# IV. BASIS FOR PROPOSED DETERMINATION FOR SPARK-IGNITED IC ENGINES

A summary of the proposed determination can be found in Chapter II. The full text of the proposed determination can be found in Appendix A. This chapter will review the basis or reasons for the emissions limits, requirements, and exemptions included in the determination. In developing this determination, the ARB and air districts staff reviewed a number of reports on IC engines, emissions inventory data, vendor literature, source test data, district rules and accompanying staff reports, and other sources of information.

## A. Applicability

This proposed determination is applicable to stationary engines that have or have had a continuous power rating equal to or greater than 50 brake horsepower. This wording was chosen to avoid circumvention of the rule through derating of the engine's power. The 50 horsepower applicability limit is based on cost-effectiveness considerations. Cost-effectiveness is not significantly different for an engine that is just over 50 horsepower in comparison to that same engine if derated to just under 50 horsepower. In several cases, districts have a substantial number of engines just over 50 horsepower. If derating is allowed, many of the emission reductions these districts expected from an IC engine rule may not be realized.

In some cases, an engine's power rating may be suspect or unknown. To assure that engines exceeding 50 brake horsepower are not exempt, spark-ignited engines with a maximum hourly fuel consumption rate above 0.52 million Btu per hour are also subject to controls. This fuel consumption level corresponds to engines rated at approximately 50 brake horsepower using a default BSFC rating of 10,400 Btu per brake horsepower-hour. For different BSFC ratings, the maximum fuel consumption ratings should be adjusted accordingly.

## B. Alternative Form of Limits

For engines in the high fuel consumption category, the proposed determination provides a choice of two NOx alternatives: operators must meet either a percent reduction or an emissions concentration limit in parts per million by volume (ppmv). Use of the percentage reduction option is limited to engines using add-on control devices that treat the exhaust gas stream. The reason for the alternatives is that exhaust controls typically reduce NOx by a certain percentage, regardless of the initial NOx concentration. Thus, for engines inherently high in NOx, the emission concentration limit may be difficult to achieve when using exhaust controls. Providing an emission limit and percent reduction option allows engine owners or operators a greater degree of flexibility in choosing appropriate controls.

Determining compliance when such exhaust controls are used is relatively straightforward, as NOx concentrations can be measured before and after the control device. In contrast, for controls based on engine changes or fuel changes, it is generally extremely difficult to determine an accurate percentage reduction. A baseline concentration must be established, and this baseline will be a function of numerous engine operating parameters such as air/fuel ratio, ignition timing, and power output. It would be difficult to verify that all of these engine parameters are representative of normal engine operation. In addition, other parameters will affect emissions, such as air density, temperature, humidity, and condition of the engine. Not all of these factors can be quantified, and it would be impossible to accurately match or correct for these parameters in subsequent source tests used to determine the percentage reduction in emissions.

Except for the optional percentage reduction for NOx, the proposed determination uses limits expressed in parts per million by volume (ppmv). These limits could have been expressed in units of grams per brake horsepower-hour. However, use of limits in terms of grams per brake horsepower-hour would require engines to be simultaneously tested for emissions and horsepower. This would increase costs for compliance verification, and for that reason limits expressed in terms of grams per brake horsepower-hour are not recommended.

## C. RACT NOx Limits

It is generally understood that RACT is the application of demonstrated technology to reduce emissions. "Demonstrated" means a particular limit has been achieved and proven feasible in practice. This demonstration need not take place in California. The demonstration also need not be performed on every make and model of IC engine, as long as there is a reasonable likelihood that the technology will be successful on these other makes and models. In addition to the control options discussed below, other options for meeting RACT are discussed in Section F of this chapter. These options include repowering with either a new controlled engine or an electric motor.

### 1. Low Fuel Consumption Engines

Different NOx emissions limits are applicable to spark-ignited engines having low fuel consumption and high fuel consumption. For spark-ignited engines, the fuel consumption cutoff of 180 million Btu per year equates to a 50 brake horsepower engine operating between 300 and 400 hours per year. The low fuel consumption limits apply to both rich-burn and lean-burn engines whose annual fuel consumption is less than the 180 million Btu cutoff. This is approximately equivalent to 170,000 standard cubic feet of natural gas or 1,400 gallons of gasoline.

The proposed RACT emission limits for spark-ignited engines having low annual fuel consumption are based on data from the Santa Barbara County APCD and other sources concerning the effect of leaning the air/fuel ratio on engines using natural gas or treated field gas. In the case of Santa Barbara, engines were able to meet a NOx limit of 50 ppmv by leaning the mixture. Other information indicates that engines burning natural gas or field gas can be leaned to reduce NOx emissions below 300 ppmv.

We acknowledge that it may not be cost-effective for some low fuel consumption engines to meet the recommended NOx limit of 350 ppmv. Because of the range of makes and models of engines and applications, we recommend that such engines be identified by districts during the rule adoption process. At that time, limits that differ from those in this proposed determination can be proposed.

2. Rich-Burn Engines

The proposed RACT emission limits for spark-ignited rich-burn engines having high annual fuel consumption are based on Ventura County APCD's Rule 74.9 that was in effect between September 1989 and December 1993 (this rule was superseded by a more effective version of Rule 74.9 in December 1993). The 1989-1993 version of this rule required all affected engines to meet applicable limits by 1990. For natural gas-fired rich-burn engines, this NOx limit is 50 parts per million by volume (ppmv), corrected to 15 percent oxygen and dry conditions. Alternatively, rich-burn engines can meet a 90 percent NOx reduction requirement.

The Ventura County rule allowed the emission limits to be increased for engines exhibiting efficiencies greater than 30 percent. However, there are few cases where such efficiency adjustments would increase the allowable emissions significantly. For example, natural gas-fired engines rarely exceed the mid-30s in percentage efficiency, and most of these engines probably are less than 30 percent efficient. In addition, districts that include an efficiency adjustment in their IC engine rules have rarely found a need to use this adjustment to meet rule requirements. This proposed determination does not include an efficiency adjustment. Such an adjustment increases the complexity of the determination, and would complicate enforcement. In many cases, it is difficult to determine the efficiency of an engine. The manufacturer's rated efficiency could be used, but in some cases this information may not be available. Even if this information is available, the efficiency of an engine in the field may differ significantly from the manufacturer's rating due to differences in air density, temperature, humidity, condition of the engine, and power output. The proposed RACT emissions limits can be met without an efficiency adjustment if controls are properly designed, maintained, and operated.

Appendix D summarizes recent source tests from Ventura County for the years 1994 through 1997. Results of source tests for 1986 through 1997 on rich-burn engines are compared to the Ventura IC engine rule applicable at the time (i.e., 50 ppmv NOx or 90 percent reduction). Included in this database were a dozen tests on engines to determine baseline values or emission reduction credits. These engines were not controlled and were not required to meet the rule's emissions limits. Excluding tests conducted to determine baseline values or emission reduction credits leaves over 1000 tests on rich-burn engines. Only about 8 percent of these tests exceeded the applicable NOx limit. In the majority of cases, engines that violated the limit passed other source tests before and after the violation. No particular engine make or model appeared to have a significant problem in attaining the applicable NOx limit. These source tests covered almost sixty different models of engines made by eight different manufacturers.

From the mid-1980s to the mid-1990s, approximately 280 of 360 stationary engines were removed from service in Ventura County. Many of these engines were first retrofitted with controls and were in compliance when they were removed. Though Ventura County's IC engine rule may have contributed to the reduction in the number of stationary IC engines, other areas of the State that did not have a rule controlling NOx emissions from existing stationary engines also experienced significant reductions in stationary engines during the same time period. Most of these engines were used in oil and gas production activities. This reduction in numbers may reflect an overall general reduction in oil and gas production in the State. It may also reflect the impact of new source review. New source review is a collection of emissions and mitigation requirements that must be met before a new or existing stationary source of emissions can be built or modified in the State. New source review may have encouraged the use of electric motors rather than IC engines for new or modified production activities. In addition, new source review may have encouraged the shutdown or replacement of existing IC engines to generate emissions offsets for new or modified production activities.

Based on these data, it appears that the proposed RACT emission levels for rich-burn engines having high annual fuel consumption are achievable for a wide variety of gaseous-fueled engines.

It is expected that the most common control method to be used to meet the proposed RACT limits for rich-burn engines having high annual fuel consumption will be the retrofit of NSCR controls. For rich-burn engines using waste-derived fuels, where fuel contaminants may poison the catalyst, the most common control method is expected to be the use of prestratified charge controls.

Cyclically operated (cyclic) engines have characteristics that may affect the effectiveness of controls. These characteristics include low exhaust gas temperatures (since the engines spend significant periods of time at idle) and rapid fluctuations in power output. Cyclic rich-burn engines have met the high fuel consumption RACT limits either by using NSCR or by leaning the air/fuel mixture in conjunction with treating the field gas to reduce the moisture and sulfur content. Both of these control methods have been used successfully on cyclic engines used on “grasshopper” oil well pumps in Santa Barbara County. Source tests of NSCR-equipped cyclic engines in Santa Barbara County have shown that these engines can be effectively controlled with or without air/fuel controllers provided the oil well pumps are air-balanced units. In the case of beam- and crank-balanced rod pumps, the air/fuel ratio controllers that are part of the control system have slow response times relative to the load fluctuations, making NSCR ineffective due to the low exhaust temperatures. For the beam- and crank-balanced oil well engines, the air/fuel ratio must be leaned to meet the NOx limits. Table IV-1 summarizes the results of source tests on cyclically operated engines in Santa Barbara County. These tests were conducted from 1992 through 1995. All engines at Site A used NSCR on engines driving air-balanced oil pumps to control NOx emissions. All engines at other sites used leaning of the air/fuel mixture to control NOx. In addition, it is important to note that the field gas used at the sites referenced in Table IV-1 was treated to pipeline-quality natural gas. These engines represent two different manufacturers and six different models. In Santa Barbara County, there are another eight of these rich-burn engines fueled by treated field gas which drive beam-balanced and air-balanced rod pumps. NSCR is installed on all of these engines with five meeting a limit of 50 ppmv NOx and three meeting 25 ppmv.

**Table IV-1**
**Summary of NOx Source Testing of Cyclically Operated Engines**
**Santa Barbara County**

| | | | | | Emissions in ppmv | | |
|---|---|---|---|---|---|---|---|
| **Site** | **Engines** | **Tests** | **Engine Size** | **Operating Capacity** | **$NO_X$** | **CO** | **VOC** |
| A | 18 | 5 | 195 hp | 50-75% | 2-14 | 79-2445 | 2-35 |
| B | 4 | 9 | 131 hp | 20-40% | 12-35 | 165-327 | 29-552[1] |
| C | 16 | 16 | 39-46 hp | 43-112% | 8-28 | 129-291 | 25-98 |
| D | 18 | 28 | 39-49 hp[2] | 30-75% | 7-33 | 154-406 | 31-196 |

1. One engine exceeded the 250 ppmv VOC limit. After repairs, this engine was retested 6 weeks later and was found to be in compliance.
2. Two engines were derated.

Because of the demonstrated success of meeting the NOx limits for cyclic rich-burn engines fueled by treated field gas, we recommend that the districts consider the cost effectiveness of field gas treatment and emission controls in setting limits for these engines. In situations where this approach exceeds the cost effectiveness threshold of $12 per pound, we would recommend that districts set a limit of 300 ppm NOx as in the San Joaquin Valley Unified APCD. In performing the cost effectiveness analysis for treating the field gas and the emission control, the additional costs for field gas treatment should be included along with the incremental materials and labor cost associated with piping the treated gaseous fuel back to the engines from the gas processing unit. Naturally, any costs, benefits, or profits realized from selling the gas should also be included in the analysis.

### 3. Lean-Burn Engines

The basis for the proposed RACT emission limits for high fuel consumption spark-ignited lean-burn engines is the same as for high fuel consumption rich-burn engines: Ventura County APCD’s Rule 74.9 that was in effect between September 1989 and December 1993. For natural gas-fired lean-burn engines, this NOx limit is 125 ppmv, corrected to 15 percent oxygen and dry conditions. Alternatively, lean-burn engines can meet an 80 percent NOx reduction requirement.

Appendix D summarizes a large number of source tests from Ventura County from the years 1994 through 1997. Results of source tests from 1986 through 1997 on lean-burn engines were compared to the limits of Ventura County's IC engine rule applicable at the time (i.e., 125 ppm NOx or 80 percent reduction). Excluding tests conducted to determine baseline values or emission reduction credits, there were 358 tests on lean-burn engines. Only 21 (approximately 6 percent) of these tests exceeded the applicable NOx limit. In most cases, engines that violated the limit passed several other source tests before and after the violation. No particular engine make or model appeared to have a significant problem in attaining the applicable NOx limit.

These source tests covered nineteen different models of engines made by nine different manufacturers.

Based on these data, we conclude that the proposed RACT emission levels for high fuel consumption lean-burn engines are achievable for a wide variety of gaseous-fueled engines.

We expect the most popular control method used to meet the proposed RACT limits for high fuel consumption lean-burn engines will be the retrofit of “clean” burn engine modifications. These modifications will probably include the retrofit of precombustion chamber heads. In cases where these modifications have not been developed for a particular make and model of engine, SCR may be used as an alternative.

D. BARCT NOx Limits

A summary of the proposed BARCT determination can be found in Chapter II. The full text of the proposed BARCT determination can be found in Appendix A.

The Health and Safety Code Section 40406 defines BARCT as "an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source." Control technology must be available by the compliance deadline that has achieved or can achieve the BARCT limits, but these limits do not necessarily need to have been demonstrated on IC engines. A technology can meet the definition of BARCT if it has been demonstrated on the exhaust gases of a similar source, such as a gas turbine, and there is a strong likelihood that the same technology will also work on exhaust gases from IC engines and that systems designed for IC engines are available from control equipment vendors. In addition to the technologies cited below, there are additional candidates described in Appendix B which potentially could be considered to be BARCT. Finally, it is important to note that South Coast AQMD requires owner/operators of stationary engines to comply with Rule 1110.2 by offering them the choice of reducing the engines emissions to specified limits, removing the engine from service, or replacing the engine with an electric motor. Electrification is another approach to consider and is discussed along with other control options in Section F of this chapter.

1. Low Fuel Consumption Engines

The proposed BARCT emission limits for low annual fuel consumption spark-ignited engines are the same as the RACT limits for this category of engine, and the basis is also the same.

2. Rich-Burn Engines

The proposed BARCT emission limits for high fuel consumption rich-burn engines are based on the current version (adopted December 1993) of Ventura County APCD's Rule 74.9, the Federal Implementation Plan for the Sacramento area, and the Sacramento Metropolitan Air Quality Management District's Rule 412. These NOx limits are 25 ppmv or 96 percent reduction for most rich-burn engines, and 50 ppmv or 90 percent reduction for rich-burn engines using waste gases as fuel. Best available control technology (BACT) determinations of the South Coast AQMD and ARB's BACT Clearinghouse meet or exceed the proposed BARCT limits.

The Ventura County source test data referenced earlier (page IV-2) indicates that about 65 percent of the tests (i.e., 623 out of 962 tests) on rich-burn engines operating on natural gas or oil field gas met the proposed BARCT NOx limit of 25 ppmv or 96 percent NOx reduction. These engines used either NSCR type catalysts or prestratified charge controls. Engines using prestratified charge controls met the limit less often (21 percent, or 32 out of 153 tests) than engines using catalysts (73 percent, or 591 out of 809 tests). The controls for these rich-burn engines were designed to meet a 50 ppmv or 90 percent reduction limit, not a 25 ppmv or 96 percent NOx reduction limit as proposed in the proposed BARCT determination. Better NOx emission reduction performance can be anticipated if controls are designed to meet a 25 (rather than 50) ppmv limit.

A separate BARCT NOx limit is proposed for rich-burn engines fueled by waste gases (e.g., sewage digester gas, landfill gas). This limit, 50 ppmv or 90 percent reduction, is the same as the proposed RACT limit for rich-burn engines. Source tests of rich-burn engines using waste gases indicate only 28 percent (9 of 32 tests) demonstrated compliance with a NOx limit of 25 ppmv. However, all of these tests demonstrated compliance with a 50 ppmv limit. The waste gas engines that were tested used prestratified charge controls because the application of NSCR to waste gas fueled engines has often been unsuccessful. NSCR catalysts often have problems with plugging and deactivation from impurities in waste gases.

It is expected that the most popular control method used to meet the proposed BARCT limits for high fuel consumption rich-burn engines using fuels other than waste gases will be NSCR with air/fuel ratio controllers. For engines using waste gases, the use of prestratified charge controls are expected to be the most popular control method.

For cyclic rich burn engines, the discussion and recommendations for RACT NOx limits apply for BARCT NOx limits as well. A review of 34 source tests on 26 cyclic rich burn engines fueled by treated field gas and driving air-balanced oil well pumps in Santa Barbara County APCD demonstrated that all engines were able to meet the 25 ppm NOx limit by using NSCR. In the case of the “leaned-out”engines fueled by treated field gas and driving beam-balanced and crank-balanced oil wells, the source tests indicate that 81 percent of the source tests met the limit. In setting limits for cyclic rich-burn engines fueled by field gas, we recommend that air districts consider the cost effectiveness of treating the field gas to reduce the moisture and sulfur content and maximize the effectiveness of the emissions controls. Another approach to controlling the emissions from these engines is electrification. As mentioned previously, South Coast AQMD in Rule 1110.2 requires owner/operators of stationary engines to reduce the emissions to meet limits, remove the engines from service, or replace the engines with electric motors. Even in remote areas without access to the power grid, South Coast AQMD requires owner/operators of oil pumps to treat the field gas which fuels a rich-burn genset with NSCR after-treatment. The genset supplies power to motors driving the beam-balanced and crank-balanced oil pumps.

For high fuel consumption engines, NSCR can be used to meet the 25 ppmv NOx limit by increasing the size of the catalyst bed along with the amount of active materials in the catalysts, and more precise air/fuel ratio controllers. In addition, closer tolerances, more frequent inspections, an increase in catalyst replacement frequency, and monitoring of a greater number of parameters under the facility's inspection and monitoring plan could be required to maintain the higher performance required to meet the proposed BARCT limits. The inspection and monitoring plan is discussed in Section I, Inspection and Monitoring Program.

3. Lean-Burn Engines

The proposed BARCT emission limits for high fuel consumption spark-ignited lean-burn engines are based on the current version (adopted December 1993) of Ventura County APCD's Rule 74.9, the Federal Implementation Plan for the Sacramento area, and the Sacramento Metropolitan Air Quality Management District's Rule 412.

We propose a 65 ppmv or 90 percent reduction level as the BARCT NOx limit. This proposed level is identical to the level in the proposed Federal Implementation Plan for the Sacramento area, and is also identical to the level found in Sacramento Metropolitan AQMD's Rule 412. This level is less effective than the current Ventura County APCD's Rule 74.9 NOx limit of 45 ppmv or 94 percent control. However, the Ventura County APCD's limit includes an efficiency correction that can allow a NOx ppmv limit higher than 45. Our proposed determination does not include an efficiency correction. In addition, only 40 percent of the Ventura County APCD's source tests (143 of 358 tests) showed compliance with a 45 ppmv or 94 percent control NOx limit. On the other hand, the Ventura County APCD's source test data show that approximately 70 percent of the source tests (249 of 358) for lean-burn engines met a NOx limit of 65 ppmv or 90 percent reduction. It is interesting to note that at the time of these source tests these engines were required to meet a less effective limit of 125 ppmv or 80 percent reduction under a previous version of Rule 74.9. The NOx reduction performance for engines using controls designed to meet the proposed BARCT limit is expected to be better than that indicated by the Ventura County source test data.

It is expected that the most common control method used to meet the proposed BARCT emission limit for high annual fuel consumption spark-ignited lean burn engines will be the retrofit of "clean" burn engine modifications (e.g., precombustion chamber heads). Other techniques may also be used to supplement these retrofits, such as ignition system modifications and engine derating. For engines that do not have "clean" burn modification kits available, SCR may be used as an alternative to achieve the BARCT emission limits.

E. Common Limits

Both the proposed RACT and BARCT determinations include identical limits for CO and VOC. The basis for these common emissions limits is discussed below. Other elements that are identical include alternatives to controlling engines and exemptions which are addressed in Sections F and G.

1. CO Limits

The proposed determination’s limit for CO is 4,500 ppmv. This 4,500 ppmv limit is based on the highest CO limit in any district IC engine rule in California. Most districts have a 2,000 ppmv CO limit. The 4,500 ppmv CO limit in the proposed determination was chosen since the main concern for emissions from IC engines has been on NOx, and some controls for NOx tend to increase CO emissions. The 4,500 ppmv CO limit should allow the proposed determination's NOx limits to be met more easily and economically. In most cases, the proposed determination’s NOx limits will be met either by the use of three-way catalysts or a leaner air/fuel mixture. Either of these techniques should readily achieve a CO level of 4,500 ppmv.

In general, vehicles have been found to be the major source of CO in areas that are nonattainment for CO, and stationary sources do not contribute significantly to the nonattainment status. However, areas that are nonattainment for CO should assess the impact of stationary engines on CO violations, and should consider adopting a lower CO limit than 4,500 ppmv.

2. VOC Limits

VOC limits are included in the proposed determination because VOC emissions, like NOx emissions, are precursors to the formation of ozone and particulate matter. VOCs are hydrocarbon compounds that exist in the ambient air and are termed “volatile” because they vaporize readily at ambient temperature and pressure. In addition, many VOCs are considered to be toxic and are classified as Toxic Air Contaminants (TAC) or Hazardous Air Pollutants (HAP). For stationary engines, the mass and impact of VOC emissions is lower than NOx emissions. However, several NOx controls tend to increase VOC emissions. The proposed determination's VOC limits are designed to assure that VOC increases from NOx controls do not become excessive.

In addition, the proposed determination's VOC limits help assure that engines are properly maintained. If an engine is misfiring or has other operational problems, VOC emissions can be excessive.

The proposed determination’s limit for VOC is 250 ppmv for rich-burn engines and 750 ppmv for lean-burn engines. The 250 ppmv limit for rich-burn engines is readily achievable through the use of three-way catalysts or other NOx control methods involving leaning of the air/fuel mixture. A higher limit is proposed for lean-burn engines, as VOC concentrations tend to increase when such engines are operated at the extremely lean levels needed to achieve the determination's NOx limits. These VOC limits are equal to the highest limits included in any district IC engine rule in California.

In cases where a district requires further VOC reductions to achieve the ambient air quality standards, the adoption of VOC limits more effective than those in the proposed determination should be considered. More effective VOC limits on lean-burn engines can be achieved through the use of oxidation catalysts without impacting NOx reduction performance.

Oxidation catalysts reduce VOC and CO emissions from lean-burn engines. See Appendix B for more information on oxidation catalysts.

F. Other Control Options

In addition to combustion modifications, exhaust controls, and use of alternative fuels, other control options can be used to meet the proposed RACT and BARCT limits.

All proposed RACT and BARCT limits can also be met by replacement of the IC engine with an electric motor or a new controlled engine. Although engine replacement does not qualify as "retrofit," the California Clean Air Act provides that districts can take this approach under "every feasible measure" if districts are having difficulty attaining the State ambient air quality standard. In the case of an engine repower, the new controlled engine would use combustion modifications, exhaust controls, or an alternative fuel similar to an existing retrofitted engine. However, since the engine is new, greater design flexibility is usually available to engineer a more efficient engine and effective control package.

For some engines, another option for meeting the proposed RACT and BARCT limits is to convert a rich-burn engine into a lean-burn engine, or a lean-burn engine into a rich-burn engine. In the case of engines converted to lean-burn, improved engine efficiencies may reduce overall costs compared to controlling the rich-burn engine. In the case of engines converted to rich-burn, the rich-burn controls may be much lower in cost than the lean-burn controls.

It is the intent of this proposed determination to maximize emission reductions. Consequently, owner/operators of rich-burn engines are not allowed to convert these engines to a lean-burn configuration in order to be subject to the less effective NOx emission limits. For rich-burn to lean-burn conversions or vice versa, the more stringent rich-burn NOx limits apply. For instance, in the case of a rich-burn engine converting to a lean-burn unit, the rich-burn limits would apply since emission reductions would be maximized. Likewise, the rich-burn NOx limits would apply for a lean-burn to rich-burn conversion. It should be noted that districts may consider these types of conversions to be modifications, which may fall under New Source Review and trigger best available control technology and offset requirements. We would recommend consultation with the appropriate district prior to undertaking one of these conversions.

In addition, market-based programs allowing the buying and selling of emission reduction credits are another approach that can be used to comply with BARCT requirements. Pursuant to Health and Safety Code, Section 40920.6.(c), a source subject to BARCT may retire marketable emission reduction credits in lieu of a BARCT requirement. Health and Safety Code, Section 40920.6.(d) allows alternative means of producing equivalent emission reductions at an equal or less dollar amount per ton reduced, including the use of emission reduction credits, for any stationary source that has demonstrated compliance costs exceeding an established cost-effectiveness value per unit of pollutant reduced for any adopted rule.

In the South Coast Air Quality Management District (SCAQMD), sources of NOx and SOx that emit greater than 4 tons per year are regulated through a separate market trading program, the Regional Clean Air Incentives Market or RECLAIM. RECLAIM allows these sources to achieve equivalent or greater emission reductions as would have been required otherwise under BARCT. Excess reductions from one RECLAIM facility can be traded to other RECLAIM facilities or permanently retired for an air quality benefit. Stationary internal combustion engines that are regulated under RECLAIM are exempt from the District's NOx/SOx limits. However, these sources must still comply with the limits for other regulated pollutants covered under district rules. Therefore, stationary engines regulated under RECLAIM for NOx and SOx would still need to comply with the CO and VOC limits specified in Rule 1110.2.

## G. Exemptions

### 1. Engines Used During Disasters or Emergencies

Engines are exempt from the proposed determination when used during a disaster or state of emergency, provided that they are being used to preserve or protect property, human life, or public health. Such disasters or states of emergency can be officially declared by local, State, or Federal officials or by an individual if it is determined that property, human life, or public health could be adversely affected without the operation of the applicable engine. Reasons for including this exemption are obvious. If controls fail on an engine used during a disaster, without this exemption the operator is faced with fines for noncompliance if operations continue, or the loss of property, human life, or public health if the engine is shut down. Another situation where this exemption would apply would be the operation of an engine where the emission controls result in a degradation in the power output or performance. It would be considered acceptable to shutdown or disengage the emission controls if that action increases the engine power output and thereby would either prevents or decrease the possibility of the loss of property, human life, or public health which would otherwise occur with the derated engine. Exempting engines under these conditions eliminates the operator dilemma of choosing between the protection of air quality and the more immediate concerns of protecting human life, public health, and property.

### 2. Permit Exemption- Engines Used in Agricultural Operations

Engines are exempt from permitting if they are used directly and exclusively by the owner or operator for agricultural operations necessary for the growing of crops or raising of fowl or animals. Health and Safety Code Section 42310(e) prohibits districts from requiring permits for agricultural engines. However, this Health and Safety Code prohibition does not preclude districts from controlling the emissions from agricultural engines in some other manner. Refer to the legal opinion in Appendix F.

### 3. Portable Engines

A portable engine is defined as one which is designed and capable of being carried or moved from one location to another. An engine is not considered portable if the engine is attached to a foundation or will reside at the same location for more than 12 consecutive months. This proposed determination exempts portable engines whether they are registered under the Statewide Portable Equipment Registration Program or with a district. The statewide program is authorized under Health and Safety Code Sections 41750 through 41755 which require the ARB to develop a registration program and emissions limits for portable engines (see Chapter VII). Owners or operators of portable engines who decide to take part in this voluntary registration and control program are exempt from meeting the requirements of district rules and regulations.

4. Nonroad or Offroad Engines

To avoid potential conflicts with federal law, the proposed determination exempts nonroad engines. Under the federal Clean Air Act Amendments of 1990, districts are prohibited from adopting emission standards or control technology requirements for all nonroad engines. However, for some categories of nonroad engines, control can be delegated to the ARB. See Chapter VII for further details. It should be noted that nonroad engines used in stationary applications are not exempt from this determination. In addition, engines used in nonroad applications are not considered "nonroad" if the engine remains at a location for more than 12 consecutive months or a shorter period of time for an engine located at a seasonal source.

5. Engines Operated No More Than 100 Hours Per Year

Engines that are not used for distributed generation of electrical power are exempt if they operate 100 hours or fewer per year. Distributed generation refers to the practice where an IC engine is operated to produce electrical power, and this power is either fed into the electric utility grid or displaces utility electric power purchased by an industrial or commercial facility. An example of the latter situation is called "peak shaving" where an IC engine genset is operated during periods of high electrical rates, and the electrical power produced by a genset is cheaper than the power from the grid. Distributed generation also refers to the operation of an IC engine that is part of a mechanical drive system (e.g., water pump, conveyor belt) consisting of at least one IC engine and one electric motor, where the system can be powered either by the electric motor(s) or the IC engine(s).

IC engines used for distributed generation are not exempt, regardless of the number of hours of operation per year. The reason for this restriction is to assure that exempt engines will not operate simultaneously on some of the highest ozone days of the year (see the following discussion on the emergency standby engine exemption).

6. Emergency Standby Engines

The exemption for emergency standby engines is limited to engines operating no more than 100 hours per year, excluding emergencies or unscheduled power outages. Emergency standby engines are typically operated for less than an hour each week to verify readiness. Additional operation may be periodically required for maintenance operations. A limit of 100 hours per year allows a reasonable number of hours for readiness testing and about 50 hours per year for maintenance and repairs.

The definition of emergency standby engine excludes engines that operate for any other purpose than emergencies, unscheduled power outages, periodic maintenance, periodic readiness testing, readiness testing during and after repairs, and scheduled power outages for maintenance and repairs on the primary power system. The purpose of these limitations is to assure that these engines do not operate during nonemergencies to displace or supplement utility grid power for economic reasons such as distributed generation, “peak shaving,” or as part of an interruptible power contract or voluntary load reduction program with an electric power utility.

The current electric utility restructuring that is occurring in California changes the pricing of electricity and the incentives applicable to commercial and industrial facilities. Under restructuring, commercial and industrial customers are able to purchase electricity on the spot market. Spot prices are relatively low during the night, but much higher when the demand for power is at a peak. This peak is typically on hot summer days, when some of the highest ozone concentrations of the year are recorded.

Under restructuring, commercial and industrial facilities have the potential to generate and sell power from their emergency generator engines, and send this power to the electrical grid. Restructuring also allows such facilities to bid a reduction in their electrical demand, and operate emergency generator engines to supplement their grid power purchases. Thus, if the price of electricity is high enough there is an economic incentive for a facility to operate its own emergency generators, and either feed this power into the electrical grid or reduce the facility's demand for power.

Because all facilities within a district simultaneously experience these high electrical prices, the potential is significant for the simultaneous operation of a large number of engine generators, even if such usage is limited to only a few hours per year. If a large number of facilities in a district operate their emergency generators simultaneously, the increase in NOx emissions within the district could be substantial. These increases would occur on the hottest days of the year, which are typically the highest ozone days of the year. Thus, unless the nonemergency operation of emergency generators is restricted, the potential to impact peak ozone concentrations could be significant.

To minimize this impact on air quality, the proposed determination prohibits the nonemergency operation of emergency engines to generate electrical or mechanical power so as to reduce a facility’s electrical power consumption from the grid or to realize an economic benefit. Examples of the latter would include operation under an interruptible power contract or voluntary load reduction program, or for purposes of “peak shaving.” In addition, emergency engines cannot be used to supply electrical power to the grid or for distributed generation.

7. Other Exemptions

Other exemptions may be justified under certain circumstances, but the inclusion of any additional exemption in a district rule should be fully justified. Before an exemption is added, the district should also investigate whether alternative, less effective controls should be required for a class of engines instead of totally exempting such engines from all control or testing requirements. Factors that should be considered include the need to adopt a RACT or BARCT level of control to meet air quality plan or Health and Safety Code requirements, and cost-effectiveness for a particular engine category.

H. Compliance Dates

In this proposed determination, low fuel consumption engines subject to RACT limits are required to comply with the emissions limits within a year of rule adoption. These engines should be able to meet these limits with relatively minor adjustments or retrofits. For engines required to retrofit more extensive controls or replacement with a different IC engine, an application for a permit to construct must be submitted and deemed complete by the district within one year of rule adoption. Final compliance is required within two years of rule adoption. This time period should be sufficient to evaluate control options, place purchase orders, install equipment, and perform compliance verification testing.

An additional year for final compliance is provided for existing engines that will be permanently removed without being replaced by another IC engine. In many cases, such an operation may be nearing the end of its useful life, and it would not be cost-effective to retrofit the engine with controls for only a year of operation. In addition, over the course of several years, the cumulative emissions from the engine to be removed will be less than if this engine were controlled. Although emissions are higher in the first year, lower emissions occur in all subsequent years.

A district adopting a BARCT level of control should consider modifying the compliance schedule for engines that already meet RACT to provide additional time in certain cases to reduce the financial burden on the engine owner or operator. For example, engines complying with a RACT level of control through the use of a catalyst could be subject to an alternative compliance schedule requiring the BARCT level of control when the catalyst is next replaced or 3 years, whichever time period is shorter.

I. Inspection and Monitoring Program

It is the engine owner or operator's responsibility to demonstrate that an engine is operated in continuous compliance with all applicable requirements. Each engine subject to control is required to have an emission control plan describing how the engine will comply. To reduce the paperwork for engine owners or operators, districts can accept an application to construct as meeting the control plan requirements, as long as the application contains the necessary information.

As part of the emission control plan, an inspection and monitoring plan is required. The inspection and monitoring plan describes procedures and actions taken periodically to verify compliance with the rule between required source tests. These procedures and actions should include the monitoring of automatic combustion controls or operational parameters to verify that values are within levels demonstrated by source testing to be associated with compliance.

Examples of parameters that can be monitored in an inspection and monitoring program include exhaust gas concentration, air/fuel ratio (air/fuel ratio control signal voltage for catalyst systems), flow rate of the reducing liquid or gas added to the exhaust, exhaust temperature, inlet manifold temperature, and inlet manifold pressure. For engines that are not required to use continuous monitoring equipment, it is recommended that the inspection and monitoring plan require periodic measurement of exhaust gas concentrations by a portable NOx monitor so that engines can be maintained to produce low emissions on a continuous basis. Where feasible, the portable NOx monitor should be used on a monthly basis. The Air Pollution Control Officer shall specify what data is to be collected and the records to be kept as part of the inspection and monitoring plan. Records of the data shall be retained for two years.

These requirements and recommendations are based on Ventura County APCD's Rule Effectiveness Study. One of the conclusions of the study was that most non-compliant engines can come into compliance easily and quickly with minor adjustments. It also appears that compliance can be significantly improved if more frequent inspections are performed. During the time period when the study was conducted, the District's rule required quarterly inspections with portable analyzers and an annual source test. To improve rule effectiveness, the rule was revised to change the frequency of inspections with portable analyzers from quarterly to monthly, while the announced source test frequency was decreased from once a year to once every two years.

In addition, this study also found that engine operators often did not adjust engines to optimal settings except for announced source tests and quarterly inspections. We recommend that, during an initial source test, optimal settings are determined for engine operating parameters affecting emissions. The inspection and monitoring program should require that these optimal settings be frequently checked and maintained. In this fashion, emissions reductions should be maximized.

J. Continuous Monitoring

Continuous monitoring of NOx and $O_2$ are required for each stationary engine with a brake horsepower rating equal to or greater than 1,000 that is permitted to operate more than 2,000 hours per year. This engine size and operating capacity is found in the SCAQMD's IC engine rule, and was determined to be cost-effective. Continuous emissions monitoring systems (CEMS) may be used to fulfill this requirement. Each district's APCO may consider alternatives, if adequate verification of the systems accuracy and performance is provided. One example of an alternative would be a parametric emissions monitoring system (PEMS) which monitors selected engine parameters and uses the values in calculating emissions concentrations of different pollutants. Continuous monitoring data must be recorded and maintained for at least two years.

In the case of engines covered by Title V permits, the continuous monitoring data should be retained for five years. Refer to the appropriate district's Title V rule(s) to determine if there are any additional monitoring requirements under Title V.

## K. Source Testing

Source testing of each engine subject to controls would be required after 8,760 hours of engine operation or every 24 months, whichever is the lesser time period. The proposed determination's testing schedule would result in testing nearly every year for IC engines that are operated almost continuously, and testing once every two years for engines operated less than 50 percent of the time. Alternative test methods which are shown to accurately determine the concentration of NOx, VOC, and CO may be used upon the written approval of the Executive Officer of the California Air Resources Board and the air pollution control officer.

Typically, source testing of many other controlled sources is required every year. However, for IC engines, source testing can be a significant expense, and allowing a longer period between tests would assure that the cost of source testing would not be out of proportion to other operating expenses. Extended source test periods normally are associated with operating out of compliance for longer periods of time and increased emissions. However, the proposed determination requires the development and implementation of a detailed inspection and monitoring program, which should provide verification that emission controls are operating properly and the IC engine is in compliance between source tests.

According to one rule effectiveness study, "Phase III Rule Effectiveness Study, VCAPCD Rule 74.9, Stationary Internal Combustion Engines," October 1, 1994, the frequency of non-compliance was greater for unannounced source tests than for annual or announced source tests (5 of 22 compared to 1 in 11). One of the main reasons for this difference is that, based on interviews with the engine owners or operators, in most cases portable emission analyzers are used to tune engines for better emissions performance immediately before announced source tests are performed. Based on this observation, we recommend that districts conduct unannounced source tests so that engines will be maintained to produce low emissions on a continuous basis.

## L. Records

Records of the hours of operation and type and quantities of fuel consumed each month would also be required for each engine subject to controls or subject to limits on annual hours of operation. Installation of nonresettable fuel meter and nonresettable elapsed operating time meter are required on any spark-ignited IC engine subject to the provisions of the determination. Nonresettable fuel meters installed on stationary spark-ignited internal combustion engines shall be calibrated periodically per the manufacturers recommendation. For emergency standby engines, the hours of operation during unscheduled power outages shall be recorded. These records would be available for inspection at any time, and would be submitted annually to the district.

As previously noted, data is also collected and recorded as part of the inspection and monitoring programs and continuous monitoring where required. All data including engine operating hours, fuel type and consumption shall be maintained for a period of at least two years.

For engines subject to Title V permits, it is recommended that these records be retained for five years and submitted as part of any Title V reporting requirements as necessary. Refer to the appropriate district's Title V rule(s).