TECHNICAL EVALUATION
&
PRELIMINARY DETERMINATION

APPLICANT

Duke Energy Florida, LLC (DEF)
1601 Weedon Island Drive
St. Petersburg, Florida 33702

P.L. Bartow Power Plant
ARMS Facility ID No. 1030011

PROJECT

Project No. 1030011-023-AC
PSD-FL-381F

Application for Minor Source Air Construction Permit
Simple-Cycle Low-Load Operation

COUNTY

Pinellas County, Florida

PERMITTING AUTHORITY

Florida Department of Environmental Protection
Division of Air Resource Management
Office of Permitting and Compliance
2600 Blair Stone Road, MS #5505
Tallahassee, Florida 32399-2400

January XX, 2016

1. GENERAL PROJECT INFORMATION

1.1. Facility Description and Location

Duke Energy Florida, LLC, (DEF) operates the P.L. Bartow Plant, which is an existing power plant (SIC No. 4911). The plant is located on Weedon Island on the east side of St. Petersburg, Pinellas County. The location with respect to other DEF facilities in Florida is shown in **Figure 1**. Also shown is the location of Weedon Island within Tampa Bay.

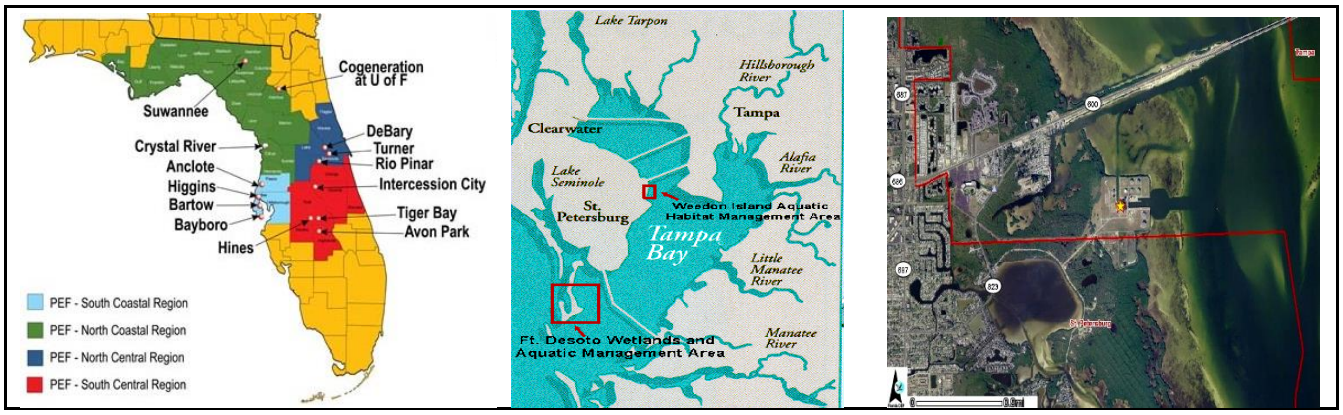

Figure 1. Bartow Power Plant in DEF System and Location of Weedon Island and Plant.

The plant is located approximately 83 kilometers (km) south of the PSD Class I Chassahowitzka Wilderness Area. The facility UTM coordinates are Zone 17, 343.87 kilometers (km) East and 3,082.69 km North. The P.L. Bartow Power Plant includes the following emissions units: 1) four 59-megawatt (MW) General Electric MS7000 simple cycle gas turbine peaking units, designated as Nos. P-1, P-2, P-3 and P-4 (EU 005-008); 2) combined cycle Unit 4 rated at approximately 1,280 MW and consisting of four 215 MW Siemens SGT6-5000F combined cycle gas turbine-electrical generators (CTs), four duct-fired heat recovery steam generators (HRSGs) (EU 038 - 041); 3) four 3 MMBtu/hr natural gas fired process heaters (EU 044); 4) two 3,500,000-gallon diesel fuel storage tanks (EU 045); 5) one 300 HP diesel-fueled emergency fire pump (EU046); and 6) various insignificant emissions units.

The steam generated in the four Unit 4 HRSGs is used in a single nominal 420 MW steam turbine-electrical generator (STEG). The actual capacity according to DEF is 450 MW. **Figure 2** is an aerial photograph of Unit 4. The four main exhaust stacks are in the foreground. Four bypass stacks are in the background and are used when the CTs operate in simple cycle mode.

Figure 2. Duke P.L. Bartow Combined Cycle Unit 4 (~1,280 MW)

Figure 3 is a simplified process flow diagram for Unit 4. Fuel is burned in the four CTs. The mechanical energy produced operates the compressor section of each CT and also drives an electric generator. Each CT generator set is rated at approximately 215 MW. The generation capacity is highly dependent upon ambient conditions. The turbine exhaust gas (TEG) exists the CTs at temperatures in the range of 1,100 degrees Fahrenheit (°F) and with an oxygen (O_2) content of approximately 12-13 percent (%).

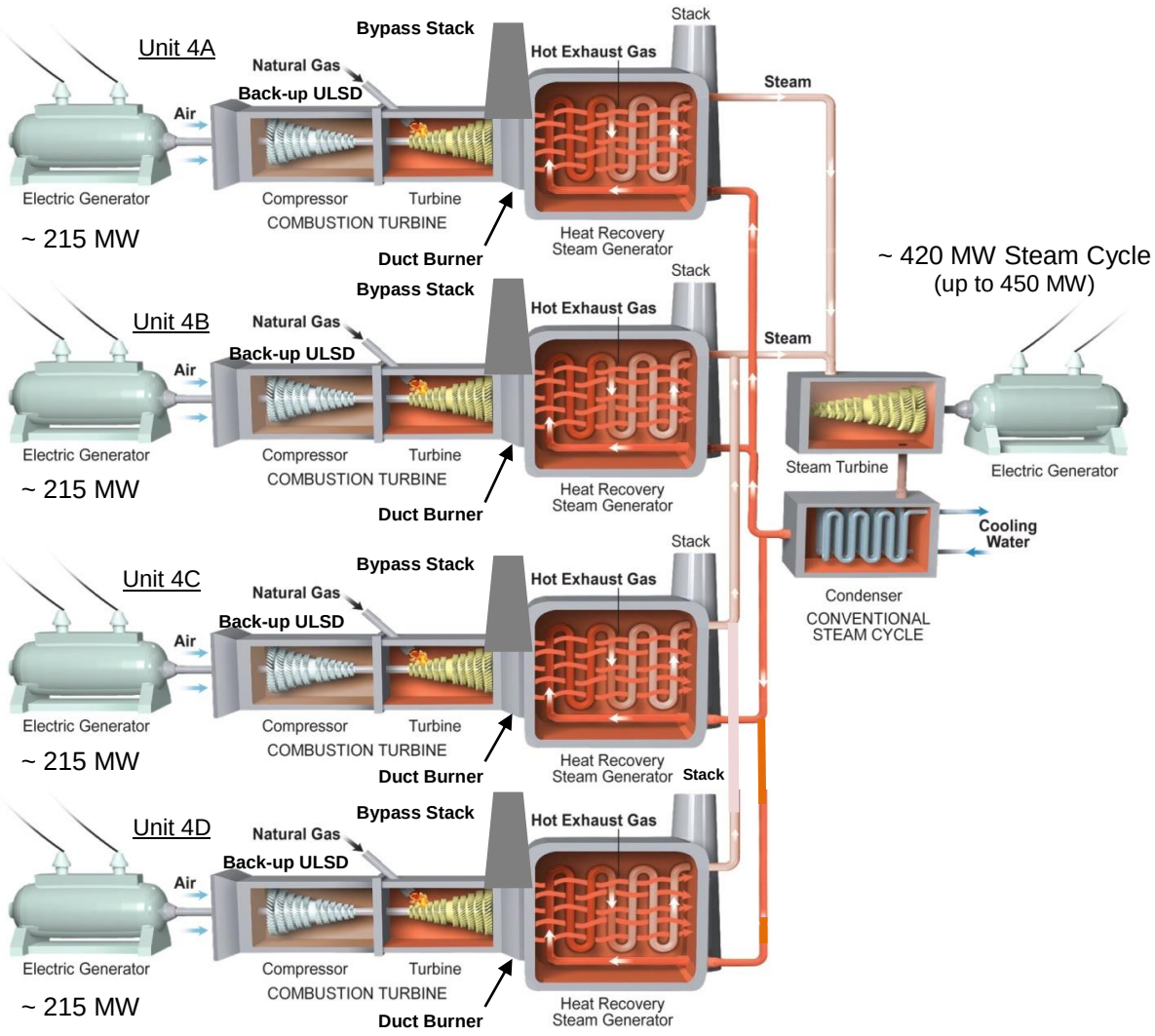

Figure 3. Process Flow Diagram for Cycle Unit 4 ("4 on 1" Combined Cycle).

When the CTs operate in simple-cycle mode, the TEG exits via the bypass stacks as shown in **Figure 3**. When operating in combined-cycle mode, the TEG enters the HRSGs, which are waste heat boilers that produce steam, and then exits via the combined-cycle stack as shown in **Figure 3**. In the case of Unit 4, the HRSGs include natural gas-fueled duct burners that use the hot, oxygen-rich TEG as combustion air to further increase temperature and the steam generation capacity of each HRSG. The high temperature, high pressure steam produced in the HRSGs then enters a conventional steam turbine-electric generator (STG) to produce approximately 420 MW of electricity.

Continuous emissions monitoring systems (CEMS) for carbon monoxide (CO) and nitrogen oxides ($NO + NO_2 = NO_X$) are installed on the combined cycle stacks, while only NO_X CEMS are included on the bypass stacks.

Construction on Unit 4 commenced in 2007 and commercial service began in the summer of 2009. Three conventional residual fuel oil units (Units 1-3) rated at approximately 462 MW (total) were shut down before the startup of Unit 4 and were demolished in 2012. The project resulted in substantial reductions of

conventional air pollutants**.** Emissions of greenhouse gases per unit of power produced declined from nearly 2,000 pounds of carbon dioxide per MW-hour (lb CO_2/MWh) for Units 1-3 to less than 900 lb CO_2/MWh for Unit 4.

1.2. Project Description

Emissions of CO and NO_X from CTs are generally high at low operating loads and during startups. A sample performance curve showing uncontrolled CO emissions as a function of load for an earlier model Siemens turbine is shown in **Figure 4**. The uncontrolled emissions shown in **Figure 4** are much greater than the emissions from the turbines in use at Bartow.

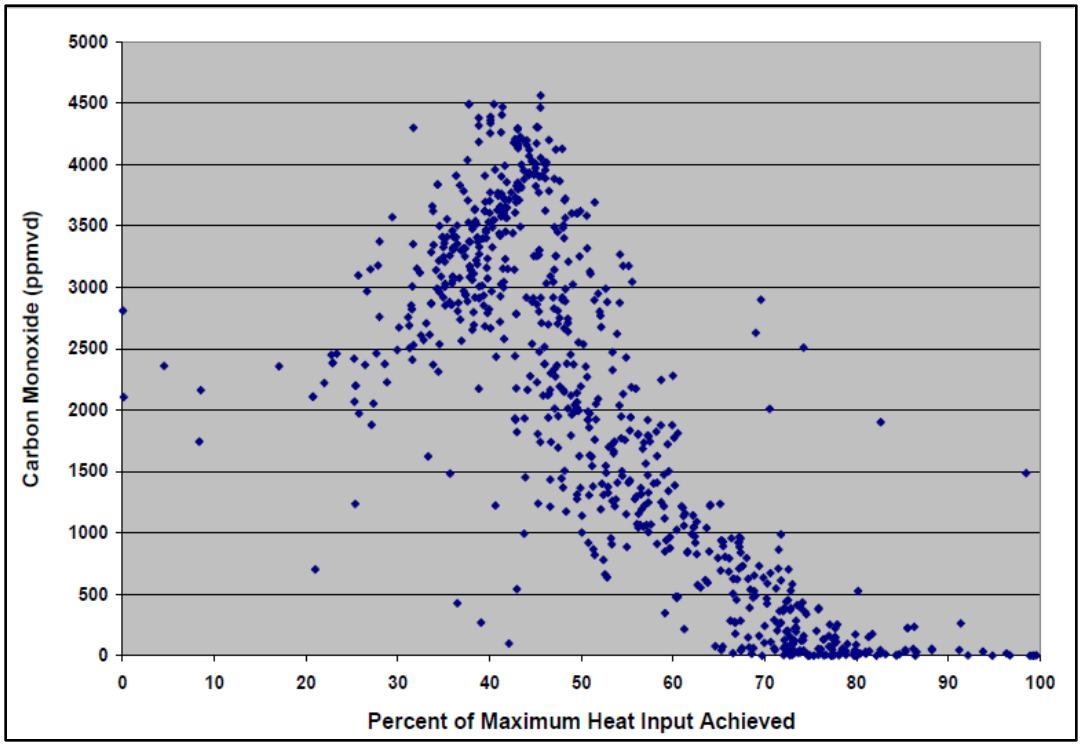

Figure 4. Illustration of Uncontrolled CO Emissions versus Load for Siemens SW501F Turbine.

Techniques to control emissions of CO and NO_X include add-on technologies such as oxidation catalyst to destroy CO, or selective catalytic reduction (SCR) to destroy NO_X. Additionally, the combustion in the CT can be tuned carefully to avoid the formation of CO or NO_X. The CTs in Unit 4 were installed with Low-Load Turndown Design (LLTD), which tunes the air-fuel ratio for combustion at low loads, which prevents CO formation. Actual CO measurements from Bartow Unit 4 at 55% load, measured on January 6, 2009, are shown in **Figure 5**. These emissions are orders of magnitude smaller than the illustrative uncontrolled emissions summarized in **Figure 4**.

In the original air construction permit for Unit 4, Permit No. 1030011-010-AC, a determination of Best Available Control Technology (BACT), and corresponding emissions limits, for CO and VOC were issued. These limits, with which the facility has consistently been in compliance, are summarized in **Table 1**.

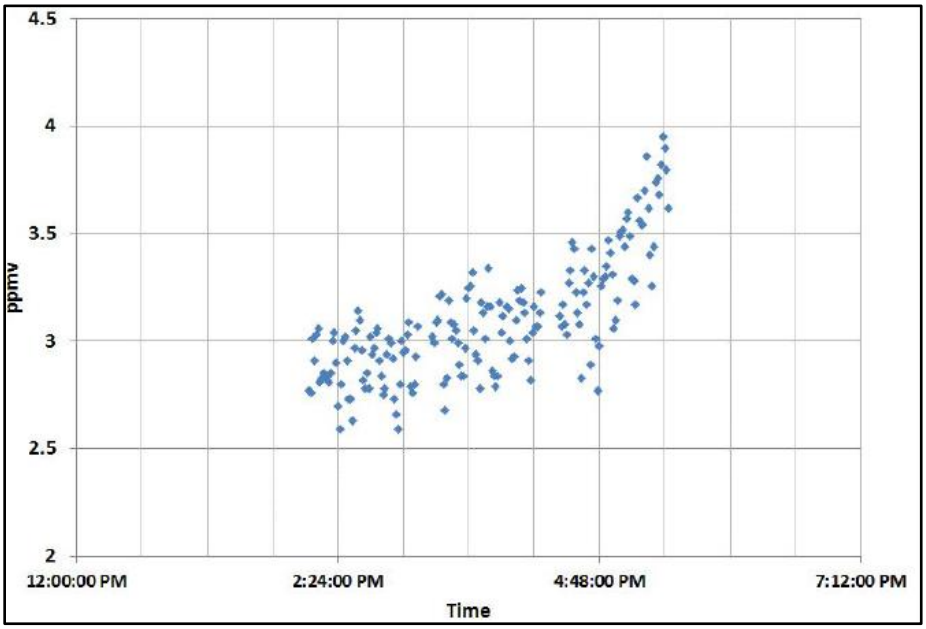

Figure 5. Measured CO Emissions at 55% Load for Bartow Unit 4 Turbines.

TABLE 1 -- UNIT 4 BACT EMISSION LIMITS FOR CO AND VOC

Pollutant	Fuel	Method of Operation [a]	Stack Test, 3-Run Average		CEMS [c] Block Average
			ppmvd @ 15% O_2	lb/hr [b]	ppmvd @ 15% O_2
Unit 4 HRSG Stacks					
CO	Oil	CT	8.0	40.4	8.0, 24-hr [d] 6, 12-month [f]
	Gas	CT	4.1	20.8	
		CT & DB	7.6	38.3	
VOC [e,g]	Oil	CT	2.8	7.6	Not Applicable
	Gas	CT	1.2	3.0	
		CT & DB	1.5	3.8	
Unit 4 Bypass Stacks					
CO	Oil	CT	8.0	40.4	Not Applicable
	Gas	CT	4.1	20.8	
VOC [e]	Oil	CT	2.8	7.6	Not Applicable
	Gas	CT	1.2	3.0	

a. CT means operation of a combustion turbine (CT) in simple cycle or in combined cycle without use of the duct burner (DB). CT & DB means operation in combined cycle mode and using the DB.
b. The mass emission rate standards are based on a turbine inlet condition of 59° F and may be adjusted to actual test conditions in accordance with the performance curves and/or equations on file with the Department.
c. CEMS for CO are required only on the HRSG stacks. Other than startup, shutdown, fuel switching or documented malfunction, simple cycle CT operations shall be at a load not less than 45% or that load at which compliance was demonstrated during the initial compliance test, whichever is higher.
d. Compliance with the continuous 24-hour CO standards shall be demonstrated based on data collected by the required CEMS on the HRSG stacks. The initial and annual EPA Method 10 tests associated with the certification of the CEMS instruments may also be used to demonstrate compliance with the individual standards for natural

gas, fuel oil, or duct burner modes. Separate CO tests shall be conducted under simple cycle mode on the CT stacks.

e. Compliance with the VOC standards shall be demonstrated by conducting tests in accordance with EPA Method 25A on the HRSG stacks and, under simple cycle mode, on the CT stacks. Optionally, EPA Method 18 may also be performed to deduct emissions of methane and ethane. The emission standards are based on VOC measured as methane.

f. *Rolling Average*. Enforcement discretion may be exercised for up to 12 months with respect to the 6 ppmvd @15% O_2 limit for any CT/Duct-fired HRSG upon notification by the permittee of intent to install oxidation catalyst. The permittee shall have 12 months to complete the oxidation catalyst installation. From time of notification to installation of the catalyst all partial or complete calendar months shall be excluded from the 12-month rolling average.

g. Compliance with the CO CEMS based limits shall be deemed as compliance with the VOC limit.

In addition to these numerical emission limits, these turbines are currently prohibited from operating at loads below 45% in simple cycle mode (other than during startups and shutdowns), since there is no CO CEMS on the simple cycle stacks.

DEF submitted an application for an air construction permit to lower-load simple cycle operation on the four CTs that make up combined cycle Unit 4 (EU Nos. 038-041). Currently, DEF is not permitted to operate these turbines in simple cycle mode at loads less than 45%, other than during startups, shutdowns, fuel switching events, or documented malfunctions. Under Permit No. 1030011-022-AC, DEF installed the Advanced Low-Load Turn Down (ALLTD) package on these four turbines. This entailed the installation of additional piping and auxiliary valves to pull heated air from the compressor discharge section and reintroduce it to the inlet of the compressor section. This recirculation allows for less dense, higher temperature air entering the compressor, which according to DEF reduces low-load CO emissions. Enhanced control software also supports this low-load operation.

Now that the ALLTD package is being installed, enabling lower CO emissions at low loads, DEF is seeking to be permitted to operate at those low loads. Prior to being permitted to operate at these lower loads in simple cycle mode, DEF would use the CEMS on the combined-cycle stacks, or a stack test on the simple cycle stacks, to demonstrate the load range in which the CO limit can be met.

The emissions units (EU) listed in **Table 2** will be affected by this project.

TABLE 2 – EMISSIONS UNITS AFFECTED BY THIS PROJECT.

EU No.	Description
038	Unit 4A – One 215 MW (ISO) Combustion Turbine with Duct-fired Heat Recovery Steam Generator
039	Unit 4B – One 215 MW (ISO) Combustion Turbine with Duct-fired Heat Recovery Steam Generator
040	Unit 4C – One 215 MW (ISO) Combustion Turbine with Duct-fired Heat Recovery Steam Generator
041	Unit 4D – One 215 MW (ISO) Combustion Turbine with Duct-fired Heat Recovery Steam Generator

1.3. Processing Schedule

December 1, 2015 Department received the application for an air pollution construction permit; application complete.

January XX, 2016 Department issued the draft permit package.

2. APPLICABLE REGULATIONS

2.1 Federal Regulations

The U.S. Environmental Protection Agency (EPA) establishes air quality regulations in Title 40, Code of Federal Regulations, Part 60 (40 CFR 60) that identifies New Source Performance Standards (NSPS) for a variety of industrial activities. 40 CFR 61 specifies National Emission Standards for Hazardous Air Pollutants (NESHAP). 40 CFR 63 specifies NESHAP provisions based on the Maximum Achievable Control Technology

(MACT) for given source categories.

Federal regulations adopted by reference are given in Rule 62-204.800, F.A.C. State regulations approved by EPA are given in 40 CFR 52, Subpart K – Florida; also known as the State Implementation Plan (SIP) for Florida. The following federal regulations apply to the Bartow Plant and this project.

- The existing facility is a major stationary source in accordance with Rule 62-212.400, F.A.C. for the Prevention of Significant Deterioration (PSD) of Air Quality and Rule 62-210.200 (Definitions), F.A.C.
- This project does not trigger a PSD review and a requirement to conduct Best Available Control Technology (BACT) determinations pursuant to Department Rule 62-212.400, F.A.C.
- The existing facility is a major source of hazardous air pollutants (HAP).
- The existing facility has units regulated under Clean Air Act, Title IV, Acid Rain provisions, Phase II.
- The existing facility is a Title V major source of air pollution in accordance with Chapter 62-213, F.A.C.
- The proposed project includes units subject to Clean Air Interstate Rule (CAIR).
- The proposed project includes units subject to the NSPS of 40 CFR 60.
- The proposed project includes units subject to the NESHAP of 40 CFR 63.

2.2 State Regulations

Projects at stationary sources with the potential to emit air pollution are subject to the applicable environmental laws specified in Section 403 of the Florida Statutes (F.S.). The statutes authorize the Department of Environmental Protection (Department) to establish air quality regulations as part of the Florida Administrative Code (F.A.C.), which includes the applicable chapters contained in **Table 3**.

TABLE 3 – APPLICABLE RULES FROM THE F.A.C.

Chapter	Description
62-4	Permits
62-17	Electrical Power Plant Siting
62-204	Air Pollution Control – General Provisions
62-210	Stationary Sources of Air Pollution – General Requirements
62-212	Stationary Sources – Preconstruction Review
62-213	Operation Permits for Major Sources (Title V) of Air Pollution
62-296	Stationary Sources – Emission Standards
62-297	Stationary Sources – Emissions Monitoring

3. PSD APPLICABILITY REVIEW

3.1 General PSD Applicability

The Department regulates major stationary sources in accordance with Florida's PSD program pursuant to Rule 62-212.400, F.A.C. PSD preconstruction review is required in areas that are currently in attainment with the state and federal ambient air quality standards (AAQS) or areas designated as "unclassifiable" for these regulated pollutants. Commonly addressed PSD pollutants in the power industry include: carbon monoxide (CO), NO_X, particulate matter (PM), PM with a mean diameter of 10 microns or less (PM_{10}), PM with a mean diameter of 2.5 microns or less ($PM_{2.5}$), sulfur dioxide (SO_2), volatile organic compounds (VOC), lead (Pb), fluorides (F), sulfuric acid mist (SAM), and mercury (Hg).

Additional PSD pollutants that are more common to certain other industries include: hydrogen sulfide (H_2S), total reduced sulfur (TRS) including H_2S, reduced sulfur compounds (RSC) including H_2S, municipal waste combustor (MWC) organics measured as total tetra- through octa-chlorinated dibenzo-p-dioxins and dibenzofurans (dioxin/furan), MWC metals measured as PM; MWC acid gases measured as SO_2 and hydrogen chloride (HCl), and MSW landfill emissions as non-methane organic compounds (NMOC).

As defined in Rule 62-210.200(189)(a)1, F.A.C., a stationary source is a "major stationary source" (major PSD source) if it emits or has the potential to emit (PTE):

- 250 tons per year (TPY) or more of any PSD pollutant; or
- 100 TPY or more of any PSD pollutant and the facility belongs to one of the 28 listed PSD major facility categories.

The list given in the citation includes the category of *"fossil fuel-fired steam electric plants of more than 250 million British thermal units per hour heat input"*. The existing Bartow Plant is a major stationary source because it meets this definition and emits, or has the PTE, 100 TPY or more of any PSD pollutant

PSD applicability for a "modification" to an existing major stationary source is based on thresholds known as the significant emission rates (SER) as defined in Rule 62-210.200(282), F.A.C. Any *"net emissions increase"* as defined in Rule 62-210.200(210), F.A.C. of a PSD pollutant from the project that equals or exceeds the respective SER is considered *"significant."* SER also means any emissions rate or any net emissions increase of a PSD pollutant associated with a major stationary source or major modification which would construct within 10 km of a Class I area and have an impact on such area equal to or greater than 1 gram per cubic meter, 24-hour average.

Although a facility may be "major" (i.e. emits or has the PTE 100 or 250 TPY as applicable) for only one PSD pollutant, a project is subject to PSD review for any PSD pollutant that exceeds the corresponding SER given in **Table 4**.

TABLE 4 – LIST OF SIGNIFICANT EMISSIONS RATES. [1]

Pollutant	SER (TPY)	Pollutant	SER (TPY)
CO	100	NO_X	40
$PM/PM_{10}/PM_{2.5}$	25/15/10	Ozone (VOC) [2]	40
$PM_{2.5}$ (NO_X)	40	$PM_{2.5}$ (SO_2)	40
Ozone (NO_X) [2]	40	SAM	7
SO_2	40	Pb	0.6
Hg	0.1	GHGs	> 75,000 (CO_2e) and > 0 (mass) [3, 4]

1. Excluding fluoride and pollutants specific to the Pulp and Paper industry, MWCs, MSW landfills.
2. Ozone (O_3) is regulated by its precursors (VOC and NO_X). PSD for $PM_{2.5}$ can be triggered by its precursors (NO_X and SO_2).
3. Pursuant to 40 CFR 52.21(b)(23)(ii), pollutants with no SER listed at 40 CFR 52.21(b)(23)(i) have a SER of zero tons/year.
4. "CO_2e" means carbon dioxide equivalents and refers to greenhouse gas (GHG) emissions. The calculation of GHG emissions is defined in 40 CFR 98, Subpart A, Table A-1.

According to guidance[1] issued by the EPA in July 2014, a source that triggers PSD review for a traditional PSD pollutant (listed above) would also trigger a PSD review for GHGs emissions if the source would emit or have the potential to emit 75,000 tons per year of GHGs on a CO_2e basis. Under this framework, a source cannot become subject to PSD review solely on the basis of GHG emissions.

3.2 PSD Applicability for the Project

The expansion of the range of loads under which these CTs are permitted to operate is expected to have a minimal impact on emissions. These turbines are rarely operated in simple cycle mode; combined-cycle mode is a more efficient method of operation. Unit 4 is dispatched overwhelmingly in combined-cycle mode. According to dispatch modeling performed by DEF, permitting simple-cycle operation down to a load of 30% would not impact future dispatch of Unit 4. Operation in low-load simple cycle mode will be occasional, and if there are increases in CO emissions, they will be minimal. It is *extremely* unlikely that CO emissions would increase by more than the PSD SER for CO (100 tons per year) due to this change in permitted operating conditions.

DEF calculated the expected changes in emissions; these are summarized in **Table 5**. Changes in emissions are

[1] U.S. Supreme Court opinion dated June 23, 2014, *UARG v EPA*. EPA guidance dated July 24, 2014.

driven not only by the project itself, but also by demand for the emission units and the manner in which they are dispatched. For the pollutants of which emissions are expected to increase relative to baseline emissions, it is clear that all increases are due to demand growth, since the emissions that the units could have accommodated during the baseline period are larger than the expected increases. Therefore, there are no net increases in emissions due to the project, and PSD review and a BACT determination are not applicable to this project.

TABLE 5 – COMPARISON OF BASELINE TO PROJECTED ACTUAL EMISSIONS AND PSD APPLICABILITY ANALYSIS.

Parameter	Baseline Actual Emissions (tons/year)[1]	Emissions with Project (tons/year)[2]	Increases due to Demand Growth (tons/year)[3]	Emissions Unit Could Have Accommodated During the Baseline Period[4]	Net Increases due to Project (tons/year)[5]	Applicable SER (tons/year)	PSD Triggered?
SO_2	19	18	0	4	**0**	40	**No**
$PM/PM_{10}/PM_{2.5}$	52/52/15	57/57/16	5/5/1	7/7/2	**0/0/0**	25/15/10	**No**
NO_X	838	620	0	108	**0**	40	**No**
CO	372	407	35	48	**0**	100	**No**
VOC	18	19	2	2	**0**	40	**No**
SAM	27	29	3	3	**0**	8	**No**
Pb	0.01	0.01	0	0	**0**	0.6	**No**
GHGs (CO_2e)[6]	3,280,503	3,525,783	255,280	422,946	**0**	0 / 75,000	**No**

1. Highest 24-month emissions expressed as tons/year (2010-2014) from operation of Unit 4.
2. Projected emissions including ALLTD project.
3. Emissions increases due to demand growth during the baseline period.
4. "Could Have Accommodated" emissions are based on historical emissions from the 24-month baseline period.
5. Net emissions increases for comparison with the SERs.
6. On mass basis. Applies if GHGs increases as CO_2e are > 75,000 tons/year and only if PSD is already triggered by another pollutant.

4. PROJECT REQUIREMENTS

The first component of this project entails a test to determine if CO emissions down to a CT load of 30% will be in compliance with the natural gas CO emission limit of 4.1 ppmvd @ 15% O_2. This permit will authorize a test burn in simple cycle mode down to 30% load. In lieu of a stack test in simple cycle mode, DEF will be permitted to use data collected from the CO CEMS in combined-cycle mode to show that the turbines comply with the 4.1 ppm limit at 30% load or less. Similarly, DEF will be permitted to perform tests on fuel oil down to a load of 45%.

If the stack test or CEMS demonstration shows that the turbine is in compliance with the CO limit in this low-load stack test, the CT will then be permitted to operate at all CT loads at or above the load at which compliance was demonstrated.

5. PRELIMINARY DETERMINATION

The Department makes a preliminary determination that the proposed project will comply with all applicable state and federal air pollution regulations as conditioned by the Draft Permit. This determination is based on a technical review of the complete application, reasonable assurances provided by the applicant, and the conditions specified in the Draft Permit. John Dawson is the project engineer responsible for reviewing the application and drafting the permit. Additional details of this analysis may be obtained by contacting the project engineer at the Department's Office of Permitting and Compliance at Mail Station #5505, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400, by phone at 850-717-9085 or by email at john.dawson@dep.state.fl.us.