Comparison of the Most Recent BACT/LAER Determinations for Combustion Turbines by State Air Pollution Control Agencies

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ABSTRACT

A survey was conducted of state air pollution control agencies to determine the most recent Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER) determinations for natural gas combustion turbines used in electric power generation facilities. BACT and LAER for both simple cycle and combined cycle modes of turbine operation were evaluated.

Any new major stationary source or major modification locating in an area attaining the National Ambient Air Quality Standards (NAAQS) is subject to Prevention of Significant Deterioration (PSD) requirements and must conduct an analysis to ensure the application of BACT. Also, any new major stationary source or major modification locating in an area not attaining the NAAQS is subject to non-attainment new source review permitting requirements and must conduct an analysis to ensure the application of LAER.

Air pollution permitting agency decisions on BACT/LAER determinations depend heavily on the most recent BACT/LAER determinations. This most recent data is not always readily available in the US EPA BACT/LAER Clearinghouse. This often results in a delay as applicants and state agencies search for the most recent BACT/LAER determinations.

This paper is intended to address the need for current BACT/LAER determinations used by the state air pollution agencies and private industries.

The study involved a survey of 23 state air pollution agencies in the eastern half of the United States. Each state was queried on the most recent BACT/LAER analysis for simple and combined cycle combustion turbines; compliance averaging time applicable to these determinations; different types of control technologies required by each state agency; the cost per ton of pollutant removed threshold for economic feasibility; and the total number of BACT/LAER determinations made by each state during the last 12 months for this source group. This investigation primarily focused on the following pollutants: PM_{10}, NOx, CO, SO_2 and hydrocarbons.

BACT and LAER determinations for large combustion turbines vary significantly by state. Similarly, the compliance averaging times also vary significantly. However, both the control technologies selected for BACT and LAER and the average cost per ton of

pollutant removed threshold for economic feasibility are more consistent among the states.

Finally, only 13% of the most recent BACT/LAER determinations in this survey were included in the RBLC database. U.S. EPA could help states make better BACT and LAER determinations by speeding up the process of incorporating the most recent BACT and LAER determinations in the RBLC database.

INTRODUCTION

Any new major stationary source or major modification locating in an area attaining the National Ambient Air Quality Standards (NAAQS) is subject to Prevention of Significant Deterioration (PSD) requirements and must conduct an analysis to ensure the application of BACT. Also, any new major stationary source or major modification locating in an area not attaining the NAAQS is subject to non-attainment new source review permitting requirements and must conduct an analysis to ensure the application of LAER.

The regulatory decisions on BACT and LAER can have significant economic impacts on a proposed project (e.g. emission limits, allowable operating conditions). Thus, at the time of project development and the decision to proceed with the project, it is important to have timely information on the BACT and LAER determinations that will actually apply to the project.

To provide a central clearinghouse for BACT, LAER and Reasonably Available Control Technology (RACT) determinations throughout the nation; U.S. EPA has established the RACT/BACT/LAER Clearinghouse. As described on its web page, "the RACT/BACT/LAER Clearinghouse (RBLC) database contains information distilled from early notification submittals and air permits received from State and local air pollution control programs in the United States. The RBLC Web site also contains summary information on air pollution emission standards. The data assists State/local agency personnel and private companies in determining what types of controls and pollution prevention measures have been applied to and/or are required for various sources and the effectiveness of these technologies." (1)

The challenge is that early in the planning process for a new project, the project developer needs access to the most recent BACT/LAER determinations to make decisions on project design and to evaluate fully the economic feasibility of the project.

The time between the state or local regulatory decision on a BACT/LAER determination and the inclusion of that decision in the RBLC varies by state and can be substantial.

The purpose of this paper is to present the results of a survey conducted of recent BACT/LAER determinations in states in the eastern half of the U.S. for a major source category - - new large combustion turbines from power generation. We compare these determinations state by state and see whether these determinations are, in fact, included in the RBLC database.

SURVEY PROCEDURES

The survey questions are given in Table 1. Questions addressed included date of permit issuance, combustion turbine type and size, pollutants for which BACT or LAER determinations were made and the determination for each pollutant, compliance averaging time, required control technology, and the cost per ton of pollutant removed threshold for economic feasibility in the determination. Responses were requested for the three most recent large combustion turbines permitted in each state.

Table 1. Survey questions

Questionnaire on State Agency Experience in BACT and LAER Determinations for Three Most Recent Large Combustion Turbines Permitted			
State: Person Providing Response: Date: Email: Phone #:			
	Permit #1	Permit #2	Permit #3
Permit #			
Date Permit Issued			
Combustion Turbine Type: (Combined Cycle (CC), Simple Cycle (SC))			
Size: (Megawatts (MW) output[(a)] , MMBTU/hour fuel input)			
Pollutant: (NOx, CO, SO_2, PM10, HC)			
Type of Determination: (BACT, LAER)			
Emission Standard: (ppm, lbs/MMBTU, % sulfur fuel, etc.)			
Compliance Averaging Time: (1 hour, rolling 4-hour, etc.)			
Required Control Technology: (SCR and/or LNB for NOx, catalytic oxidation for CO, etc.)			
Cost per ton of pollutant removed threshold for economic feasibility in the determination (dollars/ton)			
Note: (a) MW output for combined cycle combustion turbines is upstream of the HRSG.			

Table 2 lists the 23 states contacted in this survey and those states that responded. In each state, we sought to contact the person in charge of the control technology determinations in the new source review process. Surveys were sent by e-mail with phone call follow up as needed. 18 of the 23 states provided survey responses that were sufficiently complete to include in the results. A total of 144 BACT determinations and 17 LAER determinations are included in the survey results.

Table 2. States contacted in survey.

State	Status	State	Status
Alabama	Complete	Massachusetts	Info not provided
Arkansas	Complete	Michigan	Complete
Connecticut	Complete	Mississippi	Info not provided
Delaware	Complete	New Hampshire	Complete
Florida	Complete	New Jersey	Info not provided
Georgia	Complete	New York	Complete
Illinois	Complete	North Carolina	Complete
Indiana	Complete	Pennsylvania	Complete
Kentucky	Complete	Rhode Island	Info not provided
Louisiana	Complete	South Carolina	Complete
Maine	Complete	Tennessee	Complete
Maryland	Info not provided		

RESULTS

Survey results are presented in the following five tables.

Table 3 presents the average BACT determination by state for simple cycle, combined cycle and all combustion turbines for up to five air pollutants. Based on natural gas firing, for NOx, these average BACT determinations vary from of 3.5 to 9.25 ppm. For CO they vary from 4.5 to 25 ppm. For SO_2, they vary from 0.0006 to 0.006 lbs/MMBTU, for PM10 they vary from 0.0055 to 0.021 lbs/MMBTU and for HC they vary from 0.7 to 6.7 ppm.

Table 4 presents the average LAER determination by state for simple cycle, combined cycle and all combustion turbines for up to five air pollutants. Based on natural gas firing, for NOx, these average LAER determinations vary from 2.0 to 3.0 ppm. For CO the determination is 2.0 ppm. For PM10 the determination is 0.0155 lb/MMBtu and for HC they vary from 1.3 to 1.56 ppm.

Table 5 presents the compliance averaging times included in the BACT and LAER determinations. Based on natural gas firing, for NOx these compliance averaging times vary from 1-hour never to be exceeded to 12-month rolling averages never to be exceeded. For CO they vary from one-hour to 30-day rolling average never to be exceeded. For SO_2, they vary from 1-hour to 3-hour averages never to be exceeded. For PM10, they vary from 1-hour to 24-hour rolling average and for HC they vary from 1-hour to 30-day rolling average.

Table 3. The average BACT determination by state for simple cycle, combined cycle and all combustion turbines.

State	Pollutant	Average BACT Determination					
		Simple Cycle Combustion Turbine		Combined Cycle Combustion Turbine		All Combustion Turbines	
		#	Avg. BACT	#	Avg. BACT	#	Avg. BACT
Alabama	NOx			3	5.0 ppm	3	5.0 ppm
	CO			3	12.0 ppm	3	12.0 ppm
	PM10			3	0.0059 lb/mmBtu	3	0.0059 lb/mmBtu
	VOC			3	3.2 ppm	3	3.2 ppm
Arkansas	NOx			3	3.5 ppm	3	3.5 ppm
	CO			2	22.5 ppm	2	22.5 ppm
	PM10			1	0.013 lb/mmBtu	1	0.013 lb/mmBtu
	VOC			2	6.7 ppmv	2	6.7 ppmv
Connecticut	SO_2			1	.005 lb/mmBtu	1	.005 lb/mmBtu
	PM10			1	0.011 lb/mmBtu	1	0.011 lb/mmBtu
Delaware	NOx	1	9 ppm	1	3 ppm	2	6 ppm
	CO	1	9 ppm	1	9 ppm	2	9 ppm
	SO_2	1	0.003 lb/mmBtu	1	0.003 lb/mmBtu	2	0.003 lb/mmBtu
	PM10	1	0.02 lb/mmBtu	1	0.021 lb/mmBtu	2	0.0205 lb/mmBtu
Florida	NOx	1	9 ppm	2	3 ppm	3	6 ppm
	CO	1	9 ppm	2	8.5 ppm	3	8.75 ppm
	SO_2	1	0.0056 lb/mmBtu	1	0.0052 lb/mmBtu	2	0.0054 lb/mmBtu
	VOC			1	2.2 ppm	1	2.2 ppm
Georgia	NOx	1	11 ppm	2	3.25 ppm	3	7.125 ppm
	CO	1	8 ppm	2	2.25 ppm	3	5.125 ppm
	PM10	1	0.023 lb/mmBtu	2	0.014 lb/mmBtu	3	0.0186 lb/mmBtu
	VOC	1	6 ppm	1	2.0 ppm	2	4.0 ppm
Illinois	NOx			2	4.0 ppm	2	4.0 ppm
	CO			2	4.5 ppm	2	4.5 ppm
	SO_2			2	0.0039 lb/mmBtu	2	0.0039 lb/mmBtu
	PM10			2	0.01 lb/mmBtu	2	0.01 lb/mmBtu
Indiana	NOx	1	9 ppm	2	3.0 ppm	3	6.0 ppm
	CO	1	25 ppm	2	10.6 ppm	3	17.8 ppm
	SO_2	1	0.0052 lb/mmBtu	2	0.0058 lb/mmBtu	3	0.0055 lb/mmBtu
	PM10	1	0.0095 lb/mmBtu	2	0.0125 lb/mmBtu	3	0.011 lb/mmBtu
Kentucky	NOx	2	9 ppm	1	2.5 ppm	3	5.75 ppm
	CO	1	25 ppm	1	1.5 ppm	2	13.25 ppm
	VOC			1	0.7 ppm	1	0.7 ppm
Louisiana	NOx	2	13.5 ppm	1	5 ppm	3	9.25 ppm
	CO	2	25 ppm	1	25 ppm	3	25 ppm
	PM10	2	0.01 lb/mmBtu	1	0.01 lb/mmBtu	3	0.01 lb/mmBtu
	SO_2	1	0.006 lb/mmBtu			1	0.006 lb/mmBtu
Maine	NOx			2	6.25 ppm	2	6.25 ppm
	CO			3	14.66 ppm	3	14.66 ppm

Table 3: (Continued)							
State	Pollutant	Average BACT Determination					
Michigan	NOx	2	12 ppm	3	3.33 ppm	5	7.67 ppm
	CO	1	25 ppm	3	5.57 ppm	4	15.29 ppm
	VOC			3	6.47 ppm	3	6.47 ppm
New Hampshire	CO			2	15 ppm	2	15 ppm
	SO_2			2	0.00145 lb/mmBtu	2	0.00145 lb/mmBtu
	PM10			2	0.0095 lb/mmBtu	2	0.0095 lb/mmBtu
New York	SO_2			2	0.0038 lb/mmBtu	2	0.0038 lb/mmBtu
	PM10			1	0.021 lb/mmBtu	1	0.021 lb/mmBtu
Pennsylvania	CO			3	7.67 ppm	3	7.67 ppm
North Carolina	NOx	2	10.5 ppm	2	2.5 ppm	4	6.5 ppm
	CO	2	9 ppm	2	9 ppm	4	9 ppm
	SO_2	2	0.0006 lb/mmBtu	2	0.0006 lb/mmBtu	4	0.0006 lb/mmBtu
	PM10	2	0.0055 lb/mmBtu	2	0.0055 lb/mmBtu	4	0.0055 lb/mmBtu
	VOC	2	1.4 ppm	2	1.4 ppm	4	1.4 ppm
South Carolina	NOx			3	5.83 ppm	3	5.83 ppm
	CO			2	14.55 ppm	2	14.55 ppm
	VOC			1	3.3 ppm	1	3.3 ppm
Tennessee	NOx	3	9 ppm			3	9 ppm

Table 4. The average LAER determination by state for simple cycle, combined cycle and all combustion turbines.

State	Pollutant	Average BACT Determination					
		Simple Cycle Combustion Turbine		Combined Cycle Combustion Turbine		All Combustion Turbines	
		#	Avg. LAER	#	Avg. LAER	#	Avg. LAER
Connecticut	NOx	1	2.0 ppm			1	2.0 ppm
Maine	NOx			1	2.5 ppm	1	2.5 ppm
New Hampshire	NOx			2	2.5 ppm	2	2.5 ppm
New York	NOx			2	2 ppm	2	2 ppm
	CO			2	2 ppm	2	2 ppm
	PM10			1	0.0155 lb/mmBtu	1	0.0155 lb/mmBtu
	VOC			2	1.3 ppm	2	1.3 ppm
Pennsylvania	NOx			3	3 ppm	3	3 ppm
	VOC			3	1.56 ppm	3	1.56 ppm

Table 5. Comparison of compliance averaging times in BACT/LAER determinations.

State	Pollutant	Compliance Averaging Times Used in BACT/LAER Determinations
Alabama	NOx	3 hour
	CO	3 hour
Arkansas	NOx	24 hour; 3 hour
	CO	24 hour
	PM10	3 hour
	VOC	3 hour
Connecticut	NOx	3 hour
	CO	1 hour
	SO_2	3 hour
Delaware	NOx	1 hour
	CO	1 hour
	SO_2	1 hour
	PM10	1 hour
Florida	NOx	24 hour block; 3 hour
	CO	24 hour block
	VOC	3 hour
Georgia	NOx	3 hours rolling average
Illinois	NOx	1 hour
	CO	1 hour
Indiana	NOx	24 hour operating; 3 hour block
	CO	24 hour
Kentucky	NOx	3 hour average, 12 month rolling average (combined with 3 hour averaging time)
	CO	3 hour
	SO_2	3 hour
	PM10	3 hour
Louisiana	NOx	1 hour
	CO	1 hour
	SO_2	1 hour
	PM10	1 hour
Maine	NOx	3 and 24 hour block average
	CO	24 hour block average
Michigan	NOx	Day; 24 hour rolling; 3 hour
	CO	24 hour rolling; day
	PM10	Day; 24 hour rolling
	VOC	24 hour rolling
New Hampshire	NOx	3 hour block average
	CO	1 hour block average
	SO_2	3 hour rolling
	PM10	1 hour block average
New York	NOx	3 hour rolling average
	CO	1 hour
	SO_2	1 hour
	PM10	1 hour; 1 hour average
	VOC	1 hour; 1 hour average
Pennsylvania	NOx	1 hour
	CO	1 hour
	SO_2	1 hour
	PM10	1 hour
	VOC	1 hour

Table 5: (Continued)		
State	Pollutant	Compliance Averaging Times Used in BACT/LAER Determinations
North Carolina	NOx	24 hour rolling average
South Carolina	NOx	3 hour; 24 hour
	CO	Rolling 30 day
	VOC	30 day rolling

Table 6 presents the required control technologies in the BACT/LAER determinations.

Table 7 presents the average cost per ton of pollutant removed threshold for economic feasibility in the BACT determination and in the LAER determination separately by state. The average cost per ton varies significantly by pollutant and among states.

Finally, Table 8 provides an indication of how up to date the RBLC Clearinghouse data is. For each state, we show how many of the three most recent BACT/LAER determinations are in the RBLC Clearinghouse data. Overall, only 13% of the most recent BACT/LAER determinations in this survey were in the RBLC Clearinghouse.

CONCLUSIONS

BACT and LAER determinations for large combustion turbines vary significantly by state. Similarly, the compliance averaging times also vary significantly. However, both the control technologies selected for BACT and LAER and the average cost per ton of pollutant removed threshold for economic feasibility are more consistent among the states.

Finally, only 14% of the most recent BACT/LAER determinations in this survey were included in the RBLC database. U.S. EPA could help states make better BACT and LAER determinations by speeding up the process of incorporating the most recent BACT and LAER determinations in the RBLC database.

REFERENCES

(1) 40 CFR §52.21, *Prevention of Significant Deterioration of Air Quality*.

(2) 40 CFR Part 51, *Appendix S, Emission Offset Interpretive Ruling.*

(3) U.S. EPA web page. http://www.epa.gov/ttncatc1/rblc/htm/bl02.cfm

KEY WORDS
Combustion Turbines
PSD
BACT
LAER
RACT/BACT/LAER Clearinghouse

Table 6. Required control technologies in the BACT/LAER determinations

State	Pollutant	Required Control Technologies in the BACT/LAER Determinations
Alabama	NOx	Dry Low NOx; SCR
	CO	Good Combustion
	PM10	Good Combustion
	VOC	Good Combustion
Arkansas	NOx	Dry Low NOx w/SCR
	CO	Catalytic Oxidation
	SO_2	Fuel Sulfur limitation
	VOC	Catalytic Oxidation
Connecticut	NOx	SCR
	CO	Catalytic Oxidation
Delaware	NOx	SCR
	CO	Fuel Sulfur limitation
Florida	NOx	Dry Low NOx; SCR; SONOx
	CO	Combustion control; Catalytic Oxidation
	SO_2	Low sulfur fuels
Georgia	NOx	Dry Low NOx with SCR
	CO	Efficient Combustion
	SO_2	Low sulfur natural gas
	PM10	Efficient Combustion
Illinois	NOx	Dry low NOx with SCR
	CO	Catalytic Oxidation, Good Combustion Practices
	SO_2	Low sulfur natural gas
	PM10	Good combustion practices
	VOC	Good combustion practices
Indiana	NOx	Dry Low NOx Combustors; SCR
	CO	Good design/operation
	SO_2	Low sulfur fuel
	PM10	Good combustion
	VOC	Good combustion
Kentucky	NOx	Dry Low NOx Combustor with SCR
	CO	Catalytic Oxidation, Good combustion practices
	SO_2	Low sulfur natural gas
	PM10	Good combustion control
	VOC	Catalytic Oxidation
Louisiana	NOx	Dry Low NOx Combustor, SCR
Maine	NOx	Dry Low NOx Combustor, SCR
	CO	Good combustion practices
	SO_2	Natural gas combustion only
	PM10	Good combustion practices, natural gas only
	VOC	Good combustion practices
Michigan	NOx	DLNB, SCR
	CO	Catalytic Oxidation
	PM10	Good Combustion
	VOC	Catalytic Oxidation
New Hampshire	NOx	LNB with SCR
	CO	ood combustion practices
	SO_2	Low sulfur fuels, < 0.05% sulfur
	PM10	Low sulfur fuels

Table 6: (Continued)		
State	Pollutant	Required Control Technologies in the BACT/LAER Determinations
New York	NOx	SCR, LNB
	CO	Catalytic Oxidation
	SO_2	Low sulfur fuel
	PM10	Fire only natural gas
	VOC	Catalytic Oxidation
Pennsylvania	NOx	DLNB + SCR
	CO + VOC	Oxidation Catalyst
	SO_2	Low sulfur fuel
	PM10	NG
North Carolina	NOx	DLNB
	CO	Combustion control
	VOC	Combustion control
	PM10	Combustion control
South Carolina	NOx	SCR, dry low NOx burners
	CO	Good combustion practices
	VOC	Good combustion practices
	SO_2	Combustion of low sulfur fuels
Tennessee	NOx	Dry low NOx combustors

Table 7. Average cost per ton of pollutant removed threshold for economic feasibility in the BACT/LAER determination.

State	Pollutant	BACT Determinations Average Cost per Ton	LAER Determinations Average Cost per Ton
Arkansas	CO/VOC	$3,373	
	NOx	$5,108	
Connecticut	NOx	$9,000	
Florida	NOx	$2,606	
Kentucky	NOx	$12, 485	

Table 8. BACT/LAER determinations from this survey that are in U.S. EPA's RACT/LAER/BACT Clearinghouse Database

State	Pollutant	BACT /LAER Determinations in This Survey	BACT/LAER Determinations from Survey that are in U.S. EPA's RACT/LAER/BACT Clearinghouse Database	Percentage of BACT/LAER Determinations from Survey that are in U.S. EPA's RACT/LAER/BACT Clearinghouse Database
Alabama	NOx	3	0	0
	CO	3	0	0
	PM10	3	0	0
	VOC	3	0	0
Arkansas	NOx	3	2	66.6
	CO	2	2	100
	PM10	1	1	100
	VOC	2	2	100
Connecticut	NOx	1	1	100
	SO_2	1	1	100
	PM10	1	1	100
Delaware	NOx	2	0	0
	CO	2	0	0
	SO_2	2	0	0
	PM10	2	0	0
Florida	NOx	3	0	0
	CO	3	0	0
	SO_2	2	0	0
	VOC	1	0	0
Georgia	NOx	3	0	0
	CO	3	0	0
	PM10	3	0	0
	VOC	2	0	0
Illinois	NOx	2	0	0
	CO	2	0	0
	PM10	2	0	0
	SO_2	2	0	0
Indiana	NOx	3	1	33.3
	CO	3	1	33.3
	SO_2	3	1	33.3
	PM10	3	1	33.3
Kentucky	NOx	3	0	0
	CO	2	0	0
	VOC	1	0	0
Louisiana	NOx	3	0	0
	CO	3	0	0
	PM10	3	0	0
	SO_2	1	0	0
Maine	NOx	3	3	100
	CO	3	3	100
Michigan	NOx	5	0	0
	CO	4	0	0
	VOC	3	0	0

Table 8: (Continued)				
State	Pollutant	BACT /LAER Determinations in This Survey	BACT/LAER Determinations from Survey that are in U.S. EPA's RACT/LAER/BACT Clearinghouse Database	Percentage of BACT/LAER Determinations from Survey that are in U.S. EPA's RACT/LAER/BACT Clearinghouse Database
New Hampshire	NOx	2	0	0
	CO	2	0	0
	SO_2	2	0	0
	PM10	2	0	0
New York	NOx	2	0	0
	CO	2	0	0
	SO_2	2	0	0
	PM10	2	0	0
	VOC	2	0	0
Pennsylvania	NOx	3	0	0
	CO	3	0	0
	VOC	3	0	0
North Carolina	NOx	4	0	0
	CO	4	0	0
	SO_2	4	0	0
	PM10	4	0	0
	VOC	4	0	0
South Carolina	NOx	3	0	0
	CO	2	0	0
	VOC	1	0	0
Tennessee	NOx	3	2	66.7