UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: California Requirements for Large SI Engines and Possible EPA Approaches

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TO: Docket A-98-01

This memorandum describes requirements adopted by the California Air Resources Board (California ARB) that apply to new nonroad spark-ignition engines rated above 19 kilowatts. We expect to propose comparable emission limits for these engines, so this memorandum also serves to present a framework of a program we are considering that would require control of emissions from this category of engines. The affected engines are used to power industrial equipment such as forklifts, generators, pumps, compressors, aerial lifts, sweepers, airport ground-service equipment, and large lawn tractors. Engines used in marine propulsion or any recreational applications are not included in the scope of this memorandum.

I. Purpose and Background

A. Purpose

Ground-level ozone concentrations continue to be a significant problem in many areas. In the past, EPA's main strategy in the effort to reduce exposure to ozone was to reduce volatile organic compounds (VOCs). In recent years, however, it has become clear that NOx controls are also a necessary strategy for reducing ground-level ozone. As a result, EPA has turned its attention to NOx emission controls, in addition to VOC emission controls, as a critical step for improving air quality. EPA has recently finalized a new emission control program for nonroad diesel engines (63

FR 56967, October 23, 1998) and has nearly completed a revised control program that was proposed for small nonroad spark-ignition (SI) engines (63 FR 3950, January 27, 1998).[1] Both of these rules contain new emission limits for the combination of NOx and VOC emissions, with the former rule primarily reducing NOx emissions and the latter primarily reducing VOC emissions.

Nonroad SI engines rated above 19 kW (25 hp) account for approximately 1 and 2 percent of the total nationwide mobile source emissions of VOC and NOx, respectively. While not a dominant piece of the inventory, these engines nevertheless contribute significantly to high ambient ozone concentrations, particularly in areas where there is the greatest concern for high ozone levels. While the California ARB finalized emission limits for these engines, they are not currently regulated by EPA. The design of these engines has not kept pace with development of technologies for reducing emissions that have been developed for counterpart automotive engines. The emission limits anticipated for these engines would result in a substantial reduction in VOC and NOx emissions. The California ARB adopted its emission limits with the expectation that manufacturers would need electronically controlled closed-loop fuel systems with three-way catalytic converters. These control technologies would substantially reduce emissions and greatly enhance engine performance. In fact, we believe that reduced costs associated with improved fuel economy and reliability may be greater than the incremental costs of emission controls, which would result in an overall net savings in total life-cycle costs to the user.

B. Statutory Authority

Section 213(a) of the Clean Air Act (the Act) directs EPA to: (1) conduct a study of emissions from nonroad engines and vehicles; (2) determine whether emissions of carbon monoxide (CO), oxides of nitrogen (NOx), and VOCs from nonroad engines and vehicles are significant contributors to ambient ozone or CO concentrations in more than one area of the U.S. that has failed to attain the National Ambient Air Quality Standards (NAAQS) for ozone or CO; and (3) if nonroad emissions are determined to be significant, regulate those categories or classes of new nonroad engines and vehicles that contribute to such air pollution.

EPA completed the Nonroad Engine and Vehicle Emission Study, required by section 213(a)(1) of the Act, in November 1991. This study is available in Docket A-92-28. EPA published the determination of the significance of emissions from nonroad engines and vehicles on June 17, 1994 (59 FR 31306). At the same time, EPA finalized the first set of regulations for a class or category of new nonroad engines that contribute to air pollution, as required by section 213(a)(3) of the Act. That rule set emission limits for most new land-based nonroad diesel engines rated at or above 37 kW. EPA has subsequently issued final rules for other categories of nonroad engines, including land-based spark-ignition engines rated at or below 19 kW, gasoline-fueled marine engines, and locomotive engines. This memorandum addresses all land-based nonroad spark-ignition engines rated above 19 kW, except those used for recreational purposes (e.g., off-road

[1] Spark-ignition engines, which may also be referred to as otto-cycle engines, typically operate on gasoline or gaseous fuels such as liquefied petroleum gas or natural gas. This contrasts with compression-ignition (or diesel) engines, which typically operate on diesel fuel.

motorcycles, all-terrain vehicles, go-carts, and snowmobiles). This memorandum also includes spark-ignited marine auxiliary engines rated above 19 kW. While not discussed in this memorandum, emission standards for recreational engines will be pursued separately.

II. General Approach for Emission Control Program

We have made an extensive effort to coordinate EPA's anticipated program for spark-ignited engines rated above 19 kW with the requirements adopted by the California ARB. The California ARB approved emission standards and regulations for these engines on October 22, 1998. The discussion in this memorandum follows directly from that rulemaking. In addition to providing an overview of the California ARB program, the following discussion highlights a few areas where EPA may pursue additional rulemaking provisions or may reach a different conclusion than that of the California ARB.

A. Program Scope

The emission control program described in this memorandum covers most new spark-ignition engines rated above 19 kW that are used in nonroad equipment in the United States. This includes spark-ignition engines powered by any fuel, but does not cover engines used in recreational vehicles or propulsion marine engines, as described above. Examples of the types of equipment using these engines include: forklifts, portable generators, large turf care equipment, irrigation pumps, welders, scrubber/sweepers, air compressors, and a wide array of other agricultural, construction, and general industrial equipment.

EPA has generally regulated engine manufacturers that design and produce complete engines. In contrast, SI engines rated above 19 kW are typically sold as unfinished engines to a distributor, fuel system supplier, or an equipment manufacturer. Two, three, or more different companies may build or calibrate the engine before it is sold as a finished product. Because of this arrangement of shared design and assembly responsibility, there is significant uncertainty as to which company should assume responsibility for certification. We have not taken a position on whether one segment of the industry or another should assume certification responsibility.

EPA typically considers the disabling of an emission control system component or element of design of a certified engine to be tampering. This could include adjusting the engine's fuel or exhaust system or changing the engine's performance so it no longer meets the manufacturer's specifications. It may also be tampering to install a part that is not the same in design and function as the part originally installed, or to add a new part not originally certified with the engine—such as converting the engine to an alternative fuel. Any company wishing to make such changes to a certified engine may choose either to recertify the engine to meet EPA's emissions standards or to satisfy the requirements outlined in Memo 1A.[1] Memo 1A states that using an aftermarket part, alteration, or add-on part will not constitute tampering if the manufacturer has a reasonable basis to

[1] "Interim Tampering Enforcement Policy," EPA memorandum from Norman D. Shulter, Office of General Counsel, June 25, 1974.

believe that such alterations will not adversely affect emissions performance. The two principal methods of establishing this reasonable basis for aftermarket fuel conversions are to conduct emission testing or to rely on the written judgment of a government environmental control agency.

Further, the company that agrees to recertify an engine takes on the responsibility to conduct the testing required for certification and to retain the necessary records. The company also assumes the liability for all production-line and in-use testing for that engine family. On the other hand, the company certifying an engine family would be free to make contractual or other arrangements to share that liability with any number of other companies that may be involved in the design or production of the engines. The certifying entity would be considered the manufacturer of record and is therefore referred to simply as "the manufacturer" or "the engine manufacturer." This is not intended to suggest that distributors, fuel system suppliers, equipment manufacturers, or other entities would not be eligible to hold the certificate for these engines.

B. Engine Categories

Engines rated above 19 kW generally fall into two categories, based on total engine displacement. Engine displacement refers to the combustion volume within the engine's cylinders. Engines with total displacement above 1 liter are typically similar to automotive base engines. These engines power forklifts and other nonroad equipment that may be operated at varying loads for long periods. In contrast, engines with total engine displacement under 1 liter have no automotive counterpart and are similar, in both design and application, to engines rated below 19 kW.

The October 1998 California ARB program includes the following provisions for engines at or below 1 liter displacement. First, the California ARB set a mandatory useful life of 1000 hours for these engines. Second, the exchange of emission credits between engines rated above and below 25 hp is not allowed. Also, the California ARB included requirements for production-line testing for engines rated above 25 hp. We expect to propose the same set of requirements for these engines. We are, however, concerned that emissions from these engines can increase significantly in service. We therefore intend to gather information regarding the emissions durability of these engine and may pursue a requirement for manufacturers to test them after a period of service in the field.

Engines above 1 liter displacement are more numerous and, more importantly, are more capable of utilizing advanced emission control technologies. The rest of this memorandum describes the emission limits and other provisions under consideration for these larger engines, referred to simply as "Large SI engines."

C. Emission Limits

While the design of these engines has changed little over the last several years, similar base engines used in automotive applications have seen steadily improved control of emissions through the application of new technologies. In spite of the differences in engine operation for industrial applications, we believe that manufacturers can cost-effectively adapt at least the basic elements of current automotive engine technology to the similar engines used in nonroad applications.

Manufacturers can upgrade engines from an open-loop fuel system to one with electronically controlled closed-loop operation. Closed-loop control allows manufacturers to add a three-way catalyst for controlling NOx, HC, and CO emissions. Gasoline-fueled engines can utilize established fuel injection technology, while LPG- and natural gas-fueled engines can likely achieve a comparable level of emission control with closed-loop carburetor-type fuel systems or new gaseous fuel injection systems. Injection systems for gaseous-fueled engines are becoming available, but have not proven themselves to the same degree as injection systems for gasoline-fueled engines.

Upgrading to modern engine technologies greatly improves the capability of these engines to control emissions and will generally improve engine performance. Electronically controlled closed-loop operation also provides the potential for great improvement in engine operation. For example, improving control of combustion may allow a fuel economy improvement of 15 to 20 percent.[2,3] Also, feedback control of air-fuel ratios eliminates much of the need to maintain and adjust a large number of fuel system calibrations, resulting in reduced product inventories and, more importantly, less downtime and maintenance for equipment in the field. Finally, improved control of the upgraded engines should lead to significantly longer engine lifetime. The net present value of these benefits would likely be considerably greater than the incremental cost of improving the engines.

1. Test Cycle

The duty cycle and other test parameters may substantially affect emission levels. It is therefore important to address issues related to the test procedure before any discussion of numerical emission limits. The California ARB specifies that manufacturers conduct emission testing for Large SI engines with the ISO C2 duty cycle. The ISO C2 duty cycle consists of seven steady-state operating modes, including one at idle, four at intermediate speed, and one at rated speed. ISO recently revised the C2 duty cycle to better reflect the operating characteristics of a wide range of variable-speed industrial engines. Given the information available at this time, we believe that this cycle adequately represents the operation of variable-speed engines and is an appropriate test cycle for demonstrating compliance with emission limits. This duty cycle captures most of the relatively lightly loaded engine operation that is characteristic of industrial spark-ignition engines, in contrast to compression-ignition test cycles, which should focus on more heavily loaded engine operation. Manufacturers test constant-speed engines with the ISO D2 duty cycle, which operates engines over a range of operating loads at rated speed. Engines in the field are designed and manufactured to operate only at this engine speed. EPA intends to propose the same test cycles as those specified by California.

While these duty cycles capture typical operating modes for engines in the field, EPA is concerned that these steady-state tests will be inadequate to ensure the desired degree of control

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[2]"EFI Takes a Big Step Down," Diesel Progress, November 1996, p. 22.

[3] "Exhaust Controls Available to Reduce Emissions from Nonroad Heavy-Duty Engines," Clean Air Technology News, Winter 1997.

under the full range of operating conditions these engines commonly experience. The selected steady-state test modes characterize typical operating points for these engines, but engine operation away from these few discrete points is missing from emission tests. In addition, the emission test does not provide any assurance that emissions will be controlled during transient operation in the field. EPA has begun to develop provisions in other programs (e.g., highway diesel engines, locomotives, and CI marine) to ensure that emissions during such "off-cycle" operation are not unreasonably high. We anticipate much further effort in this area in the future.

Emission controls for SI engines typically operate much differently under cold-start conditions. We will therefore be looking for comment on the need for cold-start testing provisions and on the relative need for controlling cold-start emissions from engines operating on the various fuels. Absent a specific test requirement, this might be something that could be addressed under off-cycle provisions.

2. Emission Limits and Related Requirements

With the data currently available, the California ARB concluded that a 3 g/hp-hr (4 g/kW-hr) NOx + NMHC emission limit was appropriate for the targeted control technologies, though a somewhat relaxed level applies for during the first three years of in-use testing (2004 through 2006). This represents about a 75 percent reduction in combined NOx + NMHC emissions. Since manufacturers can likely achieve a comparable level of emission control for gasoline, LPG, and natural gas, a single set of numerical emission limits applies equally for all applicable fuels. The California ARB rulemaking includes a provision for reviewing the level of the full-life emission limit in 2002, with a commitment to make adjustments as appropriate given any new information. We plan to propose emission limits based on the same control technologies as those considered by California ARB. We intend to pursue a test program, jointly with the industry and California ARB if possible, to determine the emission level from engines equipped with three-way catalyst systems that have been operated for about 5,000 hours, which is the useful life adopted by California ARB for these engines. We will also attempt to find any existing information related to the long-term performance of the projected technologies. The result of this effort is intended to be a well-documented basis for the most appropriate emission limit for full-life control of these engines.

Three-way catalyst systems are effective at controlling CO emissions. While control of exhaust CO is helpful in reducing the exposure of the general population to atmospheric CO concentrations, the more pressing need for CO control relates to individual exposure, especially for individuals operating power equipment in indoor or confined space environments. Exposure to CO emission in these environments is regulated by the Occupational Safety and Health Administration and is not only a function of engine-out emissions, but also of building design, ventilation rates, and other factors. The California ARB set an emission level of 37 g/hp-hr (50 g/kW-hr) for Large SI engines in an attempt to set CO emission limits that correspond with the degree of control anticipated from closed-loop three-way catalyst system technology that manufacturers will likely use to meet new HC + NOx emission limits. We expect also to propose CO emission limits based on the capability of the projected control technologies, as described above.

The California ARB did not adopt smoke or particulate matter limits to these engines and we are not intending to propose any such emission limits. As long as spark-ignition engines operate near stoichiometry, very low levels of particulate matter and smoke formation are inherent to the combustion process.

We expect to propose the California ARB requirement for closed crankcases on these engines and are interested in learning of any implications of adopting this technology.

The California ARB did not adopt evaporative emission limits for Large SI engines or the associated equipment. Due to the penetration of propane into the market for these engines, evaporative emissions from this sector are likely to be small relative to exhaust emissions. One industry source has reported, however, that fuel boiling has been observed in gasoline fuel tanks. Fuel boiling leads to a dramatic increase in hydrocarbon emissions and introduces obvious safety issues. We will therefore need to further investigate the prevalence of evaporative emission excursions.

3. Lead Time

The California ARB is phasing in its certification requirements starting in 2001 and requires full compliance starting in the 2004 model year for all engines not preempted from state regulation (i.e., excluding farm and construction equipment). We contemplate proposing to implement new emission limits by model year 2004. Except for some of these preempted models, equipment manufacturers would need to complete the redesign of all equipment models by the 2004 model year. Also, because engine manufacturers typically supply a single engine model into both preempted and nonpreempted applications, there will likely be considerable use of low-emitting engines even in preempted equipment applications. We therefore believe it will not be necessary to phase in new requirements over multiple model years or to design flexibility options to accommodate the design needs of equipment manufacturers.

4. Useful Life and Deterioration Factors

The California ARB set the useful life period at 5,000 hours to represent the approximate median lifetime for these engines, with emission limits applying to engines over their full useful life. We expect to propose the same useful life figure adopted by California ARB.

Manufacturers applying for California ARB certification need to develop deterioration factors to demonstrate the effect of aging on emission control performance. We expect to propose deterioration factor requirements typical of other EPA and California ARB control programs. Specifically, the manufacturer would use good engineering judgment to determine a best estimate of an engine's emission levels projected out to the full useful life. This projected emission level would have to be below the numerical emission limit to qualify for certification. We also intend to mimic California ARB's requirement that test data gathered from the in-use testing program would eventually be factored into this demonstration of emission deterioration.

5. Fuel Specifications

There are currently three types of fuels used in Large SI engines—gasoline, LPG, and natural gas. To ensure that engines comply with emission limits and achieve the anticipated emission reductions in use, the Clean Air Act directs EPA to specify certification fuels that are representative of the fuels available to engines in the field. We anticipate that for gasoline-fueled engines, the test fuel specifications would mirror those in other EPA regulations, such as the small nonroad SI engine rulemaking (63 FR 3950, January 27, 1998). In-use fuel requirements in California specify that the gasoline used for nonroad engines must be the same as that for highway vehicles (California reformulated gasoline). This may result in emission rates from Large SI engines that are higher in states outside of California. Consequently, in the interest of harmonization with California ARB's emission standards, EPA might allow for an alternative certification fuel, provided there is a corresponding adjustment in either the stringency of the emission limit or the certification test results to reflect the effect of the different fuel properties.

There is considerable variation in the quality of LPG and natural gas in the field, with a corresponding variation in the emissions from these engines. This makes selection of meaningful certification fuel specifications difficult. On the other hand, closed loop fueling technology has the potential to eliminate most of the sensitivity to varying fuel composition by making internal adjustments to ensure consistent control of air-fuel ratios. We will need to investigate the range of in-use fuel quality for LPG and natural gas to be able to specify fuel properties appropriate for certification fuel and the effect of different fuels on emission levels from closed-loop fuel systems.

6. Voluntary Emission Limits

The California ARB considered, but did not finalize, voluntary standards in its recent rulemaking. EPA is interested in adopting voluntary emission limits involving very low-emitting engine technologies, similar to those finalized for nonroad diesel engines, known as Blue Sky Series engines. The Blue Sky Series program for nonroad diesel engines sets out voluntary emission limits, which manufacturers can meet using novel technologies or alternative fuels. Incentives to produce Blue Sky Series engines would be left to the discretion of states or other organizations. The intended goal of adopting voluntary emission limits is two-fold: to increase the potential for emission reductions and to encourage the development and initial introduction of new technologies. For Large SI engines, we are considering setting two possible criteria for qualifying as Blue Sky Series engines. First, we are considering a voluntary emission limit for NOx + NMHC emissions that would be substantially more challenging than the emission limit established for all engines. As an alternative, we will consider allowing the Blue Sky designation for any engines from light-duty highway vehicles certified to meet emission limits, provided that manufacturers sell those engines into the nonroad market with the same configuration as for highway applications.

7. Engine Diagnostics

The California ARB did not include engine diagnostic requirements in its final rule. Emission controls from an engine with a three-way catalyst system are, however, very dependent on maintaining a consistent air-fuel ratio and a functioning catalyst. Engine malfunctions that result in

rich air-fuel ratios may not be apparent to the operator, but can result in much higher emissions. The lack of control resulting from these malfunctions can significantly degrade engine performance over time and potentially shorten the engine's operating life. We are therefore interested in pursuing a requirement for including basic diagnostic capability for Large SI engines.

Such diagnostics would not need to approach the complexity of systems required for automotive applications, but should include, at a minimum, continuous detection for air-fuel ratio, misfire, and catalyst functioning. An indicator light or other visible or audible cue should be sufficient notification to the operator that a malfunction has occurred. These basic diagnostic functions could be very effective at identifying maintenance needs that affect emissions, while adding very little to the cost of the engine. Such a diagnostic system would have the added benefit of protecting manufacturers from unexpected high emission levels from engines selected for in-use testing.

D. Certification and Compliance Requirements

1. Certification

We intend to put into place certification, engine family selection, recordkeeping and reporting, and engine labeling requirements similar to provisions from other nonroad rules. To minimize the burden of certifying engines, these requirements will incorporate the recent developments resulting from the effort to streamline the certification process for other engine programs and with California ARB. Manufacturers may submit applications in a fully electronic format or with paper forms. Manufacturers may also carry over emission data to subsequent years, a common practice in other programs, which would ease the financial burden of certifying engines.

As with California ARB, emission testing will be a fundamental step in certifying a family of engines. Existing definitions for engine families would allow manufacturers to combine engine models or calibrations with differing power ratings or even different fuels under a single certification application. To ensure that the range of different engines in an engine family complies with the emission limits at certification, EPA would require manufacturers to determine the worst-case engine configuration and test this configuration for each engine family.

2. Emissions Warranty

EPA and California ARB typically require that certified engines carry an emissions warranty for replacement of engine components related to controlling emissions. California ARB set a warranty period for 2004 and later model year Large SI engines of 2,500 hours or 3 years. These figures represent a fraction of the useful life that is consistent with most other EPA programs. The California ARB set a longer warranty period of 3,500 hours or 5 years for components with a replacement value of $400 or greater. Affected engine components include, but are not limited to, fuel injectors or other fuel system components, electronic control module, catalytic converter, and any sensors or other components that may affect the engine's air-fuel ratio. Under the warranty requirements, the manufacturer must provide replacement parts and service at no cost to customers

experiencing defects, provided that the user maintained the engine according to the schedule described in the owner's manual.

To constrain the maintenance requirements engine manufacturers may call for, EPA and California ARB typically also define allowable maintenance intervals. Defining these minimum performance periods prevents a manufacturer from establishing maintenance schedules that set up an unreasonable burden for operators to adequately maintain engines. These allowable maintenance intervals preserve the desired degree of emission control and avoid invalidating warranties unnecessarily. California ARB set allowable maintenance intervals as detailed in Table 1. EPA expects to propose the same figures.

Table 1
California ARB Minimum Allowable Maintenance Intervals

Engine Component	Interval
Fuel injector	4500 hours
Catalytic converter	*
Oxygen sensor	4500 hours
EGR (cleaning)	*

*California ARB considers catalytic converters and EGR systems as critical emission control components; manufacturers may therefore not schedule maintenance requirements for these items.

3. Production-Line Testing

The certification program ensures that engine manufacturers are able to design and build a prototype engine that demonstrates compliance with emission limits. A production-line testing program ensures that the prototype design can be mass-produced and still maintain adequate emission control. EPA has traditionally relied on a Selective Enforcement Audit (SEA) program, in which EPA directs a manufacturer to conduct emission tests on engines at the point of assembly. While Selective Enforcement Auditing has been an effective enforcement tool, it requires EPA scheduling and oversight and may be disruptive to manufacturers.

California ARB adopted a requirement to conduct production-line testing, in which engine manufacturers conduct periodic emission testing on newly assembled engines. Manufacturers need to test at least two engines each quarter. Manufacturers will determine the degree of additional testing required and demonstrate compliance or noncompliance by a statistical program referred to as the cumulative sum method or "Cum Sum." The Cum Sum calculations generally dictate more testing where there is a high degree of variability. We expect to propose the production line testing requirements adopted by California ARB. Under such a requirement for regular production-line testing, EPA would reserve Selective Enforcement Audits only as a backstop enforcement tool for

occurrences of improper testing or reporting from a manufacturer or for cases where EPA believes that the Cum Sum process may be failing to address a particular group of engines.

4. In-use Testing

While the certification and production-line compliance requirements are important to ensure that engines are designed and produced in compliance with established emission limits, there is also a need to ensure that manufacturers build engines with sufficient durability to meet emission limits as they age in service. Consistent with the California ARB rulemaking and EPA's earlier rulemaking for marine SI engines, we expect to require engine manufacturers to conduct emission tests on a small number of field-aged engines to demonstrate compliance with emission limits.

Under an in-use testing program like that adopted by California ARB, EPA would use its discretion to select up to 25 percent of a manufacturer's engine families in a given year to be subject to in-use testing. For manufacturers with three or fewer engine families, EPA would be able to select a single engine family per year for in-use testing. A manufacturer could choose to conduct in-use testing on any number of additional engine families at its discretion. If the results of testing on the additional families indicate that measured emission levels are below emission limits, then the manufacturer could generate in-use emission credits, as discussed below. Results of any in-use testing would be sent to EPA.

We intend to propose the provisions adopted by California ARB specifying that manufacturers select engines that have accumulated a total service time of at least 50 percent of the useful life, but not more than the full useful life. At the point of receiving a directive to conduct in-use testing, the manufacturer would develop and initiate a testing plan. During that period, the manufacturer would establish a fleet of eligible engines with representative field operation and make arrangements to procure and test those engines as needed to complete the test requirements. EPA would expect the manufacturers to make preliminary arrangements at the point of production to cooperate with a company or companies that agree to maintain engines according to the prescribed schedule, including documentation of service history. Once a manufacturer has been notified that a particular engine family has been selected, the final report must be sent to EPA within 24 months.

If EPA directs a manufacturer to conduct in-use testing on an engine family, the appropriate sample size of in-use engines from the engine family is determined to a large extent by the manufacturer. The manufacturer must test at least four engines. The sample size may grow to ten engines, either to cover for engines that have been tested and found to have emissions above emission limits or to increase the value of generated in-use credits. For a given engine family, the manufacturer determines the in-use compliance level by averaging the results from in-use testing performed for all engines in that engine family. If the in-use compliance level is below the applicable emission limit to which the engine family is certified, the manufacturer will generate in-use credits for that engine family. If the in-use compliance level is above the applicable emission limit, the engine family will have a credit deficit.

If mean test results from emission testing of in-use engines exceed applicable emission limits, there are a variety of measures available to address the noncompliance. First, as stated

above, manufacturers can generate credits by testing additional engine families. Manufacturers would calculate credits based on the measured emission levels (as compared to the applicable emission limits) and several additional variables, such as rated power, useful life, and engine family population. A 10 percent discount would apply to any credits manufacturers use to cover a deficit. This is intended to provide an additional incentive to produce uniformly complying engines. The credit calculation also includes a sample-size adjustment factor designed to encourage a greater degree of engine testing and to enhance the statistical certainty of generated credits. The manufacturer must accumulate enough credits (through either averaging, banking, or trading) to offset a noncomplying engine family.

Second, if in-use emission credits are not sufficient to remedy noncompliance, California ARB or EPA may require the manufacturer to recall the engines from that engine family. In this case, the manufacturer would need to develop a technological solution to improve the emission performance of the engines, then offer to repair or retrofit the affected engines at no cost to the customer. Because of concerns about the ability of manufacturers to identify and remedy a significant number of these engines, EPA would prefer to resolve the noncompliance through an alternative to recall.

5. Warranty Reporting and Other Compliance Issues

California ARB did not adopt provisions related to warranty reporting. We are, however, contemplating warranty reporting requirements to provide further assurance that engines in the field are operating according to design. To avoid an excessive administrative burden, EPA is considering a requirement for manufacturers to report warranty claims only when unscreened warranty claims for an engine family exceed a 10 percent level. Once unscreened claims exceed this level, the manufacturer would screen the claims to identify those that show a legitimate defect of an emission-related component. If the warranty claims after screening exceed a significant percentage, then EPA will direct the manufacturer to initiate a recall or will establish an alternative to recall to remedy the problem. We will be investigating and will be looking for comment on the potential effectiveness of warranty reporting leading to a correction of Large SI engine defects in the field.

Also, EPA intends to extend defeat device prohibitions, tampering prohibitions, and importation restrictions described in 40 CFR 86.094-16, 40 CFR 89.1003, and 40 CFR 85 Subpart P to Large SI engines.

E. Importation of Nonconforming Nonroad Engines

We intend to propose certain restrictions on the importation of nonconforming Large SI engines. Such restrictions are based on the existing regulations for the importation of nonconforming motor vehicles and motor vehicle engines. Under this program, the independent commercial importer must certify the engine to applicable U.S. regulations via the certification process before importing an engine. Independent commercial importers would be responsible for assuring that, subsequent to importation, someone properly modifies or tests the nonroad engines to comply with EPA's emission limits and other requirements over their useful lives. The independent commercial importers would also be responsible for recalls, maintenance instructions, emission

warranties, engine emission labeling, and recordkeeping in the same manner as an engine manufacturer.

We intend to propose that any individual may bring in one nonconforming engine for personal use during his or her lifetime. This is a one-time exemption and would be addressed on entry forms available at U.S. ports of entry.

We are likely to include certain exceptions to the restrictions on importing nonconforming nonroad engines. These exceptions are similar to the existing regulations on importing nonconforming motor vehicles and motor vehicle engines and include exemptions for repairs and alterations, testing, precertification, display, national security, nonroad engines greater than 20 original production years old, and certain nonroad engines proven to be identical, in all material respects, to their corresponding United States versions.

F. Small-Volume Provisions

In the process of developing the proposed emission limits for Large SI engines, we should consider appropriate provisions to reduce the compliance burden for small businesses and any companies that sell a very small number of engines in this market segment. Small-volume provisions could include reduced requirements for conducting production-line or in-use testing. For example, EPA typically includes a provision that no more than one percent of a manufacturers production volume be subject to production-line testing. Also, EPA would likely limit routine in-use testing to engine families larger than a specified quantity. We will be examining these and other ideas for addressing the needs of small-volume manufacturers, as well as the definition of what qualifies a company as a small-volume manufacturer.

G. Fuel Conversions

One unique aspect of the Large SI market is the large number of aftermarket fuel conversions. Converting an engine from one fuel to another is currently routine business practice in many cases. EPA's historical concern with conversions is the wide variability in their emission performance and their lack of emissions durability. California ARB included requirements that apply to aftermarket conversions. Any company wishing to convert a certified engine to an alternative fuel may choose to either recertify the engine to meet EPA's emissions standards or satisfy the requirements outlined in Memo 1A (see Section II.A. above).