VI. IMPACTS

A. Air Quality

NOx is a precursor to ozone, and State and Federal ozone ambient air quality standards are violated throughout many parts of California. In addition, although most NOx is emitted in the form of nitric oxide (NO), on most days NO will rapidly oxidize to form nitrogen dioxide (NO_2). There are State and federal ambient air quality standards for NO_2. NOx is also a precursor to particulate nitrate, which can contribute to violations of PM10 (particulate matter less than 10 micrometers in aerodynamic diameter) and PM2.5 ambient air quality standards. Violations of PM10 standards are even more widespread than ozone violations in California. Reductions in NOx emissions will reduce ozone, nitrogen dioxide, and PM10 and PM2.5 concentrations, and reduce the number of violations of State and Federal ambient air quality standards for these four pollutants.

Table VI-1 lists emission reduction estimates by district for NOx emissions from stationary IC engines. In order to develop NO_x emissions reductions estimates for this determination, we used the 1996 Air Resources Board's point source emissions inventory. We first identified districts that do not currently have IC engine rules and are designated as nonattainment for the State ozone standard. We also identified which districts are required to adopt RACT rules, and which districts are required to adopt BARCT rules.

The Table VI-1 emission reduction estimates were calculated assuming no reduction would come from engines emitting one ton or less of NOx per year. Engines with emissions of one ton or less are often standby emergency generators, which would be exempt from control requirements. In addition, no reductions were assumed for engines that are already controlled.

In order to determine emissions reduction percentages, we identified control technologies likely to be used for compliance with the proposed guidelines. For spark-ignited engines in districts required to adopt RACT emissions limits, leaning of the air-fuel mixture or retrofitting of clean burn engine kits are the control technologies expected to be used. These technologies are expected to achieve NO_x reductions of approximately 80 percent. For waste gas fueled engines, the BARCT limits will be met by using prestratified charge systems or clean burn retrofits. These technologies are expected to achieve NO_x reductions of approximately 80 percent. For engines burning fuels other then waste gas, the BARCT emissions limits are expected to be met using NSCR, clean burn retrofit, or SCR. These technologies are expected to achieve NO_x reductions of at least 90 percent. We looked at the number of engines in each district that were spark-ignited, or used waste gas for fuel and applied these NO_x emissions reduction estimates to each engine to determine NO_x emissions reductions. Since in some respects this inventory may underestimate actual emissions (see Chapter I), the actual emission reductions may be greater than the estimates in Table VI-1. However, to the extent that engines have already been controlled but are reported in the inventory as being uncontrolled, the Table VI-1 estimates may be higher than actual emissions reductions. Total statewide NO_x emissions reductions from districts without rules are 601 tons per year, or about 2.5 percent of NO_x emissions from SI engines.

Table VI-1

Estimated NO_x Emissions Reductions for Stationary Source Spark Ignited (SI) Engines from Districts without IC Engine Rules

Emissions in Tons per Year

District	Ozone Classification	1996 Inventory	SI Engine Emissions Reductions
Butte County AQMD	Moderate	14	6
Feather River AQMD	Moderate	361	289
Glenn County APCD	Moderate	325	248
Monterey Bay Unified APCD	Moderate	76	58
Totals		**776**	**601**

Source: Air Resources Board 1996 Point Source Inventory

Potential emissions reductions for some of the larger districts with IC engine rules are estimated in Table VI-2. Engines in districts that already have IC engine rules may already be controlled. Therefore, it may not be cost effective for these districts to require these lower limits. To the extent that requiring lower emissions limits is not cost effective, or if controlled engines are already emitting at levels below those required by district rules, the emissions reductions in Table VI-2 are overestimated.

Table VI-2

Estimated NO_x Emissions Reductions for Stationary Source Spark Ignited (SI) Engines from Larger Districts with IC Engine Rules[1,2]

Emissions in Tons per Year

District	Ozone Classification	1996 Inventory	SI Emissions Reductions
San Diego	Serious	238	155
San Joaquin Valley	Severe	4,882	2,104
Santa Barbara	Moderate	985	433
South Coast[3,4]	Extreme	4,259	1,375
Totals		**10,364**	**4,067**

Source: Air Resources Board 1996 Point Source Inventory

[1] Includes only point sources.
[2] Assumes engines emit at levels required in district rules.
[3] Assumes 87 percent of SI engines are rich-burn per 1990 SCAQMD IC engine staff report.
[4] Assumes 50 percent of rich-burn SI engines are > 500 hp, 50% are < 500 hp, as different standards apply for each category.

Totaling tables VI-1 and VI-2 gives potential NO_x reductions of approximately 4,700 tons per year, or approximately 20 percent of statewide NO_x emissions from SI engines.

B. Economic Impacts

The economic impacts from meeting the requirements of this proposed determination will be a function of the type of engine and controls used, and the financial health of the engine owner or operator. The costs and cost effectiveness are discussed in detail in Chapter V.

An NSCR catalyst is the control method expected to be used on most rich-burn engines. The total (annualized capital plus operating and maintenance) cost of an NSCR catalyst will range from approximately $9,400 to $19,000 depending on the size of the engine. This annualized cost is based on a ten-year life for the catalyst. The required source testing would add to this total. These costs are detailed in Table V-2. In addition, source testing of an engine's emissions is required periodically, and this will cost about $ 3,000 for a single engine, and less on a unit basis if multiple engines are tested during the same period.

The costs of retrofitting a lean-burn engine to meet the proposed determination's NOx limits will generally be greater than for a rich-burn engine. Retrofit costs can vary significantly, with lower costs associated with the use of an economical clean burn retrofit kit, and higher costs if a turbocharger or other expensive equipment must be replaced or added, or if SCR controls are used.

For larger engines operating a substantial number of hours per year, NOx and oxygen concentrations must be monitored continuously. In addition, for other engines using SCR, a continuous NOx monitor is often included as part of the controls package. The cost of continuous monitoring can be significant. The purchase and installation costs of a stand-alone NOx monitor and data acquisition and reporting system can range from $25,000 to $100,000. As an alternative to monitoring NOx directly, districts may find parametric monitoring to be a reasonable alternative. In parametric monitoring, several engine ambient and operational parameters are monitored, and these parameters are used to calculate NOx emissions. The monitoring of engine parameters can be less expensive than monitoring NOx directly. The capital cost for a parametric system ranges from $25,000 to $40,000. The annual operating and maintenance costs (per engine) are estimated to be $7,500 for a continuous emission monitoring system, and $2,000 for a parametric emission monitoring system.

Table VI-3
Cost Estimates for IC Engine Monitoring

Monitoring Device	Capital Costs	O&M Costs (per engine)
Continuous Emissions Monitoring	$25,000-$100,000	$7,500
Parametric Emissions Monitoring	$25,000-$40,000	$2,000

C. Catalysts

Both NSCR and SCR catalysts contain heavy metals and other toxic substances that may create environmental problems if they are not disposed of properly. In the case of NSCR catalysts, it is usually cost-effective to reclaim and recycle the heavy metals from spent catalysts. For all catalysts, the cost of proper disposal is relatively minor, and catalyst vendors generally will agree to dispose of their own used catalysts at no charge.

In the case of SCR, ammonia or urea is injected into the exhaust gas to reduce NOx, and some of the ammonia is released into the atmosphere unreacted. Ammonia is a toxic compound (but not a TAC) at high concentrations and can also be a precursor to the formation of particulate matter. At lower concentrations, ammonia can cause health effects and can be a nuisance due to odor. Therefore, many districts have adopted rules or specified permit conditions, which limit the ammonia concentration in the exhaust vented to the atmosphere. These limits vary from a few ppmv to about 50 ppmv. Two districts have engine rules which set an ammonia emission limit of 20 ppmv from any emissions control device.

There are also safety concerns associated with accidental spills of ammonia. Not only is ammonia a toxic compound, but it is also a fire hazard at extremely high concentrations. Constructing and operating the ammonia system in conformance with existing safety and fire regulations can mitigate these concerns. Another way to minimize the safety concerns with ammonia is to replace it with urea. Urea, which has been used extensively in Europe, is nontoxic, non-odorous, and nonflammable. It dissolves easily in water and has been used as a fertilizer and an additive in animal feed and cosmetics.

D. Methanol

Methanol is a toxic compound that can cause serious health effects if ingested, breathed, or absorbed through the skin. In addition, combustion of methanol in IC engines can result in elevated formaldehyde exhaust emissions. The ARB has identified formaldehyde as a toxic air contaminant. Careful handling of methanol and conformance to existing health and industrial standards should minimize any safety hazards associated with methanol. Formaldehyde emissions can be minimized by assuring that the IC engine does not operate overly rich, and by the use of an oxidation catalyst. Methanol has been used as a fuel for cars and buses for a number of years with little or no adverse health impacts noted.

E. Energy Impacts

Controls used to meet the NOx limits in this proposed determination are not expected to have a significant impact on energy usage. In many instances, controls may increase fuel consumption by a few percent, but there may be a net fuel savings in other instances. For example, if a NOx limit is met by replacing a rich-burn engine with a new, low NOx lean-burn engine, fuel consumption will decrease by about five to eight percent.

F. PM Impacts

Controls used to meet the NOx limits in this proposed determination may also increase PM emissions. Emissions of particulate matter are generally very low for a properly operating spark-ignited engine. Particulate matter emissions from spark-ignited engines can be minimized by assuring that the air/fuel ratio is not overly rich and the fuel is low in sulfur content. Commercial natural gas, commercial LPG, and California cleaner burning gasoline are all extremely low in sulfur. For fuels high in sulfur such as waste gases, scrubbing the sulfur from the fuel before it is introduced into the engine can minimize emissions of particulate matter.