SACRAMENTO METROPOLITAN
AIR QUALITY MANAGEMENT DISTRICT

COMMENTS BY
12-13-94 AM

STAFF REPORT

January 9, 1995

RULE 412,
CONTROL OF EMISSIONS
FROM
INTERNAL COMBUSTION ENGINES

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BACKGROUND

NO_x RACT Mandates
Under the provisions of the Federal Clean Air Act Amendments (FCAAA) of 1990, the Sacramento Metropolitan Air Quality Management District (District) has been designated a "serious" nonattainment area for failing to meet the federal ozone standard. Ozone occurs when volatile organic compounds and nitrogen oxides react in the atmosphere in the presence of heat and sunlight.

Section 182(f) of the Federal Clean Air Act Amendments of 1990 (FCAAA) requires the District to submit NO_x Reasonably Available Control Technology (RACT) rules for stationary sources by November 1992. Implementation of RACT is required by May 31, 1995. The District did not submit NO_x RACT rules in 1992 because it was in the process of conducting photochemical grid modeling to determine the extent of the NO_x contribution to ozone formation before adopting NO_x regulations. Section 110(k)(4) of the FCAAA provided an alternative which extends the deadline by one year by submitting a "Committal SIP" for the NO_x RACT Rules.

NO_x RACT Sanctions
The committal SIP is a commitment to complete the photochemical modeling and to adopt RACT for identified major stationary sources. The committal SIP was submitted to EPA through ARB on August 31, 1993. The committal SIP was later deemed complete by EPA in November, 1993. This action stopped the sanctions process. In July 1994, as a result of a National Resources Defense Council suit on other Committal SIPs, EPA rejected the Committal SIP. This action restarted the sanctions process. The imposition of sanctions will occur no later than July, 1995, if the District fails to submit complete NO_x RACT rules.

Health Risks
In 1993, Sacramento exceeded the federal, health based, standard for ozone 6 days and the state standard 28 days. Ozone is a strong irritant which attacks the respiratory system, leading to the damage of lung tissue. Prolonged exposure can cause permanent lung damage. Ozone decreases the flow of oxygen in the lungs and increases resistance to air passage in the lung tissue. Ozone damages the individual air sacs in the lungs where the exchange of oxygen and carbon dioxide between the air and blood takes place. Persons suffering from asthma, bronchitis, and other respiratory ailments, as well as cardiovascular disease, are particularly susceptible to the effects of ozone. Other groups which are susceptible include children, the elderly, and persons engaged in heavy exercise.

Other Damage
Ozone causes crop damage estimated to cost at least $330 million dollars per year in California. Additionally, ozone has been linked to the damage of certain materials, including paint and rubber.

Sanctions

The FCAAA directs EPA to impose sanctions on any area that fails to comply with the requirements of the law. The two mandatory sanctions consist of increased emissions offsets (from 1.2 to 2.0:1) for construction of new or modified major stationary sources, and cut-off of federal highway funds. Highway fund sanction prohibits the Secretary of Transportation from approving or awarding transportation projects or grants, except for projects designed to improve a demonstrated safety problem or intended to minimize air pollution.

EPA has the authority to impose sanctions at any time after making a finding that:

1. there has been a failure to submit a required rule; or
2. the required rule submittal is incomplete; or
3. the submitted rule is disapproved because it fails to meet a requirement of the Act.

The finding, however, will not generally result in the immediate imposition of the sanctions. Usually, this starts an 18 month sanctions clock during which time the District has an opportunity to correct the deficiency. If the deficiency is not corrected in this time the offset sanction will automatically be imposed at the end of the 18 months. The highway fund sanction will be automatically imposed 6 months later. The EPA must adopt a rule which satisfies the requirements within two years of finding listed above.

<u>1991 Attainment Plan</u>
The proposed rule is included as a control measure in the District's "Sacramento 1991 Air Quality Attainment Plan", adopted by the District Board of Directors on July 24, 1991.

<u>CA Clean Air Act</u>
Because the District violated the state ozone standard at least four times in the three year period from 1989 through 1991 and the violations were over 13 parts of ozone per hundred million parts of ambient air, the District is designated serious non-attainment for the state ozone standard.

California Health & Safety Code (CHSC) Section 40910 states "...districts shall endeavor to achieve and maintain state ambient air quality standards for ozone...and shall strive to achieve the most efficient methods of air pollution control. However, priority shall be placed upon the expeditious progress toward the goal of healthful air."

The California Clean Air Act requires areas designated as serious non-attainment for ozone to adopt Best Available Retrofit Control Technology (BARCT) for all existing permitted sources (CHSC Section 40919(c)). BARCT means 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 (H&SC Section 40406).

According to the document, **<u>DETERMINATION OF REASONABLY AVAILABLE CONTROL TECHNOLOGY AND BEST AVAILABLE RETROFIT CONTROL TECHNOLOGY FOR INDUSTRIAL, INSTITUTIONAL, AND COMMERCIAL BOILERS, STEAM GENERATORS, AND PROCESS HEATERS</u>**, (RACT/BARCT Guidance) a California Clean Air Act Guidance prepared by the California Air Resources Board (CARB or ARB), BARCT should be the more stringent of:

1. The most effective limits in effect in any regulation anywhere in the world; or
2. The most effective limit determined to be achievable in the near future; or
3. Any combination of control technologies that will result in equivalent emission reductions.

<u>Authority for Stationary Source Rules</u>
The Board of Directors of the Sacramento Metropolitan Air Quality Management District is authorized by Sections 40000, 40001, 40702, 40716, 40961, 41010, and 41013 of the California Health and Safety Code to adopt, amend, and repeal rules that regulate stationary sources of air pollution.

<u>Section 40000</u>: Local and regional authorities have the primary responsibility for controlling air pollution from stationary sources.

Section 40001: Air districts shall adopt rules to achieve and maintain state and federal ambient air quality standards.

Section 40702: An air district shall adopt rules to execute its statutory powers and duties.

Section 40961: Locally, the Sacramento Metropolitan AQMD has the primary responsibility for developing air pollution control strategies.

Section 41010: Locally, requires the Sacramento Metropolitan AQMD to adopt rules and regulations that require best available control technology for new and modified sources, and best available retrofit control technology for existing sources.

Section 40716: An air district may adopt rules to reduce or mitigate emissions from indirect and areawide sources.

Section 41013: The Sacramento Metropolitan AQMD may adopt regulations to limit or mitigate the impact on air quality of indirect and areawide sources.

RULE PURPOSE

The purpose of this rule is to set emission limits for Nitrogen Oxides, Carbon Monoxide and Non-methane hydrocarbons from the combustion of gaseous or liquid fuels in IC engines of greater than 50 horsepower.

SUMMARY OF REQUIREMENTS

- RACT: As specified in Section 182 (b) (2) (C) of the CAA, NO_x RACT must be implemented by May 31, 1995. The following table summarizes RACT requirements to meet that deadline. Because some of the control options available to the owners or operators of engines have an increase in CO or hydrocarbon emissions associated with the control of NO_x, emission limits have been set for both CO and nonmethane hydrocarbons in both the RACT and BARCT standards.

  If an engine cannot meet the RACT standards without retrofitting the engine as defined in the rule, then the owner or operator of the engine may bypass the RACT standards provided they meet the specified increments of progress contained in the rule.

Engine Type	EMISSIONS LIMIT (ppmv @ 15% O_2)		
SPARK IGNITED	NO_x	CO	NMHC
Spark Ignited Rich Burn	50	4000	250
Spark Ignited Lean Burn	125	4000	750
COMPRESSION IGNITED			
Diesel	700	4000	750

- BARCT: Section 40919 (c) of the H&SC requires the District to adopt BARCT standards. The following table summarizes BARCT requirements to be implemented prior to May 31, 1997.

ENGINE OPERATING CONDITIONS			EMISSION LIMITS (ppmv corrected to 15% O_2)		
			NO_x	CO	NMHC
Spark Ignited Rich Burn			25	4,000	250
Spark Ignited Lean Burn			45	4,000	750
Diesel Fueled					
Operating Parameters					
If Engine Size is greater than...	...but less than or equal to...	and the annual hours of operation are greater than or equal to...	... then the emission limits are...		
50 hp	75 hp	1,435 hours	80	4,000	750
75 hp	125 hp	830 hours			
125 hp	155 hp	565 hours			
155 hp	200 hp	460 hours			
If the engine size is greater than 200 hp and the annual hours of operation are greater than 365 hours, then the emission limits are ..					

DISCUSSION

IC engines are used in a variety of applications where there is a requirement for mechanical work which can be derived from the power generated through a shaft. Power is generated through the combustion process in the IC engine. The combustion process for IC engines consists of the compression of a combustible mixture by a piston, igniting the mixture and allowing the high pressures generated to push the piston back through the cylinder. The piston is connected to a crankshaft and as the piston is pushed back through the cylinder the crankshaft is rotated. This rotating shaft is the point for the extraction of available energy in the form of work.

This process may be accomplished in either two strokes or four strokes of the piston. In the four stroke cycle, the power is generated in the following sequence of strokes:

- Intake stroke: During this stroke the combustible mixture of fuel and air is introduced into the cylinder. This is accomplished either through injection or by suction from the downward motion of the piston through the cylinder or a combination of the two.

- Compression stroke: The compression stroke immediately follows the intake stroke. The intake and exhaust valves are both closed trapping the combustible air-fuel mixture between the top of the piston and the walls of the cylinder. The piston compresses the air-fuel mixture while it is moving upward. When the piston reaches Top Dead Center (TDC) the combustible mixture is fully compressed. The reason for compressing the mixture is to give greater force to the expanding gases when combustion takes place on the next stroke.

- Power stroke: When the piston reaches TDC the fully compressed fuel mixture is ignited and combustion takes place. The fuel burns with explosive speed and pressure. The high temperatures associated with the combustion process cause the gaseous charge to expand with tremendous force creating a pressure inside the cylinder six or seven times greater than the original compression pressure. As the piston is forced downward the useful work is extracted through the rotation of an output shaft that is attached to some mechanical device.

- Exhaust stroke: As the piston approaches Bottom Dead Center (BDC) and the energy available to do work has been dissipated the exhaust valve opens. The exhaust valve remains open while the piston moves upward to TDC again forcing the products of combustion and the unburned fuel out to the atmosphere.

In a two stroke engine the intake and compression strokes, and the power and exhaust strokes are combined.

There are three common methods used to charge the air or air-fuel mixture into the cylinders in an IC engine: naturally aspirated, blower-scavenging, and turbocharged or supercharged.

- Naturally Aspirated: A naturally aspirated engine uses the reduced pressure behind the piston during the intake stroke to draw the fresh air into the cylinder through induction. This process is somewhat inefficient as the volume of air drawn into the cylinder by natural aspiration is usually equal to only 50 to 75 percent of the displaced volume.

- Blower - Scavenging: Might be more accurately called high volume low pressure air blower. More often used on two-stroke engines, such systems are usually called blower-scavenged because the high volumetric flow rates achieved are quite effective in purging the cylinder of exhaust gases while the relatively small increase in pressure produced by the blower does not increase the overall engine efficiency.

- Supercharging/ Turbocharging: Supercharging refers to any method used to increase the charge density of the combustion air. A charge compressor is driven by either the engine crankshaft (mechanical supercharging) or by energy recovered from the engine exhaust (turbocharging). The air pressurization allows a higher mass of air to be introduced into a given cylinder. For a constant air-to-fuel ratio, this increase in air mass allows a corresponding increase in fuel so the power output for a given cylinder is increased. If an engine is built to withstand the additional pressures resulting from supercharging, supercharging can be used to increase the engines charging capacity and therefore its power output by two to three times its naturally aspirated value.

There are two ways to ignite the fuel mixture; spark ignition or compression ignition. The ignition method is related to the type of fuel used and the thermodynamic cycle involved.

- Spark ignition: Spark ignited engines operate on fuels such as natural gas, gasoline, digester gas, landfill gas or some combination of those fuels. The fuel is mixed with the air and delivered to the combustion chamber. The fuel is then ignited in the cylinder by a spark (electrical discharge) across a spark plug. All gasoline or natural gas engines are spark ignited.

- Compression Ignition: Compression ignited engines operate on distillate fuel oil (diesel) or a combination of diesel and natural gas. Air is introduced into the cylinder and then compressed. Due to the compression of the air in the cylinder, the temperature of the air is increased to the ignition temperature of diesel. The diesel is then injected into the hot air and spontaneous ignition occurs. Compression ignited engines usually operate at higher compression ratios (the ratio of the volume of the cylinder when the piston is at the bottom of the stroke to the volume when the piston is at the top of the stroke) than Spark ignited engines because fuel is not present during the compression hence, there is no danger of premature auto-ignition. Engine thermal efficiency rises with increasing compression ratio therefore, Compression ignited engines are more efficient than Spark ignited engines.

There are two methods of delivering the fuel to the combustion chamber: fuel injection and carburetion.

- Carburetion: A carburetor combines the fuel with the air upstream of the intake manifold. This air-fuel mixture is then distributed to each cylinder by the intake manifold. Carbureted fuel delivery is only used on Spark ignited engines.

- Fuel Injection: Fuel injection systems inject the fuel either into the intake manifold just upstream of the cylinder or directly into the cylinder itself. Two methods of fuel injection are commonly used; direct or indirect. Direct injection places the fuel directly into the cylinder and the principal combustion chamber. Indirect injection places the fuel into an antechamber where combustion begins in a fuel-rich (oxygen-deficient) atmosphere and then progresses into the cooler excess-air region of the main chamber.

All IC engines can be classified as either rich-burn or lean burn.

- Rich Burn: A rich-burn engine is an engine with an air-to-fuel ratio (A/F) that is less than stoichiometric.

- Lean Burn: A lean-burn engine is an engine with an A/F that is fuel-lean of stoichiometric. Lean-burn means the air-to-fuel ration is greater than stoichiometric.

☛ **ALL COMPRESSION IGNITED ENGINES ARE TREATED AS LEAN-BURN ENGINES.**

To summarize, air and fuel are combined in the cylinder of an IC engine. This mixture is ignited producing energy that is transmitted through a rotating shaft. The energy is converted to work through the attachment of some sort of mechanical device to the rotating shaft.

<u>Emissions Control Options:</u>

The control of oxides of nitrogen from the combustion process is well established within the state as well as nationally and the costs are well defined. NO_x control can range between the relatively inexpensive injection or ignition timing adjustment to the more expensive Non-Selective Catalytic Reduction (NSCR) and Selective Catalytic Reduction.

The following is a discussion of the different types of control options available to affected industry and the related costs. This discussion of control options will be presented in order of ascending cost. In addition, new control options that are being developed will be briefly discussed. Where control techniques are not applicable to a specific type of engine, it will be so noted.

AIR-TO-FUEL RATIO (A/F) ADJUSTMENT AND CONTROL:

- Discussion: If the A/F is adjusted to a richer setting (less air more fuel), there is less O_2 present for the formation of NO_x. Because there is less O_2 present, the combustion temperature is reduced due to incomplete combustion. The reduced combustion temperature inhibits the formation of NO_x and the engine response to load changes is improved.

  If the A/F is adjusted to a leaner setting (less fuel more air), the higher air content increases the heat capacity of the mixture in the combustion chamber which lowers the combustion temperatures and reduces NO_x formation but decreases the engine response to load changes. The increased air needs from the adjustment of the A/F may necessitate the installation of a turbocharger on naturally aspirated engines to provide the necessary air.

- Application: Adjustment of the A/F can be performed on site on all engines. For effective NO_x reduction, an automatic A/F feedback controller should be installed on the engine to ensure that NO_x reductions continue even under changes in operation of the engine.

- Reductions: It is expected that the adjustment of the A/F to fuel rich will achieve a 10% to 40% reduction in the formation of NO_x. However, the incomplete combustion that produces the cooler environment also raises the Carbon Monoxide (CO) and hydrocarbon (HC) emission levels.

Adjustment of the A/F to air rich for a lean burn engine will achieve a 5% to 30% reduction in NO_x emissions with no noticeable change in CO or HC emissions.

TIMING RETARD:

- Discussion: Timing of the ignition or injection affects the operating pressures and temperatures in the combustion chamber. Advancement of the ignition timing for spark ignited engines or injection for compression ignition engines so that ignition occurs in the compression cycle just prior to TDC results in combustion when the combustion chamber volume is at a minimum. This results in maximum performance of the IC engine. This also results in maximum pressures and temperatures in the cylinders. These conditions provide the right environment for maximum NO_x formation. Conversely, retarding the ignition or injection timing causes the ignition of the fuel mixture to occur in the power stroke after TDC when the combustion chamber volume is expanding as the piston is in its downward motion. This retardation of the ignition reduces pressure, temperature and combustion residence time in the cylinder which can reduce the formation of NO_x.

- Application: Adjustment of the ignition or injection timing can be performed on site on all engines. In order to achieve sustained NO_x reductions and satisfactory engine performance, replacement of the ignition or injection system with an electronic control system is generally required.

- Impacts: The shift of the combustion process to the beginning of the power stroke increases exhaust gas temperature which may affect turbocharger speed and damage exhaust valves. In addition to an increase in fuel consumption, retarding the ignition timing adversely affects the power output and engine response to load change. Additionally, retardation of the injection timing results in an increase in both black smoke and cold smoke (white smoke during start-up). Retardation of the injection timing may cause catastrophic failure of the engine due to the piston hitting the exhaust valve at the top of the stroke. These adverse affects occur proportionately with the degree of retard. Therefore, ignition or injection timing retard is usually limited to 4° from the manufacturer's setting.

- Reductions: The available data suggest that the effect of ignition and injection timing retard on NO_x reduction is engine specific and is somewhat dependant on the A/F. The NO_x reductions achievable with this strategy range from essentially 0 to 40% depending on the engine model and the A/F. Without source test data, District permit staff accept a 10% reduction in NO_x emissions associated with a 4° ignition or injection timing retard.

NON-SELECTIVE CATALYTIC REDUCTION (NSCR):

- Discussion: NSCR is specific to rich burn engines only. This is essentially the same catalytic control technique used for automotive applications and is often referred to as a three way catalyst because it simultaneously reduces NO_x, CO, and HC to water, CO_2, and N_2.

- **Application:** NSCR is not readily applicable to landfill or digester gas fueled engines because the fuels may contain catalyst masking or poisoning material that can alter or kill the catalyst. NSCR is best suited for rich burn, natural gas or gasoline fueled, steady load engines.

- **Reductions:** NO_x emission reductions of 90% can be achieved with the use of NSCR on rich burn engines.

SELECTIVE CATALYTIC REDUCTION (SCR):

- **Discussion:** SCR is applicable to all lean burn and all compression ignited engines. SCR is an add-on NO_x control device that is placed in the exhaust stream. The SCR system reduces NO_x through the injection of ammonia (NH_3) into the exhaust gas. The NH_3 reacts with the NO_x in the presence of a catalyst to form water (H_2O) and nitrogen (N_2).

- **Application:** As with NSCR, contaminants in the fuel can mask or poison the catalyst. The masking of the catalyst requires the periodic removal and washing of the catalyst. The poisoning of the catalyst requires the replacement of the catalyst. The use of a zeolite catalyst reduces the risk of masking or poisoning of the catalyst.

- **Reductions:** NO_x reductions of 90% or better with an NH_3 slip of 10 ppmv or less is the standard guarantee catalyst vendors surveyed. NH_3 slip is controlled because of the health effects of ammonia.

LOW EMISSION COMBUSTION

- **Discussion:** Low emission combustion modifications can be made to both rich and lean burn engines. Substantial modification of the combustion chamber is required to ensure ignition and stable combustion of the higher A/F mixture. The increase in the air content serves to raise the heat capacity of the mixture and results in lower combustion temperatures, thus lowering NO_x formation.

- **Application:** The applicability of modifications for low emission combustion is limited only by the availability of conversion kits.

- **Reductions:** NO_x reductions ranging from 70% to 90% for the conversion of a Rich-Burn engine to low emission combustion can be achieved while reductions ranging from 80% to 93% can be achieved for the conversion of Lean-Burn engines to low emission combustion.

NEW TECHNOLOGY

- **Clean Fuels:** The use of clean alternative fuels such as methanol or coal/water slurries are being tested at this time. The limited data available suggest that the use of clean burning fuels reduces NO_x output. For example Methanol produces lower combustion temperatures than either natural gas or diesel thus reducing the formation of NO_x by approximately 40% from the uncontrolled diesel engine. However, an ignition additive is needed to burn methanol in a compression ignition engine. Because of the need for an igniter and the corrosivity of methanol, modification of the fuel delivery system is needed for the conversion from diesel to methanol fuel. At this time, there does not appear to be widespread availability of diesel to methanol conversion kits.

- Adsorption: Under development is a process that adsorbs NO_x out of the exhaust stream. Preliminary test data show a NO_x reduction of 99%. This procedure is expected to be commercially available by mid 1995.

EMISSIONS IMPACT:

- Currently permitted: There are approximately 470 IC Engines currently under the purview of the District. Emissions estimates indicate NO_x emissions from these engines are approximately 175 tons per year. Of the approximately 470 engines currently under District purview, approximately 70% are used for emergency electrical power generation, fire suppression systems or flood water pumping.

- Future: An analysis of the SIC Codes and District permit files to identify the types of industry and businesses that might use IC Engines indicates the target group is quite large. From this analysis, District staff estimates there may be as many as 500 additional engines operating in the District that are not now in the inventory that would be subject to the provisions of the proposed rule. Staff estimates there may be an additional 175 tons per year of NO_x emissions from these additional engines.

COST EFFECTIVENESS ANALYSIS:

- How: Cost effectiveness, in dollars per pound of NO_x removed ($/lb) is found by dividing the total annualized costs by the total annual emission reductions.

  The cost effectiveness of the proposed rule has been analyzed pursuant to California Health and Safety Code Section 40703. Other factors pursuant to Health and Safety Code Section 40922, such as technological feasibility, public acceptability, and enforceability are also discussed. The total emission reduction potential and rate of reduction is addressed under the "SOCIOECONOMIC IMPACTS" section.

  This analysis is consistent with the approach used by the EPA Office of Air Quality and Planning Standards (OAQPS) Control Cost Manual and the Alternative Control Techniques Document for NO_x Emissions from Stationary Reciprocating Internal Combustion Engines published by EPA (ACT for NO_x).

- Capital Costs: Total capital costs are found by summing the direct capital costs and the indirect capital costs. Direct capital costs include the purchased equipment costs and the direct installation costs. Indirect capital costs include;

indirect installation costs such as engineering, construction and field expenses, and performance tests, and; contingencies such as equipment redesign and start-up delays.

- ANNUAL COSTS

Annual costs are found by summing the direct annual operating costs and the indirect annual operating costs. Direct annual operating costs include materials and labor for operation and maintenance, utilities and material replacement and disposal. Indirect annual operating costs include facility and management overhead and capital recovery costs.

- COST EFFECTIVENESS

  - Lean Burn/Diesel:

The following three classes of diesel engines were analyzed for costs. The capital cost estimates were supplied by Peerless Manufacturing Co. and Environmental Emissions Systems, Inc (EESI). Staff derived the annualized costs from the capital costs and assumptions made by both PEERLESS and EESI and the Control Cost Manual and the EPA's ACT for NO_x.

SIZE (hp)	ANNUAL HOURS OF OPERATION	CAPITAL COSTS (1,000's $)		ANNUAL COSTS	COST EFFECTIVENESS ($/lb)
		per engine	range per facility		
125	565	$87	$87 - $4350	$18,500	$11.90
700	156	$118	$118 - $5900	$26,200	$10.50

For diesel engines the preceding information shows the cost effectiveness to install SCR on a wide range of engines is similar to the cost effectiveness of hydrocarbon control measures previously adopted by the Board. Diesel engines greater than 700 hp, operating more than 3 hours per week may utilize SCR and maintain cost effectiveness.

  - Rich Burn

Using the same style of analysis for gasoline engines as above shows that a gasoline fueled engine may utilize NSCR and maintain a cost effectiveness ranging from approximately $0.88 to $2.82 per pound of reduction. The same type of analysis for a natural gas fired engine shows a cost effectiveness for the installation of NSCR to range from approximately $0.44 to $0.64 per pound of reduction. The following tables summarize these findings.

Gasoline Engines

Size (hp)	Annual Hours of Operation	Capital Costs	Annual Costs	Cost Effectiveness ($/lb)
52	1820	$23,436	$7,570	$2.80
112	1820	$23,436	$7,780	$1.34
168	1820	$23,436	$7,970	$0.92
175	1820	$23,436	$8,000	$0.88

Natural Gas

Size (hp)	Annual Fuel Usage (MM BTU)	Capital Costs	Annual Costs	Cost Effectiveness ($/lb)
60	6	$23,436	$8,710	$0.64
80	7.7	$23,436	$8,820	$0.50
350	10	$23,436	$9,925	$0.44

Other factors to consider as required by Section 40922 of the Health and Safety Code are as follows:

- Technological Feasibility:
  As discussed in the Emission Control Options Section beginning on page 5 there is a range of control options for NO_x emissions from IC engines.

- Public Acceptability:
  The adoption of the proposed RACT standards will not be unacceptable to most of the affected sources. Even though the most stringent standards are cost effective for the class of engines to be controlled, the costs are still high.

- Enforceability: Staff finds the proposed rule enforceable as drafted.

SOCIOECONOMIC IMPACTS

A socioeconomic analysis has been done for the proposed rule pursuant to California Health and Safety Code Section 40728.5. The six separate elements as defined in Section 40728.5 are discussed below.

Type of Industry Affected:

— Those numbers do not match the 470 under Emission Impact

There are currently 299 IC Engines under permit within the District. There are an additional 180 IC Engines that are in the process of being permitted. Facilities using IC engines represent a wide range of industries (aerospace, hospitals, chemical production, aggregate processing). Approximately 50%

(241) of the engines permitted or in the process of being permitted are used exclusively for emergency power generation or flood or fire control. District permit conditions prohibit these engines from operating more than 100 hours per year except during actual power disruption or emergency conditions. These engines will be exempt from the emission controls proposed in this rule.

Engines used for aircraft support at McClellan Air Force Base account for approximately 30% (72) of the remaining 240 engines under regulatory consideration. The engines at McClellan AFB amount to approximately 29% of the NO_x emissions from IC Engines under regulatory consideration. The remainder of the engines are used primarily to generate electrical power for a variety of purposes that include but are not limited to water pumping; aggregate conveyors; compressors, welders and other construction equipment; and drilling equipment. The majority of engines proposed to be controlled are diesel fueled.

Impact on Regional Economy:

- RACT — The cost to operators of engines to comply with the proposed RACT standards will average approximately $1,000 per engine to perform any necessary modifications to the timing or air-fuel ratio or both.

  The cost to operators may result in a benefit to local engine service facilities with a corresponding increase in business if the RACT standards are adopted.

- BARCT — Although the proposed BARCT standards are cost effective, the capital costs are still high. Local operators of engines can spend from $23,000 to as much as $125,000 per engine to comply with the standards. This money will be spent to purchase and install any control equipment necessary to achieve the emission standards. The manufacturers of the control equipment are not locally based. However, the staff necessary to install and operate the equipment can be found either in the local community or in-house.

  That portion of the capital costs associated with the installation of control equipment may benefit the local construction economy if local people in the construction field are hired to provide the necessary catalyst housing and support facilities.

Range of Probable Costs Due to the Proposed Rule

The capital costs per facility for this rule could range from approximately $23,000 for a facility with one 50 hp gasoline fueled engine, to $6,250,000 for a facility with 50, 150 hp diesel fueled engines.

Alternatives to the Proposed Rule

- Alternative 1. The Board of Directors (Board) of the Sacramento Metropolitan Air Quality Management District has the option to decide not to adopt the proposed rule. The proposed rule is mandated under Section 182(f) of the CAA. Under this section the District was required to submit NO_x RACT rules for all major stationary sources by November 1992. If the Board exercises this option the EPA will take sanctions against the District. These sanctions will involve the loss of grant money, federal highway funds or an increase in the offset ratio from 1.2:1 to 2:1. Additionally, the EPA will promulgate a FIP for this particular source category.

- Alternative 2. Another alternative to the proposed rule would be to not adopt the proposed BARCT standards. The Board has the option to adopt just the RACT standards. This alternative would fulfill the requirements of the CAA and remove any threat of sanctions by the EPA. However, this alternative would not fulfill the BARCT requirements of the California Clean Air Act. This may result in the California Air Resources Board (CARB or ARB) assuming the powers of the Board and adopting the more stringent standards in the Board's place.

- Alternative 3. Another alternative to the proposed rule would be to adopt more stringent standards. The Board has the option to adopt standards that would require electrification of all new engines and some existing engines depending on size and hours of operation.

Emission Reduction Potential of the proposed rule

- RACT District staff does not expect the proposed RACT standards for diesel fueled engines to achieve any measurable reductions in NO_x emissions.

  However, the proposed RACT standards for rich burn gasoline fueled engines represents an 88% reduction[1] in the uncontrolled NO_x emissions for these types of engines. The reductions achieved through the control of natural gas fueled compressor engines is approximately 94% of the uncontrolled state.[2]

  District staff is not aware of any lean burn gasoline or natural gas fueled engines.

- BARCT The proposed BARCT standards for diesel fueled engines represents a 90% reduction in the uncontrolled state.

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1 Based on AP-42 emission factors for uncontrolled gasoline fueled engines.

2 This reduction estimate is based on the ACT document for IC engines estimated uncontrolled emissions for these types of engines.

The proposed standards for rich burn gasoline and natural gas fueled engines represents a 94% and 97% reduction in the uncontrolled state respectively.

<u>Necessity of Adopting the proposed rule</u>

- Requirement: The District is required under Section 182(f) of the CAA to adopt NO_x RACT rules for all major stationary sources. Major stationary source is defined in Sections 302(j) and 182(c) with NO_x applicability demonstrated in Section 182(f) of the CAA.

FINDINGS

California Health and Safety Code (H&S Code), Division 26, Air Resources, requires local districts to comply with a rule adoption protocol as set forth in Section 40727. This section mandates the District to make six categories of findings before adopting, amending, or repealing a rule. The proposed findings for these six categories are listed in the table below.

FINDING	DEFINITION	REFERENCE
Authority	The District is permitted or required to adopt, amend, or repeal the rule by a provision of law or a state or federal regulation.	• California Health and Safety Code; Section 40702 and Section 41010. • Federal Clean Air Act Section 182(f). • Federal Clean Air Act Section 182(c).
Necessity	The District demonstrates that a need exists for the rule, or for its amendment or repeal.	• The District is designated a serious nonattainment area for ozone. • Serious nonattainment areas for ozone must meet federal standards by 1999. Federal Clean Air Act Section 181(a)(1). • Serious nonattainment areas for ozone are required to adopt NO_x RACT. Federal Clean Air Act Section 182(f).
Clarity	The rule is written or displayed so that its meaning can be easily understood by the persons directly affected by it.	• There is no indication at this time that the persons affected by the rule will not understand its meaning.
Consistency	The rule is in harmony with, and not in conflict with or contradictory to, existing statutes, court decisions, or state or federal regulations.	• The District has found the amendments are consistent with existing state and federal guidelines.
Non-duplication	The rule does not impose the same requirements as an existing state or federal regulation, unless the District finds that the requirements are necessary or proper to execute the powers and duties granted to, and imposed upon the District.	• There does not exist any state or federal rule or regulation that applies to internal combustion engines for sources within the District.
Reference	Any statute, court decision, or other provision of law that the District implements, interprets, or makes specific by adopting, amending, or repealing the rule. An example of this would be the 1988 EPA State Implementation Plan call to revise District rules.	• Federal Clean Air Act Section 182(c) and 182(f)