN	Permit No.	A Actual Emissions[3]	B Baseline Emissions[4]	Proposed Emissions[5]	Projected Actual Emissions	Difference (B - A) [6]	Correction[7]	Project Increase[8]
1	CBY51	CBY51	160538			122.86		122.86		122.86
2	AUX-BLR	AUX-BLR	160538			3.25		3.25		3.25
3	GAS-HTR	GAS-HTR	160538			0.51		0.51		0.51
4	EMGEN	EMGEN	160538			0.55		0.55		0.55
5	FUG-MSS	FUG-MSS	160538			0.000001		0.000001		0.000001
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
							Page Subtotal[9]			127.16

Table A-10
Natural Gas Fired Auxiliary Boiler Emission Calculations
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Assumptions:

Maximum Natural Gas Firing Rate	89.1	MMBtu/hr
Maximum Natural Gas Firing Rate	87,087	scf/hr
Exhaust Gas	2,934	lbmol/hr-dry
Annual Operating Schedule	2,000	hours/year
Natural Gas Max Sulfur Content	1.0	gr/100scf
Natural Gas Annual Avg Sulfur Content	0.5	gr/100scf

Calculations:

Pollutant	Emission Factor[1]	Units	Max Hourly Emission Rate lb/hr	Max. Annual Emission Rate ton/yr
NO_x[2]	30	ppmvd at 3% O2	--	--
	0.0364	lb/MMBtu	3.25	3.25
CO[2]	50	ppmvd at 3% O2	--	--
	0.037	lb/MMBtu	3.29	3.29
SO_2[3]	--	gr/100scf	0.25	0.12
$PM/PM_{10}/PM_{2.5}$[4]	7.6	lb/MMscf	0.66	0.66
VOC[4]	0.0054	lb/MMBtu	0.48	0.48

Notes:

1. These emission factors are used solely to calculate full load mass emission rates.
2. Proposed BACT limit.
3. Calculated based on fuel sulfur content and max fuel consumption.
4. EPA AP-42 Compilation of Air Pollution Emission Factors, Natural Gas Combustion Table 1.4-2 (7/98).

Sample Calculations:

NOx = (89 MMBtu/hr) * (0.04 lb/MMBtu) = 3.25 lb/hr NOx

SO2 = (87087 scf/hr) * (1 gr S/100scf) * (lb/ 7000 gr) * (lbmole S/32 lb S) * (1 lbmole SO2/ 1 lbmole S) * (64 lb SO2/lbmole SO2) = 0.25 lb/hr SO2

Stack Parameters			
Stack diameter ft	Exhaust Flow acfm wet	Temperature °F	Velocity ft/sec
4.00	27,158.0	299	36.02

Table B-10
GHG Emission Calculations - Calculation of Design Heat Rate and Output Limits for Combustion Turbine
Cedar Bayou Electric Generating Station
NRG Cedar Bayou 5 LLC

Combined Cycle Turbine

	Gross Output Basis	
Base Heat Rate; 59°F Ambient Temp (without duct firing):	**6,095**	Btu/kWh (HHV)
Base Heat Rate; 97°F Ambient Temp (with duct firing):	**6,413**	Btu/kWh (HHV)
Estimated Annual Duct Firing Hours	**1,910**	hrs
Annual Average Base Heat Rate	**6,165**	Btu/kWh (HHV)
Design Margin:	3.3%	
CTG Degradation Margin:	6.0%	
HRSG/Steam Turbine Degradation Margin:	3.0%	
Adjusted Base Heat Rate with Compliance Margins:	**6,953**	Btu/kWh (HHV)

EPN	Base Heat Rate (Btu/kWhr)	Electrical Output Basis	Heat Input Required to Produce 1 MW (MMBtu/MWhr)	Pollutant	Emission Factor (lb/MMBtu)[1]	lb GHG/MWhr[2]	Global Warming Potential[3]	lb CO_2e/MWhr[4]
CBY51	6,953	Gross	6.95	CO_2	118.86	826.37	1	826.37
				CH_4	2.2E-03	1.53E-02	25	3.83E-01
				N_2O	2.2E-04	1.53E-03	298	4.57E-01
				Total:		**826.4**		**827.2**

Simple Cycle Turbine

	Gross Output Basis	
Base Heat Rate; 97°F Ambient Temp:	**9,169**	Btu/kWh (HHV)
Design Margin:	3.3%	
CTG Degradation Margin:	6.0%	
Adjusted Base Heat Rate with Compliance Margins:	**10,040**	Btu/kWh (HHV)

EPN	Base Heat Rate (Btu/kWhr)	Electrical Output Basis	Heat Input Required to Produce 1 MW (MMBtu/MWhr)	Pollutant	Emission Factor (lb/MMBtu)[1]	lb GHG/MWhr[2]	Global Warming Potential[3]	lb CO_2e/MWhr[4]
CBY51	10,040	Gross	10.04	CO_2	118.86	1,193.31	1	1,193.31
				CH_4	2.2E-03	2.21E-02	25	5.53E-01
				N_2O	2.2E-04	2.21E-03	298	6.60E-01
				Total:		**1,193.3**		**1,194.5**

Notes

1. CH_4 and N_2O GHG factors based on Table C-2 of 40 CFR 98 Mandatory Greenhouse Gas Reporting.

2. CO_2 emissions based on 40 CFR Part 75, Appendix G, Equation G-4

$W_{CO2} = (F_c \times H \times U_f \times MW_{CO2})/2000$

$W_{CO2} = CO_2$ emitted from combustion, tons/yr

F_c = Carbon based F-factor,1040 scf/MMBtu

H = Heat Input (MMBtu/yr)

U_f = 1/385 scf CO_2/lbmole at 14.7 psia and 68 $^{\circ}$F

MW_{CO2} = Molecule weight of CO_2, 44.0 lb/lbmole

4. Example calculation: GHG emissions (lbs) x Global Warming Potential / 1 MW = lb CO_2e/MWhr