SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Draft Staff Report for
Proposed Amended Best Available Control Technology (BACT) Guidelines, Part D- Non-Major Polluting Facilities, Regarding Distributed Generation

DRAFT

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

To be written

CHAPTER 1

BACKGROUND

INTRODUCTION

DISTRIBUTED GENERATION (DG)

CURRENT STATUS OF BACT FOR DG PROJECTS

CARB CERTIFICATION PROGRAM FOR DG EQUIPMENT NOT REQUIRING A DISTRICT PERMIT

CALIFORNIA SELF GENERATION INCENTIVE PROGRAM

INTRODUCTION

The South Coast Air Quality Management District (AQMD) Regulation XIII – New Source Review (NSR) and Regulation XX – Regional Clean Air Incentives Market (RECLAIM), require applicants to use Best Available Control Technology (BACT) for new sources, relocated sources, and for modifications to existing sources that may result in an emission increase of any nonattainment air contaminant, any ozone depleting compound (ODC), or ammonia. Additionally, Regulation XIII requires the Executive Officer to periodically publish BACT Guidelines that establish the procedures and the BACT requirements for commonly permitted equipment. The BACT Guidelines were first published in May 1983, and later revised in October 1988. The Guidelines consisted of two parts: Part A – Policy and Procedures, and Part B – BACT Determinations. Part A provided an overview and general guidance while Part B contained specific BACT information by source category and pollutant. After the October 1988 revision, Part A was amended once in 1995, and Part B was updated six times between 1997 and 1998.

On December 11, 1998, the public participation process was enhanced to include technical review and comments by a focused Scientific Review Committee (SRC) at periodic intervals, prior to the updates of the AQMD BACT Guidelines. At the same time, the Board established a 30-day notice period for the SRC and interested persons to review and comment on AQMD BACT determinations that result in BACT requirements that are more stringent than previously imposed BACT.

As a result of amendments to AQMD's NSR regulations in October 2000, the BACT Guidelines were separated into two: one for major polluting facilities and another for non-major (minor) polluting facilities. A facility is a major polluting facility if it emits, or has the potential to emit, a criteria air pollutant at a level that equals or exceeds emission thresholds given in the Clean Air Act. Table 1-1 shows those emission thresholds for each criteria air pollutant for each air basin in AQMD. If a threshold for any one criteria pollutant is equaled or exceeded, the facility is a major polluting facility[1].

The BACT Guidelines for major polluting facilities include:

- Part A: Policy and Procedures for Major Polluting facilities, and
- Part B: LAER/BACT Determinations for Major Polluting Facilities.

The BACT Guidelines for non-major polluting facilities include:

- Part C: Policy and Procedures for Non-Major Polluting Facilities, and
- Part D: BACT Guidelines for Non-Major Polluting Facilities.

Both the format of the guidelines and the process for determining BACT are significantly different between major and non-major polluting facilities. Major polluting facilities that are

[1] Major polluting facilities are also subject to the Title V permitting program of AQMD Regulation XXX.

Table 1-1. Actual or Potential Emission Threshold Levels (Tons per Year) for Major Polluting Facilities

Pollutant	South Coast Air Basin	Riverside County Portion of Salton Sea Air Basin	Riverside County Portion of Mojave Desert Air Basin
VOC	10	25	100
NOx	10	25	100
SOx	100	100	100
CO	50	100	100
PM-10	70	70	100

subject to NSR are required by the Clean Air Act to have the Lowest Achievable Emission Rate (LAER), which is very similar to the AQMD definition of BACT. LAER is determined at the time the permit is issued, with little regard for cost, and pursuant to United States Environmental Protection Agency (U.S. EPA) LAER policy as to what is achieved in practice.

The Part B BACT and LAER determinations for major polluting facilities are only examples of past determinations that help in determining LAER for new permit applications.

For non-major polluting facilities, BACT is determined in accordance with state law at the time an application is deemed complete. For the most part, it is as specified in Part D of the BACT Guidelines adopted by the AQMD Board in October 2000. Changes to Part D for minor source BACT (MSBACT) to make them more stringent are subject to public review and AQMD Board approval, in view of cost considerations.

DISTRIBUTED GENERATION

Distributed generation (DG) is stationary, non-emergency electricity generation equipment that produces power primarily for use within the facility in which it is sited and/or another facility with which it has a direct energy interconnection. DG power plants are thus differentiated from utility-owned or merchant power plants, which provide power to the grid, and only when the power is needed.

DG projects, other than those utilizing digester gas, landfill gas, refinery gas or other by-product gases, are restricted by South Coast Air Quality Management District's (AQMD) Clean Fuels Policy (in the BACT Guidelines) in their choice of fuels, and virtually all are fueled on natural gas. Most DG plants utilize internal combustion (I.C.) engine or gas turbine technology.

Cleaner technologies such as fuel cells are being utilized more as they continue to be developed and become more cost competitive. These DG technologies have electrical efficiencies ranging from approximately 20% to 40%, with the balance of the fuel heating value appearing as waste heat. DG projects are generally not economically justified unless part of the waste heat can be utilized by the host facility, and are thus almost always configured as "cogeneration" or "combined heat and power (CHP)" projects.

Solar photovoltaic (PV) power is the predominant form of DG in the residential market. Larger PV systems are also being installed in commercial and institutional buildings.

Both fuel cell and PV DG systems do not require an AQMD permit.

CURRENT STATUS OF MSBACT FOR DG PROJECTS

DG power plants tend to be much smaller than merchant or central station power plants since they are limited in size to the power demand of the facilities that they serve. Many DG power plants have capacities <1 MW to a few MW, and a small number are larger than 25 MW. Many DG projects will occur in non-major polluting facilities and will themselves be non-major; and thus criteria pollutant constraints on many of these projects will consist of AQMD's Minor Source BACT (MSBACT) guidelines for gas turbines and I.C engines. The current MSBACT guidelines for gas turbines and I.C. engines applicable to DG projects are summarized in Tables 1-2 and 1-3. The MSBACT emission limits for gas turbines are significantly more stringent than those for I.C. engines.

CARB CERTIFICATION PROGRAM FOR DG EQUIPMENT NOT REQUIRING DISTRICT PERMITS

SB1298, chaptered into law in September 2000 by the California state legislature, recognized that distributed generation that is exempt from district permits could have significantly higher emissions than the extremely low emissions of new central station power plants. Therefore it required the California Air Resources Board (CARB) to institute a certification program for DG technologies to be applied to equipment that is exempt from district permits. Furthermore, it required that as soon as practicable, certified DG meet emission standards equivalent to the best available control technology for permitted central station power plants in California, and that the standards be expressed as pounds per megawatt-hour (MW-hr) produced.

CARB's DG certification program[2] pursuant to this order took effect January 1, 2003. Table 1-4 summarizes the emission standards that are required by this program. The 2003 standards are nearly equivalent to AQMD's current MSBACT requirements for I.C. engines, but the 2007 standards are equivalent to emission standards applied to new central station power plants in California, and much

[2] California Code of Regulations, Title 17, Division 3, Chapter 1, Subchapter 8, Article 3, Sections 9400-94214, www.arb.ca.gov/energy/dg/dg.htm.

more stringent than current I.C. engine MSBACT. The CARB standards provide a credit for any recovered waste heat (cogeneration) that makes it easier to meet the emission standards.

Table 1-2. Current MSBACT Guidelines for Gas Turbines Applicable to DG Projects

10-20-2000 Rev. 0
12-3-2004 Rev. 1

Equipment or Process: Gas Turbine

	Criteria Pollutants					
Subcategory/ Rating/Size	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
Natural Gas Fired, < 3 MWe		9 ppmvd @ 15% O_2 (10-20-2000)		10 ppmvd @ 15% O_2 (10-20-2000)		9 ppmvd ammonia @ 15% O_2 (10-20-2000)
Natural Gas Fired, ≥ 3 MWe and < 50 MWe		2.5 ppmvd @ 15% O_2 x $\frac{\text{efficiency (\%)}^{1)}}{34\%}$ (6-12-98)		10 ppmvd @ 15% O_2 (6-12-98)		5.0 ppmvd ammonia @ 15% O_2 (10-20-2000)

Notes:

1) The turbine efficiency correction for NOx is limited to 1.0 as a minimum. The turbine efficiency is the demonstrated percent efficiency at full load (corrected to the higher heating value of the fuel) without consideration of any downstream energy recovery.

Table 1-3. Current MSBACT Guidelines for I.C. Engines Applicable to DG Projects

10-20-2000 Rev. 0
6-6-2003 Rev. 1
7-9-2004 Rev.2

Equipment or Process: I.C. Engine, Stationary

	Criteria Pollutants					
Subcategory/ Rating/Size	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
Non-Emergency, < 2064 bhp	0.15 grams/bhp-hr (4-10-98)	0.15 grams/bhp-hr (4-10-98)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	0.60 grams/bhp-hr (4-10-98)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	
Non-Emergency, ≥ 2064 bhp	25 ppmvd @ 15% O_2 (7-9-2004)	9 ppmvd @ 15% O_2 (7-9-2004)	Same as Above (10-20-2000)	33 ppmvd @ 15% O_2 (5-8-98)	Same as Above (7-9-2004)	Ammonia: 10 ppmvd @ 15% O_2 (7-9-2004)

Table 1-4. Summary of DG Emission Standards Required by CARB Certification Program

	Effective 1/1/2003 lb/MW-hr		Effective 1/1/2007 lb/MW-hr
	w/o CHP	**w/ CHP**	
NOx	0.5	0.7	.07*
CO	6.0	6.0	0.1*
VOC	1.0	1.0	.02*
PM	Clean Fuel**	Clean Fuel**	Clean Fuel**

*Allows CHP credit of 1 MW-hr per 3.4 MMBtu waste heat recovered.
**Equivalent to natural gas with maximum sulfur content of 1 gr/100scf.

CARB has certified two fuel cells to meet the 2007 standards and two microturbines to meet the 2003 standards. No I.C. engines have been certified to meet either the 2003 or 2007 CARB standards. Only the four certified DG technologies and any zero-emission DG technologies such as wind and solar power may be sold in California, unless the DG is large enough to require a district permit.

CALIFORNIA'S SELF-GENERATION INCENTIVE PROGRAM

In 2000 the California legislature adopted AB970 that authorized a self-generation incentive program to be administered by the investor-owned utilities until December 31, 2004. The program offers incentives up to 50% of the project cost, depending on the type of self-generation. The legislature extended the program through 2007 by adopting AB1685 in 2003, but will limit the incentives to "ultra-clean" electricity generation. Starting January 1, 2005, combustion-operated DG projects using fossil fuels will only be eligible for an incentive if NOx emissions meet a standard of 0.14 pounds per MW-hr (twice the CARB 2007 DG standard). And by January 1, 2007 only projects complying with the CARB 2007 standard of 0.07 pounds of NOx per MW-hr will qualify.

CHAPTER 2

BACT AND THE BACT PROCESS

DEFINITION OF BACT

Definitions of BACT are found in: Rule *1302 -Definitions* of *Regulation XIII - New Source Review*, which applies to all cases in general, except for *Rule 2000 - General*, which applies to NOx and SOx emissions from nearly 400 RECLAIM facilities. While the definitions are not identical, they are essentially the same. Section (f) of *Rule 1302 - Definitions* defines BACT as:

> *BEST AVAILABLE CONTROL TECHNOLOGY (BACT) means the most stringent emission limitation or control technique which:*
>
> *(1) has been achieved in practice for such category or class of source; or*
>
> *(2) is contained in any state implementation plan (SIP) approved by the United States Environmental Protection Agency (U.S. EPA) for such category or class of source. A specific limitation or control technique shall not apply if the owner or operator of the proposed source demonstrates to the satisfaction of the Executive Officer or designee that such limitation or control technique is not presently achievable; or*
>
> *(3) is any other emission limitation or control technique, found by the Executive Officer or designee to be technologically feasible for such class or category of sources or for a specific source, and cost-effective as compared to measures as listed in the Air Quality Management Plan (AQMP) or rules adopted by the District Governing Board.*

The first two requirements in the BACT definition are required by federal law, as LAER for major sources. The third part of the definition is unique to AQMD and some other areas in California, and allows for more stringent controls than LAER.

Rule 1303(a)(2) further requires that economic and technical feasibility be considered in establishing the class or category of sources and the BACT requirements for non-major polluting facilities.

CLEAN FUEL REQUIREMENTS

In January 1988, the AQMD Governing Board adopted a Clean Fuels Policy that included a requirement to use clean fuels as part of BACT. A clean fuel is one that produces air emissions equivalent to or lower than natural gas for NO_X, SO_X, ROG, and fine respirable particulate matter (PM_{10}). Besides natural gas, other clean fuels are methanol, liquid petroleum gas (LPG), and hydrogen. The burning of landfill, digester, refinery and other by-product gases is not subject to the clean fuels requirement as burning of these gases is considered essential to each industry. However, the combustion of these fuels must comply with other AQMD rules, including the sulfur content of the fuel.

The requirement of a clean fuel is based on engineering feasibility. Engineering feasibility considers the availability of a clean fuel and safety concerns associated with that fuel. Some state and local safety requirements limit the types of fuel that can be used for emergency standby purposes. Some fire departments or fire marshals do not allow the storage of LPG near occupied buildings. Fire officials have, in some cases, vetoed the use of methanol in hospitals. If special handling or safety considerations preclude the use of the clean fuel, the AQMD has allowed the use of fuel oil as a standby fuel in boilers and heaters, and for emergency standby generators. The use of these fuels must meet the requirements of AQMD rules limiting NO_X and sulfur emissions.

MSBACT UPDATE PROCESS

As technology advances, the AQMD's MSBACT Part D Guidelines need to be updated. Updates may include revisions to the guidelines for existing equipment categories, as well as new guidelines for new categories.

The MSBACT Guidelines are revised based on specific criteria described below. Once a more stringent emission limit or control technology has been reviewed by staff and is determined to meet the criteria for MSBACT, it is reviewed through a public process. The process is shown schematically in Figure 2-1. The public is notified and the Scientific Review Committee (SRC) has an opportunity to comment. Following the public process, the guidelines are presented to the Governing Board for approval at a public hearing.

CRITERIA FOR NEW MSBACT AND UPDATING PART D

MSBACT requirements are determined for each source category based on the definition of MSBACT. In essence, MSBACT is the most stringent emission limit or control technology that is:

- found in a state implementation plan (SIP) that has been approved by U.S. EPA, or
- achieved in practice (AIP), or
- is technologically feasible and cost effective.

For practical purposes, nearly all AQMD MSBACT determinations will be based on AIP or SIP because state law contains some constraints on AQMD from using the third approach. For minor polluting facilities, MSBACT also takes economic feasibility into account.

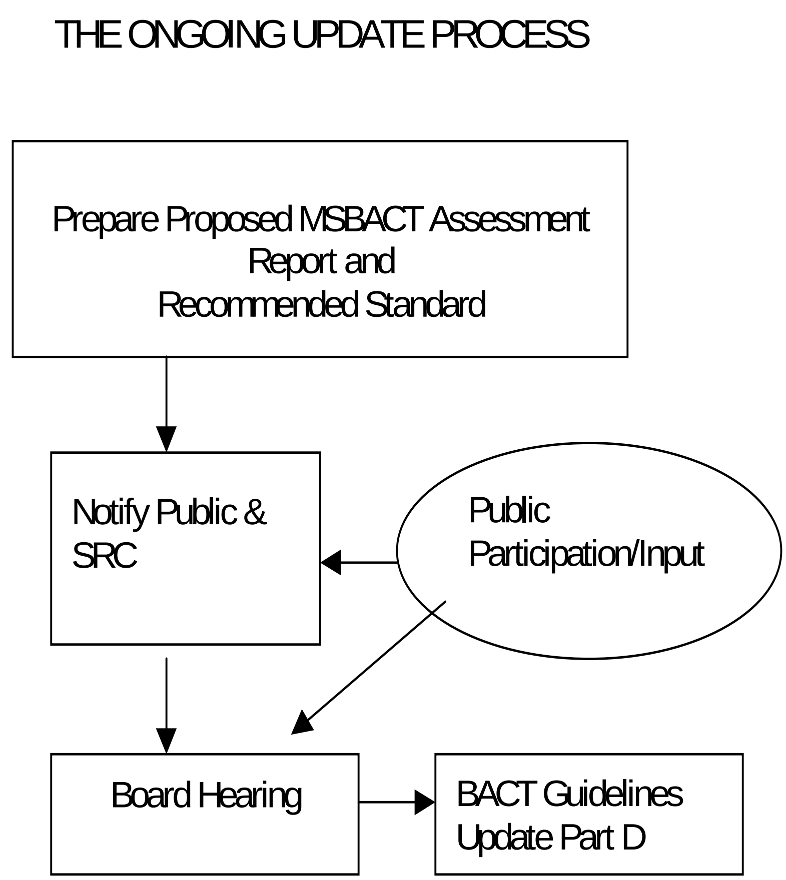
AIP control technology may be in operation in the United States or any other part of the world. AQMD permitting engineers review the following sources to determine what is the most stringent AIP MSBACT:

- LAER/BACT determinations in Part B of the BACT Guidelines
- CAPCOA BACT Clearinghouse
- U.S. EPA RACT/BACT/LAER Clearinghouse
- Other districts' and states' BACT Guidelines
- Permits to operate issued by AQMD or other agencies
- Any other source for which the requirements of AIP can be demonstrated

Achieved in Practice Criteria

A control technology or emission limit found in any of the references above may be considered as AIP if it meets all of the following criteria:

Figure 2-1



Commercial Availability: At least one vendor must offer this equipment for regular or full-scale operation in the United States. A performance warranty or guaranty must be available with the purchase of the control technology, as well as parts and service.

Reliability: The control technology must have been installed and operated reliably for at least twelve months on a comparable commercial operation. If the operator did not require the basic equipment to operate continuously, such as only eight hours per day and 5 days per week, then the control technology must have operated whenever the basic equipment was in operation during the twelve months.

Effectiveness: The control technology must be verified to perform effectively over the range of operation expected for that type of equipment. If the control technology will be allowed to operate at lesser effectiveness during certain modes of operation, then those modes must be identified. The verification shall be based on a performance test or tests, when possible, or other performance data.

Cost Effectiveness: The control technology or emission rate must be cost effective for a substantial number of sources within the class or category. Cost effectiveness criteria are described in detail below. Cost criteria are not applicable to an individual permit but rather to a class or category of source.

Based on Governing Board policy, MSBACT also includes a requirement for the use of clean fuels. MSBACT clean fuels requirements are the same as the general BACT Clean Fuel Requirements, which are described in Chapter 1.

REQUIREMENTS OF HEALTH & SAFETY CODE SECTION 40440.11

Senate Bill 456 (Kelley) was chaptered into state law in 1995 and became effective in 1996. California State Health & Safety Code Section 40440.11 specifies the criteria and process that must be followed by the AQMD to update its BACT Guidelines to establish more stringent BACT limits for listed source categories. In general, the provisions require:

- Considering only control options or emission limits to be applied to the basic production or process equipment in a source category or similar source category;
- Evaluating cost to control secondary pollutants;
- Determining that the control technology is commercially available;
- Determining that the control technology has been demonstrated for at least one year on a comparable commercial operation;
- Calculating total and incremental cost-effectiveness;
- Determining that the incremental cost-effectiveness is less than AQMD's established cost-effectiveness criteria;
- Putting BACT Guideline revisions on a regular meeting agenda of the AQMD Governing Board;
- Holding a Board public hearing prior to revising maximum incremental cost-effectiveness values;
- Keeping a BACT determination made for a particular application unchanged for at least one year from the application deemed complete date; and
- Considering a longer period for a major capital project (> $10,000,000)

After consultation with the affected industry, the California Air Resources Board (CARB), and the U.S. EPA, and considerable legal review and analysis, staff concluded that the process specified in SB 456 to update the BACT Guidelines should be interpreted to apply only if the AQMD proposes to make BACT more stringent than LAER. Therefore, the SB 456 requirements do apply to BACT requirements for non-major polluting facilities, but do not apply to federal LAER determinations for major polluting facilities.

COST EFFECTIVENESS METHODOLOGY

Cost effectiveness is measured in terms of control costs (dollars) per air emissions reduced (tons). If the cost per ton of emissions reduced is less than the maximum required cost effectiveness, then the control method is considered to be cost effective. This section also discusses the updated maximum cost effectiveness values, and those costs which can be included in the cost effectiveness evaluation.

There are two types of cost effectiveness: average and incremental. Average cost effectiveness considers the difference in cost and emissions between a proposed MSBACT and an uncontrolled case. On the other hand, incremental cost effectiveness looks at the difference in cost and emissions between the proposed MSBACT and alternative control options.

Discounted Cash Flow Method

The discounted cash flow method (DCF) is used in the MSBACT Guidelines. This is also the method used in the 1999 Air Quality Management Plan. The DCF method calculates the present value of the control costs over the life of the equipment by adding the capital cost to the present value of all annual costs and other periodic costs over the life of the equipment. A real interest rate[3] of four percent, and a ten-year equipment life is used. The cost effectiveness is determined by dividing the total present value of the control costs by the total emission reductions in tons over the same ten-year equipment life.

Maximum Cost Effectiveness Values

The MSBACT maximum cost effectiveness values, shown in Table 2-1, are based on a DCF analysis with a 4% real interest rate.

The cost criteria are based on those adopted by the AQMD Governing Board in the 1995 BACT Guidelines, adjusted to second quarter 2003 dollars using the Marshall and Swift Equipment Cost Index.

Top Down Cost Methodology

The AQMD uses the top down approach for evaluating cost effectiveness. This means that the best control method, with the highest emission reduction, is first analyzed. If it is not cost effective, then the second-best control method is evaluated for cost effectiveness. The process continues until a control method is found to be cost-effective.

AQMD staff will calculate both incremental and average cost effectiveness. The new MSBACT must be cost effective based on both analyses.

[3] The real interest rate is the difference between market interest rates and inflation, which typically remains constant at four percent.

Costs to Include in a Cost Effectiveness Analysis

Cost effectiveness evaluations consider both capital and operating costs. Capital cost includes not only the price of the equipment, but also the cost for shipping, engineering and installation. Operating or annual costs include expenditures associated with utilities, labor and replacement costs.

Table 2-1: Maximum Cost Effectiveness Criteria

Pollutant	Average (Maximum $ per Ton)	Incremental (Maximum $ per Ton)
ROG	20,200	60,600
NOx	19,100	57,300
SOx	10,100	30,300
PM_{10}	4,500	13,400
CO	400	1,150

Finally, costs are reduced if any of the materials or energy created by the process result in cost savings. These cost items are shown in Table 2-2. Methodologies for determining these values are given in documents prepared by U.S. EPA through their Office of Air Quality Planning and Standards (OAQPS Control Cost Manual, 4th Edition, U.S. EPA 450/3-90-006 and Supplements). Indirect costs are estimated as percentages of direct costs.

The cost of land is not considered because 1) add-on control equipment usually takes up very little space, 2) add-on control equipment does not usually require the purchase of additional land, and 3) land is non-depreciable and has value at the end of the project. In addition, the cost of controlling secondary emissions and cross-media pollutants caused by the primary MSBACT requirement should be included in any required cost effectiveness evaluation of the primary MSBACT requirement.

Table 2-2: Cost Factors

Total Capital Investment

Purchased Equipment Cost	Indirect Installation Costs
Control Device	Engineering
Ancillary (including duct work)	Construction and Field Expenses
Instrumentation	Start-Up
Taxes	Performance Tests
Freight	Contingencies
Direct Installation Cost	
Foundations and Supports	
Handling and Erection	
Electrical	
Piping	
Insulation	
Painting	

Total Annual Cost

Direct Costs	Indirect Costs
Raw Materials	Overhead
Utilities	Property Taxes
- Electricity	Insurance
- Fuel	Administrative Charges
- Steam	**Recovery Credits**
- Water	Materials
- Compressed Air	Energy
Waste Treatment/Disposal	
Labor	
- Operating	
- Supervisory	
- Maintenance	
Maintenance Materials	
Replacement Parts	

CHAPTER 3

MSBACT GUIDELINE AMENDMENT

INTRODUCTION

Part D of the MSBACT Guidelines specifies the MSBACT requirements for all of the commonly permitted categories of equipment. This chapter will describe the proposed MSBACT amendments for DG equipment and explain the basis for the proposed amendments.

PROPOSED MSBACT AMENDMENT

Staff proposes to create a new MSBACT category, “Distributed Generation”, which will require DG equipment to meet the CARB 2007 DG emission standards. In other words, DG equipment will have to meet emission limits equivalent to those for new, large central power plants. DG equipment includes I.C. engines and gas turbines used to produce electricity primarily for use within the facility in which it is sited and/or another facility with which it has a direct energy interconnection(s). The proposed DG MSBACT guideline would not apply to DG projects fueled by digester gas, landfill gas or stranded natural gas. The proposed new DG category MSBACT is shown in Table 3-1.

Since an applicant normally selects either gas turbine or I.C. engine technology for a DG project, the guidelines for those equipment categories will be modified to direct the applicant to the Distributed Generation category, as shown in Tables 3-2 and 3-3.

It is also proposed that gas turbines rated at ≥3 MW have the option of meeting either the new DG MSBACT or the existing Gas Turbine MSBACT. This is because the cost effectiveness of meeting the 2007 emission standards relative to the existing MSBACT guidelines for gas turbines in this size category (2.5 ppm NOx, etc., see Table 1-2) does not meet the AQMD cost effectiveness criteria for amending MSBACT. A gas turbine project could choose to meet the DB MSBACT, instead of the gas turbine BACT, and take advantage of the waste heat recovery credit in the proposed DG BACT standards.

The full text of the proposed MSBACT amendments as they will appear in Part D of the BACT Guidelines is presented in Appendix A.

Table 3-1. Proposed New Distributed Generation MSBACT Guideline

2-4-2005 Rev. 0

Equipment or Process: Distributed Generation [1)]

	Criteria Pollutants					
Rating/Size	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
All[2)]	.02 lb/MW-hr [3)] (2-4-2005)	.07 lb/MW-hr [3)] (2-4-2005)	See Clean Fuels Policy in Part C of the BACT Guidelines (2-4-2005)	0.1 lb/MW-hr [3)] (2-4-2005)	See Clean Fuels Policy in Part C of the BACT Guidelines (2-4-2005)	See Appropriate Guideline for Gas Turbine or Stationary I.C. Engine (2-4-2005)

1) Applies to any electricity generation project producing electricity primarily for use within the facility in which it is sited and/or another facility(ies) with which it has a direct energy interconnection(s). Does not include distributed generation fueled by by-product gases such as digester gas , landfill gas or refinery gas or stranded natural gas. Stranded natural gas is natural gas that is being flared or for which processing to meet pipeline quality requirements and/or connecting to the nearest commercial pipeline clearly cannot be economically justified.

2) A gas turbine rated at ≥3 MWe must meet either this guideline or the applicable Gas Turbine guideline.

3) Calculation of lb/MW-hr may consider both electrical generation and waste heat utilization (3.413 MMBtu of waste heat is equivalent to 1 MW-hr).

Table 3-2. Proposed Amendment of Gas Turbine MSBACT Guideline

10-20-2000 Rev. 0
12-3-2004 Rev. 1
2-4-2005 Rev. 2

Equipment or Process: Gas Turbine

	Criteria Pollutants					
Subcategory/ Rating/Size	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
Distributed Generation[1)]	A natural gas fired gas turbine rated at ≥3 MWe and used for distributed generation must meet either the applicable guideline in this table or the Distributed Generation guideline (2-4-2005)					
Natural Gas Fired, < 3 MWe		9 ppmvd @ 15% O_2 (10-20-2000)		10 ppmvd @ 15% O_2 (10-20-2000)		9 ppmvd ammonia @ 15% O_2 (10-20-2000)
Natural Gas Fired, ≥ 3 MWe and < 50 MWe		2.5 ppmvd @ 15% O_2 x $\frac{\text{efficiency (\%)}^{2)}}{34\%}$ (6-12-98)		10 ppmvd @ 15% O_2 (6-12-98)		5.0 ppmvd ammonia @ 15% O_2 (10-20-2000)
Natural Gas Fired, ≥ 50 MWe	2.0 ppmvd (as methane) @ 15% O_2, 1-hour avg. OR 0.0027 lbs/MMBtu (higher heating value) (10-20-2000)	2.5 ppmvd @ 15% O_2, 1-hour rolling avg. OR 2.0 ppmvd @ 15 %O_2, 3-hour rolling avg. x $\frac{\text{efficiency (\%)}^{2)}}{34\%}$ (10-20-2000)		6.0 ppmvd @ 15% O_2, 3-hour rolling avg. (10-20-2000)		5.0 ppmvd ammonia @ 15% O_2 (10-20-2000)
Continued						

Table 3-2. (Continued)

Emergency		See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)		See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	
Landfill or Digester Gas Fired		25 ppmv, dry, corrected to 15 $\%O_2$ (1990)	Compliance with Rule 431.1 (10-20-2000)	130 ppmv, dry, corrected to 15 $\%O_2$ (10-20-2000)	Fuel Gas Treatment for Particulate Removal (1990)	

Notes:

1) Applies to any electricity generation project producing electricity primarily for use within the facility in which it is sited and/or another facility with which it has a direct energy interconnection(s). Does not include distributed generation fueled by by-product gases such as digester gas, landfill gas or refinery gas or stranded natural gas. Stranded natural gas is natural gas that is being flared or for which processing to meet pipeline quality requirements and/or connecting to the nearest commercial pipeline clearly cannot be economically justified.

2) The turbine efficiency correction for NOx is limited to 1.0 as a minimum. The turbine efficiency is the demonstrated percent efficiency at full load (corrected to the higher heating value of the fuel) without consideration of any downstream energy recovery.

Table 3-3. Proposed Amendment of Stationary I.C. Engine MSBACT Guideline

10-20-2000 Rev. 0
6-6-2003 Rev. 1
7-9-2004 Rev. 2
12-3-2004 Rev. 3
2-4-2005 Rev. 4

Equipment or Process: I.C. Engine, Stationary

	Criteria Pollutants					
Subcategory/ Rating/Size	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
Distributed Generation[1)]	See Distributed Generation guideline (2-4-2005)					
Emergency[2)], Compression-ignition[3)]	1.0 grams/bhp-hr (4-10-98) See Table 1 for Tier 2 limits and schedule. (6-6-2003)	6.9 grams/bhp-hr (4-10-98) See Table 1 for Tier 2 limits and schedule. (6-6-2003)	Diesel Fuel Sulfur Content ≤ 0.05% by Weight (4-10-98) On or after June 1, 2004 the user may only purchase diesel fuel with a sulfur content no greater than 0.0015% by weight (Rule 431.2). (6-6-2003)	8.5 grams/bhp-hr (4-10-98) See Table 1 for Tier 2 limits and schedule. (6-6-2003)	0.38 grams/bhp-hr (4-10-98) See Table 1 for Tier 2 limits and schedule. (6-6-2003) Compliance with Rule 1470 (12-3-2004)	
Emergency[2)], Spark Ignition[4)]	1.5 grams/bhp-hr (10-20-2000)	1.5 grams/bhp-hr (10-20-2000)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	2.0 grams/bhp-hr (10-20-2000)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	

Continued

Table 3-3. (Continued)

Landfill or Digester Gas Fired	0.8 grams/bhp-hr (4-10-98)	0.60 grams/bhp-hr (4-10-98)	Compliance with Rule 431.1 (10-20-2000)	2.5 grams/bhp-hr (4-10-98)		
Non-Emergency, < 2064 bhp	0.15 grams/bhp-hr (4-10-98)	0.15 grams/bhp-hr (4-10-98)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	0.60 grams/bhp-hr (4-10-98)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000) Compliance with Rule 1470 (12-3-2004)	
Non-Emergency, ≥ 2064 bhp	25 ppm @ 15% O_2 (7-9-2004)	9 ppmvd @ 15% O_2 (7-9-2004)	Same as Above (10-20-2000)	33 ppmvd @ 15% O_2 (5-8-98)	Same as Above (7-9-2004)	Ammonia: 10 ppmvd @ 15% O_2 (7-9-2004)

1) Applies to any electricity generation project producing electricity primarily for use within the facility in which it is sited and/or another facility(ies) with which it has a direct energy interconnection(s). Does not include distributed generation fueled by by-product gases such as digester gas, landfill gas or refinery gas or stranded natural gas. Stranded natural gas is natural gas that is being flared or for which processing to meet pipeline quality requirements and/or connecting to the nearest commercial pipeline clearly cannot be economically justified.

(The full text of the proposed MSBACT amendments is available in Appendix A.)

BASIS OF THE PROPOSED DG MSBACT REQUIREMENTS

As California's population and energy demands increase, there is certainly a need for increased electric generation equipment in California. CEC estimates that between 2003 and 2013, approximately 10,000 MW (including reserves) of generation or demand-reducing programs will be needed to serve the growth in the state economy.[4] The increased power capacity can be provided by large central generating stations, by DG, or a combination of the two.

From 2001 to 2003, over 7,200 MWs of electrical generating capacity were added in California[5], but only 376 MWs of DG were added in the same period in the service territories of the three large investor-owned utilities in California[6]. The vast majority of the additions were from large central generating stations. Although the DG is not a large part of the overall growth in electrical generating capacity, its air quality impacts per MW can be much higher than for large central generating stations.

Comparison of Emissions from Central Power Plants and I.C Engine DG

The current BACT requirements for most DG permitted by AQMD (I.C. engines) allow emissions that are from 6 to 23 times higher than the emissions allowed from new large central station power plants. Figure 3-1 demonstrates the differences between the BACT emission limits for an I.C. engine and the CARB 2007 DG standards, which are equivalent to the BACT emission limits for a new large central station power plant.

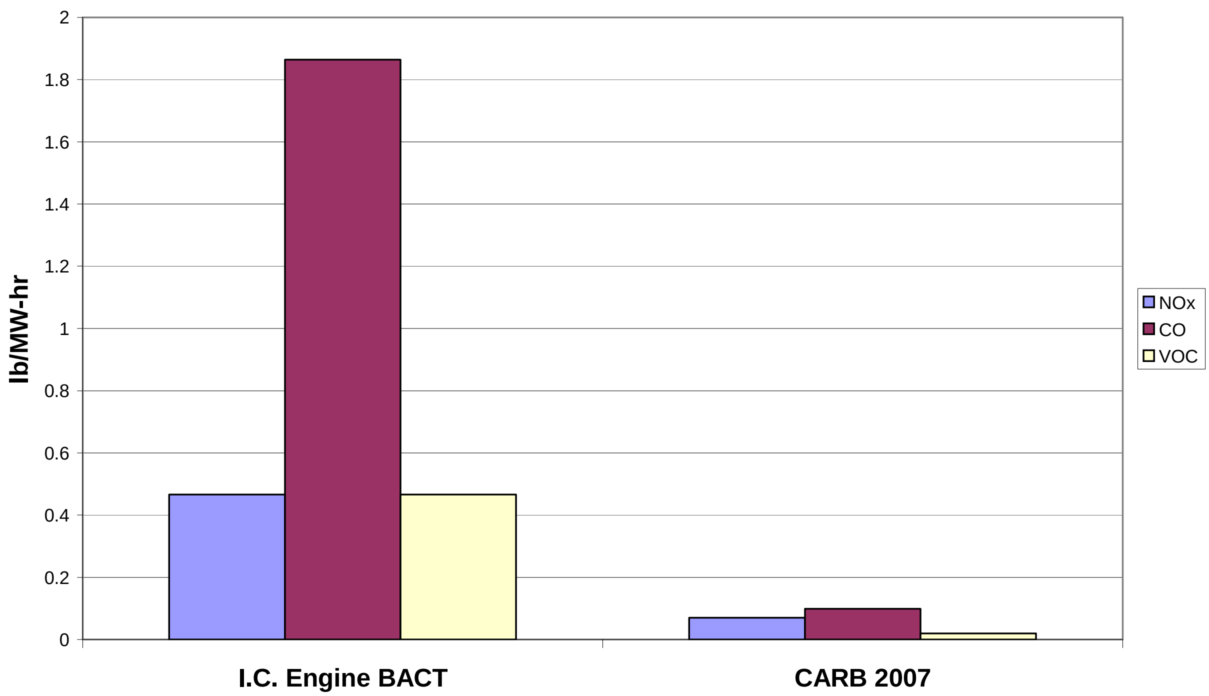
CARB's 2007 standards will be applicable only to equipment not requiring permits, so in AQMD's jurisdiction, only gas turbines rated at ≤2.975 MMBtu/hr heat input and I.C. engines rated at ≤50 bhp will be affected[7].

Characteristics of Central Power Plants

AQMD regulations have been incredibly successful in reducing NOx emissions from central power plants. In 1969, power plant NOx emissions averaged 156 tons/day. In 2003, power plants in AQMD's RECLAIM emission trading program[8] emitted only 1.9 tons/day, a 98.8% reduction from 1969 emissions. The reductions have occurred as a result of using natural gas instead of fuel oil, repowering some plants with modern, efficient, and combined cycle gas turbines with BACT emission controls, and retrofitting the older power plants with selective catalytic reduction NOx controls.

[4] Electricity and Natural Gas Report, California Energy Commission, December 2003
[5] Ibid.
[6] http://www.energy.ca.gov/distgen/interconnection/rule21_stats.html
[7] AQMD Rule 219, Equipment not Requiring a Written Permit Pursuant to Regulation II.
[8] This includes all central power plants emitting ≥4 tons/year (0.011 tons/day) of NOx, with the exception of the Glendale Department of Water and Power.

Figure 3-1. Current BACT for DG (I.C. Engine) versus CARB's 2007 DG Standards



New central station power plants also:

- Are installed only when additional electric power is needed;
- Are only operated when needed, often as peaking units;
- Provide emission offsets for all emission increases to mitigate emission impacts;
- Have continuous emission monitoring systems (CEMS) for NOx and CO;
- Must promptly report emissions exceedances to AQMD; and
- Are staffed 24/7 by personnel who can respond to and correct emission problems.

Characteristics of Distributed Generation

All DG produce the same product, electricity. Some DG also produces useful thermal energy.

Air emissions from DG vary widely. Solar photovoltaic and wind power DG produce zero emissions. Fuel cells have near zero emissions and can meet the CARB 2007 DG emission standards. Large gas turbine cogeneration DG (over 3MW) are very similar to large central power plants, have the same emission controls and comparable emissions. But, the majority of DG projects are comprised of I.C engine DG which, as shown in Figure 3-1, are permitted to have much higher emissions than large central power plants or clean DG.

In comparison to large central power plants, I.C. engine DG are:

- Discretionary. Facilities install I.C. engine DG in anticipation of economic benefits, not because there is a need for power. Facilities always have the option to use clean grid power;
- Are often used as a 24/7 baseload unit, whether the electric grid needs the power or not;
- Usually exempt from providing emission offsets because their permitted emissions are below the New Source Review offset thresholds;
- In most cases not required to have CEMS;[9]
- Generally not required to report emission exceedances to AQMD;[10]
- Are often operated without onsite supervision or trained operating personnel.

I.C. Engine Emission Controls

For most DG projects, natural gas-fired, rich-burn, I.C. engines are selected. Although emissions of particulate matter and Sox are very low with a natural gas engine, uncontrolled emissions of NOx, CO and unburned hydrocarbons are extremely high from this type of engine. These engines can comply with current MSBACT guidelines by operating the engine very close to the stoichiometric air/fuel ratio, i.e., the exact amount of air theoretically required to combust the fuel, and passing the exhaust gas through a type of catalyst known as a "three-way" catalyst. The three-way catalyst promotes a reducing reaction between unburned CO and hydrocarbons and NOx, thus eliminating most of the NOx. The catalyst also promotes oxidation of any unreacted CO and hydrocarbons with small amounts of oxygen remaining in the exhaust gas. The success of this process is strongly dependent upon maintaining the air/fuel ratio within a very narrow range to achieve optimum amounts of CO, hydrocarbons and oxygen in the exhaust. For this reason, the engine air/fuel ratio must be regulated by an air/fuel ratio controller (AFRC), which regulates a fuel valve based on a continuous measurement of the exhaust gas O2 content using an O2 sensor.

A significant weakness of this technology is the fact small departures (±1%) of the air/fuel ratio from the optimum range result in extremely high emissions of either NOx or CO and hydrocarbons. If the mixture is slightly too lean, high NOx emissions occur. If the mixture is slightly too rich, high emissions of CO and hydrocarbons occur. Field data gathered by AQMD show that emissions of NOx are frequently in the hundreds of ppm and emissions of CO are frequently in the thousands of ppm if the emission control system is not operating properly.

Avoidance of these extremely high emissions depends upon an accurate O2 signal from the sensor and a knowledge of the O2 setting that corresponds to the optimum air/fuel ratio. Unfortunately, both of these critical factors are subject to considerable uncertainty. In most cases the AFRC system is "tuned" on the basis of emission measurements at the time of its initial source test. However, the O2 sensor response tends to change over time, thus causing the AFRC system to control to a non-

[9] Only engines over 1000 HP are currently required to have CEMS for NOx. None are required to have CO CEMS.
[10] Only Title V major sources are required to report emission exceedances.

optimum air/fuel ratio. AQMD was recently informed that significant sensor drift occurs rapidly, in a matter of hours following the engine tuning. Furthermore, changes in engine load are known to affect the optimum O2 setting, and some AFRC systems are tuned only for operation at one load, causing the air/fuel ratio to be non-optimum whenever the engine is not at its normal load. Even systems that are programmed with O2-vs.-load information may experience high emissions during a load change if the AFRC system does not respond quickly to the changes.

I.C. Engine DG Emission Compliance

Current regulations only require most I.C. engine DG to demonstrate emission compliance once every three years by an emission source test. This usually results in a compliant source test because the facility schedules when the test will occur, and will assure that the engine is serviced and operating properly before the test by the hired contractor commences. Even if the test shows non-compliance, only major sources (Title V) are required to report the results to AQMD.

A lot can go wrong in the three year period between emission tests on an I.C. engine DG unit. On a unit used 24/7, it is typical to require an oil change once a month, and tune-ups every two months, including new spark plugs and O2 sensors. The things that can go wrong to cause excess emissions include:

- A bad spark plug
- A faulty spark plug wire
- A failed O2 sensor
- A O2 sensor for which the mV signal has drifted
- A catalyst that has plugged due to ash from oil blowby
- A catalyst that has become deactivated due to poisoning from ash blowby or excess exhaust temperature
- A catalyst that degrades from vibration allowing bypassing of the catalyst
- A failed air/fuel ratio controller
- A air/fuel ratio controller that is not properly recalibrated after an O2 sensor replacement

In the past year, AQMD enforcement personnel acquired portable analyzers capable of measuring NOx, CO and O2 concentrations in the exhaust of combustion equipment. These analyzers are not expected to be as accurate Method 100.1 source test, but they are much easier to set up and use, and can detect emission problems. Enforcement inspectors have been using the portable analyzers to do unannounced emission tests on various types of combustion equipment, and write Notices of Violation.

These emission tests have shown that I.C. engines, no matter whether they are driving pumps, compressors or electrical generators, have very high non-compliance rates and very high excess emissions. As of September 30, 2004, 43 emission tests with portable analyzers have been conducted on I.C. engines driving electrical generators. The engines all are natural gas fired and have 3-way catalyic emission controls. The equipment tested include engines manufactured by General Motors, Ford, Caterpillar, Waukesha, Deutz and Daewoo, and packaged engine/cogeneration units manufactured by Tecogen, Hess and Coast Intelligen. The engines include a combination of older and new units. The results of the tests are summarized in Table 3-4.

Table 3-4. Recent AQMD Compliance Testing of I.C. engine DG

	NOx	CO
Engines Tested	42	42
Out of Compliance	63%	28%
Overall In Compliance	28%	
I.C. Engine BACT, ppm*	12	80
Average ppm*	120	670
Maximum ppm*	850	12,500
Central Station BACT, ppm*@	2	6

- All dry and corrected to 15% O2

72% of the I.C. engine DG units were out of compliance with their CO emission limit, their NOx emission limit, or both. The average NOx and CO emissions were 8 to 10 times more than the I.C engine BACT emission limits, and 60 to 110 times higher than the allowed emissions from new central power plants. The highest emissions measured were 71 to 156 times more than the I.C engine BACT emission limits, and 425 to 2,100 times higher than the allowed emissions from new central power plants.

DG Technologies that Meet CARB 2007 DG Standards

The following DG technologies can already meet CARB's 2007 emission standards:

- ♦ Kawasaki GPB15X Gas Turbine--1.423 gross MW at ISO conditions (sea level, 59^oF), guaranteed emission limits of 2.5 ppm NOx, 6 ppm CO and 2 ppm VOC, all dry basis, corrected to 15% O2, down to 70% of rated load. These emission limits together with heat input of 20.7 MMBtu/hr (LHV) and 53.7% waste heat recovery specified by the manufacturer meet the CARB 2007 standards.
- ♦ Fuel Cells--available and certified by CARB to meet the CARB 2007 DG standards in sizes from 5 to 1000 kW.[11]

[11] http://www.arb.ca.gov/energy/dg/dg.htm

- Large combustion gas turbines with combined heat and power (CHP). These are very similar to the central station combined-cycle power plants that are the basis of the 2007 CARB DG standards.

In addition, facilities may install other DG technologies such as: zero-emission solar or wind DG, renewable fuel technologies using biogas, or microturbines certified by CARB to meet the current 2003 CARB DG Standards. All of the above technologies are either inherently low emissions, or will have CEMS to assure proper operation of their add-on emission controls.

State of California Initiatives for Clean DG

The State of California recognizes the need for clean electric power and has led the way in requiring clean and renewable electric power. Recent legislation includes the following bills.

SB1298: This required CARB to establish the 2007 DG standards for small unpermitted DG units and to issue guidance to local air districts by the earliest practicable date to require DG BACT for permitted DG units that is equivalent to BACT for central station power plants.

AB1685: This limits the self generation incentives provided by the local utilities to DG projects that: 1) meet a NOx emission limit of 0.14 lbs/MW-hr (twice the CARB 2007 DG standard) beginning January 1, 2005; and 2) meet the CARB 2007 DG standards beginning January 1, 2007. It also provides the highest incentives to solar, fuel cell and renewable DG.

SB1078: This requires the investor-owned utilities to increase electric generation from renewable technologies to 20% of total generation by 2017. This will spur more solar, wind and other renewable projects and make the grid electric power even cleaner than it is today.

Staff's proposal to require new DG to be as clean as new grid power is in line with the State's initiatives.

I.C. Engine Advancements

Advancements are being made in I.C. engine technologies that may lead to them being able to also achieve the CARB 2007 DG standards. At a recent conference sponsored by the California Energy Commission (CEC)[12] and the U.S. Department of Energy, the CEC program manager for the California Advanced Reciprocating Internal Combustion Engine Collaborative reported that they have three I.C. engines projects that will achieve the CARB 2007 DG standards by 2004-2005 by increasing the efficiency and reducing the emissions from I.C. engines. The three projects involve cooled exhaust gas recirculation with a three-way catalyst, homogeneous charge compression ignition, and advanced laser ignition. However, I.C. engines need to demonstrate that they can reliably meet these standards.

COMMERCIAL AND TECHNICAL STATUS OF THE LOW-EMISSION DG TECHNOLOGIES

Kawasaki GPB15X Gas Turbine

[12] http://www.energetics.com/recips04.html

The Kawasaki GPB15X gas turbine employs a catalytic combustor to achieve low NOx emissions while maintaining low emissions of CO and VOC. For sales within AQMD's jurisdiction, Kawasaki will guarantee operation at or below 2.5 ppm NOx, 6 ppm CO and 2 ppm VOC (all dry, volumetric, corrected to 15% O2) down to 70% rated load. Based on technical data provided by Kawasaki, the net electrical efficiency for local conditions is 19.7% and 63% of the waste heat can be recovered. With this ratio of thermal recovery to electrical output, operation at or below the guaranteed maximum emissions will meet the CARB 2007 DG emission standards (applying the thermal credit of one MW-hr per 3.4 MMBtu/hr of waste heat utilized). In fact, a project with substantially less than 63% waste heat utilization can meet the 2007 standards. The ability of the GPB15X to operate within the emission limits that Kawasaki guarantees for sales in AQMD jurisdiction are substantiated by the cases discussed below.

The first commercial use of a GPB15X gas turbine equipped with a catalytic combustor was at the Silicon Valley Power plant in Santa Clara, CA, where it was started up in December 1998 and has been in regular use. That unit has undergone several modifications over the years mainly to improve its emissions performance. During the second half of 1999, the catalyst developer conducted emissions monitoring for six months pursuant to a CARB technology verification program, and CARB verified the technology not to exceed 2.5 ppm NOx and 6 ppm CO (dry, 15% O2) when operating at or above 98% of rated capacity[13]. Additional emissions monitoring was conducted under CEC's PIER program, and the results of that monitoring, which covered three phases of hardware modifications, are summarized in Table 3-5. The history of operation at the Silicon Valley Power plant together with the emission monitoring performed for CARB and CEC establish that the technology has been practiced for more than a year and supports the capability of the technology to meet the emission guarantee offered by the manufacturer.

More recent installations have occurred at the Sonoma Developmental Center (SDC) in Eldridge, CA and at an oil production field operated by Plains Exploration & Production Co. (PXP) in San Luis Obispo County in California. The SDC installation was actually a retrofit of the Xonon catalytic combustor into an existing Kawasaki gas turbine. The unit started up with the new combustor in place in November 2002 and has operated essentially full time at or near full load since then. The waste heat from the gas turbine is utilized via a waste heat boiler for facility steam and hot water needs. There is also a duct burner upstream of the waste heat boiler to augment steam and hot water production. This installation was not subject to New Source Review, and the permit limits on NOx, CO and VOC do not fully reflect the low-emission capability of the catalytic combustor. Although NOx and CO emissions are continuously monitored, monitoring occurs downstream of the waste heat boiler, where emissions include those produced by the duct burner. However, under an arrangement with the California Energy Commission (CEC), the facility does monitor the NOx and CO concentrations at the gas turbine exit for approximately one hour per month and reports those readings to the CEC. Table 3-6 shows monthly NOx/CO reports from May, when the CEC program started, through August 2004, which is the most recent report available.

[13] The gas turbine wasn't operated below 98% load during the test period.

Table 3-5. Summary of Kawasaki Gas Turbine Emissions Documented for CEC PIER Program

	PPMVD@15%O2, Avg./Max.		
	NOx	CO	VOC
Phase I **June-December 1999**	1.3/2.8	1.2/9.6	1.0/8.8
Phase II **April-August 2000**	1.2/1.7	0.5/25.9	0.6/3.5
Phase III **May-June 2001**	1.1/1.5	0.4/5.5	0.4/3.0

Table 3-6. Monthly Turbine-Exit NOx/CO Reports, Sonoma Developmental Center

Month (2004)	**PPMVD, Corrected to 15% O2**	
	NOx	**CO**
May	2.2	1.2
June	2.4	1.2
July	1.9	1.7
August	2.4	1.1

The PXP installation is at an oil production field in San Luis Obispo County. The waste heat is utilized to preheat boiler feed water for steam flooding the wells. This unit started operation in November 2003 and has operated essentially full time at or near full load since that time. Emission limits in the air permit are 3 ppm NOx, 10 ppm CO and 2 ppm VOC (all dry, volumetric, corrected to 15% O2). These limits are enforced based on an initial source test and quarterly emission measurements. The unit was source tested in December 2003, and quarterly emission measurement reports that have been received thus far by the district are of tests that occurred in March and July 2004. The emission results from these tests are summarized in Table 3-7.

In addition to the above three installations, Kawasaki has sold three more units which are not yet installed and expects to close five sales in 2005.

Table 3-7. Summary of Emission Measurement Results from PXP's GPB15X Gas Turbine

Test	PPMVD, Corrected to 15% O2		
	NOx	**CO**	**VOC**
Source Test, 12-4-2003:			
100% Load	1.4	0.3	<1.4
90% Load	1.4	0.4	<1.5
80% Load	1.9	2.6	<1.6
70% Load	2.6	3.9	<1.7
Quarterly Test, 3-16-2004, 100% Load	2.5	2.0	---
Quarterly Test, 7-9-2004, 100% Load	1.3	1.0	---

Fuel Cells

Fuel cells produce power from natural gas and air via electrochemical reactions, which produce virtually no pollution. There are a number of fuel cell technologies in use today. The following four commercially available fuel cells are certified by CARB to meet the 2007 DG emission standards:

- Fuel Cell Energy (FCE) DFC300 250 kW molten carbonate fuel cell
- Fuel Cell Energy (FCE) DFC1500 1,000 kW molten carbonate fuel cell
- UTC Power PC25 (now called Pure Cell 200) 200 kW phosphoric acid fuel cell
- Plug Power GenSys 5C - 5 kW fuel cell

FCE has seven DFC300 fuel cell-based power plants installations in the U.S. Table 3-8 summarizes those installations. The unit at Bourne, MA has been extensively reported[14]. The PC25 has excellent turndown characteristics and is capable of both load-following and peaking operation. The DFC300 is well suited to base-load operation but is not well suited to load following or peaking applications since the unit has only limited turndown capability and cannot tolerate very much on/off cycling. Although several of the FCE installations were essentially commercial sales, all installations listed in the table have been subsidized by government and/or other sources of funds. The DFC1500 is a newer product, and FCE recently sold the first one to Alameda County where it will supply power and heat to a correctional facility.

UTC Power's PC25 is actually a more established product than the DFC300. It has been commercially available since 1991, and there are now 50 operating in the U.S. and more than 250 worldwide. A large majority of these units have been operating for 12 months or more.

[14] "United States Coast Guard Air Station Cape Cod Fuel Cell, Installation and Preliminary Production Report, U.S.C.G. Research & Development Center, Groton, CT, February 19, 2004.
"Final technical Report, Climate Change Fuel Cell Program, USCG Air Station, Cape Cod, Bourne, MA", John K. Steckel, Jr., P.E., PPL Spectrum, Inc., June 30, 2004.

Plug Power's GenSys 5C 5-kW product is intended for smaller facilities and its cost per kW is more than twice those of the FCE and UTC Power products.

COST EFFECTIVENESS

Staff determined the differential costs and emission reductions corresponding to use of low-emission DG technologies in place of the technologies that have traditionally been used and found the low-emission technologies to meet AQMD's cost effectiveness criteria for amending MSBACT. The cost effectiveness calculations are discussed in Chapter 4. For power needs below approximately 170 kW, there is no technology that meets AQMD's cost effectiveness criteria. However, purchase from the grid does meet the criteria.

Table 3-8. Fuel Cell Energy DFC250 Installations

Site	Type of Project	No. of Units	Startup Mo./Yr	Operating Load(s)	Status
LADWP, Hope Street	Demo	1	August 2001	Full	Operating
LADWP, Terminal Island	Demo	1	June 2003	Full	Operating
LADWP, Main Street	Demo	1	Sept. 2003	Full	Operating
U.S. Coast Guard Air Station, Bourne, MA	Commercial	1	June 2003	155 kW	Unplanned shutdown in July 2004 Being upgraded and utility agreement being modified to allow full-load operation.
Starwood Hotels, Edison, NJ					
Starwood Hotels, Parsippany, NJ					
Ocean County College, Toms River, NJ	Commercial	1	July 2004	Full	Operating

RECOMMENDATIONS

Based on the above findings, staff recommends the following.

1. Amend the MSBACT guidelines as shown in Appendix A. This amendment creates a new equipment category entitled "Distributed Generation" to encompass all DG projects, regardless of the DG technology that is chosen by the applicant. The proposed guideline

requires that the project meet the CARB 2007 DG emission standards for NOx, CO and VOC. AQMD's Clean Fuels Policy is referenced as the guideline for SOx and PM. Ammonia emission guidelines for gas turbines and I.C. engines are referenced to constrain ammonia emissions in case an applicant chooses to meet the CARB 2007 NOx limit by using one of these DG technologies together with selective catalytic reduction of NOx using ammonia or an ammonia derivative.

2. As noted in Appendix A, the proposed DG MSBACT guidelines should not apply to DG projects fueled by digester gas, landfill gas, refinery gas or stranded natural gas since the low-emission DG technologies are not proven for those fuels.
3. Since an applicant normally prefers either gas turbine or I.C. engine technology for a DG project, the guidelines for those equipment categories should be modified to direct the applicant to the Distributed Generation category, as shown in Appendix A.
4. For gas turbines rated at or above 3 MW, the proposed guidelines are preferable to the existing MSBACT guidelines for this equipment category. However, the proposed DG guidelines do not meet AQMD's cost effectiveness criteria for amending MSBACT; and should therefore be optional for gas turbines in this size category, as noted in Appendix A.

COMPLIANCE WITH THE AQMD MSBACT UPDATE PROCESS REQUIREMENTS

As discussed above, AQMD must demonstrate that the proposed MSBACT amendment satisfies both AQMD criteria for altering MSBACT and the requirements of Health & Safety Code section 40440.11. The following paragraphs will address each of the requirements.

Notification of the Public and the BACT Scientific Review Committee (SRC)

The proposed MSBACT amendment was placed on the agenda and discussed at the March 25, 2004 meeting of the SRC, and revised versions were placed on the agendas and discussed at the May 27, 2004 and November 18, 2004 meetings of the SRC. One week in advance of each meeting, the agenda was issued by e-mail to the committee members and all parties who have expressed an interest in these meetings since their inception in December 1998. In addition, a public notice was issued on May 11, 2004 inviting public comments by June 10, 2004. Comments received and AQMD responses are provided in Appendix B.

Presentation to the AQMD Governing Board for Approval in a Public Hearing

The proposed MSBACT update will be placed on the agenda for the February 4, 2005 regular meeting of the AQMD Governing Board. This agenda will be posted on the AQMD web site and in the lobby of AQMD's Diamond Bar facility 30 days prior to the date of the meeting.

Determination that the MSBACT Requires Only Emission Limits or Control Technology on the Basic Production or Process Equipment in a Source Category or Similar Source Category

This is a requirement of Health & Safety Code Section 40440.11. This criterion is met because the proposed MSBACT only applies emission limits to DG equipment. The state law allows the same emission limits to be placed on a "….source category or similar source category." Gas turbine and

I.C engine DG are both combustion-based equipment that produce the same product, electricity, and are therefore similar.

Evaluation of Cost of Controlling Secondary Pollutants

This is a requirement of Health & Safety Code Section 40440.11. This is not an issue in this case since no secondary pollutants are known or expected to result from the technologies upon which the proposed MSBACT is based.

Determination that the Control Technology is Commercially Available

The low-emission DG technologies upon which the proposed DG MSBACT is based, as decribed above, are commercially available.

Determination that the Control Technology Has Been Demonstrated for At Least One Year on a Comparable Commercial Application

As discussed above, each of the low-emission DG technologies upon which the proposed DG MSBACT is based has been successfully demonstrated in normal commercial operation for a year or more.

Determination that the Control Technology is Effective

The proposed DG MSBACT is based on three low-emission DG technologies-the Kawasaki GPB15X gas turbine and three fuel cell products. As discussed above, the Kawasaki GPB 15X gas turbine, applied in a DG project with a sufficient amount of waste heat utilization, can meet the 2007 standards. The three fuel cell products have been certified by CARB to meet the 2007 standards.

Calculation of Total and Incremental Cost Effectiveness and Determination that the Cost Effectiveness is Less than AQMD's Established Cost Effectiveness Criteria

A cost effectiveness analysis is presented in Chapter 3. This analysis shows that the proposed revision meets AQMD's cost-effectiveness criteria for changing MSBACT.

Clean Fuels Policy

As discussed in Chapter 1, AQMD's Clean Fuel Policy, which is part of the BACT Guidelines, requires the use of clean fuels wherever possible. The low-emission DG technologies upon which the proposed DG MSBACT is based normally operate on natural gas fuel, which is a clean fuel. The proposed MSBACT exempts DG projects that operate on landfill or digester gas or stranded natural gas, all of which are exempt from the Clean Fuel Policy.

CHAPTER 4

COST EFFECTIVENESS ANALYSIS

INTRODUCTION

As discussed in Chapter 2, one of the criteria that must be satisfied by any new MSBACT requirement is that it's cost to the end user must not exceed AQMD's cost effectiveness criteria, i.e., in terms of cost per ton of pollutant controlled. In this chapter, the incremental cost and amounts of pollutants reduced in using the low-emission DG technologies are examined. Following the procedure described in Chapter 2, the average and incremental cost effectiveness of using the low-emission DG technologies versus using the DG technologies that are normally used today were calculated and compared to AQMD's cost effectiveness criteria for amending the MSBACT guidelines. Since purchase of power from the grid is an alternative to DG, the cost effectiveness of this low-emission option was also considered.

CALCULATIONS

The cost effectiveness calculations are summarized in Tables 4-1 through 4-6 and are presented in detail in Appendix C. The details of the cost assumptions are noted in Appendix C.

Since baseline DG technologies that are most commonly used today depend on plant size and low-emission technologies are available only in certain size increments, three plant sizes were considered in the calculations in order to encompass all important technology comparisons. Baseline DG technologies consist of rich-burn I.C. engine for DG plants sized at or below approximately 1.5 MW and lean-burn I.C. engines for DG plants sized at or above approximately 1.5 MW. Baseline emission controls that are used to meet current MSBACT consist of three-way catalyst with air/fuel ratio controller for rich-burn engines and selective catalytic reduction (SCR) and oxidation catalyst for lean-burn engines. Low-emission DG technologies are available in 200-kW or 250-kW increments in the case of fuel cells and in 1.298 MW increments in the case of the GPB15X gas turbine. Cost effectiveness calculations were therefore performed for the following three cases: (1) two 250-kW FCE fuel cells (500 kW net power) versus a rich-burn engine, (2) one GPB15X gas turbine (1.298 MW net power) versus a rich-burn engine and (3) two GPB15X gas Turbines (2.96 MW net power) versus a lean-burn engine. Calculations were based on the 250-kW FCE fuel cell as opposed to the 200-kW UTC Power fuel cell since more detailed cost data were available for the FCE system.

Capital costs considered in the calculations include installed cost, the cost of purchasing emission reduction credits, and the cost of a continuous emission monitoring system (CEMS), which AQMD normally requires for engines sized at or above 1000 bhp. Funds available from the California Public Utilities Commission (CPUC) pursuant to California's Self Generation Incentive Program were also considered, as a capital cost reduction. Since the CPUC program requires purchase of a three-year (for engines or turbines) or five-year (for fuel cells) maintenance contract, the cost of such a contract was included in the installed cost in each case.

Annual costs that were considered include maintenance cost after expiration of the maintenance contract, restacking in the case of fuel cells (normally needed in the eight year of operation for FCE fuel cells), emission fees that must be paid to AQMD, the cost of maintenance and testing of a CEMS system if one is present, and the cost of fuel. Unless specified otherwise, the calculations assume that the plant is located in the SCE service territory and that departing load charges must therefore be paid to the electric utility. In calculating the annual cost of fuel, utilization of waste heat in the facility hot water system was assumed, thus reducing the amount of boiler fuel purchased by the facility. The assumed price of natural gas was $5.90 per million Btu, which was based on the recent history of natural gas prices at the AQMD. The effect of a 50% increase in the price of natural gas was also considered.

As mentioned in Chapter 2, the cost effectiveness of power purchase from the grid was also considered as an alternative low-emission option to the baseline DG technologies. There is no capital cost associated with this option, and the only annual cost is the cost of the purchased power.

Based on the capital and annual costs, the present value of the ten-year cost of each option was calculated following the methodology described in Chapter 2. The differential costs of using the low-emission options versus baseline DG technologies were then compared to maximum allowable cost differentials, which were calculated from the emission reductions associated with each low-emission option based on AQMD's cost effectiveness criterion for each pollutant. In addition to direct emission differences between the various options, emission reductions associated with waste heat recovery, i.e., reduction in boiler emissions, were considered. In order to calculate the cost-effectiveness in $ per ton, the differential costs were distributed among each pollutant controlled in proportion to the amount each pollutant was reduced.

RESULTS

Table 4-1 summarizes the results for base-load plants that are sized based on the minimum size increments of the low-emission DG technologies (250 kW in the case of fuel cells and 1.298 MW in the case of the GPB15X gas turbine). For this case, the cost effectiveness of the low-emission DG technologies met the AQMD criteria in all three plant sizes, as did the option to purchase power from the grid in either the LADWP or the SCE system.

Since it may be desirable to operate at less than maximum capacity, the effect of derating each low-emission DG technology was examined. For FCE fuel cells, it was found that a 500-kW plant could be operated at 420 kW (16% derate) and still meet the cost effectiveness criteria. The GPB15X gas turbine was also cost-effective down to 70% of rated capacity. The purchase of grid power was also very cost-effective these derated loads. The results of these cases are summarized in Table 4-2.

Operation of the DG plant only during periods when electric utility rates are higher was also examined. The results for peaking operation in the LADWP service area are summarized in Tables 4-3 and 4-4, and analogous results for the SCE service area are summarized in Tables 4-5 and 4-6. The GPB15X gas turbine meets the cost effectiveness criteria in all peaking scenarios. Fuel cells do not meet the cost effectiveness criteria in any of the peaking scenarios. However, again, purchase from the grid does meet the criteria for the 500-kW plant size in all peaking scenarios.

The effect of a 50% higher natural gas cost was also evaluated. For the sake of brevity, results are not show here, but in general the low-emission DG technologies become even more cost-effective. The purchase of grid power not only becomes more cost effective, but is generally the least-cost alternative.

In summary, the low-emission DG technologies are cost effective compared to the baseline DG technologies in a variety of DG scenarios. Also, the purchase of clean grid power, whether from SCE or LADWP, is cost effective in all the evaluated scenarios.

Table 4-1. Results of Cost Effectiveness Calculations for Base-Load Plants Sized for Low-Emission Technologies ($/ton)

			0.5 MW Case			1.298 MW Case			2.596 MW Case		
		Maximum Allowable	Fuel Cell	LADWP Power	SCE Power	GPB15X Gas Turbine	LADWP Power	SCE Power	GPB15X Gas Turbine	LADWP Power	SCE Power
NOx	Average	**19,100**	-9,574	-11,700	-10,052	-11,683	-12,474	-10,857	-6,316	-6,988	-5,998
	Incremental	**57,300**	34,857	-50,747	22,335	-27,092	-68,703	4,412	-8,650	-67,925	17,645
CO	Average	**400**	-201	-245	-211	-245	-261	-227	-132	-146	-126
	Incremental	**1,200**	730	-1,063	468	-567	-1,439	92	-181	-1,423	370
VOC	Average	**20,200**	-10,125	-12,374	-10,631	-12,356	-13,192	-11,483	-6,680	-7,390	-6,343
	Incremental	**60,600**	36,864	-53,670	23,621	-28,653	-72,660	4,666	-9,148	-71,837	18,661
PM10	Average	**4,500**	-2,256	-2,757	-2,368	-2,753	-2,939	-2,558	-1,488	-1,646	-1,413
	Incremental	**13,500**	8,212	-11,956	5,262	-6,383	-16,187	1,039	-2,038	-16,003	4,157
Baseline DG Technology			Rich-Burn I.C. Engine			Rich-Burn I.C. Engine			Lean-Burn I.C. Engine		
Baseline Emission Control Technology			Three-Way Catalyst/AFRC			Three-Way Catalyst/AFRC			SCR/Oxidation Catalyst		

Table 4-2. Results of Cost Effectiveness Calculations for Base-Load Plants Sized for Derated Low-Emission Technologies ($/ton)

			0.5 MW Case			1.298 MW Case			2.596 MW Case		
		Maximum Allowable	Fuel Cell	LADWP Power	SCE Power	GPB15X Gas Turbine	LADWP Power	SCE Power	GPB15X Gas Turbine	LADWP Power	SCE Power
NOx	Average	**19,100**	-8,888	-11,581	-9,930	-10,791	-12,170	-10,551	-5,860	-6,995	-6,004
	Incremental	**57,300**	55,912	-50,868	22,334	-3,032	-62,170	11,090	15,932	-69,335	16,298
CO	Average	**400**	-186	-243	-208	-226	-255	-221	-123	-146	-126
	Incremental	**1,200**	1,171	-1,065	468	-63	-1,302	232	334	-1,452	341
VOC	Average	**20,200**	-9,400	-12,248	-10,502	-11,413	-12,871	-11,159	-6,198	-7,398	-6,350
	Incremental	**60,600**	59,132	-53,798	23,621	-3,206	-65,751	11,729	16,849	-73,328	17,236
PM10	Average	**4,500**	-2,094	-2,728	-2,340	-2,542	-2,867	-2,486	-1,381	-1,648	-1,415
	Incremental	**13,500**	13,173	-11,985	5,262	-714	-14,647	2,613	3,754	-16,335	3,840
Baseline DG Technology			Rich-Burn I.C. Engine			Rich-Burn I.C. Engine			Lean-Burn I.C. Engine		
Baseline Emission Control Technology			Three-Way Catalyst/AFRC			Three-Way Catalyst/AFRC			SCR/Oxidation Catalyst		

Table 4-3. Results of Cost Effectiveness Calculations for Peaking Operation in LADWP System (20 hrs/week) ($/ton)

			0.5 MW Case		1.298 MW Case		2.596 MW Case	
		Maximum Allowable	Fuel Cell	LADWP Power	GPB15X Gas Turbine	LADWP Power	GPB15X Gas Turbine	LADWP Power
NOx	Average	**19,100**	10,005	-13,473	-14,219	-19,401	-7,147	-11,553
	Incremental	**57,300**	594,291	-332,822	-118,626	-392,744	-77,384	-495,332
CO	Average	**400**	210	-282	-298	-406	-150	-242
	Incremental	**1,200**	12,446	-6,970	-2,484	-8,225	-1,621	-10,373
VOC	Average	**20,200**	10,581	-14,249	-15,038	-20,519	-7,559	-12,218
	Incremental	**60,600**	628,518	-351,989	-125,458	-415,363	-81,841	-523,858
PM10	Average	**4,500**	2,357	-3,174	-3,350	-4,571	-1,684	-2,722
	Incremental	**13,500**	140,016	-78,413	-27,949	-92,531	-18,232	-116,701
Baseline DG Technology			Rich-Burn I.C. Engine		Rich-Burn I.C. Engine		Lean-Burn I.C. Engine	
Baseline Emission Control Technology			Three-Way Catalyst/AFRC		Three-Way Catalyst/AFRC		SCR/Oxidation Catalyst	

Table 4-4. Results of Cost Effectiveness Calculations for High and Low Peak Operation in LADWP System (50 hrs/week) ($/ton)

			0.5 MW Case		1.298 MW Case		2.596 MW Case	
		Maximum Allowable	Fuel Cell	LADWP Power	GPB15X Gas Turbine	LADWP Power	GPB15X Gas Turbine	LADWP Power
NOx	Average	**19,100**	-3,388	-11,666	-12,490	-14,115	-6,580	-8,029
	Incremental	**57,300**	210,233	-115,154	-56,197	-146,320	-30,505	-168,382
CO	Average	**400**	-71	-244	-262	-296	-138	-168
	Incremental	**1,200**	4,403	-2,412	-1,177	-3,064	-639	-3,526
VOC	Average	**20,200**	-3,584	-12,338	-13,209	-14,927	-6,959	-8,492
	Incremental	**60,600**	222,341	-121,786	-59,434	-154,747	-32,262	-178,079
PM10	Average	**4,500**	-798	-2,749	-2,943	-3,325	-1,550	-1,892
	Incremental	**13,500**	49,531	-27,131	-13,240	-34,473	-7,187	-39,671
Baseline DG Technology			Rich-Burn I.C. Engine		Rich-Burn I.C. Engine		Lean-Burn I.C. Engine	
Baseline Emission Control Technology			Three-Way Catalyst/AFRC		Three-Way Catalyst/AFRC		SCR/Oxidation Catalyst	

Table 4-5. Results of Cost Effectiveness Calculations for Peak Operation in SCE System (30 hrs/wk June-September) ($/ton)

			0.5 MW Case		1.298 MW Case		2.596 MW Case	
		Maximum Allowable	Fuel Cell	SCE Power	GPB15X Gas Turbine	SCE Power	GPB15X Gas Turbine	SCE Power
NOx	Average	**19,100**	32,656	-13,052	-17,232	-24,454	-8,134	-14,685
	Incremental	**57,300**	1,267,018	-519,028	-227,380	-633,941	-159,049	-805,168
CO	Average	**400**	684	-273	-361	-512	-170	-308
	Incremental	**1,200**	26,534	-10,870	-4,762	-13,276	-3,331	-16,862
VOC	Average	**20,200**	34,536	-13,804	-18,225	-25,862	-8,603	-15,531
	Incremental	**60,600**	1,339,987	-548,920	-240,475	-670,450	-168,209	-851,539
PM10	Average	**4,500**	7,694	-3,075	-4,060	-5,761	-1,916	-3,460
	Incremental	**13,500**	298,512	-122,284	-53,571	-149,358	-37,472	-189,699
Baseline DG Technology			Rich-Burn I.C. Engine		Rich-Burn I.C. Engine		Lean-Burn I.C. Engine	
Baseline Emission Control Technology			Three-Way Catalyst/AFRC		Three-Way Catalyst/AFRC		SCR/Oxidation Catalyst	

Table 4-6. Results of Cost Effectiveness Calculations for Peak and Mid-Peak Operation in SCE System (65-75 hrs/wk) ($/ton)

			0.5 MW Case		1.298 MW Case		2.596 MW Case	
		Maximum Allowable	Fuel Cell	SCE Power	GPB15X Gas Turbine	SCE Power	GPB15X Gas Turbine	SCE Power
NOx	Average	**19,100**	-5,433	-9,997	-12,213	-11,929	-6,490	-6,492
	Incremental	**57,300**	152,456	-19,146	-46,208	-46,274	-23,004	-31,915
CO	Average	**400**	-114	-209	-256	-250	-136	-136
	Incremental	**1,200**	3,193	-401	-968	-969	-482	-668
VOC	Average	**20,200**	-5,746	-10,573	-12,916	-12,616	-6,863	-6,865
	Incremental	**60,600**	161,237	-20,249	-48,869	-48,939	-24,329	-33,753
PM10	Average	**4,500**	-1,280	-2,355	-2,877	-2,810	-1,529	-1,529
	Incremental	**13,500**	35,919	-4,511	-10,887	-10,902	-5,420	-7,519
Baseline DG Technology			Rich-Burn I.C. Engine		Rich-Burn I.C. Engine		Lean-Burn I.C. Engine	
Baseline Emission Control Technology			Three-Way Catalyst/AFRC		Three-Way Catalyst/AFRC		SCR/Oxidation Catalyst	

APPENDIX A

PROPOSED MSBACT AMENDMENT

2-4-2005 Rev. 0

Equipment or Process: Distributed Generation [1)]

	Criteria Pollutants					
Rating/Size	VOC	NOx	SOx	CO	PM_{10}	Inorganic
All[2)]	.02 lb/MW-hr [3)] (2-4-2005)	.07 lb/MW-hr [3)] (2-4-2005)	See Clean Fuels Policy in Part C of the BACT Guidelines (2-4-2005)	0.1 lb/MW-hr [3)] (2-4-2005)	See Clean Fuels Policy in Part C of the BACT Guidelines (2-4-2005)	See Appropriate Guideline for Gas Turbine or Stationary I.C. Engine (2-4-2005)

1) Applies to any electricity generation project producing electricity primarily for use within the facility in which it is sited and/or another facility(ies) with which it has a direct energy interconnection(s). Does not include distributed generation fueled by by-product gases such as digester gas , landfill gas or refinery gas or stranded natural gas. Stranded natural gas is natural gas that is being flared or for which processing to meet pipeline quality requirements and/or connecting to the nearest commercial pipeline clearly cannot be economically justified.

2) A gas turbine rated at ≥3 MWe must meet either this guideline or the applicable Gas Turbine guideline.

3) Calculation of lb/MW-hr may consider both electrical generation and waste heat utilization (3.413 MMBtu of waste heat is equivalent to 1 MW-hr).

10-20-2000 Rev. 0
12-3-2004 Rev. 1
2-4-2005 Rev. 2

Equipment or Process: Gas Turbine

	Criteria Pollutants					
Subcategory/ Rating/Size	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
Distributed Generation[1)]	A natural gas fired gas turbine rated at ≥3 MWe and used for distributed generation must meet either the applicable guideline in this table or the Distributed Generation guideline (2-4-2005)					
Natural Gas Fired, < 3 MWe		9 ppmvd @ 15% O_2 (10-20-2000)		10 ppmvd @ 15% O_2 (10-20-2000)		9 ppmvd ammonia @ 15% O_2 (10-20-2000)
Natural Gas Fired, ≥ 3 MWe and < 50 MWe		2.5 ppmvd @ 15% O_2 x $\frac{\text{efficiency (\%)}^{2)}}{34\%}$ (6-12-98)		10 ppmvd @ 15% O_2 (6-12-98)		5.0 ppmvd ammonia @ 15% O_2 (10-20-2000)
Natural Gas Fired, ≥ 50 MWe	2.0 ppmvd (as methane) @ 15% O_2, 1-hour avg. OR 0.0027 lbs/MMBtu (higher heating value) (10-20-2000)	2.5 ppmvd @ 15% O_2, 1-hour rolling avg. OR 2.0 ppmvd @ 15 %O_2, 3-hour rolling avg. x $\frac{\text{efficiency (\%)}^{2)}}{34\%}$ (10-20-2000)		6.0 ppmvd @ 15% O_2, 3-hour rolling avg. (10-20-2000)		5.0 ppmvd ammonia @ 15% O_2 (10-20-2000)
Continued						

Emergency		See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)		See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	
Landfill or Digester Gas Fired		25 ppmv, dry, corrected to 15 %O_2 (1990)	Compliance with Rule 431.1 (10-20-2000)	130 ppmv, dry, corrected to 15 %O_2 (10-20-2000)	Fuel Gas Treatment for Particulate Removal (1990)	

Notes:

1) Applies to any electricity generation project producing electricity primarily for use within the facility in which it is sited and/or another facility with which it has a direct energy interconnection(s). Does not include distributed generation fueled by by-product gases such as digester gas, landfill gas or refinery gas or stranded natural gas. Stranded natural gas is natural gas that is being flared or for which processing to meet pipeline quality requirements and/or connecting to the nearest commercial pipeline clearly cannot be economically justified.

2) The turbine efficiency correction for NOx is limited to 1.0 as a minimum. The turbine efficiency is the demonstrated percent efficiency at full load (corrected to the higher heating value of the fuel) without consideration of any downstream energy recovery.

10-20-2000 Rev. 0
6-6-2003 Rev. 1
7-9-2004 Rev. 2
12-3-2004 Rev. 3
2-4-2005 Rev. 4

Equipment or Process: I.C. Engine, Stationary

	Criteria Pollutants					
Subcategory/ Rating/Size	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
Distributed Generation[1)]	See Distributed Generation guideline (2-4-2005)					
Emergency[2)], Compression-ignition[3)]	1.0 grams/bhp-hr (4-10-98) See Table 1 for Tier 2 limits and schedule. (6-6-2003)	6.9 grams/bhp-hr (4-10-98) See Table 1 for Tier 2 limits and schedule. (6-6-2003)	Diesel Fuel Sulfur Content ≤ 0.05% by Weight (4-10-98) On or after June 1, 2004 the user may only purchase diesel fuel with a sulfur content no greater than 0.0015% by weight (Rule 431.2). (6-6-2003)	8.5 grams/bhp-hr (4-10-98) See Table 1 for Tier 2 limits and schedule. (6-6-2003)	0.38 grams/bhp-hr (4-10-98) See Table 1 for Tier 2 limits and schedule. (6-6-2003) Compliance with Rule 1470 (12-3-2004)	
Emergency[2)], Spark Ignition[4)]	1.5 grams/bhp-hr (10-20-2000)	1.5 grams/bhp-hr (10-20-2000)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	2.0 grams/bhp-hr (10-20-2000)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	
Continued						
Landfill or Digester Gas Fired	0.8 grams/bhp-hr (4-10-98)	0.60 grams/bhp-hr (4-10-98)	Compliance with Rule 431.1	2.5 grams/bhp-hr (4-10-98)		

			(10-20-2000)			
Non-Emergency, < 2064 bhp	0.15 grams/bhp-hr (4-10-98)	0.15 grams/bhp-hr (4-10-98)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000)	0.60 grams/bhp-hr (4-10-98)	See Clean Fuels Policy in Part C of the BACT Guidelines (10-20-2000) Compliance with Rule 1470 (12-3-2004)	
Non-Emergency, ≥ 2064 bhp	25 ppm @ 15% O_2 (7-9-2004)	9 ppmvd @ 15% O_2 (7-9-2004)	Same as Above (10-20-2000)	33 ppmvd @ 15% O_2 (5-8-98)	Same as Above (7-9-2004)	Ammonia: 10 ppmvd @ 15% O_2 (7-9-2004)

1) Applies to any electricity generation project producing electricity primarily for use within the facility in which it is sited and/or another facility(ies) with which it has a direct energy interconnection(s). Does not include distributed generation fueled by by-product gases such as digester gas, landfill gas or refinery gas or stranded natural gas. Stranded natural gas is natural gas that is being flared or for which processing to meet pipeline quality requirements and/or connecting to the nearest commercial pipeline clearly cannot be economically justified.
2) An emergency engine is an engine which operates as a temporary replacement for primary mechanical or electrical power sources during periods of fuel or energy shortage or while a primary power source is under repair. This includes fire pumps, emergency electrical generation and other emergency uses. Exceptions to the requirements in Table 1 may be made for emergency fire pumps if it is demonstrated that there are no UL-listed fire pumps that meet the Tier 2 emission limits.
3) AQMD restricts operation of emergency compression-ignition engines to 50 hours per year, or less if required by Rule 1470, for maintenance and testing or emission compliance demonstrations and a maximum of 200 hours per year total operation. For engines used to drive standby generators, operation beyond maintenance and testing or emission compliance demonstrations is allowed only in the event of a loss of grid power or up to 30 minutes prior to a rotating outage provided that the electrical grid operator or electric utility has ordered rotating outages in the control area where the engine is located or has indicated that it expects to issue such an order at a certain time, and the engine is located in a control area that is subject to the rotating outage.
4) AQMD restricts operation of emergency spark-ignition engines to 50 hours per year for maintenance and testing and a maximum of 200 hours per year total operation. For emergency spark-ignition engines used to drive standby generators, operation beyond 50 hours per year for maintenance and testing is allowed only during emergencies resulting in an interruption of service of the primary power supply or during Stage II or III electrical emergencies declared by the electrical grid operator. Operators are allowed to use emergency spark-ignition engines as part of an interruptible electric service program. An interruptible electric service program is a program in which the facility receives payment or reduced rates in return for a requirement to reduce its electric load on the grid when requested to do so by the utility, the grid operator, or other organization.

Table 1. U.S. EPA Tier 2 Certification Levels Required for Compression-ignition Engines (6-6-2003)[a)]

Rating/Size	Applicable to Applications Deemed Complete After	NMHC + NOx[b)]	CO	PM
50 ≤ HP < 100	6/30/2004	7.5 grams/kW-hr (5.6 grams/bhp-hr)	5.0 grams/kW-hr (3.7 grams/bhp-hr)	0.40 grams/kW-hr (0.30 grams/bhp-hr)
100 ≤ HP < 175	6/30/2003	6.6 grams/kW-hr (4.9 grams/bhp-hr)	5.0 grams/kW-hr (3.7 grams/bhp-hr)	0.30 grams/kW-hr (0.22 grams/bhp-hr)
Continued on next page				
175 ≤ HP < 300	6/30/2003	6.6 grams/kW-hr (4.9 grams/bhp-hr)	3.5 grams/kW-hr (2.6 grams/bhp-hr)	0.20 grams/kW-hr (0.15 grams/bhp-hr)
300 ≤ HP < 600	6/6/2003	6.4 grams/kW-hr (4.8 grams/bhp-hr)	3.5 grams/kW-hr (2.6 grams/bhp-hr)	0.20 grams/kW-hr (0.15 grams/bhp-hr)
600 ≤ HP < 750	6/6/2003	6.4 grams/kW-hr (4.8 grams/bhp-hr)	3.5 grams/kW-hr (2.6 grams/bhp-hr)	0.20 grams/kW-hr (0.15 grams/bhp-hr)
≥750 HP	6/30/2006	6.4 grams/kW-hr (4.8 grams/bhp-hr)	3.5 grams/kW-hr (2.6 grams/bhp-hr)	0.20 grams/kW-hr (0.15 grams/bhp-hr)

Notes to Table 1:

a) The engine must be certified by U.S. EPA or CARB to meet the Tier 2 emission requirements of 40 CFR Part 89 – Control of Emissions from New and In-use Nonroad Compression-Ignition Engines shown in Table 1– or otherwise demonstrate that it meets the Tier 2 emission limits shown in Table 1. If, because of the averaging, banking, and trading program, there is no new engine from any manufacturer that meets the above standards, then the engine must meet the family emission limits established by the manufacturer and approved by U.S. EPA.

b) NMHC + NOx means the sum of non-methane hydrocarbons and oxides of nitrogen emissions.

APPENDIX B

PUBLIC COMMENTS AND RESPONSES

Proposed DG MSBACT
Public Comments and Staff Responses

(Repetitious comments are not repeated.)

Comment: This proposal runs counter to the state effort to promote DG, e.g., AB970 funds subsidizing new DG installations. The proposed MSBACT would effectively stop new DG installations in SCAQMD that are in the sub-7 MW size range.

Response: The self-generation incentive program authorized by the California Public Utilities Commission does provide rebates for some qualified DG. However, it also shows preference for zero and near-zero emission technologies and renewable technologies by providing them larger incentives. In 2003 the state legislature further restricted the incentive program by limited it to DG technologies that emit no more than 0.14 lbs/MW-hr by January 1, 2005 and 0.07 lbs/MW-hr by January 1, 2007. The state legislature also adopted SB1298 in 2000 that requires CARB and local districts to require, as soon as practicable, electrical generation technologies to meet emission standards equivalent to BACT for permitted central station power plants. Electrical generation technologies exist now to meet these standards for DG projects.

Comment: Essentially all new DG installations are I.C. engines. Installations do not go ahead unless the payback is 5 years or less. The payback for a KHI system is well over 5 years.

Response: I.C engines do cost less, but their NOx, CO and HC emissions exceed those of clean central station plants by 500% to 2200%. SB 1298 does not include payback or cost as a factor to consider. Neither do AQMD BACT for major sources or federal Lowest Achievable Emission Rate.

Comment: The KHI system is well suited only to facilities having 1.4 MW electrical load (or a multiple of 1.4 MW) and a 2:1 ratio of thermal to electrical load.

Response: The CPUC incentive program requires fossil fuel-fired DG to recover waste heat in order to qualify. Without heat recovery, DG efficiencies are poor compared to central station plants. The large amount of waste heat recoverable from gas turbines is a bonus, not a drawback.

Comment: A small turbine cannot follow load changes nearly as well as an I.C. engine. Of DG systems 500 kW or larger that have been installed, approximately 80% are required to follow load changes part of the time or all of the time.

Response: Because the current economics of new DG discourage export of electrical power and non-use of recovered thermal energy, we would expect DG to not be sized to serve peak loads and to not have to follow facility electrical loads as much. However, the manufacturer reports that the KHI gas turbine generator is an excellent load follower.

Comment: CARB chose 1/1/07 for the effective date because no suitable technology is available now.

Response: CARB's standards are statewide and apply to areas that comply with the ambient air quality standards as well as those that don't. AQMD has the worst air quality in the nation, and cannot wait until 2007 to require clean DG technologies when cleaner alternatives exist now. The proposed BACT is based on currently available technology.

Comment: This proposal should be aired in additional public forums to give more DG equipment manufacturers a chance to comment. SCE's DG group should be included in one such meeting.

Response: AQMD will follow its usual procedure when more stringent BACT is proposed. There will be a 30-day public comment period. In addition, the AQMD Board will consider the adoption of the new standards for minor sources at a public hearing.

Comment: BACT should identify a control technology, not an alternative basic technology.

Response: Section 41514.10 of the California State Health and Safety Code (CSHSC) requires BACT determinations "for electrical generation technologies" to be "equivalent to the level determined by the state board to be the best available control technology for permitted central station power plants in California." It does not distinguish between different types of electrical generation technologies. The target is the same for all.

BACT is defined by Section 40405 of the CSHSC to be "the most stringent emission limitation", not the most stringent control technology.

Section 40440.11 of the CSHSC requires AQMD to "consider only control options *or emission limits* to be applied to the basic production or process equipment existing in that source category *or a similar source category*."

Certainly, state law provides for requiring all electrical generation technologies to meet the same stringent emission limits.

Comment: If you are going to compare DG emissions to grid power emissions, the emissions from a boiler that may be displaced by the DG may not be at BACT levels.

Response: The cost effectiveness calculations have been refined and are now based on typical boiler emissions, not BACT.

Comment: The KHI installation at the Silicon Valley Power plant, which is the achieved-in-practice case cited by AQMD for this technology, is not a DG installation and does not have permit limits as low as the CARB 2007 standards.

Response: The KHI gas turbine generator is electric generation technology that can be used for DG. The extensive emission testing shows that it can meet the CARB 2007 DG emission standards.

Comment: The source test data for the KHI gas turbine at 98% and greater load are not adequate to demonstrate that the proposed DG BACT emissions are achieved in practice.

Response: Except for larger equipment that have continuous emission monitoring, there are never emission data for all load conditions. It is adequate that the manufacturer guarantees the emissions down to 70% load, and has guaranteed them in specific cases to 60% load.

Comment: SCE uses the term "distributed generation" to designate small power plants owned by or contracted to an electric utility to support weak areas of the grid when high demand is pulling power away from those areas. SCE is concerned that the two different usages of the term may lead to problems.

Response: It was not staff's intention for the proposed DG requirements to apply to the large power plants that provide power only to the grid. Staff will work with SCE to better understand SCE's concerns.

Comment: The installed cost of the KHI system that you used seems low compared to costs we quoted to potential customers.

Response: AQMD has received better cost information and redone the cost calculations.

Comment: How can the maintenance cost for the KHI system be less than for the IC engine?

Response: The basis for each cost factor is provided with the calculations. Several references indicate that IC engines require significantly more routine maintenance than gas turbines.

Comment: The calculations did not consider the effects of temperature, elevation or turndown on gas turbine efficiency or power output.

Response: The cost effectiveness analysis has been refined to include these factors.

Comment: The calculations do not appear to have included the cost (capital and maintenance) and parasitic load of a compressor, which is needed for the KHI system but not for an I.C. engine.

Response: The source of our cost data confirms it includes compressor costs. The effect on net power output and efficiency has been included.

Comment: Since many installations may not be multiples of 1.4 MW, the calculations for the KHI system should consider the case of a unit operating consistently below rated load.

Response: Derated applications of both a fuel cell system and a KHI system were evaluated for cost effectiveness versus correctly sized I.C. engines. This is conservative since I.C. engines also are available only in discrete sizes. The results of these calculations are shown in Attachment A. In the sub-1 MW size range, it was found that a fuel cell system remains cost effective versus an I.C. engine based system when derated as much as 11%. For systems sized at 0.9 MW and above, a KHI system can be derated as much as 30% and still be cost effective versus I.C. engine based systems.

Comment: Taking credit for reduction in boiler emissions is valid only in cases which have adequate thermal load to use all the recoverable waste heat. In calculating these emission credits, the assumption of 12 ppm NOx is probably not appropriate since most facilities have older boilers producing higher levels of NOx.

Response: Natural gas-fired DG technology electrical efficiencies are only 50 to 80% as much as new central station power plants, so they are an environmentally poor option unless there is an opportunity to recover waste heat from the DG. The boiler emissions have been recalculated based on typical boiler emissions instead of BACT.

Comment: The proposed BACT amendment is improperly premised on a single, unique research and development project.

Response: The proposed amendment is based on two commercial products (the KHI catalytic gas turbine and the Fuel Cell Energy molten carbonate fuel cell), each with an operating history of twelve months or more, installations at more than one location, and technical data showing that each can meet the CARB 2007 emission standards.

Comment: The proposed amendment will amount to an improper ban on advanced technology gaseous-fueled I.C. engines.

Response: The purpose of AQMD's BACT program is to require applicants to select the cleanest technology that is available and cost effective. While the proposed amendment may temporarily prevent use of I.C. engines for DG applications until cleaner I.C. engine -based DG systems are developed, this would not be an “improper ban”. It would be an example of the BACT program functioning properly by requiring equipment with the lowest achievable emission rate.

Comment: AQMD’s cost effectiveness analysis shows that in cases where there is no opportunity for combined heat and power (CHP), the DG emission limits cannot be met by any proven, cost effective technology.

Response: The economics of new DG plants operating on pipeline natural gas are unlikely to be favorable in the absence of CHP. Grid power based on new central station plants is more efficient, much cleaner and very cost effective compared to an I. C. engine generator without CHP.

Comment: California Health & Safety Code (CHSC) section 40440.11(a) requires AQMD to “consider only control options or emission limits to be applied to the basic production or process equipment existing in a source category or a similar source category. SCAQMD hasn’t done this.

Response: Actually, AQMD staff has done exactly that by applying the same emission limits to all DG equipment. The law allows emission limits that can be met by one type of electrical generating equipment to be applied to other similar source categories. Because all electrical generating technologies produce the same identical product, electricity, they are extremely similar in nature.

Comment: AQMD cannot combine all DG equipment into one source category. This is contrary to past AQMD practice. There should be separate BACT requirements for engines, gas turbines, etc.

Response: Actually, AQMD has included different technologies into the same category before. There are not separate categories for open-top batch vapor degreasers, or single-chamber incinerators, transfer-type dry cleaning equipment, and stationary, non-emergency diesel engines. This equipment has been included in more generic categories that require better emission control. It is immaterial whether DG equipment are in multiple categories or one, since as the previous comment pointed out, the same emission limits can be applied to similar source categories.

Comment: California law (Health & Safety Code section 40440.11(c)) specifies that prior to revising the BACT guidance for a source category AQMD must, among other things, “demonstrate that the proposed limit has been achieved on a comparable commercial operation for at least one year.”

Response: The applicable wording in section 40440.11(c) is: “Prior to revising the best available control technology guideline for a source category…the south coast district shall…determine that the proposed emission limitation has been met by production equipment, control equipment, or a process that is commercially available for sale, and has achieved the best available control technology in practice on a comparable commercial operation for at least one year.” This is subtly different, and has been complied with.

Comment: Compared to the KHI gas turbine, I.C. engines have higher electrical efficiency, are less costly, and much more popular.

Response: Granted, but I.C. engine emissions are many times higher than the KHI gas turbine.

Comment: I.C. engine emissions compare very favorably with emissions from the average California central power plant.

Response: In considering BACT, new I.C. engines should be compared to other new electrical generating technologies, not to existing electric generators. Compared to the 2007 CARB DG standards, which are representative of emissions from new central generating stations, I.C. engine emissions are many times higher for NOx, CO and VOC.

Comment: In order to avoid otherwise unnecessary and wasteful litigation over this matter, the SCAQMD should withdraw its unlawful proposal to implement a revised BACT standard "for all DG projects."

Response: No comment.

Comment: The proposed amendment would be devastating to the DG industry at a time when economic growth, job retention and economic competitiveness and grid reliability are critical to the economic comeback of California.

Response: California requires new electrical generating capacity to serve the future growth in demand. The proposed DG BACT standards will simply assure that the economic growth, jobs, and grid reliability achieved by the new generating capacity will be focused into cleanest possible electrical generating technologies.

Comment: It has not been shown that the proposed amendment would make a significant difference in view of the fact that most NOx is generated by the mobile and on- and off-road sectors.

Response: Although the proposed BACT amendment would be to reduce NOx and VOC emissions by approximately 1.5 tons per year each per MW of new DG, it is not part of the BACT process to consider the aggregate impact on area emissions. .

Comment: In making regulatory decisions concerning DG, air districts should await information to be assembled by CARB in its 2005 technology review, which begins in June 2004, and the results of a PUC 18-month proceeding to evaluate the costs and benefits of DG, which is just starting.

Response: CARB's DG standards only apply to unpermitted equipment; they do not apply to equipment permitted by AQMD. The BACT process is the required way to regulate new permitted equipment.

Comment: Adopting a DG BACT is analogous to adopting a single BACT for printing requiring all types of print products to be printed using the lowest-emitting printing technology.

Response: Different printed products require different printing technologies, whereas DG all produce the same identical product, electricity.

Comment: AQMD must consider economic impacts upon I.C. engine vendors, DG project developers, customers and utilities in adopting a BACT guideline for DG.

Response: Procedures to be followed by AQMD in revising its BACT guidelines are specified in AQMD's BACT Guidelines and state law. While these procedures do require, for minor sources, a demonstration that the proposed BACT change is cost effective in terms of cost per ton of pollutant reduced, they do not include consideration of economic impacts on affected individuals or entities.

Comment: AQMD's concerns that many DG projects are exempt from offsets and CEMS requirements whereas new central station power plants are not is clearly the basis for the proposed new MSBACT.

Response: The basis for the proposed amendment is the fact that cleaner DG technologies have now been achieved in practice and meet AQMD's cost effectiveness criteria for amending MSBACT, but the concerns stated in the comment are also justified.

Comment: Within-the-fence efficiencies such as reduction in use of older boilers, have not been quantified in the analysis.

Response: The cost effectiveness analysis assumes waste heat will be utilized and will produce a corresponding reduction in emissions from existing boilers.

Comment: It is appropriate to have DG emission limits in terms of lbs/MW-hr, although procedures will need to be developed for determining the power level at which a DG plant is operating during emissions testing.

Response: True, and waste heat utilization will also need to be determined if the plant needs the CHP credit to meet the emission limit.

Comment: Existing simple cycle natural gas turbines should be exempt from the proposed DG BACT.

Response: The proposed DG BACT will not apply to an existing gas turbine.

Comment: The KHI gas turbine should not be named as BACT because the operating and maintenance cost are higher than other technologies that achieve the same or better emissions at lower cost.

Response: The proposed DG BACT consists of emission limits, not a required technology. The KHI gas turbine is simply an example of one way to meet the emission limits. A permit applicant could use any technology that meets the emission limits.

Comment: AQMD should not be endorsing a particular brand name of equipment.

Response: AQMD is not endorsing any particular brand of equipment. However, when equipment establishes new achieved-in-practice BACT levels it is necessary to publish the information. Examples of this for many types of equipment are found on AQMD's website at http://www.aqmd.gov/bact/AQMDBactDeterminations.htm.

Comment: Is it AQMD's intent to eliminate I.C. engine generators from the market?

Response: No, it is AQMD's intent to require new DG equipment to be as clean as new central generating stations.

Comment: Cogeneration equipment should only have to demonstrate a net emission reduction compared to the boiler emissions displaced by the cogeneration equipment. **Response:** With previous BACT requirements, installation of I.C. engine DG would result in emission increases at a facility, not emission reductions, even with heat recovery credit. AQMD's New Source Review rules require new equipment to have BACT even if the new equipment emits less than the equipment it replaces.

Comment: It is almost impossible to verify how much thermal energy is actually recovered from cogeneration equipment. How will AQMD determine verify actual heat recovery in the field?

Response: Third-party cogenerators monitor the electricity and thermal energy produced by their DG equipment and bill the host site for the energy provided. These monitoring methods can be used to determine if the emission standards are being complied with.

Comment: Instead of the proposed levels, DG emission limits should be set at 0.14 lbs/MW-hr for NOx and CO.

Response: Emissions have been achieved-in-practice at the lower levels proposed by AQMD.

Comment: Any new DG emission limitations should be achievable by a broad variety of equipment.

Response: The principles of BACT require only that the emission limits are achievable by at least one type of commercial technology.

Comment: For large gas turbines from 10.5 to 50 MW, whose BACT requirements are already very stringent, AQMD has not demonstrated that the proposed DG emission limits meet the of State law BACT requirements.

Response: For large gas turbines over 3 MW, the minor source BACT Guidelines specifies limits of 2.5 ppm NOx and 10 ppm CO (both corrected to 15% oxygen.) These emission limits are significantly more stringent than the BACT requirements for I.C. engines, and almost as stringent as the emission limits on new, large, central generating stations. AQMD staff agrees that an incremental cost effectiveness analysis for > 3 MW gas turbines would not show that the proposed emission limits meet the cost criteria. Therefore, staff will propose that the DG minor source emission standards not apply to 3 MW or larger gas turbines.

Comment: The Fuel Cell Energy DFC300A fuel cell meets the achieved in practice criteria of commercial availability, reliability, effectiveness, and cost-effectiveness.

Response: Thank you.

Comment: Some DG projects operate much less than the 8000 hours per year assumed by AQMD.

Response: Staff has evaluated the costs of various alternatives for facilities interested in self generation during periods when the cost of electricity in higher. Facilities like this are on time-of-use electric schedules. Although the fuel cell would not be cost effective for this situation, it would be cost-effective to continue to purchase clean grid power in the service territories of both the Los Angeles Department of Water and Power and the Southern California Edison Company.

Comment: AQMD should open a second public comment period because the documentation available before the public notice did not explain that permitted DG of all sizes would be affected.

Response: The notice clearly stated what the proposed change is. There was a high level of public participation in the subsequent BACT Scientific Review Committee meeting and a great deal of written public comment submitted in response to the notice. Another notice is not necessary. However, the topic will brought back to the BACT Scientific Review Committee for further discussion.

Comment: Contrary to what the white paper states, emission offsets for small DG projects and other small projects are provided by AQMD offset reserves.

Response: It is correct that AQMD must provide offsets for small projects, but the statement in the white paper that small DG projects are exempt from providing offsets is still true as well.

Comment: The information in the white paper about advancements in I.C. engine technology that may lead to meeting the proposed standards should not be used as a basis for achieved in practice BACT.

Response: Those statements are not the basis of the proposed BACT.

Comment: When AQMD is required by SB1298 to issue a permit to a small engine generator that is not CARB-certified and is smaller than the AQMD Rule 219 permit exemption, AQMD should only require compliance with the emission limits from the CARB certification program.

Response: AQMD is not required to issue permits to equipment that is exempt from a permit by AQMD Rule 219.

Comment: AQMD should not reduce the cost the equipment by any rebates authorized by PUC's incentive program.

Response: The rebates are real and available to some distributed generation customers.

Comment: The emission reduction credit (ERC) costs are unrealistically high; their basis is unexplained. Also, the dollar cost of offsets provided by AQMD would be much less than offsets provided by applicants.

Response: The ERC costs are based on actual average costs during 2003. ERC costs to the applicant for the 500 kW controlled I.C. engine case were assumed to be zero, because smaller projects often do not have to provide their own emission offsets.

Comment: The I.C. engine baseline uncontrolled emission factors are not realistic. For example, baseline NOx for a lean burn engine should be from 2.2 to 3.7 lbs/MW-hr.

Response: The uncontrolled emission factors are from USEPA's Compilations of Air Pollutant Emission Factors. The NOx emission factors stated in the comment are actually more typical of lean burn engines using combustion technologies to reduce NOx. In any case, the uncontrolled emission factors do not affect the incremental cost-effectiveness analysis, which is the deciding factor.

Comment: We support the establishment of consistent, output-based, emission standards regardless of technology, but the proposed levels are not presently achievable by microturbines.

Response: Thank you for your support of consistent, output-based, emission standards regardless of technology. Because the same stringent standards would apply to all electrical generation technologies, not all technologies may be able to meet the standards. However, the proposed DG BACT will not apply to microturbines because they do not require an AQMD permit.

Comment: The proposed DG BACT requirements should not apply to equipment that has already received a permit to construct from AQMD, or that has already been purchased.

Response: The proposed DG BACT requirements would not apply to equipment that has received a permit to construct. It also would not apply to minor sources that have submitted a complete application for a permit prior to the AQMD Board approving changes in the minor source BACT guidelines.

Comment: For the many I.C. engine DG projects developed by our company in California, the KHI gas turbine would technically not be a good fit and a fuel cell would be too expensive. The proposed DG standards would have killed the projects. These proposed standards should not be adopted.

Response: DG projects are always discretionary. The host site may choose to install DG whose emissions are as clean as new central generating stations, or continue to purchase clean electricity from their utility company.

Comment: The proposed DG standards will harm potential customers, particularly public sector institutions like schools, colleges, cities and counties.

Response: Many facilities like these have installed microturbines certified by CARB and that do not require an AQMD permit, or large gas turbines that can comply with the proposed DG standards. .

Comment: AQMD should consider the additional costs of risk, R&D, lost DE market, higher electric peak load in California, higher CO2, higher electric distribution costs, and higher energy prices for consumers.

Response: These costs are not direct costs to the DG operator, not definable, and/or not in accordance with AQMD's BACT Guidelines.

Comment: The proposed DG BACT requirements should be limited to DG projects over 1.5 MW.

Response: The proposed DG BACT requirements can also be met by smaller projects.

Comment: A DG project that operates only 3000 hours per year should be allowed to emit the same annual emissions as a DG project operating 8760 hours per year.

Response: BACT requires the lowest achievable short-term emission rate. It is not based on annual emissions. The current short-term BACT emission limits for DG equipment applies to all DG equipment regardless of operating hours.

Comment: Public facilities may no longer have the option to install natural gas fired DG technology that would continue to operate in the event of an extended electric power outage.

Response: The proposed DG BACT requirements will not apply to natural gas or diesel emergency generators.

Comment: Over 50% of the hospitals in New York lost power due to diesel backup system failures and the inability to refill diesel fuel supplies.

Response: When a rare event like that occurs it often catches people unprepared, but it causes them to be better prepared next time. The BACT process can not be based on one in a million eventualities.

Comment: Contrary to AQMD's white paper, CHP DG can have energy efficiency that is 30 to 45% more efficient than the best central station power plant.

Response: The commenter misrepresents the white paper by taking quotes out of context. The statements in the white paper are accurate.

Comment: AQMD states in the white paper that most DG have emissions that are 6 to 23 times greater than emissions allowed from new large central station power plants, and are exempt from offsets, RECLAIM and CEMS. That is not true for gas turbines over 3 MW meeting current AQMD BACT.

Response: Granted, but gas turbine over 3 MW are not in the "most DG" category.

Comment: Not all DG projects are CHP. Some electricity-only DG projects are primarily for enhanced availability and reliability.

Response: Regardless of the reason for new DG, it should be as clean as new central generating stations.

Comment: For applications that cannot be served by grid power, distributed generation is the only way to provide necessary power.

Response: It is extremely rare for grid power to not be available to a facility, but AQMD would make a case-by-case BACT determination in this situation.

Comment: It is illogical, inappropriate, and not consistent with the BACT Guidelines to use uncontrolled liquid fuel-fired reciprocating engines as the basis for the cost effectiveness analysis.

Response: In accordance with the BACT Guidelines, AQMD evaluates both the average cost effectiveness of the proposed BACT compared to the uncontrolled case, and the incremental cost effectiveness compared to current BACT. The uncontrolled engine emissions are for an uncontrolled natural gas-fired engine, not a liquid fuel-fired engine.

Comment: Is AQMD interested in DG achieving continuous compliance with BACT requirements, and has DG equipment demonstrated continuous compliance with the proposed DG standards.

Response: AQMD staff is concerned about continuous compliance of DG with BACT requirements. The proposed DG BACT standards meet the BACT Guidelines requirements for achieved in practice.

Comment: Solar Turbine's latest 4.6 MW, Mercury 50 gas turbine has warranted emissions of 5 ppm NOx, 10 ppm CO and 10 ppm unburned HC, but would not meet the proposed DG BACT standards without expensive selective catalytic reduction (SCR) controls that could render a project economically infeasible.

Response: As explained in a previous response, AQMD is proposing to exclude 3 MW or greater gas turbines, which would include the Mercury 50, from the proposed DG BACT standards. The Mercury 50 emissions NOx emissions exceed the current MSBACT NOx standard for ≥ 3 MW gas turbines of 2.5 ppm, corrected to 34% efficiency, that was established in 1998. That limit is usually achieved with the use of SCR control equipment that results in ammonia slip, which is limited to 5 ppm by the MSBACT Guidelines. Because the Mercury 50 would not require SCR to meet 5 ppm NOx and would not have ammonia slip of up to 5 ppm allowed for SCR, AQMD staff would consider making a case-by-case BACT determination on a permit application allowing a 5 ppm NOx limit on the basis that the lack of ammonia slip is a good tradeoff for the 2.5 ppm of additional NOx.

Comment: Alliance Power has been awarded two contracts to install Fuel Cell Energy fuel cells in California. Fuel cells projects are economically competitive. We support the proposed DG BACT standards.

Response: Thank you.

Comment: Fuel cells have not demonstrated cost effectivity, are not commercially proven, and should not be used as a basis for BACT.

Response: Fuel cell power plants may be less cost effective in terms of $/kW-hr than some other DG technologies. However, to amend its MSBACT guidelines, AQMD must only show that the cost effectiveness of the lower-emitting technology in terms of $ per ton of pollutant reduced meets cost effectiveness criteria (California Health & Safety Code section 40440.11(c)(2)). Molten carbonate fuel cell technology meets the state criterion for being adequately proven for purposes of BACT (12 months commercial operation [California Health & Safety Code section 40440.11(c)(3) and (4)]).

Comment: The Coalition for Clean Air and 13 other environmental/health organizations support the proposed DG BACT standards. DG is a discretionary function by the user, and it is incumbent on AQMD to require that new DG in no more polluting than new centralized power plants.

Response: Thank you.

Comment: The fuel cell evaluation did not take into account the parasitic losses of pumps, compressors and heat exchangers required to support the fuel cell.

Response: The electrical efficiency that is used in the calculation is a net plant figure, which does consider all parasitic power requirements to operate the plant.

Comment: The gas turbine evaluation did not take into account the fuel gas delivery requirements or the gas cooling after compression.

Response: The calculation did consider fuel compression but did not consider fuel cooling. Staff has found that fuel cooling is required in some cases and may require up to approximately 0.3% of gross power. This is now included in the cost calculations.

Comment: The KHI gas turbine is not space effective and could not be installed where some I.C. engines could be installed.

Response: The footprint of the gas turbine is not much different from the footprint of an I.C. engine of the same output.

Comment: For smaller projects, facilities may not have room for the fuel cell(s) which require more room than I.C. engine generators.

Response: If there is not adequate room, facilities can still continue to purchase grid power.

Comment: AQMD should have separate BACT categories for rich-burn and lean-burn engines.

Response: Both types accomplish the same function. AQMD has in the past had a separate BACT subcategory for large I.C. engines where lean-burn engines predominate. But in the smaller engines, BACT was based on the lower emission rates achievable by rich-burn engines with 3-way catalysts.

Comment: The San Francisco Planning department found that an I.C. engine cogeneration project would not have significant effect on the environment, would be more fuel-efficient and would improve air quality.

Response: AQMD's analysis shows that even if all the available waste heat is made use of, which is often not the case, the I.C. engine will emit significantly more than the boiler it replaces. Compared to a new small boiler with BACT, the I.C. engine would emit over four times more NOx than the boiler.

Comment: Based on data from USEPA' eGRID database of electric emissions, the current DG NOx emission limits per MW-hr are much lower than actual emissions from large power plants in Southern California.

Response: That is not correct. The data referenced include power produced by high-NOx coal-fired power plants located outside California.

Comment: As NOx limits are made more stringent, it is more difficult to control emissions of CO and VOC.

Response: That is probably true for an I.C. engine, but new large power plants and the clean DG technologies highlighted in the white paper have lower emissions of all three pollutants.

Comment: The introduction of less efficient alternatives will significantly increase CO_2 emissions compared to I.C. engines.

Response: CO_2 is not a pollutant regulated by AQMD, but fuel cells, large central power plants, and wind and solar electric plants have much lower CO_2 emissions per MW-hr than I.C. engines.

Comment: I.C. engines are making improvements towards achieving the proposed DG BACT standards, but cannot do so now.

Response: Other DG technologies can now comply with the proposed standards.

Comment: It is difficult to measure emissions compliance with lower emissions limits.

Response: Lower emissions have required new procedures to ensure accuracy. The proposed DG BACT standards are no lower that BACT already established for other equipment categories.

Comment: AQMD should not require permits for microturbines rated over 2,975,000 Btu/hr (about 235 kW).

Response: Requiring permits for air pollution-emitting equipment is how AQMD regulates stationary source emissions.

Comment: It is questionable that the Fuel Cell Energy fuel cell and KHI gas turbine are really commercially available.

Response: They are commercially available, according to the manufacturers.

Comment: The emissions from the KHI gas turbine exceed the proposed DG BACT standards.

Response: The commenter's emission calculations are in error, but most importantly they neglect the credit for heat recovery.

Comment: The proposed action to include all DG in one equipment category departs from the policy established in the BACT Methodology Report, developed with industry in 1994-1995, that the permittee may choose the basic equipment and AQMD may establish the BACT for the basic equipment selected.

Response: As stated previously, there are still equipment categories where AQMD specifies through BACT the type of equipment to be used. AQMD staff has reevaluated the past policy for the DG category in light of: 1) the State's actions to put uniform emission limits on unpermitted DG and DG incentive programs, regardless of the type of technology; 2) the wording of CHSC section 40440.11 that allows the same emission limits on similar equipment categories; and 3) the major difference in emissions between new central power plants and some DG that has developed in the last ten years.

Comment: It would be more appropriate for AQMD to adopt a Regulation XI rule requiring CARB 2007 DG standards, rather than implement them through BACT.

Response: It could be done that way as well, but it is the specific purpose of New Source Review BACT requirements to regulate new equipment emissions.

Comment: Tecogen has permitted CHP I.C. engine generators in the San Joaquin Valley APCD at NOx levels one-half of the levels required by AQMD. With heat recovery credit, Tecogen products will qualify for the 2005 DG incentive program.

Response: AQMD has found Tecogen engines, as well as other engines, to often fail compliance tests. They have not demonstrated reliable compliance with even existing BACT limits.

Comment: The amount of recoverable waste heat from the FCE fuel cell is less than used in AQMD cost effectiveness calculations.

Response: The calculations have been revised.

Comment: According to a November 2003 report, the installed cost of the FCE fuel cell is higher than the amounts in the AQMD cost effectiveness analysis.

Response: The manufacturer reports that costs are dropping with time.

Comment: There is a market for DG less than 250 kW that the FCE 250-kw fuel cell is too large for. Tecogen's primary product is a 75 kW I.C. engine DG unit.

Response: The purchase of cleaner grid power is a cost-effective option in lieu of small DG projects.

Comment: The proposal is not technology-neutral because microturbines and fuel cells would be exempt from the proposal.

Response: BACT requirements only apply to equipment requiring AQMD permits.

Comment: Equipment that does not require an AQMD permit, such as fuel cells, should not be the basis for BACT.

Response: AQMD already requires as BACT for cold cleaning equipment the use of equipment that is exempt from AQMD permit.

Comment: The proposed DG BACT requirements are inconsistent with CARB guidelines (Guidance for the Permitting of Electrical Generation Technologies, CARB, 2001) which said they are not achievable, but will be reviewed by CARB staff in 2005.

Response: Those guidelines are simply that, guidelines. It is still the responsibility of the local air districts to determine what BACT is.

Comment: The KHI gas turbine's electrical efficiency drops significantly with higher ambient temperature, making a higher efficiency I.C. engine a better choice.

Response: Gas turbines can utilize inlet air evaporative cooling to increase load and efficiency in hot weather.

APPENDIX C

COST EFFECTIVENESS CALCULATIONS