APPENDIX 5.1E

Evaluation of Best Available Control Technology

APPENDIX 5.1E

EVALUATION OF BEST AVAILABLE CONTROL TECHNOLOGY

The project is required to use best available control technology on the combustion turbine/HRSG, the auxiliary boiler and the cooling tower for various pollutants, in accordance with the requirements of the federal PSD and the District new source review programs. The applicability of BACT requirements under PSD regulations is discussed in Section 5.1. For sources subject to PSD, BACT is defined in 40 CFR 52.21(j) as:

> "an emissions limitation…based on the maximum degree of reduction for each pollutant subject to regulation under the Clean Air Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant…"

The applicability of BACT requirements under District regulations is discussed in Section 5.1.7.2.7. The YSAQMD defines BACT as:

> "208.1 For any emissions unit the most stringent of:
>
> a. The most effective emission control device, emission limit, or technique, singly or in combination, which has been required or used for the type of equipment comprising such an emissions unit unless the applicant demonstrates to the satisfaction of the Air Pollution Control Officer that such limitations required on other sources have not been demonstrated to be achievable in practice.
>
> b. Any alternative basic equipment, fuel, process, emission control device or technique, singly or in combination, determined to be technologically feasible and cost-effective by the Air Pollution Control Officer.
>
> 208.2 In making a BACT determination for each affected pollutant, the Air Pollution Control Officer may consider the overall effect of the determination on other affected pollutants. In some cases the lowest emission rates may be required for one or more affected pollutants at the cost of not achieving the lowest emission rate for other pollutants. The Air Pollution Control Officer shall discuss these considerations in the Preliminary Decision prepared pursuant to Section 404.
>
> 208.3 Under no circumstances shall BACT be determined to be less stringent than the emission control required by any applicable provision of district, state or federal laws or regulations, or contained in the implementation plan of any State, for such class or category of stationary source unless the applicant

demonstrates to the satisfaction of the Air Pollution Control Officer that such limitations are not achievable." [Rule 3-4, Section 208]

The federal PSD BACT requirement is applicable for NOx and CO, while the District BACT requirement is applicable for all pollutants. The emission rates and control technologies determined to be BACT for this project are discussed in detail in the following sections. For the CTG/HRSG, separate determinations are provided for normal operation and startup/shutdown operation.

5.1E.1 BACT for the CTG/HRSG: Normal Operations

5.1E.1.1 NOx Emissions

Achievable Controlled Levels and Available Control Options

The most recent NOx BACT listings for combined-cycle combustion turbines in this size range are summarized in Table 5.1E-1. The most stringent NOx limit in these recent BACT determinations is a 2.0 ppm[3] limit averaged over a 1-hour averaging period, excluding startups and shutdowns. This level is achieved using DLN combustors and SCR. The Elk Hills project was given the option of using SCONOx instead of SCR, with a NOx limit of 2.5 ppm.

SCONOx is a NOx reduction system produced by Goal Line Environmental Technologies. It is now distributed by EmeraChem as EMx. This system uses a single catalyst to oxidize both NOx and CO and then a regeneration system to convert the NO_2 to N_2 and water vapor. The system does not use ammonia as a reagent. The EMx process has been demonstrated in practice on much smaller gas turbines, including the Redding Unit 5 combined-cycle gas turbine, a *-MW unit. While the technology has never been demonstrated on a gas turbine the size of the 7FA, the technology is considered by the manufacturer to be scalable.

The SCR system uses ammonia injection to reduce NOx emissions. SCR systems have been widely used in combined-cycle gas turbine applications of all sizes, including the 7FA and the larger H-class. The SCR process involves the injection of ammonia into the flue gas stream via an ammonia injection grid upstream of a reducing catalyst. The ammonia reacts with the NOx in the exhaust stream to form N_2 and water vapor. The catalyst does not require regeneration, but must be replaced periodically—approximately every 3 years.

Either SCR or SCONOx technology, in combination with dry low-NOx (DLN) combustion, will achieve a NOx emission level of 2.0 ppmvd@ 15% O_2.

Environmental Impacts

The use of SCR will result in ammonia emissions due to an allowable ammonia slip limit of 5 ppmvd @ 15% O_2. A health risk screening analysis of the proposed project using air dispersion modeling showed an acute hazard index and a chronic hazard index to be each much less than 1, resulting from an ammonia slip limit of 5 ppmv @ 15% O_2. In accordance with the District Toxic Risk Management Policy and currently accepted practice, a hazard

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[3] All turbine/HRSG exhaust emissions concentrations shown are corrected to 15% O_2.

index of less than 1.0 or above is considered not significant. Therefore, the toxic impact of the ammonia slip resulting from the use of SCR is deemed to be not significant and is not a sufficient reason to eliminate SCR as a control alternative.

The ammonia emissions resulting from the use of SCR may have another environmental impact through its potential to form secondary particulate matter such as ammonium nitrate. Because of the complex nature of the chemical reactions and dynamics involved in the formation of secondary particulates, it is difficult to estimate the amount of secondary particulate matter that will be formed from the emission of a given amount of ammonia. However, the San Joaquin Valley APCD and Bay Area AQMD have both stated that because of high background levels of ammonia, the formation of ammonium nitrate in the Bay Area and San Joaquin Valley air basins is limited by the formation of nitric acid and not driven by the amount of ammonia in the atmosphere. Therefore, ammonia emissions from the proposed SCR system are not expected to contribute significantly to the formation of secondary particulate matter at the project site.

A second potential environmental impact that may result from the use of SCR involves the storage and transport of aqueous ammonia. Although ammonia is toxic if swallowed or inhaled and can irritate or burn the skin, eyes, nose, or throat, it is a commonly used material that is typically handled safely and without incident. The project will be required to maintain a Risk Management Plan (RMP) and implement a Risk Management Program to prevent accidental releases. The RMP will provide information on the hazards of the substance handled at the facility and the programs in place to prevent and respond to accidental releases. The accident prevention and emergency response requirements reflect existing safety regulations and sound industry safety codes and standards. Thus the potential environmental impact due to aqueous ammonia storage at the project does not justify the elimination of SCR as a control alternative.

Regeneration of the EMx catalyst is accomplished by passing hydrogen gas over an isolated catalyst module. The hydrogen gas is generated by reforming steam, so additional steam would be required beyond that for which the project is designed. This would require an increase in the size of the auxiliary boiler as well as an increase in expected boiler operation and emissions.

Conclusion

Because both SCR and EMx are expected to achieve the proposed BACT NO_x emission limit of 2.0 ppmvd @ 15% O_2 averaged over one hour and neither will cause significant energy, economic, or environmental impacts, neither can be eliminated as viable control alternatives. The concern remains regarding the long-term effectiveness of EMx as a control technology as the technology has not been demonstrated on the turbine used in this project. For these reasons, SCR has been selected as the NOx control technology to be used for the CPVVS.

TABLE 5.1E-1

Recent NOx BACT Determinations for Combustion Turbines/HRSGs

Facility	District/State	NOx Limit	Averaging Prd	Control Method Used	Date Permit Issued	Source
Gateway Generating Station	BAAQMD	2.0 ppmc	1 hour	DLN/SCR	July 2008 (proposed permit)	BAAQMD
Colusa Generating Station	EPA Region 9	2.0 ppmc	1 hour	DLN/SCR	May 2008	EPA AQIA
Russell City Energy Center	BAAQMD	2.0 ppmc	1 hour	DLN/SCR	June 2007	BAAQMD website
Blythe Energy LLC (Blythe II)[a]	MDAQMD	2.0	3 hours	DLN/SCR	April 2007	PSD permit
San Joaquin Valley Energy Center	EPA Region 9	2.0	1 hour	DLN/SCR	August 2006	PSD permit
Mountainview Power	SCAQMD	2.0	1 hour	DLN/SCR	2004	amendment
Pastoria Energy LLC	SJVAPCD	2.5	1 hour	DLN/SCR	2004	PSD amendment
Magnolia Power Project	SCAQMD	2.0	3 hours	DLN/SCR	February 2004	SCAQMD website
Vernon City Power & Light	SCAQMD	2.0	2 hour	DLN/SCR	February 2004	SCAQMD website
PSO Southwestern Power Plant	Oklahoma	9.0 ppm	--	DLN	February 2007	EPA RBLC
Rocky Mountain Energy Center	Colorado	3.0 ppm	1 hour	DLN/SCR	May 2006	EPA RBLC
Sierra Pacific Power Company	Nevada	2.0 ppm	3 hours	DLN/SCR	August 2005	EPA RBLC
Wanapa Energy Center	Oregon	2.0 ppm	3 hours	DLN/SCR	August 2005	EPA RBLC
Crescent City Power, LLC	Louisiana	3.0 ppm	annual	DLN/SCR	June 2005	EPA RBLC
Berrien Energy, LLC	Michigan	2.5 ppm	24 hours	DLN/SCR	April 2005	EPA RBLC
Turner Energy Center[b]	Oregon	2.0 ppm	1 hour	DLN/SCR	January 2005	EPA RBLC

Notes:

a. Construction on hold.

b. RBLC record indicates that project will not be built.

NOx BACT Determination

BACT must be at least as stringent as the most stringent level achieved in practice, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the NOx BACT determination of 2.0 ppm @ 15% O_2 on a 1-hour average basis made for recently permitted combined cycle turbine projects in SJVUAPCD and elsewhere reflects the most stringent achievable NOx emission limit. The CPVVS facility will be designed to meet a NOx level of 2.0 ppmv @ 15% O_2 on a 1-hour average basis using SCR.

5.1E.1.2 CO Emissions

Achievable Controlled Levels and Available Control Options

Oxidation catalyst technology is commonly used to control CO emissions.

The ARB's BACT guidance document for electric generating units rated at greater than 50 MW[4] indicates that BACT for the control of CO emissions from stationary gas turbines used for combined-cycle and cogeneration power plants is 6 ppmvd @ 15% O_2.

The BAAQMD's BACT guidelines specify that, for natural gas-fired combined-cycle gas turbines larger than 40 MW, a CO limit of 4 ppmv @ 15% O_2 has been "achieved in practice." The SJVUAPCD's BACT guidelines contained determinations for gas turbines larger than 50 MW with uniform load and with heat recovery. The SJVUAPCD concluded that a CO exhaust concentration of 6 ppmv @ 15% O_2 constituted BACT that had been achieved in practice, while 4.0 ppmv @ 15% O_2 is considered technologically feasible.

A summary of recent CO BACT determinations for large, combined-cycle gas turbines is shown in Table 5.1E-2. Similar facilities using oxidation catalysts have been permitted at between 2.0 and 4.0 ppm CO. CO emission limits for projects in the SCAQMD may be considered to go beyond BACT because of the following two reasons: (1) the District is a nonattainment area for CO, so more stringent control requirements apply; and (2) applicants in the SCAQMD are required to provide offsets for CO, so there is additional incentive to reduce CO emission levels beyond BACT to minimize offset requirements.

Published prohibitory rules from the BAAQMD, SMAQMD, SDCAPCD, SJVUAPCD, and SCAQMD were reviewed to identify the CO standards that govern existing natural gas-fired simple cycle combustion gas turbines. Of the five prohibitory rules reviewed, the SJVUAPCD prohibitory rule for combustion gas turbines is the only one that includes an emission limit for CO (200 ppmv @ 15% O_2). The applicable NSPS (40 CFR 60 Subpart KKKK) does not include a CO limit.

BACT Determination for CO

BACT must be at least as stringent as the most stringent level achieved in practice, required in a federal NSPS or district prohibitory rule, or considered technologically feasible. The proposed CO emission limit of 3 ppmvd @ 15% O_2 on a 3-hour average basis is more stringent than the level currently considered BACT, but is expected to be achievable in practice.

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[4] CARB, "Guidance for Power Plant Siting and Best Available Control Technology," July 1999.

TABLE 5.1E-2

Recent CO BACT Determinations for Combustion Turbines/HRSGs

Facility	District/State	CO Limit	Averaging Prd	Control Method Used	Date Permit Issued	Source
Gateway Generating Station	BAAQMD	4.0 ppmc	3 hours	oxidation catalyst	July 2008 (proposed permit)	BAAQMD
Colusa Generating Station	EPA Region 9	3.0 ppmc	3 hours	oxidation catalyst	May 2008	EPA AQIA
Russell City Energy Center	BAAQMD	4.0 ppmc	3 hours	oxidation catalyst	June 2007	BAAQMD website
Blythe Energy LLC (Blythe II)[a]	MDAQMD	4.0 ppmc	3 hours	oxidation catalyst	April 2007	PSD permit
San Joaquin Valley Energy Center	EPA Region 9	4.0 ppmc	1 hour	oxidation catalyst	August 2006	PSD permit
Pastoria Energy LLC	SJVAPCD	9.0 ppmc	3 hours	oxidation catalyst	2004	PSD amendment
Magnolia Power Project	SCAQMD	2.0 ppmc	1 hour	oxidation catalyst	February 2004	SCAQMD website
Vernon City Power & Light	SCAQMD	2.0 ppmc	3 hour	oxidation catalyst	February 2004	SCAQMD website
PSO Southwestern Power Plant	Oklahoma	25 ppmc	--	oxidation catalyst	February 2007	EPA RBLC
Rocky Mountain Energy Center	Colorado	3.0 ppmc	--	oxidation catalyst	May 2006	EPA RBLC
Sierra Pacific Power Company	Nevada	3.5 ppmc	3 hours	oxidation catalyst	August 2005	EPA RBLC
Wanapa Energy Center	Oregon	2.0 ppmc	3 hours	oxidation catalyst	August 2005	EPA RBLC
Crescent City Power, LLC	Louisiana	4.0 ppmc[b]	annual	oxidation catalyst	June 2005	EPA RBLC
Berrien Energy, LLC	Michigan	2.0 ppmc	3 hours	oxidation catalyst	April 2005	EPA RBLC
Turner Energy Center[c]	Oregon	2.0 ppmc / 3.0 ppmc	1 hour	oxidation catalyst	January 2005	EPA RBLC

Notes:

a. Construction on hold.

b. Separate CO limit set for duct burners; this limit is for turbines only.

c. RBLC record indicates that project will not be built.

5.1E.1.3 ROC Emissions

Achievable Controlled Levels and Available Control Options

Most ROCs emitted from natural gas-fired turbines are the result of incomplete combustion of fuel. Therefore, most of the ROCs are methane and ethane, which are not effectively controlled by an oxidation catalyst. However, oxidation catalyst technology designed to control CO can also provide some degree of control of ROC emissions, especially the more complex compounds and toxic compounds formed in the combustion process. Therefore, use of an oxidation catalyst is generally considered BACT for ROC.

The ARB's BACT guidance document for electric generating units rated at greater than 50 MW[5] indicates that BACT for the control of ROC emissions from turbines used for combined-cycle and cogeneration power plants is 2 ppmvd at 15% O_2.

The BAAQMD's BACT guidelines specify that, for natural gas-fired combined cycle combustion gas turbines larger than 40 MW, a ROC limit of 2 ppmvd at 15% O_2 has been "achieved in practice."

The SJVUAPCD's BACT guidelines contained a determination for gas turbines rated at larger than 50 MW with uniform load and with heat recovery. The SJVUAPCD concluded that an ROC exhaust concentration of 2.0 ppmvd at 15% O_2 constituted BACT that had been achieved in practice, while 1.5 ppmvd at 15% O_2 is considered technologically feasible.

The SCAQMD database contains BACT determinations for ROC emissions from two natural gas-fired combined cycle combustion gas turbines at 2.0 ppmvd at 15% O_2.

Published prohibitory rules from the BAAQMD, SMAQMD, SDCAPCD, SJVUAPCD, and SCAQMD were reviewed to identify the ROC standards that govern existing natural gas-fired combined cycle combustion gas turbines. None of the prohibitory rules for combustion gas turbines, discussed previously in Section 5.1E1.3, specify an emission limit for ROC. The applicable NSPS (40 CFR 60 Subpart KKKK) does not include a ROC limit.

A summary of recent ROC BACT determinations for large, combined-cycle gas turbines is shown in Table 5.1E-3. Similar facilities using oxidation catalysts have been permitted at 2.0 ppm ROC. While some facilities have been permitted with limits below 2.0 ppm, none of those facilities has been constructed or operated so no in-use data is available to determine whether those levels can be achieved in practice.

BACT Determination for ROC

BACT must be at least as stringent as the most stringent achieved in practice, required in a federal NSPS or district prohibitory rule, or considered technologically feasible and cost effective. Based upon the results of this analysis, the proposed ROC emission limits of 2.0 at 15% O_2 are considered to be BACT for the proposed project.

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[5] Ibid, Table I-1.

TABLE 5.1E-3

Recent ROC BACT Determinations for Combustion Turbines/HRSGs

Facility	District/State	ROC Limit	Averaging Prd	Duct Fired?	Date Permit Issued	Source
Gateway Generating Station	BAAQMD	2.0 ppmc	3 hours	yes	July 2008 (proposed permit)	BAAQMD
Colusa Generating Station	EPA Region 9	2.0 ppmc	1 hour	yes	May 2008	EPA AQIA
Russell City Energy Center	BAAQMD	2.0 ppmc	3 hours	yes	June 2007	BAAQMD website
Blythe Energy LLC (Blythe II)[a]	MDAQMD	1.0 ppmc	3 hours	yes	December 2005	CEC website
Magnolia Power Project	SCAQMD	2.0 ppmc	1 hour	yes	February 2004	SCAQMD website
Vernon City Power & Light	SCAQMD	2.0 ppm[c]	1 hour	yes	February 2004	SCAQMD website
Rocky Mountain Energy Center	Colorado	0.0029 lb/MMBtu	--	unknown	May 2006	EPA RBLC
Sierra Pacific Power Company	Nevada	4.0 ppmc	3 hours	yes	August 2005	EPA RBLC
Crescent City Power, LLC	Louisiana	1.1 ppmc	annual	no[b]	June 2005	EPA RBLC
Turner Energy Center[c]	Oregon	1.0 ppmc	3 hours	yes	January 2005	EPA RBLC

Notes:

a. Construction on hold.

b. Separate ROC limit set for duct burners; this limit is for turbines only.

c. RBLC record indicates that project will not be built.

5.1E.1.4 $PM_{10}/PM_{2.5}$ Emissions

Achievable Controlled Levels and Available Control Options

PM emissions from natural gas-fired turbines and HRSGs primarily result from carryover of noncombustible trace constituents in the fuel. PM emissions are minimized by using clean burning pipeline quality natural gas with low sulfur content.

The ARB BACT Clearinghouse, as well as the BAAQMD and SJVAPCD BACT guidelines, identify the use of natural gas as the primary fuel as "achieved in practice" for the control of PM_{10} for combustion gas turbines. The SJVAPCD also requires the use of an air inlet filter cooler and a lube oil vent coalescer to remove ambient particulate matter from the inlet air and to minimize the formation of lube oil mists.

The ARB's BACT guidance document for stationary gas turbines used for combined-cycle and cogeneration power plant configurations[6] indicates that BACT for the control of PM emissions is an emission limit corresponding to natural gas with fuel sulfur content of no more than 1 grain/100 standard cubic foot.

Title 40 CFR Part 60 Subpart KKKK contains the applicable NSPS for combustion gas turbines. Section III.H previously identified the requirements of Subpart KKKK applicable to the proposed combustion gas turbine; Subpart KKKK does not regulate PM_{10} emissions.

Published prohibitory rules from the District, SCAQMD, SJVUAPCD, SMAQMD, and SDCAPCD were reviewed to identify the PM_{10} standards that govern natural gas-fired combustion gas turbines. These prohibitory rules do not regulate PM_{10} emissions. The applicable NSPS (40 CFR 60 Subpart KKKK) limits SOx emissions to 0.56 lb/MWh, well above permitted limits for natural gas-fired turbines.

Recent PM_{10} BACT determinations for similarly-sized gas turbines/HRSGs are summarized in Table 5.1E-4.

Conclusions

Based upon the results of this analysis, the BAAQMD BACT guideline reflects the most stringent PM_{10} emission limit. The District established a requirement for the use of natural gas as the primary fuel to control PM_{10} emissions from combustion gas turbines. Therefore, the use of natural gas as the primary fuel source constitutes BACT for PM_{10} emissions from small simple cycle combustion gas turbines. Through the use of natural gas, the turbines are expected to be able to meet the proposed emission limit of 7.5 lb/hr per turbine without duct firing and 9.0 lb/hr with duct firing. These limits are consistent with or lower than the limits shown in the summary table, with the exception of the Blythe II project. Since the Blythe II project has not yet been constructed or operated and no performance data are available, this permit limit is not considered achieved in practice.

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[6] Ibid, Table I-2.

TABLE 5.1E-4

Recent PM_{10} BACT Determinations for Combustion Turbines/HRSGs

Facility	District/State	PM_{10} Limit, no duct firing	PM_{10} Limit, with duct firing	Date Permit Issued	Source
Colusa Generating Station	EPA Region 9	12.9 lb/hr	20.0 lb/hr	May 2008	CEC final decision
Russell City Energy Center	BAAQMD	8.6 lb/hr	11.6 lb/hr	June 2007	BAAQMD website
Blythe Energy LLC (Blythe II)	MDAQMD		6.0 lb/hr[a]	December 2005	CEC website
Magnolia Power Project	SCAQMD	--	11.0 lb/hr	February 2004	SCAQMD website
Vernon City Power & Light	SCAQMD	--	11.0 lb/hr	February 2004	SCAQMD website
Rocky Mountain Energy Center	Colorado	--	0.0074 lb/MMBtu	May 2006	EPA RBLC
Sierra Pacific Power Company	Nevada	--	0.011 lb/MMBtu	August 2005	EPA RBLC
Crescent City Power, LLC	Louisiana	29.6 lb/hr	0.01 lb/MMBtu[b]	June 2005	EPA RBLC
Turner Energy Center[c]	Oregon	--	18 lb/hr	January 2005	EPA RBLC

Notes:

a. Construction on hold.

b. Annual limit.

c. RBLC record indicates that project will not be built.

5.1E.1.5 SOx Emissions

Achievable Controlled Levels and Available Control Options

The CARB BACT Clearinghouse, as well as the BAAQMD and SJVUAPCD BACT guidelines, identify the use of PUC-quality natural gas or natural gas with a limit on the sulfur content (i.e., 1 grain/100 scf) as the primary fuel as "achieved in practice" for the control of SOx for combustion gas turbines. The two most recent BACT determinations in the SCAQMD did not indicate BACT for SOx.

Federal NSPS

Title 40 CFR Part 60 Subpart KKKK contains the applicable NSPS for combustion gas turbines. Section III.B previously identified the requirements of Subpart KKKK applicable to the proposed combustion gas turbine. A combustion gas turbine is subject to a SO_2 emission limit of 0.015% by volume (150 ppmv) @ 15% O_2. The NSPS also limits the sulfur content of fuel to 0.8% by weight.

District Prohibitory Rules

Published prohibitory rules from the BAAQMD, SJVUAPCD, and SCAQMD were reviewed to identify the SO_2 standards that govern existing gas turbines.

- BAAQMD Rule 9-9 (Nitrogen Oxides from Stationary Gas Turbines) is the BAAQMD's only prohibitory rule that specifically addresses gas turbines but does not limit SO_2 emissions. The BAAQMD adopted Rule 9-1 (Sulfur Dioxide) to limit SO_2 emissions from all sources. Rule 9-1 prohibits SO_2 emissions in excess of 300 ppm. No other BAAQMD Rule or Regulation contains a relevant prohibitory rule regulating either the sulfur content in the fuel or the emission of SO_2 from gas turbines.

- SJVUAPCD Rule 4703 (Stationary Gas Turbines) is the SJVUAPCD's only prohibitory rule that specifically addresses gas turbines but does not limit SO_2 emissions. The SJVUAPCD adopted Rule 4301 (Fuel Burning Equipment) to limit SO_2 emissions from these devices. Rule 4301 specifies a SO_2 emission limit of 200 pounds per hour. The SJVUAPCD also adopted Rule 4801 (Sulfur Compounds) to limit emissions of sulfur compounds. Rule 4801 specifies a SO_2 emission limit of 0.2%, or 2,000 ppm.

- SCAQMD Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) is the SCAQMD's only prohibitory rule that specifically addresses gas turbines but does not limit SO_2 emissions. The SCAQMD adopted Rule 431.1 (Sulfur Content of Gaseous Fuels) to reduce SOx emissions from the burning of gaseous fuels in stationary equipment. Rule 431.1 specifies a sulfur limit of 16 grains/100 scf (as H_2S) in natural gas sold within the SCAQMD. The SCAQMD also adopted Rule 407 (Liquid and Gaseous Air Contaminants) to limit SO_2 emissions from all sources. Rule 407 specifies an emission limit of 2,000 ppm for sulfur compounds (calculated as SO_2).

Conclusions

BACT must be at least as stringent as the most stringent limit achieved in practice, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the CARB database and BAAQMD and SJVUAPCD BACT guidelines reflect the most stringent SOx emission limit. These sources established a requirement for the use of natural gas as the primary fuel to control SOx emissions from combustion gas turbines. Therefore, the use of natural gas as the primary fuel source constitutes BACT for SOx emissions from the gas turbine/HRSG.

5.1E.2 BACT for the CTG/HRSG: Startup/Shutdown

Startup and shutdown periods are a normal part of the operation of combined cycle power plants such as CPVVS. BACT must also be applied during the startup and shutdown periods of gas turbine/HRSG operation. The BACT limits discussed in the previous section apply to steady-state operation, when the turbine, HRSG, and steam turbine have reached stable operations and the emission control systems are fully operational.

During gas turbine startup, there are equipment and process requirements that must be met in sequential order to protect the equipment. Many of these require holding the gas turbine at low loads, where operation is inefficient and emissions are relatively high, to allow the HRSG to warm up and for steam turbine seals and condenser vacuum to be established. At low turbine loads, the combustors are not yet operating in lean pre-mix mode so turbine-out NOx emission rates are also high during startup. In addition, incomplete combustion at low loads results in higher CO and ROC emission rates. Further, the post-combustion controls that are used to achieve additional emissions reductions (SCR and oxidation catalyst) require specific exhaust temperature ranges to be fully effective. The use of SCR to control NOx is not technically feasible when the surface of the SCR catalyst is below the manufacturer's recommended operating range. When surface temperatures are low, ammonia will not react completely with the NOx, resulting in excess NOx emissions or excess ammonia slip. The oxidation catalyst is not effective at controlling CO emissions when exhaust temperature is outside the optimal temperature range. Therefore, the BACT determinations for NOx, CO, and ROC during normal, steady-state operation are not applicable during startup and shutdown. However, since SO_2 and PM_{10} emissions result from the characteristics of the fuel burned and not on any emissions control system, the BACT determinations for SO_2 and PM_{10} emissions are applicable during startup and shutdown as well.

Because NOx, CO, and ROC emissions during startup and shutdown are not effectively reduced by combustion controls or add-on control devices, the emission rates themselves cannot be effectively reduced. Therefore, the pound per hour NOx, CO, and ROC limits proposed by the applicant for startup and shutdown periods represent achievable emissions limits based on experience with other similar turbine projects and are considered BACT for startup and shutdown.

Since the emission rates cannot be reduced, startup emissions must be addressed by minimizing the amount of time the gas turbine and HRSG spend in startup. Efforts have been made by turbine and HRSG manufacturers to develop ways of reducing the time required to ramp up the CTG load to where the DLN combustors will be effective and exhaust temperatures will allow the control devices to be effective.

A new system, called Rapid Response, is currently being marketed by GE. The system is designed to reduce the period needed for a warm start to a few minutes. In order to achieve this, the entire power train (turbine, duct burners, HRSG, and system controls) must be purchased as a package. Because this Rapid Response system has not yet been demonstrated on an operating gas turbine plant, Rapid Response cannot be considered to be Achieved in Practice. Because Rapid Response is not a technology that has been demonstrated in other source categories, it cannot be considered to be technologically feasible, either. As a result, Rapid Response, while promising, cannot be considered to be BACT.

5.1E.3 BACT for the Auxiliary Boiler

5.1E.3.1 NOx Emissions

Achievable Controlled Levels and Available Control Options

NOx is formed during combustion through two mechanisms: (1) thermal NOx, which is the oxidation of elemental nitrogen in combustion air; and (2) fuel NOx, which is the oxidation of fuel-bound nitrogen. Since natural gas is relatively free of fuel-bound nitrogen, the contribution of this second mechanism to the formation of NOx emissions in natural gas-fired equipment is minimal and thermal NOx is the chief source of NOx emissions. Thermal NOx formation is a function of residence time, oxygen level and flame temperature, and can be minimized by controlling these elements in the design of the combustion equipment.

There are two basic means of controlling NOx emissions from boilers: combustion controls and post-combustion controls. Combustion controls act to reduce the formation of NOx during the combustion process, while post-combustion controls remove NOx from the exhaust stream. Combustion control technologies for this type of boiler application include low-NOx burners, flue gas recirculation and staged combustion. Post-combustion controls include SCR, EMx and selective non-catalytic reduction (SNCR). These are discussed in order of most effective to least effective below.

Selective Catalytic Reduction. The effectiveness of an SCR system requires the catalyst, and thus the treated exhaust stream, to be within a certain temperature range for the NOx reduction reaction to take place. The auxiliary boiler will be operated to support the Rapid Response turbine startup process and will be operated only up to 468 hours per year. The boiler is designed to provide 45,000 lb/hr of steam, with a minimum load of approximately 20,000 lb/hr to provide steam for steam turbine seals and sparging and the remaining 25,000 lb/hr for fuel gas heating. Most of the boiler operation is expected to be at this low load, where the exhaust gas temperature will be below the minimum needed for effective SCR control. While the boiler will operate at full load periodically, the length of time at which it will operate are expected to be so short that the SCR system could rarely, if ever, be used effectively. Therefore, this technology is not considered technically feasible for the auxiliary boiler in this application.

Selective Noncatalytic Reduction (SNCR). SNCR involves injection of ammonia or urea with proprietary conditions into the exhaust gas stream without a catalyst. SNCR technology requires gas temperatures in the range of 1200 to 2000°F. The exhaust temperature for the proposed auxiliary boiler is 375°F, well below the minimum SNCR operating temperature. Therefore, SNCR is not technically feasible for this application.

Ultra-Low NOx Burners with Flue Gas Recirculation. Low-NOx burners with FGR are commonly used on industrial-sized package boilers such as the CPVVS auxiliary boiler. These burners minimize the formation of thermal NOx and FGR reduces the oxygen in the combustion zone to further reduce NOx formation. Ultra-low NOx burners with FGR can achieve NOx emission rates of 9 ppmvd at 3% O_2 without post-combustion controls. This emission rate was recently accepted as BACT for the Colusa Generating Station auxiliary boiler and is considered the lowest technologically feasible emission rate for this application. A summary of the permitted emissions limits for other similar boilers is provided in Table 5.1E-5 below.

District BACT Determinations

The SJVAPCD's BACT determination for boilers in this size range with variable loads show that less than 15 ppmc is considered achieved in practice while 9 ppm is considered technically feasible.

The BAAQMD has determined that 9 ppmc is achieved in practice while 7 ppmc is considered technologically feasible. However, the BAAQMD BACT guideline recognizes that SCR is needed to achieve 7 ppmc, and as discussed above, SCR is not feasible for this application.

District Prohibitory Rules

The SJVAPCD is proposing to adopt more stringent boiler NOx control rules in the near future as part of its ozone and $PM_{2.5}$ attainment strategies. Rule 4306 would require natural gas-fired boilers of this size range and limited annual fuel use to achieve a NOx limit of 30 ppmvd at 3% O_2. Proposed new Rule 4320 will be applicable to the proposed auxiliary boiler and provides three options for compliance. One of the options is payment of an annual emissions fee in lieu of achieving the optional NOx limit in the rule. The NOx limit that would otherwise be applicable to the auxiliary boiler is 7 ppmvd at 3% O_2. Since 9 ppm is the lowest emission rate that can be achieved without SCR and SCR is not technically feasible for this boiler application, 9 ppm is still considered BACT.

TABLE 5.1E-5

Recent NOx and CO BACT Determinations for Medium-Sized Auxiliary Boilers

Facility	District/State	Heat Input Rating (MMBtu/hr HHV)	NOx Limit	CO Limit	Date Permit Issued	Source
Colusa Generating Station	EPA Region 9	44	9	50	May 2008	CEC final decision
Genentech	BAAQMD	97	9	50	September 2005	CARB BACT Clearinghouse
Medimmune, Inc	Maryland	29.4	9	n/a	January 2008	RBLC # MD-0037
CPV Warren	Virginia	97	0.011 lb/MMBtu [a]	0.036 lb/MMBtu[c]	January 2008	RBLC # VA-0308
Minnesota Steel Industries	Minnesota	99	0.035 lb/MMBtu[b]	0.08 lb/MMBtu[d]	September 2007	RBLC # MN-0070
Thyssenkrupp Steel and Stainless USA, LLC	Alabama	64.9	0.035 lb/MMBtu[b]	0.040 lb/MMBtu[c]	August 2007	RBLC # AL-0230
Daimler Chrysler Corporation	Ohio	20.4	0.0350 lb/MMBtu[b]	0.0830 lb/MMBtu[d]	May 2007	RBLC # OH-0309

Notes:

a. Equivalent to approximately 9 ppmc NOx.

b. RBLC record shows 0.0035 lb/MMBtu, but based on rated heat input and hourly limit, this is believed to be a typographical error. This is equivalent to approximately 27 ppmc NOx.

c. Equivalent to approximately 50 ppmc CO.

d. Equivalent to approximately 100 ppmc CO.

Conclusion

BACT must be at least as stringent as the most stringent limit achieved in practice, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the proposed 9 ppm NOx limit represents BACT for this application.

5.1E.3.2 CO and ROC Emissions

Achievable Controlled Levels and Available Control Options

CO and ROC emissions during natural gas combustion result from incomplete combustion of the fuel gas. CO and ROC emissions are minimized by combustion practices that promote high combustion temperatures, long residence times at those temperatures, and turbulent mixing of fuel and combustion air. Since those practices tend to increase NOx emissions, the effectiveness of the NOx control system may affect the ability of the boiler to achieve low CO and ROC emission rates.

District BACT Determinations

The SJVAPCD's BACT determination for boilers in this size range with variable loads shows no determination of BACT for CO. The use of natural gas fuel is considered to be BACT for ROCs and for CO for other smaller boilers.

The BAAQMD has determined that BACT for boilers in this size range is 50 ppm CO and the use of good combustion practices for ROC control.

District Prohibitory Rules

SJVAPCD draft Rule 4320 includes a CO limit of 400 ppmc. The rule does not contain a ROC limit.

Conclusion

BACT must be at least as stringent as the most stringent limit achieved in practice, federal NSPS, or district prohibitory rule. Based upon the results of this analysis, the proposed 50ppm CO limit represents BACT for this application. The proposed ROC limit of 10 ppmc is expected to be achievable through the use of good combustion practices.

5.1E.3.3 SO_2 and PM_{10} Emissions

Achievable Controlled Levels and Available Control Options

SO_2 and PM_{10} emissions from natural gas combustion result from sulfur and other impurities in the fuel. Emissions of these pollutants will be minimized through the use of low sulfur pipeline quality natural gas. There are no add-on control technologies that are effective in reducing SO_2 and PM_{10} emissions from naturally low-emitting natural gas-fired boilers.

District BACT Determinations

The SJVAPCD and BAAQMD BACT guidelines both indicate that the use of natural gas fuel is considered BACT for boilers.

Conclusion

Use of pipeline quality natural gas is considered BACT for this boiler application. The proposed emissions limitations are expected to be achievable with natural gas firing.

Summary

The criteria that constitute BACT for the proposed natural gas-fired combined cycle combustion gas turbine are summarized in Table 5.1E-4 and compared against the design criteria for the proposed combustion gas turbine.

Table 5.1E-6
Summary of Emission Limits and BACT Requirements

Equipment	Pollutant	BACT	Proposed Control Level
Turbines	NOx	Emission Limit = 2.0 ppmv @ 15% O_2	Design Exhaust Concentration = 2.0 ppmv @ 15% O_2
	CO	Emission Limit = 4 ppmv @ 15% O_2	Design Exhaust Concentration = 3 ppmv @ 15% O_2
	ROC	Emission Limit = 2 to 4 ppmv @ 15% O_2	Design Exhaust Concentration = 2 ppmv @ 15% O_2 (no duct firing) 3 ppmv @ 15% O_2 (with duct firing)
	SOx	Natural gas fuel	Natural gas fuel
	PM_{10}	Natural gas fuel	Natural gas fuel
Boiler	NOx	Emission Limit = 9.0 ppmv @ 3% O_2	Emission Limit = 9.0 ppmv @ 3% O_2
	CO	Emission Limit = 50 ppmv @ 15% O_2	Emission Limit = 50 ppmv @ 15% O_2
	ROC	Good combustion practices	Good combustion practices
	SOx	Natural gas fuel	Natural gas fuel
	PM_{10}	Natural gas fuel	Natural gas fuel