PROPOSED RACT/BARCT DETERMINATION FOR STATIONARY SPARK-IGNITED INTERNAL COMBUSTION ENGINES

I. INTRODUCTION

This document presents the proposed determination of reasonably available control technology (RACT) and best available retrofit control technology (BARCT) for controlling nitrogen oxides (NOx), volatile organic compounds (VOCs), and carbon monoxide (CO) from stationary, spark-ignited (SI) reciprocating internal combustion (IC) engines. This report also presents the basis for the proposed determination, an overview of the control technologies for spark-ignited engines, an assessment of the cost and cost-effectiveness, and the expected associated economic and other impacts.

The determination was developed by the Air Resources Board (ARB) staff and a workgroup made up of representatives of the air pollution control and air quality management districts (districts).

A. Background

The districts have responsibility under State statute for control of air pollution from stationary sources. The California Clean Air Act (CCAA) of 1988 requires that the districts develop attainment plans to achieve the state ambient air quality standards by the earliest practicable date. These plans must include measures that require control technologies for reducing emissions from existing sources. RACT/BARCT determinations aid districts in developing regulations to attain and maintain the state ambient air quality standards. The determinations also promote consistency of controls for similar emission sources among districts with the same air quality attainment designations.

While the CCAA does not define RACT, RACT for existing sources is generally considered to be those emission limits that would result from the application of demonstrated technology to reduce emissions. BARCT is defined in the California Health and Safety Code, section 40406, but applicable statewide in this case, 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."

The California Health and Safety Code, section 40918(a)(2), requires nonattainment areas that are classified as moderate for the State ozone standard to include in their attainment plan the use of RACT for all existing stationary sources, and BARCT for existing stationary sources permitted to emit 5 tons or more per day or 250 tons or more per year of nonattainment pollutants or their precursors. This requirement applies to the extent necessary to achieve standards by the earliest practicable date.

The California Health and Safety Code, section 40919(a)(3), requires nonattainment areas that are classified as serious for the State ozone standard to include in their attainment plan the use of BARCT on all permitted stationary sources to the extent necessary to achieve standards by the earliest practicable date. Districts classified as being severe nonattainment must take all

measures required of moderate and serious nonattainment areas. In addition, Title 17, Section 70600 of the California Code of Regulations requires districts to adopt BARCT if the districts are within an area of origin of transported air pollutants, as defined in Section 70500(c).

In developing this determination, the ARB and air districts staff reviewed a number of reports on spark-ignited IC engines, emissions inventory data, vendor literature, source test data, district rules and accompanying staff reports, and other sources of information regarding SI engines.

Stationary spark-ignited IC engines are major contributors of NOx, VOC, and CO emissions to the atmosphere. The 1996 point source emissions inventory for stationary SI engines includes about 21,932 tons of NOx per year, 16,479 tons of CO per year, and 23,606 tons of VOC per year from IC engines. Tables I-1, I-2, and I-3 summarize this inventory by district. As can be seen from these tables, spark-ignited IC engines are responsible for a significant percentage of the NOx, VOC, and CO emissions from stationary point sources in California. This significance, however, varies from district to district. The 1996 point source emissions inventory also indicates that there are approximately 5,900 diesel-fueled and spark-ignited engines located at 1,700 facilities statewide. Forty-four percent of these engines are fueled by diesel fuel; 42 percent are fueled by natural gas; and 7 percent are fueled by gasoline.

It should be noted that not all districts in California with significant stationary source IC engine emissions are included in Tables I-1, I-2, and I-3. In some districts, all stationary IC engines emissions may not have been reported in the 1996 emissions inventory. In those cases, these tables underestimate the actual emissions.

In other cases, some classes of spark-ignited IC engines with substantial emissions may be exempt from permit, and their emissions may not be reflected in Tables I-1, I-2, and I-3. For example, engines used in agricultural operations in the San Joaquin Valley Unified Air Pollution Control District (APCD) are exempt from permit and their emissions are not included in these tables. Annual NOx emissions for these agricultural engines (spark-ignited and diesel-fueled) have been estimated at 12,000 tons per year. This emissions estimate is greater than the NOx emissions for all stationary engines in the inventory for San Joaquin Valley APCD. Moreover, this annual NOx estimate is approximately 40 percent of the emissions from the stationary IC engines in the State as reported in the 1996 point source inventory. It appears that agricultural engines can be a significant contributor to emissions. Because of the potential adverse air quality impacts from these engines, the control of emissions from IC engines used in agricultural operations will be addressed. It should also be noted that it is believed that the majority of these engines are diesel-fueled.

Table I-1

NO_x Emissions Comparison
Stationary Spark-Ignited IC Engines and All Stationary Sources
in Tons Per Year

District*	Spark-Ignited IC Engines	All Stationary Sources	Percent of Total
Antelope Valley APCD	0.1	365	0.03
Bay Area AQMD	2,077	36,500	5.7
Butte County AQMD	14	730	1.9
Colusa County APCD	680	1,460	47
Feather River AQMD	361	1,100	33
Glenn County APCD	325	1,100	30
Lake County AQMD	0.06	146	0.04
Mojave Desert AQMD	7,499	31,000	24
Monterey Bay Unified APCD	76	7,300	1.0
Northern Sierra AQMD	0.3	730	0.04
Sacramento Metropolitan AQMD	27	1,825	1.5
San Diego County APCD	238	5,840	4.2
San Joaquin Valley Unified APCD	4,882	65,700	7.4
San Luis Obispo County APCD	92	1,460	6.3
Santa Barbara County APCD	985	2,190	45
South Coast AQMD	4,259	47,450	9.0
Ventura County APCD	176	1,825	9.6
Yolo/Solano AQMD	241	1,100	22
Totals	**21,932**	**218,776**	**10**

Source: ARB 1996 Point Source Inventory

* APCD = Air Pollution Control District
AQMD = Air Quality Management District

Table I-2

CO Emissions Comparison
Stationary Spark-Ignited IC Engines and All Stationary Sources
in Tons Per Year

District*	Spark-Ignited IC Engines	All Stationary Sources	Percent of Total
Amador APCD	NR	1,100	-
Antelope Valley APCD	1.3	365	0.4
Bay Area AQMD	1,932	21,170	9.1
Butte County AQMD	1.0	1,460	0.07
Colusa County APCD	88	365	24
Feather River AQMD	128	730	17
Glenn County APCD	75	1,100	6.8
Great Basin Unified APCD	NR	7.3	-
Imperial County APCD	NR	365	-
Kern County APCD	NR	730	-
Lake County AQMD	0.01	3,285	0
Mojave Desert AQMD	1,094	5,840	19
Monterey Bay Unified APCD	79	10,585	0.7
Northern Sierra AQMD	0.06	4,015	0
Placer County APCD	NR	730	-
Sacramento Metro AQMD	56	730	7.7
San Diego County APCD	526	7,665	7.0
San Joaquin Valley Unified APCD	4,818	22,630	21
San Luis Obispo County APCD	57	365	16
Santa Barbara County APCD	928	1,460	64
South Coast AQMD	5,095	22,630	23
Ventura County APCD	1,553	3,285	47
Yolo-Solano AQMD	48	730	6.6
Totals	**16,479**	**111,342**	**15**

Source: ARB 1996 Point Source Inventory

* APCD = Air Pollution Control District
AQMD = Air Quality Management District

Table I-3

VOC Emissions Comparison
Stationary Spark-Ignited IC Engines and All Stationary Sources
in Tons Per Year

District*	Spark-Ignited IC Engines	All Stationary Sources	Percent of Total
Amador County APCD	NR	365	-
Antelope Valley APCD	1.6	1,100	0.15
Bay Area AQMD	822	43,800	1.9
Butte County AQMD	3	1,100	0.3
Colusa County APCD	275	730	38
Feather River AQMD	148	1,460	10
Glenn County APCD	146	730	20
Imperial County APCD	NR	730	-
Kern County APCD	NR	365	-
Lake County AQMD	0.003	730	0
Mojave Desert AQMD	1,209	2,920	41
Monterey Bay Unified APCD	362	5,475	6.6
Northern Sierra AQMD	0.02	730	0
Placer County APCD	NR	2,555	-
Sacramento Metro AQMD	23	6,570	0.4
San Diego County APCD	666	16,425	4.1
San Joaquin Valley Unified APCD	6,,776	43,800	15
San Luis Obispo County APCD	9.6	2,555	0.4
Santa Barbara County APCD	1,684	2,920	58
South Coast AQMD	11,116	109,500	10
Ventura County APCD	352	3,650	9.6
Yolo-Solano AQMD	13	4,015	0.3
Totals	**23,606**	**252,225**	**9.4**

Source: ARB 1996 Point Source Inventory

* APCD = Air Pollution Control District
AQMD = Air Quality Management District

IC engines generate power by combustion of an air/fuel mixture. In the case of spark-ignited engines, a spark plug ignites the air/fuel mixture while a diesel-fueled IC engine relies on heating of the inducted air during the compression stroke to ignite the injected diesel fuel. A more detailed description of spark-ignited IC engine operation is included in Appendix B. Most stationary IC engines are used to power pumps, compressors, or electrical generators. IC engines are used in the following industries: oil and gas pipelines, oil and gas production, water transport, general industrial (including construction), electrical power generation, and agriculture. The combined NOx emissions from the oil and gas industry, manufacturing facilities, power plants, and landfill and waste water treatment facilities contribute almost 85 percent of the annual NOx emissions from stationary IC engines according to the 1996 point source inventory. According to the inventory, approximately 11 percent of the annual NOx emissions from the engines in these categories are emitted by diesel-fueled stationary IC engines with the remaining 89 percent emitted from stationary spark-ignited IC engines.

Engines used for electrical power generation include base load power generation (generally in remote areas), resource recovery facilities in areas where waste fuels are available (such as landfills and sewage treatment facilities), portable units used as temporary sources of electrical power, and emergency generators used during electrical power outages.

There are a wide variety of spark-ignited IC engine designs, such as:

- Two stroke and four stroke
- Rich-burn and lean-burn
- Supercharged, turbocharged, and naturally aspirated

Spark-ignited engines can use one or more fuels, such as natural gas, oil field gas, digester gas, landfill gas, propane, butane, liquefied petroleum gas (LPG), gasoline, methanol, ethanol, residual oil, and crude oil. IC engines can also exhibit a wide variety of operating modes, such as:

- Emergency operation (e.g., used only during testing, maintenance, and emergencies)
- Seasonal operation
- Continuous operation
- Continuous power output
- Cyclical power output

These differences in use, design, and operating modes must be taken into account when setting standards to control emissions from IC engines.

B. Diesel-fueled Engines

Diesel engines not only have significant NOx emissions but also emit particulate matter (PM) which has been identified as a Toxic Air Contaminant (TAC) by the ARB. Once a substance is identified as a TAC, the ARB is required by law to determine if there is a need for further control. The ARB is developing a Diesel Risk Reduction Plan (RRP) in consultation with

the Advisory Committee on TACs from Diesel-fueled Engines and Vehicles. The Advisory Committee is made up of industry, environmental groups, other government agencies, and members of the public. The Diesel RRP will be released in the fall of the year 2000. Because of the timing of the Diesel RRP and the potential threat to public health from diesel particulate matter, stationary diesel-fueled engines are being addressed separately in a manner which takes into account the potential need to further control diesel PM and NOx simultaneously.

Emissions from diesel-fueled engines have the potential to pose significant cancer risks to the public working or living in close proximity to a diesel engine installation. Pending the findings of the Diesel RRP, it is possible that both NOx and PM emissions will need to be controlled from these engines. Unfortunately, many combustion modification techniques and technologies used to reduce NOx emissions can tend to increase PM emissions and vice versa. In addressing diesel-fueled engines, a balanced approach will be taken so that the maximum benefit to public health will be realized in reducing both pollutants. ARB staff are evaluating technologies that reduce PM emissions from diesel-fueled engines and the results from their evaluation will be considered in controlling emissions from stationary diesel-fueled engines. The effect on NOx emissions from these different technologies will also be evaluated in the document addressing diesel-fueled engines.

C. IC Engines used in Agricultural Operations

Also discussed previously, were the potentially significant emissions from the IC engines used in agricultural operations, particularly in the San Joaquin Valley. Although limited information is available, statewide NOx emissions have been estimated to be about 8,400 tons per year, which is about 28 percent of the emissions from stationary spark-ignited and diesel-fueled IC engines in the 1996 point source inventory. According to Health and Safety Code Section 42310(e), districts are prohibited from requiring permits for agricultural engines which accounts for the incomplete information and data on their engine population, operating hours, and emissions. Consequently, these engines are not regulated, and their emissions are uncontrolled. However, the Health and Safety Code prohibition does not preclude districts from controlling the emissions from agricultural engines in some other manner. Appendix F provides a legal opinion on this issue.

In recent years, there has been a growing concern with the NOx and other emissions from these uncontrolled sources and their contribution to ozone. Because of the magnitude of the potential emissions from these engines, we recommend that districts develop programs to address emissions reductions from the engines used in this industry. It is important to note that the majority of these engines are believed to be diesel-fueled with a smaller portion being natural gas-fueled SI engines.

For the purpose of this proposed determination, stationary spark-ignited engines used in agricultural operations are exempted from permitting. We recommend that the districts develop regulatory or voluntary programs for the purpose of reducing emissions from these engines. An example of a voluntary approach would be the Carl Moyer program which provides incentives for owner/operators of internal combustion engines to repower with low emissions engines or to

replace an existing engine with an electric motor. This type of program has demonstrated the potential to significantly reduce NOx emissions.