APPENDIX 5.1C

BACT Analysis

APPENDIX 5.1C

Evaluation of Best Available Control Technology

The A2PP project is required to use Best Available Control Technology (BACT) on the combustion turbines for various pollutants, in accordance with the requirements of the District's New Source Review program. The applicability of BACT requirements under District regulations is discussed in Section 5.1.7.3. The SJVAPCD defines BACT as:

> "the most stringent emission limitation or control technique of the following:
>
> - Achieved in practice for such category and class of source;
> - Contained in any State Implementation Plan approved by the Environmental Protection Agency for such category and class of source. A specific limitation or control technique shall not apply if the owner of the proposed emissions unit demonstrates to the satisfaction of the APCO that such a limitation or control technique is not presently achievable; or
> - Contained in an applicable federal New Source Performance Standard; or
> - Any other emission limitation or control technique, including process and equipment changes of basic or control equipment, found by the APCO to be cost effective and technologically feasible for such class or category of sources or for a specific source." [Rule 2201, Section 3.9]

The District BACT requirement is applicable for all pollutants except CO.[1] The emission rates and control technologies determined to be BACT for this project are discussed in detail in the following sections. Separate determinations are provided for normal operation and for startup/shutdown operation.

5.1C.1 BACT for the CTG: Normal Operations

5.1C.1.1 NOx Emissions

Achievable Controlled Levels and Available Control Options

The most recent NOx BACT listings for simple-cycle combustion turbines in this size range are summarized in Table 5.1C-1. The most stringent NOx limit in these recent BACT determinations is a 2.5 ppm[2] limit averaged over a 1-hour averaging period, excluding startups and shutdowns. This level is achieved using water injection and SCR.

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[1] Per Rule 2201, Section 4.2,1, CO BACT threshold not applicable to facilities with total CO emissions less than 200,000 lb/year. Since total CO emissions from the project plus the existing facility will be below 100 tpy, CO BACT is not required.

[2] All turbine exhaust emissions concentrations shown are expressed as ppmvd, corrected to 15% O2.

TABLE 5.1C-1
Recent NOx BACT Determinations for Simple-Cycle Combustion Turbines[a]

Facility	District	NOx Limit[b]	Averaging Prd	Control Method Used	Date Permit Issued	Source
Miramar Energy Facility II	SDCAPCD	2.5 ppmvd	3 hrs	water injection and SCR	11/4/08	ATC
Starwood Midway Firebaugh/Panoche	SJVAPCD	2.5 ppmvd	1 hr	water injection and SCR	9/5/07 (FDOC)	CEC Siting Div website
San Francisco Electric Reliability Project	BAAQMD	2.5 ppmvd	1 hr	water injection and SCR	2/8/06 (FDOC)	CEC Siting Div website
El Colton	SCAQMD	3.5 ppmvd	3 hrs	water injection and SCR	1/10/03	SCAQMD website
MID Ripon	SJVAPCD	2.5 ppmvd	3 hrs	water injection and SCR	2004	ATC
Calpeak Border	SDCAPCD	3.0 ppmvd 2.5 ppmvd	3 hrs 24 hrs	DLN combustors/SCR	7/01 (FDOC)	CEC Siting Div website
Calpine Gilroy	BAAQMD	5 ppmvd	1 hr	water injection and SCR	5/01 (FDOC)	CEC Siting Div website
Larkspur Energy Facility Indigo Energy Facility	SCAQMD	5 ppmvd	1 hr	water injection and SCR	3/01 (FDOC)	CEC Siting Div website

[a]All projects listed here utilize GE LM6000-model units except Starwood Midway Firebaugh/Panoche, which uses Pratt & Whitney Swiftpaks (two 30-MW gas turbine engines driving a single 60 MW generator), and CalPeak Border, which consists of Pratt & Whitney Twinpaks (two 25-MW gas turbine engines driving a 49.5 MW generator).

[b]All concentrations expressed as parts per million by volume dry, corrected to 15% O_2.

The SJVAPCD adopted Rule 4703 (Stationary Gas Turbines) to limit NOx emissions from these devices. Rule 4703 specifies an enhanced Tier II NOx emission limit of 3 ppmvd @ 15% O_2 for natural gas-fired combustion gas turbines rated at no less than 10 MW and equipped with SCR (April 30, 2008 deadline).
The turbine-out NOx emission rate for the water-injected LM6000 PG turbines is 25 ppmvd @ 15%O_2. This is a significantly higher turbine-out NOx emission rate than the 9 ppmvd rate achieved by turbines equipped with dry low-NOx (DLN) combustors. The LM6000 PG turbines are not available with DLN combustors.

SCONOx is a NOx reduction system formerly 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 smaller gas turbines, including Redding Unit 5, a 43-MW Alstom GTX100 combined-cycle gas turbine. The applicability of the EMx process to a simple-cycle turbine is discussed in more detail below.

The SCR system uses ammonia injection to reduce NOx emissions. SCR systems have been widely used in simple-cycle gas turbine applications of all sizes, including the LM6000 and the larger F-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 to 5 years.

Either SCR or SCONOx technology, in combination with water injection for NOx control, will achieve a NOx emission level of 2.5 ppmvd@ 15% O_2.

Environmental Impacts

The use of SCR will result in ammonia emissions due to an allowable ammonia slip limit of 10 ppmvd @ 15% O_2. A health risk screening analysis of the proposed project using air dispersion modeling showed the acute hazard index and a chronic hazard index each to be much less than 1, based on an ammonia slip limit of 10 ppmvd @ 15% O_2. In accordance with the District's Integrated Air Toxics program and currently accepted practice, a hazard index below 1.0 is not considered 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 the 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 SJVAPCD has consistently stated in its planning documents that because of high background levels of ammonia, the formation of ammonium nitrate and ammonium sulfate in the San Joaquin Valley air basin is limited by the formation of nitrates and sulfates 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 within the SJVAPCD.

A second potential environmental impact that may result from the use of SCR involves the storage and transport of anhydrous 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 and is already being used at the existing Almond power plant. TID is already required to maintain a Risk Management Plan (RMP) and to implement a Risk Management Program to prevent accidental releases. The RMP will be updated to include use of ammonia at the A2PP (see Section 5.5 of the AFC). The RMP provides 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. In addition, the modeling analyses of the health impacts arising from a catastrophic release of ammonia due to spontaneous storage tank failure at the facility shows that the impact would not be significant. Thus, the potential environmental impact due to anhydrous ammonia use at the A2PP 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 the project would need to be modified to include a supply of steam. This would likely require the addition of an auxiliary boiler, which would result in additional project emissions.

Achieved in Practice Evaluation

The "achieved in practice" criteria in the SJVAPCD are as follows:

> In order for a control technology to be deemed as having been achieved in practice, the following conditions must be met:
>
> A. The rating and capacity for the unit where the control was achieved must be approximately the same as that for the proposed unit.
>
> B. The type of business (i.e. class of source) where the emissions units are utilized must be the same.
>
> C. The availability of resources (i.e. fuel, water) necessary for the control technology must be approximately the same.

The applicability of each of these criteria to SCR and EMx technology is discussed below.

SCR has been achieved in practice at numerous combustion turbine installations throughout the world. There are numerous utility-scale simple-cycle projects that limit utilize SCR to achieve NOx emissions limits of 2.5 ppm, including the MID Ripon and Starwood Midway facilities. An evaluation of the proposed AIP criteria as applied to the achievement of extremely low NOx levels (2.5 ppm and lower) using SCR technology is summarized below.

- Rating and capacity: All of the combustion turbines listed in Table 5.1C-1 utilize SCR for NOx control, and all are of the same or similar ratings and capacities as the LM6000 CTGs proposed for use at A2PP. Several of these projects have limits of 2.5 ppm.
- Type of business/class of source: All of the combustion turbines listed in Table 5.1C-1 utilize SCR for NOx control, and all are simple-cycle peaking turbines used for power generation, the same class of source as the proposed A2PP.

- Availability of resources: No special resources in addition to fuel, water and ammonia are required for SCR control technology at A2PP. These resources are available at the project site.

Further, SCR technology is available with standard commercial guarantees for NOx levels at least as low as 2.5 ppm. In addition, SCR technology has been shown to be capable of achieving NOx levels consistent with a 2.5 ppm permit limit during extended, routine operations at several commercial power plants. There are no reported adverse effects of operation of the SCR system at these levels on overall plant operation or reliability.

Short-term excursions have resulted in NOx concentrations above the permitted level of 2.5 ppm; however, these excursions have not been associated with diminished effectiveness of the SCR system. Rather, these excursions have been associated with SCR inlet NOx levels in excess of those for which the SCR system was designed.

An evaluation of the proposed AIP criteria as applied to the achievement of extremely low NOx levels (2.5 ppm and lower) using EMx technology is summarized below.

- Rating and capacity: The EMx process has been demonstrated in practice on Redding Unit 5, a 43-MW Alstom GTX100 combined-cycle gas turbine. This turbine is of the same or similar rating and capacity as the LM6000 CTGs proposed for use at A2PP. This turbine also has a permitted NOx emission limit of 2.5 ppm.
- Type of business/class of source: Redding Unit 5 is a combined-cycle turbine. Although it is used for power generation, the combined-cycle turbine is not considered the same class of source as the proposed A2PP, which will utilize simple-cycle turbines.
- Availability of resources: EMx technology requires steam in addition to fuel and water. Because the A2PP generating units are simple-cycle turbines, they do not produce steam and so steam will not be available at the project site without a supplemental steam source.

Because EMx technology has been demonstrated in practice to achieve the proposed BACT NO_x emission limit of 2.5 ppmvd @ 15% O_2 averaged over one hour, the 2.5 ppm limit is considered to be achievable using EMx technology. However, EMx does not meet two of the three AIP criteria listed above and therefore cannot be considered achieved in practice for this class and category of source. Because SCR is already in use at the facility, SCR has been selected as the NOx control technology to be used for the A2PP CTGs.

Conclusions

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 2.5 ppm @ 15% O_2 on a 1-hour average basis made for recently permitted simple cycle turbine projects in SJVAPCD and elsewhere reflects the most stringent achievable NOx emission limit. The A2PP facility will be designed to meet a NOx level of 2.5 ppmv @ 15% O_2 on a 1-hour average basis using SCR.

5.1C.1.2 VOC Emissions

Achievable Controlled Levels and Available Control Options

Most VOCs emitted from natural gas-fired turbines are the result of incomplete combustion of fuel. Therefore, most of the organic compound emissions from natural gas combustion are methane and ethane, which are not effectively controlled by an oxidation catalyst but are also not defined as VOCs by the SJVAPCD because these compounds have been determined not to contribute to the formation of ozone. However, oxidation catalyst technology designed to control CO can also provide some degree of control of VOC 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 VOC.

CARB's BACT guidance document for simple cycle power plant units rated at greater than 50 MW[3] indicates that BACT for the control of VOC emissions is 2 ppmvd @ 15% O_2.

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

Published prohibitory rules from the BAAQMD, SMAQMD, SDCAPCD, SJVAPCD, and SCAQMD were reviewed to identify the VOC standards that govern existing natural gas-fired simple cycle combustion gas turbines. None of the prohibitory rules for combustion gas turbines specify an emission limit for VOC. The applicable NSPS (40 CFR 60 Subpart KKKK) does not include a VOC limit.

Table 5.1C-2 summarizes recent VOC BACT determinations for simple-cycle gas turbines. Similar facilities using oxidation catalysts have been permitted at 2.0 ppm VOC.

Conclusions

BACT must be at least as stringent as the most stringent achieved in practice limit, federal NSPS or district prohibitory rule requirement, or considered technologically feasible. Based upon the results of this analysis, the VOC emission limit of 2.0 ppmv @ 15% O_2 is considered to be BACT for the proposed project.

5.1C.1.3 PM_{10}/$PM_{2.5}$ Emissions

Achievable Controlled Levels and Available Control Options

PM emissions from natural gas-fired turbines 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 CARB 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 and a lube oil vent coalescer to remove ambient particulate matter from the inlet air and to minimize the formation of lube oil mists, respectively.

[3] CARB, "Guidance for Power Plant Siting and Best Available Control Technology," July 22, 1999, Table I-1.

TABLE 5.1C-2
Recent VOC BACT Determinations for Simple Cycle Combustion Turbines

Facility	District	VOC Limit*	Averaging Prd	Date Permit Issued	Source
Miramar II Energy Facility	SDAPCD	2.0 ppmvd	none specified	11/4/08	ATC
Starwood Midway Firebaugh/Panoche	SJVAPCD	2.0 ppmvd	3 hrs	9/5/07 (FDOC)	CEC Siting Div website
San Francisco Electric Reliability Project	BAAQMD	2.0 ppmvd	3 hrs	2/8/06 (FDOC)	CEC Siting Div website
EI Colton	SCAQMD	2.0 ppmvd	3 hrs	1/10/03	SCAQMD website
MID Ripon	SJVAPCD	2.0 ppmvd	3 hrs	2004	ATC

*All concentrations expressed as parts per million by volume dry, corrected to 15% O_2.

CARB's BACT guidance document for stationary gas turbines used for simple-cycle power plants[4] 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 feet.

Title 40 CFR Part 60 Subpart KKKK contains the applicable NSPS for combustion gas turbines. Subpart KKKK does not regulate PM_{10} emissions.

Published prohibitory rules from the BAAQMD, SCAQMD, SJVAPCD, 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 are summarized in Table 5.1C-3.

Conclusions

Based upon the results of this analysis, the SJVAPCD 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 combustion gas turbines. Through the use of natural gas, the turbines are expected to be able to meet the proposed emission limit of 2.5 lb/hr. This limit is consistent with, or lower than, the limits shown in the summary table.

5.1C.1.5 SOx Emissions

Achievable Controlled Levels and Available Control Options

The CARB BACT Clearinghouse, as well as the BAAQMD and SJVAPCD BACT guidelines, identifies 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. A combustion gas turbine is subject to a SO_2 emission limit of 0.56 lb/MWh.

District Prohibitory Rules

Published prohibitory rules from the BAAQMD, SJVAPCD, 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.

[4] Ibid, Table I-2.

TABLE 5.1C-3
Recent PM_{10} BACT Determinations for Simple-Cycle Combustion Turbines

Facility	District	PM_{10} Limit, lb/hr	Date Permit Issued	Source
Starwood Midway Firebaugh/Panoche	SJVAPCD	3.7*	9/5/07 (FDOC)	CEC Siting Div website
San Francisco Electric Reliability Project	BAAQMD	2.5	2/8/06 (FDOC)	CEC Siting Div website
El Colton	SCAQMD	3.0	1/10/03	SCAQMD website
MID Ripon	SJVAPCD	3.0	2004	ATC

*These are Pratt and Whitney Swiftpaks; 3.7 lb/hr limit applies to exhaust from two 30-MW units. This is equivalent to approximately 3.1 lb/hr from an LM6000 on an equivalent heat input basis.

- SJVAPCD Rule 4703 (Stationary Gas Turbines) is the SJVAPCD's only prohibitory rule that specifically addresses gas turbines but does not limit SO_2 emissions. The SJVAPCD 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 SJVAPCD 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; however, it 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 SJVAPCD 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 turbines.

5.1C.2 BACT for the CTGs: Startup/Shutdown

Startup and shutdown periods are a normal part of the operation of simple-cycle power plants such as A2PP. BACT must also be applied during the startup and shutdown periods of gas turbine operation. The BACT limits discussed in the previous section apply to steady-state operation, when the turbines 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. Some of these require holding the gas turbine at low loads, where operation is inefficient and emissions are relatively high, to allow the emission control systems to warm up. 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 VOC 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 do not rely 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 VOC 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 VOC 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 turbines spend in startup. The applicant is proposing a 1-hour limit for startup periods, which would be defined as the period beginning with initiation of fuel flow to the turbine and ending when the turbine meets the concentration and mass emissions limitations for normal operation. In addition, all emissions during startups and shutdowns will accrue toward the annual emissions limits, providing further incentive to the applicant to minimize startup and shutdown times and emissions.