ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 86, 94, 1048 and 1051

[FRL–6907–6]

Control of Emissions From Nonroad Large Spark Ignition Engines, Recreational Engines (Marine and Land-Based), and Highway Motorcycles

AGENCY: Environmental Protection Agency.

ACTION: Advance notice of proposed rulemaking.

SUMMARY: With this advance notice of proposed rulemaking (ANPRM), we are continuing with our process of establishing standards for nonroad engines and vehicles that cause or contribute to air pollution. The ANPRM addresses nonroad engines and vehicles that have yet to be regulated by EPA, including: Large spark ignition (SI) engines such as those used in forklifts and airport tugs; Recreational vehicles using spark ignition engines such as off-highway motorcycles, all-terrain vehicles, and snowmobiles; and Recreational marine diesel engines and marine spark ignition sterndrive and inboard engines.

These engines and vehicles contribute to ozone, carbon monoxide (CO), and particulate matter (PM) nonattainment. We are also concerned in some cases about personal exposure to high levels on CO, air toxics, and PM to persons operating or close to this equipment. With this ANPRM, we invite early input to the process to establishing standards and programs for these nonroad sources.

We are also seeking comment on whether EPA should pursue rulemaking to establish more stringent emissions standards for highway motorcycles. While standards are in place for highway motorcycles, the current standards were established more than twenty years ago. Since off-highway motorcycles are included this ANPRM as part of nonroad recreational vehicles, we believe it may be appropriate to consider standards for both types of motorcycles together.

DATES: We request comment on this Advance Notice by February 5, 2001.

ADDRESSES: You may send written comments in paper form and/or by e-mail. Send paper copies of written comments (in duplicate if possible) to the contact person listed below. You may also submit comments via e-mail to ''nranprm@epa.gov''. In your correspondence, refer to Docket A–2000–01.

EPA's Air Docket makes materials related to this rulemaking available for review in Dockets A–2000–01 and A–98–01. These materials are located at U.S. Environmental Protection Agency (EPA), Air Docket (6102), Room M–1500, 401 M Street, SW, Washington, DC 20460 (on the ground floor in Waterside Mall) from 8:00 a.m. to 5:30 p.m., Monday through Friday, except on government holidays. You can reach the Air Docket by telephone at (202) 260–7548 and by facsimile at (202) 260–4400. We may charge a reasonable fee for copying docket materials, as provided in 40 CFR part 2.

FOR FURTHER INFORMATION CONTACT: Margaret Borushko, U.S. EPA, National Vehicle and Fuels Emission Laboratory, 2000 Traverwood, Ann Arbor, MI 48105; Telephone: (734) 214–4334, Fax: (734) 214–4050, e-mail: borushko.margaret@epa.gov.

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I. Overview

A. History of Nonroad Engine Regulations

The process of establishing standards for nonroad engines began in 1991 with a study to determine whether emissions of carbon mononxide (CO), oxides of nitrogen (NO_X), and volatile organic compounds (VOCs) from new and existing nonroad engines, equipment, and vehicles are significant contributors to ozone and CO concentrations in more than one area that has failed to attain the national ambient air quality standards for ozone and CO.[1] In 1994, EPA finalized its finding that nonroad engines as a whole ''are significant contributors to ozone or carbon monoxide concentrations'' in more than one ozone or carbon monoxide nonattainment area.[2]

Upon this finding, EPA was tasked by the Clean Air Act (CAA or the Act) to establish standards for all classes or categories of new nonroad engines that

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[1] ''Nonroad Engine and Vehicle Emission Study—Report and Appendices,'' EPA–21A–201, November 1991 (available in Air docket A–91–24). It is also available through the National Technical Information Service, referenced as document PB 92–126960.

[2] 59 FR 31306 (July 17, 1994).

off-highway motorcycles, and all-terrain vehicles (ATVs))

• Marine sterndrive and inboard (SD/I) engines [3]

• Land-based engines rated over 19 kw (Large SI) (for example, engines used in forklifts); this category includes auxiliary marine engines, which are not used for propulsion.

We have found that the nonroad engines included in this ANPRM cause or contribute to air quality nonattainment in more than one ozone or carbon monoxide (CO) nonattainment area.[4] CAA section 213(a)(3) requires EPA to establish standards that achieve the greatest degree of emissions reductions achievable taking cost and other factors into account. We plan to propose emissions standards and related programs consistent with the requirements of the Act and, with this ANPRM, are seeking early input from interested parties.

In addition to the nonroad vehicles and engines noted above, today's ANPRM also reviews EPA requirements for highway motorcycles. The emissions standards for highway motorcycles were established twenty-three years ago. California recently adopted new emissions standards for highway motorcycles and new standards have also been proposed internationally. There may be opportunities to reduce emissions in a way that also allows manufacturers to benefit from harmonized requirements, which may reduce product lines and production costs. In addition, we believe it is important to consider the emissions standards for highway motorcycles in the context of setting standards for off-highway motorcycles. We are interested in providing regulatory programs for off-highway and highway motorcycles that are consistent, and which may also allow for the transfer of technology across product lines for manufacturers.

This ANPRM covers engines and vehicles that vary in design and use, and many readers may only be interested in one or two of the applications. There are various ways we could group the engines and present information. For purposes of this ANPRM, we have chosen to group engines by common applications (*e.g*, recreational land-based engines, marine engines, large spark ignition engines used in commercial applications). We have attempted to organize the document in a way that allows each reader to focus on the applications of particular interest. The Air Quality discussion which follows in section II is general in nature and applies to all the categories covered by the ANPRM. Sections III through VI of the ANPRM present self-contained discussions of standards and programs for each of the vehicle and engine categories. While some of the information may be repetitive among the discussions, we hope that this structure helps the reader focus on the categories and information of interest. The remaining sections VII through X are generally applicable to all of the engines and vehicles.

II. Air Quality

A. Overview

As directed by the Act, EPA has set National Ambient Air Quality Standards for, among other pollutants, ground-level carbon monoxide, ozone, NO_2, and particulate matter.[5] States are divided into discrete areas for air quality planning purposes. Currently, 17 areas around the U.S. are classified as CO nonattainment areas. Additionally, 31 areas are not in attainment with ozone air quality standards.

State and local governmental organizations charged with designing and implementing emission control programs to bring specific areas into attainment with these air quality standards have mounted significant efforts in recent years to reduce CO and ozone concentrations. Their state implementation plans, combined with federal stationary and mobile source emission control programs, have yielded encouraging signs of success. Emissions of the targeted pollutants have been significantly reduced in many areas. Average carbon monoxide and ozone levels, as well as the number of nonattainment areas, are beginning to decrease. We project, however, that emission increases accompanying general growth and economic expansion will eventually outpace per-source emission rate reductions. Increases in the number of sources, as well as increased use of existing sources, mean that even full implementation of current emission control programs may fall short of that needed to achieve long term attainment and maintenance of the air quality standards.

In addition to nonattainment concerns, we are also concerned about hazardous air pollutants (air toxics). In August 2000, we proposed a list of Mobile Source Air Toxics (MSATs) of concern, including those emitted from nonroad engines.[6] These pollutants are known or suspected to have serious health impacts. The engines and vehicles included in this ANPRM are sources of MSATs which are included on the proposed list, including diesel exhaust and several components of VOC emissions.

B. Public Health and Welfare Concerns

The nonroad engines included in this ANPRM and highway motorcycles all contribute to air pollution with a wide range of adverse health and welfare impacts. The following sections contain a brief description of some of the health effects associated with ozone, PM, air toxics and CO and the importance of continuing to reduce the associated emissions. This section also contains a brief description of issues that are unique to the engines and vehicles being considered in this document. The NPRM will contain a more detailed discussion of the health and welfare benefits which can be expected from a program regulating these engines.

1. Ozone and its Precursors

Ground-level ozone, the main ingredient in smog, is formed by complex chemical reactions of volatile organic compounds (VOC) and nitrogen oxides (NO_X) in the presence of heat and sunlight. Ozone forms readily in the lower atmosphere, usually during hot, summer weather. VOCs are a broad group of compounds composed mainly of hydrocarbons (HC). Aldehydes, alcohols, and ethers are also present, but in small amounts. VOCs are emitted from a variety of sources, including motor vehicles, chemical plants, refineries, factories, consumer and commercial products, and other industrial sources. NO_X is emitted largely from motor vehicles, nonroad equipment, power plants, and other sources of combustion.

Ozone is a highly reactive chemical compound which can damage both biological tissues and man-made materials. When inhaled, ozone can cause acute respiratory problems; aggravate asthma; cause significant temporary decreases in lung function of 15 to over 20 percent in some healthy adults; cause inflammation of lung tissue; may increase hospital admissions and emergency room visits; and impair the body's immune system defenses,

[3] As a shorthand notation in this document, we are using ''recreational marine engines'' to mean recreational marine diesel engines and all gasoline SD/I engines, even though some SD/I applications could be commercial.

[4] See Final Finding, ''Control of Emissions from New Nonroad Spark-Ignition Engines Rated above 19 Kilowatts and New Land-Based Recreational Spark-Ignition Engines'' elsewhere in today's Federal Register for EPA's finding for Large SI engines and recreational vehicles. EPA's findings for marine engines are contained in 61 FR 52088 (October 4, 1996) for gasoline engines and 64 FR 73299 (December 29, 1999) for diesel engines.

[5] See 42 U.S.C. 7409.

[6] 65 FR 48058, August 4, 2000.

making people more susceptible to respiratory illnesses. In addition to human health effects, ozone adversely affects crop yield, vegetation and forest growth, and the durability of materials. Because ground-level ozone interferes with the ability of a plant to produce and store food, plants become more susceptible to disease, insect attack, harsh weather and other environmental stresses. Ozone causes noticeable foliar damage in many crops, trees, and ornamental plants (*i.e.,* grass, flowers, shrubs, and trees) and causes reduced growth in plants. Studies indicate that current ambient levels of ozone are responsible for damage to forests and ecosystems (including habitat for native animal species).

Besides their role as an ozone precursor, NO_X emissions produce a wide variety of health and welfare effects.[7,8] Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection (such as influenza). NO_X emissions are an important precursor to acid rain and may affect both land and water ecosystems. Atmospheric deposition of nitrogen leads to excess nutrient enrichment problems (''eutrophication'') in the Chesapeake Bay and several nationally important estuaries along the East and Gulf Coasts. Eutrophication can produce multiple adverse effects on water quality and the aquatic environment, including increased algal blooms, excessive phytoplankton growth, and low or no dissolved oxygen in bottom waters. Eutrophication also reduces sunlight, causing losses in submerged aquatic vegetation critical for healthy estuarine ecosystems.

Need for NO_X and VOC Control. Photochemical modeling highlights the fact that ozone pollution is a regional problem, not simply a local or state problem. Ozone and its precursors are transported long distances by winds and other meteorological events. Thus, achieving ozone attainment for an area, and thereby protecting its citizens from ozone-related health effects, often depends on the ozone and precursor emission levels of upwind areas. For many areas with persistent ozone problems, attainment of the ozone NAAQS will require control strategies for both NO_X and VOC that extend beyond the areas' boundaries.

We expect that reducing NO_X and HC emissions from engines that would be regulated under this potential program would help reduce the health and welfare effects of ozone.[9] Manufacturers and users of snowmobiles provided comments during the ''finding'' rulemaking indicating that snowmobiles should not be regulated for ozone precursors because snowmobiles are used during cold weather, when ozone is less of a health concern.[10] However, ozone precursors are also responsible for other pollution problems including air toxics, discussed below, and indirect PM. We are examining the need to reduce precursors of ozone in the context of this rulemaking and request comment. In particular, we request comment on whether EPA should distinguish snowmobiles from other recreational vehicles in regulating ozone precursors and whether emissions of ozone precursors such as NO_X and VOC should in any case be regulated due to other pollution problems.

2. Particulate Matter

Particulate matter (PM) is the general term used for a mixture of solid particles and liquid droplets found in the air. These particles, which come in a wide range of sizes, originate from many different stationary and mobile sources as well as from natural sources. They may be emitted directly by a source (direct emissions) or formed in the atmosphere by the transformation of gaseous precursor emissions such as sulphur dioxide (SO_2), nitrogen oxides (NO_X), or organic compounds (secondary particles). Their chemical and physical compositions vary depending on source location, time of year and meteorology.

Scientific studies show a link between inhalable PM (alone, or combined with other pollutants in the air) and a series of significant health effects. Inhalable PM includes both fine and coarse particles. Fine particles can be generally defined as those particles with an aerodynamic diameter of 2.5 microns or less (also known as $PM_{2.5}$), and coarse particles are those with an aerodynamic diameter between 2.5 and 10 microns. All particles 10 microns or smaller are called PM_{10}. The health and environmental effects of PM are strongly related to the size of the particles.

Diesel particles are a component of both coarse and fine PM, but fall mostly in the fine range. Both coarse and fine particles can accumulate in the respiratory system and are associated with numerous health effects. Exposure to coarse fraction particles is primarily associated with the aggravation of respiratory conditions such as asthma. Fine particles are more deeply inhaled into the lungs than course particles. They are most closely associated with such health effects as decreased lung function, increased hospital admissions and emergency room visits, increased respiratory symptoms and disease, and premature death. Sensitive groups that appear to be at greatest risk to such effects include the elderly, individuals with cardiopulmonary disease such as asthma, and children.

In addition, PM causes adverse impacts to the environment. Fine PM is the major cause of reduced visibility in parts of the United States, including many of our National Parks. Other environmental impacts occur when particles deposit onto soils, plants, water or materials. For example, particles containing nitrogen and sulphur that deposit on to land or water bodies may change the nutrient balance and acidity of those environments. An ecosystem condition known as ''nitrogen saturation,'' where addition of nitrogen to soil over time exceeds the capacity of the plants and microorganisms to utilize and retain the nitrogen, has already occurred in some areas of the United States. When deposited in sufficient quantities such as near unpaved roads, tilled fields, or quarries, particles block sunlight from reaching the leaves, stressing or killing plants. Finally, PM causes soiling and erosion damage to materials, including culturally important objects such as carved monuments and statues.

Recreational marine diesel engines tend to be concentrated in specific areas of the country (ports, coastal areas, lakes and rivers), so the emissions contribution of these engines in local areas can be more important. Consequently addressing PM and other emissions from recreational marine diesel engines can be an important tool toward the goal of reducing health and environmental hazards.

Considerations For PM From Recreational Two-Stroke Gasoline Engines. Two-stroke engines used in land-based recreational vehicles generally use a fuel and oil mixture to both produce power while lubricating the engine. As much as 30 percent of the intake charge passes through the engine unburned and exhausts to the atmosphere. As a consequence, PM emissions from these engines can be very high. Two stroke gasoline engines are commonly used in off-highway motorcycles and snowmobiles.

Snowmobile engine emissions are of particular concern in environmentally

[7] ''U.S. EPA (1995), Review of National Ambient Air Quality standards for Nitrogen Dioxide, Assessment of Scientific and Technical Information,'' OAQPS Staff Paper, EPA–452/R–95–005.

[8] ''U.S. EPA (1993), Air Quality Criteria for Oxides of Nitrogen,'' EPA/600/8–91/049aF.

[9] The emissions inventory contributions for these sources are provided in the Final Finding document referenced in footnote 4.

[10] International Snowmobile Manufacturers Association, Docket A–98–01, document IV–D–03.

sensitive areas, such as Yellowstone National Park. Snowmobiles are typically powered by 2-stroke engines that have high emissions of hydrocarbons (HC), carbon monoxide (CO) and PM compared to 4-stroke engines. Recent studies have concluded that particulate emission rates from a snowmobile engine are more comparable to those of older, pre-control diesel engines.[11,12] Particle diameters were found to be typically less than 0.1 microns, which is of respirable size and able to be delivered into the deepest and most sensitive areas of the human lung. While formation rates of secondary PM may be lower in the winter months, PM concentrations can be elevated under some meteorological conditions (*e.g.,* low mixing heights). We request comment on the health benefits of reducing PM emissions from recreational vehicle 2-stroke gasoline engines.

3. Air Toxics

These engines are also sources of a number of chemical species which we have proposed to list as mobile source air toxics (MSATs), that are known or suspected human or animal carcinogens, or have serious noncancer health effects.[13] They include pollutants such as diesel exhaust, benzene, 1,3-butadiene, formaldehyde, acetaldehyde, and acrolein, described in more detail below. While the harmful effects of air toxics are of particular concern in areas closest to where they are emitted, they can also be transported and affect other geographic areas. Some can persist for considerable time in the environment.

Many of the air toxics discussed below are components of VOC and we expect that the HC standards discussed in this document would reduce exposure to air toxics and therefore reduce the incidence of cancer and noncancer health effects related to emissions from these engines. We request comment on the need to control air toxics emissions from the engines and vehicles included in this document.

Considerations for Diesel Exhaust. Diesel exhaust emissions are a by-product of incomplete combustion and include gaseous and particulate components. Gaseous components of diesel exhaust include organic compounds, sulfur compounds, carbon monoxide, carbon dioxide, water vapor, and excess air (nitrogen and oxygen). Particulate components include many organic compounds that are mutagenic as well as several trace metals (including chromium, manganese, mercury and nickel) that may have general toxicological significance (depending on the specific chemical species). In addition, small amounts of dioxins have been measured in diesel exhaust, some of which may partition to the particle phase.

Because the chemical composition of diesel exhaust includes hazardous air pollutants, or air toxics, diesel exhaust emissions are of concern to the agency. There have been health studies specific to diesel exhaust emissions which indicate potential hazards to human health that appear to be specific to this emissions source. For chronic exposure, these hazards include respiratory system toxicity and carcinogenicity. Acute exposure also causes transient effects (a wide range of physiological symptoms stemming from irritation and inflammation mostly in the respiratory system) in humans though they are highly variable depending on individual human susceptibility.

The EPA draft Health Assessment Document for Diesel Exhaust was reviewed in a public session by the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board on October 12–13, 2000.[14] The CASAC, in public session, found that the Agency's conclusion that diesel exhaust is likely to be carcinogenic to humans by inhalation, was scientifically sound. The comments provided by CASAC on the draft Assessment are being incorporated into the final Assessment to be released in late 2000 or early 2001. California EPA has identified diesel PM as a toxic air contaminant.[15] Several other agencies and governing bodies have also designated diesel exhaust or diesel PM as a ''potential'' or ''probable'' human carcinogen.[16,17,18] The International Agency for Research on Cancer (IARC) considers diesel exhaust a ''probable'' human carcinogen and the National Institutes for Occupational Safety and Health have classified diesel exhaust a ''potential occupational carcinogen''. Thus, the concern for the health hazard resulting from diesel exhaust exposures is widespread. We request comment on the health benefits of reducing PM emissions from marine diesel engines.

Benzene. Benzene is an aromatic hydrocarbon which is present as a gas in both exhaust and evaporative emissions from motor vehicles. Benzene in the exhaust expressed as a percentage of total organic gases (TOG), varies depending on control technology (e.g., type of catalyst) and the levels of benzene and aromatics in the fuel, but is generally about four percent from gasoline engines. The benzene fraction of gasoline evaporative emissions also depends on control technology (i.e., fuel injector or carburetor) and fuel composition (e.g. benzene level and Reid Vapor Pressure or RVP) and is generally about one percent.

The EPA has recently reconfirmed that benzene is a known human carcinogen by all routes of exposure (including leukemia at high, prolonged air exposures), and is associated with additional health effects including genetic changes in humans and animals and increased proliferation of bone marrow cells in mice.[19] Respiration is the major source of human exposure. Long-term exposure to high levels of benzene in the air has been shown to cause cancer of the tissues that form white blood cells. Among these are acute nonlymphocytic leukemia, chronic lymphocytic leukemia and possibly multiple myeloma (primary malignant tumors in the bone marrow). A number of adverse noncancer health effects, blood disorders such as preleukemia and aplastic anemia, have also been associated with low-dose, long-term exposure to benzene. People with long-term exposure to benzene may experience harmful effects on the blood-forming tissues, especially the bone marrow. Many blood disorders associated with benzene exposure may occur without symptoms.

OSHA recently conducted an industrial hygiene survey to examine park employee exposures during winter

[11] ''Characterization of Snowmobile Particulate Emissions conducted for Yellow Stone Park Foundation Inc.,'' James N. Carroll and Jeff J. White, Southwest Research Institute, June 1999.

[12] ''Emissions from Snowmobile Engines using bio-based fuels and lubricants conducted for the Montana department of Environmental Quality,'' Jeff J. White and James N. Carroll, Southwest Research Institute, October 1998.

[13] 65 FR 48058, August 4, 2000.

[14] U.S. EPA(2000) Health Assessment Document for Diesel Exhaust: SAB Review Draft EPA/600/8–90/057 Office of Research and Development, Washington, D.C. The document is available electronically at www.epa.gov/ncea/dieslexh.htm.

[15] ''Proposed Identification of Diesel Exhaust at a Toxic Air Contaminant, Health risk assessment for diesel exhaust,'' California Environmental Protection Agency, April 1998.

[16] ''Carcinogenic effects of exposure to diesel exhaust,'' NIOSH Current Intelligence Bulletin 50. DHHS, Publication No. 88–116, 1988.

[17] ''Diesel and gasoline engine exhausts and some nitroarenes,'' Vol. 46, Monographs on the evaluation of carcinogenic risks to humans, International Agency for Research on Cancer, World Health Organization, 1989.

[18] ''Diesel fuel and exhaust emissions: International program on chemical safety,'' World Health Organization, 1996.

[19] ''U.S. EPA, Carcinogenic Effects of Benzene: An Update,'' National Center for Environmental Assessment, Washington, D.C. 1998.

at Yellowstone National Park.[20] They reported exposure to benzene above the NIOSH recommended exposure levels (REL) of 0.10 ppm. Since exhaust emission benzene levels generally decrease as HC emissions decrease, we expect new emission control technology to substantially reduce ambient benzene levels.

1,3-Butadiene. 1,3-butadiene is formed in engine exhaust by incomplete combustion of fuel. It is not present in evaporative and refueling emissions, because it is not present in any appreciable amount in gasoline fuel. 1,3-butadiene accounts for 0.4 to 1.0 percent of total exhaust TOG, depending on control technology and fuel consumption. Nonroad mobile sources contribute 15.2 percent to the 1,3-butadiene inventory (baseline NTI).

The Environmental Health Committee of EPA's Scientific Advisory Board (SAB), in reviewing the draft document, issued a majority opinion that 1,3-butadiene should be classified as a probable human carcinogen.[21,22] The Agency has revised the draft Health Risk Assessment of 1,3-butadiene based on the SAB and public comments. The draft Health Risk Assessment of 1,3-butadiene will undergo the Agency consensus review, during which time additional changes may be made prior to its public release and placement on the Integrated Risk Information System (IRIS).

Formaldehyde. Nonroad mobile sources contribute 23 percent to the formaldehyde inventory (baseline NTI). EPA has classified formaldehyde as a probable human carcinogen based on evidence in humans and in rats, mice, hamsters, and monkeys.[23] Epidemiological studies in occupationally exposed workers suggest that long-term inhalation of formaldehyde may be associated with tumors of the nasopharyngeal cavity, nasal cavity and sinus. Formaldehyde exposure also causes a range of noncancer health effects, including irritation of the eyes (tearing of the eyes and increased blinking) and mucous membranes. Sensitive individuals may experience these adverse effects at lower concentrations than the general population. In persons with bronchial asthma, the upper respiratory irritation caused by formaldehyde can precipitate an acute asthmatic attack.

The OSHA industrial hygiene survey at Yellowstone, described above, reported exposure to formaldehyde at 0.033 ppm, which is above the NIOSH recommended exposure level of 0.016 ppm.

Acetaldehyde. Nonroad mobile source emissions are responsible for 27 percent of the total acetaldehyde inventory (Baseline NTI). Acetaldehyde is classified as a probable human carcinogen and humans are exposed by inhalation, oral, and intravenous routes. The primary acute effect of exposure to acetaldehyde vapors is irritation of the eyes, skin and respiratory tract. At high concentrations, irritation and pulmonary effects can occur, which could facilitate the uptake of other contaminants.

Acrolein. Nonroad mobile source emissions are responsible for 11 percent of the total acrolein invenory (Baseline NTI). Acrolein is extremely toxic to humans when inhaled, with acute exposure resulting in upper respiratory tract irritation and congestion. The Agency has developed a reference concentration for inhalation (RfC) of acrolein of 0.02 micrograms/m^3. Although no information is available on its carcinogenic effects in humans, EPA considers acrolein a possible human carcinogen based on laboratory animal data.[24]

4. Carbon Monoxide (CO)

Carbon monoxide (CO) is a colorless, odorless gas produced through the incomplete combustion of carbon-based fuels. Carbon monoxide enters the bloodstream through the lungs and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Healthy individuals also are affected, but only at higher CO levels. Exposure to elevated CO levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.

Several recent epidemiological studies have shown a link between CO and premature morbidity (including angina, congestive heart failure, and other cardiovascular diseases). Several studies in the United States and Canada have also reported an association of ambient CO exposures with frequency of cardiovascular hospital admissions, especially for congestive heart failure (CHF). An association of ambient CO exposure with mortality has also been reported in epidemiological studies, though not as consistently or specifically as with CHF admissions. EPA is reviewing these studies as part of the CO Criteria Document process.

The toxicity of CO effects on blood, tissues and organs have also been topics of substantial research efforts. Such studies provided information for establishing the NAAQS for CO. The current primary NAAQS for CO are 35 parts per million for the one-hour average and 9 parts per million for the eight-hour average. There are currently 17 designated CO nonattainment areas, with a combined population of 31 million. EPA estimated that emissions from nonroad gasoline engines and vehicles have increased by 24 percent from 1980 to 1998.[25]

In addition to concerns related to air quality standards for broad areas, exhaust emissions from indoor applications can cause CO poisoning from individual human exposure. These engines (for example, engines used in forklifts) routinely operate in warehouses and production facilities. Unregulated industrial SI engines frequently have exhaust CO concentrations over 30,000 ppm (3 percent). The maximum allowable time-weighted average 8-hour workplace exposure set by the Occupational Safety and Health Administration is 50 ppm. Manufacturers in some cases may adjust engine calibration for somewhat lower CO emission levels. Also, engines used indoors are often fueled with LPG, which typically has lower CO exhaust concentrations than gasoline-fueled engines. However, improper maintenance or poor calibrations can lead to even higher levels than the 30,000 ppm level noted above from any industrial SI engine.

The typical snowmobile, which utilizes a two-stroke engine, produces significantly more CO than a modern automobile on a unit of work basis. There has been an increasing concern that snowmobile emissions in and around some national parks are reaching significant levels. During the winters of 1994–95 and 1995–96, studies were conducted at Yellowstone, Flagg Ranch, and Grand Teton National Park which indicated that snowmobile tourists are potentially exposed to significant CO

[20] "U.S. Department of Labor, Industrial Hygiene Survey of Park Employee Exposures During Winter Use at Yellowstone National Park," February, 2000.

[21] "U.S. EPA Health Risk Assessment of 1,3–Butadiene," EPA/600/P–98/001A, February 1998.

[22] "An SAB Report: Review of the Health Risk Assessment of 1,3–Butadiene," EPA–SAB–EHC–98, August 1998.

[23] "U.S. EPA Assessment of health risks to garment workers and certain home residents from exposure to formaldehyde," Office of Pesticides and Toxic Substances, April 1987.

[24] "U.S. EPA Integrated Risk Assessment System (IRIS)," Office of Health and Environmental Assessment, Cincinnati, OH, 1993.

[25] U.S. EPA (March 2000). "National Air Pollutant Emission Trends, 1900–1998," Office of Air Quality and Standards.

levels.[26] While the studies did not record official exceedances of the CO NAAQs, levels near and in some cases above the 35 ppm NAAQS standard were observed. These measurements were not considered NAAQS exceedances because sampling methods and measurement locations did not meet the criteria for NAAQS measurements. However, the measurements were reported to be scientifically valid and an indication of potentially significant exposure to CO.

A study of snowmobile rider exposure conducted at Grand Teton National Park showed that CO levels when trailing a single snowmobile at distances of 25–125 feet at speeds of 10–40 mph ranged from 0.5–23 ppm, with a maximum level of 45 ppm (as compared to the current NAAQS for CO of 35 ppm).[27] Since snowmobile riders typically travel in large groups, the riders towards the back of the group are likely to experience significantly higher exposures to CO. An additional consideration is that the risk to health from CO exposure increases with altitude, especially for un-acclimated individuals. Therefore, a park visitor who lives at sea level and then rides his or her snowmobile on trails at high-altitude is more susceptible to the effects of CO than local residents. In addition, the OSHA industrial hygiene survey mentioned earlier reported a peak CO exposure of 268 ppm for a Yellowstone employee, in exceedance of the NIOSH peak recommended exposure limit of 200 ppm.

The U.S. Coast Guard reported cases of CO poisoning caused by recreational boat usage.[28] These Coast Guard investigations into recreational boating accident reports between 1989 to1998, show that 57 accidents were reported, totaling 87 injuries and 32 fatalities, that involved CO poisoning. We believe that controlling CO emissions from marine engines could provide some benefits to boaters.

C. National Emissions Inventory

We have estimated the contribution of the sources included in this ANPRM to the nationwide emissions inventories for the 2000 and 2007 calendar years, as shown in Table II–1.[29]

TABLE II–1.—ESTIMATED NATIONWIDE ANNUAL EMISSION LEVELS

[in thousand short tons (percent of mobile source inventory)]

	NO_X		HC		CO		PM	
	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent
Year 2000:								
Nonroad Sources in ANPRM	371	2.8	822	11.0	7,157	9.0	8.4	1.2
Highway Motorcycles	22	0.2	21	0.3	147	0.2	0.4	0.1
Year 2000 Total	393	3.0	843	11.3	7,304	9.2	8.8	1.3
Year 2007:								
Nonroad Sources in ANPRM	444	4.3	870	16.6	7,536	9.7	9.2	1.5
Highway Motorcycles	25	0.2	26	0.5	171	0.2	0.5	0.1
Year 2007 Total	469	4.5	896	17.1	7,707	9.9	9.7	1.6

III. Recreational Vehicles

A. Background

1. What Recreational Vehicles Would be Included in This Rulemaking?

The vast majority of vehicles that fall into the land-based recreational vehicles category are snowmobiles, off-highway motorcycles (e.g., dirt bikes), and all terrain vehicles (ATVs).[30] The engines used in these vehicles are a subset of nonroad SI engines.[31] Engines used in recreational vehicles include both Small SI (at or below 19 kW) and Large SI engines (above 19 kW). These engines, however, were excluded from our Small SI program (for lawn mowers, chain saws, etc.) because they have different design characteristics and usage patterns than other engines in the Small SI category. This suggests that the recreational engines covered by this ANPRM should be tested differently than Small SI engines. We would similarly expect to treat them separately from our Large SI engine program (discussed later in this ANPRM). We therefore request comment on whether engines used in recreational vehicles should be tested and regulated differently from other small and Large SI engines.

In our rulemaking regulating Small SI engines (defined as nonroad SI engines below 19 kW), we established criteria that effectively excluded the types of engines used in the recreational vehicles listed above.[32] These criteria, such as normal range of operating engine rpm, can greatly affect the basic engine design and the opportunities for emissions control. Engines used in some other types of recreational vehicles may be covered by the Small SI standards, depending on the characteristics of the engines. For example, lawnmower-type engines used in go carts would typically be covered by the Small SI standards. Engines used in golf carts are also typically included in the Small SI program due to their design and

[26] Exposure to Snowmobile Riders to Carbon Monoxide, Park Science Volume 17—No. 1, National Park Service, U.S. Department of the Interior.

[27] Snook and Davis, 1997, ‘‘An Investigation of Driver Exposure to Carbon Monoxide While Traveling Behind Another Snowmobile.’’

[28] Summarized in an e-mail Phil Cappel of the U.S. Coast Guard to Mike Samulski of the U.S. Environmental Protection Agency, October 19, 2000.

[29] Inventory data is further provided in Tables 1 and 2 of the Final Finding (see footnote 4).

[30] ATVs are typically four-wheeled vehicles that are straddled by the operator.

[31] Almost all recreational vehicles are equipped with SI engines. Any diesels used in these applications must meet our nonroad diesel engine standards.

[32] See 40 CFR 90.1(b)(5) for the list of criteria.

operating characteristics being similar to lawnmower-type applications.

There may be other types of recreational vehicles that should be included in the recreational vehicles program in addition to snowmobiles, off-highway motorcycles, and ATVs. For example, some small mopeds or motor scooters could be included in the program depending on their characteristics.[33] We are interested in information and request comment about other types of vehicles that may exist so that we may consider them in developing our proposals.

There may be some uncertainty surrounding the use of ''recreational'' in distinguishing between vehicle types and in determining which set of standards a vehicle or engine must meet. ATVs, for example, may have some utility aspects to their use. We request comment how to best differentiate among engines types. We could establish a definition for ''recreational'', for example, based on the primary intended use of the vehicle model. Under such an approach, vehicles primarily intended for utility or work use by the manufacturer would be part of either the Small or Large SI programs, as applicable. We could also differentiate engines based solely upon engine design and operating characteristics without regard to usage; this option might eliminate potential confusion over whether a particular engine should be appropriately certified as a ''recreational'' or ''utility'' engine.

Hobby engines. The Small SI rule categorized engines used in model cars, boats, and airplanes as recreational engines and exempted them from the Small SI program.[34] Historically, we have exempted hobby engines from our regulations. The nonroad diesel engine final rule exempted hobby engines due to feasibility, testing, and compliance concerns related to regulating such small engines. Also noted in the nonroad diesel engine rule, because hobby engines are very small with very low power output relative to other nonroad engines and have low annual usage rates, they contribute very little to emissions inventories.[35] We request comment on how to proceed for SI hobby engines, including data and information that would allow us to further consider the potential for establishing standards for them or for exempting them from this rule.

2. Who Makes Recreational Vehicles?

Based on industry information available to us, the recreational vehicle industry appears to be dominated by eight manufacturers. Of these eight manufacturers, seven of them manufacture a combination of two or more of the three recreational vehicle sub-categories: off-highway motorcycles, ATVs, and snowmobiles. For example, there are four major companies that manufacture both off-highway motorcycles and ATVs. There are three major companies that manufacture ATVs and snowmobiles and one major company that manufactures all three. These eight companies represent approximately 95 percent of all domestic sales of recreational vehicles.

We are aware of five major companies that dominate sales of off-highway motorcycles. Four of these companies, Honda, Kawasaki, Suzuki, and Yamaha, are long established, major corporations that manufacture a number of products including highway and off-highway motorcycles. They have dominated the off-highway motorcycle market for over thirty years. The fifth major company, KTM, is also long established but has had a major impact in domestic sales over the last 10 to 15 years. These five companies account for approximately 90 to 95 percent of all domestic sales for off-highway motorcycles. There are also several relatively small companies that manufacture off-highway motorcycles, many of which specialize in racing or competition machines.

Based on available industry information, four major manufacturers, Arctic Cat, Bombardier (also known as Ski-Doo), Polaris, and Yamaha, account for approximately 99 percent of all domestic snowmobile sales. The remaining percent comes from very small manufacturers who tend to specialize in unique designs or racing machines. The ATV sector has the broadest assortment of major manufacturers. With the exception of KTM, all of the companies noted above for off-highway motorcycles and snowmobiles are significant ATV producers. These seven companies represent over 95 percent of total domestic ATV sales. The remaining 5 percent come from importers who tend to import inexpensive, youth-oriented ATVs from China and other Asian nations.

3. What Types of Engines Are Used in the Vehicles?

The engines used in recreational vehicles tend to be small, air- or liquid-cooled, reciprocating Otto-cycle engines that operate on gasoline.[36] They are designed to be used in vehicles, where engine performance is characterized by highly transient operation, with a wide range of engine speed and load capability. Maximum engine speed is typically well above 5,000 rpm. Also, the vehicles are equipped with transmissions to ensure performance under a variety of operating conditions.

These engines can be separated into two-stroke and four-stroke designs. The distinction between two-stroke and four-stoke engines is important for emissions because two-stroke engines tend to emit much greater amounts of unburned hydrocarbons (HC) and particulate matter (PM) than four-stroke engines of similar size and power. Two-stroke engines also have greater fuel consumption resulting in poorer fuel economy than four-stroke engines, but they also tend to have higher power output per unit displacement, lighter weight, and better cold starting performance. These advantages combined with a simple design and lower manufacturing costs tend to make two-stroke engines a popular choice as the power unit for recreational vehicles. Currently, snowmobiles use two-stroke engines almost exclusively, whereas about 63 percent of all off-highway motorcycles (predominantly in high performance, youth, and entry-level bikes) and 12 percent of all ATVs sold in the United States use two-stroke engines. Engine displacement for off-highway motorcycles and ATVs typically range from 50 cubic centimeters (cc) to 500 cc for two-stroke engines, and 50 cc to 650 cc for four-stroke engines. Snowmobile engines range from 100 cc to over 1,000 cc.

The basis for the differences in engine and exhaust emissions performance between two-stroke and four-stroke engines can be found in the fundamental differences in how two-stroke and four-stroke engines operate. Four-stroke operation takes place in four distinct steps: intake, compression, power, and exhaust. Each step corresponds to one up or down ''stroke'' of the piston or 180° of crankshaft rotation. The first step of the cycle is for an ''intake'' valve in the combustion chamber to open during the intake stroke allowing a mixture of air and fuel to be drawn into the cylinder while the piston moves down the cylinder. The intake valve then closes and the momentum of the crankshaft causes the

[33] The definition of motor vehicle excludes ''any vehicle that cannot exceed a maximum speed of 25 miles per hour over level, paved surfaces'' (see 40 CFR 85.1703(a)(1)). Such vehicles are therefore considered nonroad vehicles.

[34] 80 FR 24292, April 25, 2000.

[35] 63 FR 56971, October 23, 1998.

[36] Otto cycle is another name for a spark-ignition engine which utilizes a piston with homogenous external or internal air and fuel mixture formation and spark ignition.

piston to move back up the cylinder compressing the air and fuel mixture. At the very end of the compression stroke, the air and fuel mixture is ignited by a spark from a spark plug, and begins to burn. As the air and fuel mixture burns, increasing temperature and pressure cause the piston to move back down the cylinder. This is referred to as the ''power'' stroke. At the bottom of the power stroke, an exhaust valve opens in the combustion chamber and as the piston moves back up the cylinder, the burnt gases are pushed out through the exhaust valve to the exhaust manifold, and the cycle is complete.

In a four-stroke engine, combustion and the resulting power stroke only occur once every two revolutions of the crankshaft. In a two-stroke engine, on the other hand, combustion occurs in every revolution of the crankshaft. Two-stroke engines eliminate the intake and exhaust strokes, leaving only compression and power strokes. This is due to the fact that two-stroke engines do not use intake and exhaust valves. Instead, they have intake and exhaust ''ports'' in the sides of the cylinder walls. With a two-stroke engine, as the piston approaches the bottom of the power stroke, it uncovers exhaust ports in the wall of the cylinder. The high pressure combustion gases blow into the exhaust manifold. As the piston gets closer to the bottom of the power stroke, the intake ports are uncovered, and fresh mixture of air and fuel are forced into the cylinder while the exhaust ports are still open. Exhaust gas is ''scavenged'' or forced into the exhaust by the pressure of the incoming charge of fresh air and fuel. In the process, however, some mixing between the exhaust gas and the fresh charge of air and fuel takes place, so that some of the fresh charge is also emitted in the exhaust. The loss of part of the fuel out of the exhaust during scavenging is one of the major reasons for the very high hydrocarbon emission characteristics of two-stroke engines. The other major reason for high HC emissions from two-stroke engines is their tendency to misfire under low load conditions due to greater combustion instability.

4. What Are the Pollutants of Interest for Each Type of Vehicle?

Recreational vehicles utilizing two-stroke engines, such as snowmobiles and some models of off-highway motorcycles and ATVs, emit significant quantities of fine particulate matter (PM), unburned hydrocarbons (HC), and carbon monoxide (CO). Recreational vehicles utilizing four-stroke engines, such as some models of off-highway motorcycles and most ATVs, also emit significant quantities of CO, however, they tend to emit considerably lower levels of HC and PM than their two-stroke counterparts. Both engine types emit oxides of nitrogen (NO_X). Two-stroke engines tend to emit very low levels of NO_X whereas four-stroke engines emit greater quantities, similar to four-stroke HC emission levels. Exhaust hydrocarbon emissions also include significant quantities of toxic air contaminants including benzene, formaldehyde, acetaldehyde, and 1,3 butadiene. The most important source of recreational vehicle emissions is the engine exhaust, but HC emissions are also produced from the crankcase in four-stroke engines, by evaporation from the fuel system, and by vapor displacement during refueling.

5. What Programs Are in Place in California and Elsewhere To Control Emissions from Recreational Vehicles?

California established standards for off-highway motorcycles and ATVs which took effect in January 1997 (1999 for vehicles with engines of 90 cc or less). The standards, shown in Table III–1, are based on the highway motorcycle chassis test procedures. Manufacturers may certify ATVs to optional standards, also shown in Table III–1, which are based on the utility engine test procedure.[37] This is the test procedure over which Small SI engines are tested. The stringency level of the standards was based on the emissions performance of 4-stroke engines and advanced 2-stroke engines equipped with a catalytic converter. California anticipated that the standards would be met initially through the use of high performance 4-stroke engines.

TABLE III–1.—CALIFORNIA OFF-HIGHWAY MOTORCYCLE AND ATV STANDARDS FOR MODEL YEAR 1997 AND LATER

[1999 and later for engines at or below 90 cc]

	HC	NO_X	CO	PM
Off-highway motorcycle and ATV standards (g/km)	[a] 1.2	....	15	....
	HC + NO_X		CO	PM
Optional standards for ATV engines below 225 cc (g/bhp-hr)	[a] 10.0		300	....
Optional standards for ATV engines below 225 cc (g/bhp-hr)	[a] 12.0		300	....
Optional standards for ATV engines at or above 225 cc (g/bhp-hr)	[a] 10.0		300	....

[a] Corporate-average standard.

California revisited the program in the 1997 time frame because a lack of certified product from manufacturers was reportedly creating economic hardship for dealerships. The number of certified off-highway motorcycle models was particularly inadequate.[38] In 1998, California revised the program, allowing the use of uncertified products in off-highway vehicle recreation areas with regional/seasonal use restrictions. Currently, noncomplying vehicles can be legally sold in California and used in attainment areas year-round and in nonattainment areas during months when exceedances of the state ozone standard are not expected. For enforcement purposes, certified and uncertified products are identified respectively with green and red stickers. Only about one-third of off-highway motorcycles sold in California are certified. All certified products are powered by 4-stroke engines.

California has not adopted standards for snowmobiles. In addition, EPA is not aware of emission control programs for nonroad recreational vehicles that have been adopted in other countries.

[37] Notice to Off-Highway Recreational Vehicle Manufacturers and All Other Interested Parties Regarding Alternate Emission Standards for All-Terrain Vehicles, Mail Out #95–16, April 28, 1995, California Air Resources Board (Docket A–2000–01, document II–D–06).

[38] Initial Statement of Reasons, Public Hearing to Consider Amendments to the California Regulations for New 1997 and Later Off-highway Recreational Vehicles and Engines, State of California Air Resources Board, October 23, 1998 (Docket A–2000–01, II–D–08).

B. Technology

1. What Are the Baseline Technologies and Emissions Levels?

As discussed earlier, recreational vehicles are equipped with relatively small high performance two- or four-stroke engines that are either air- or liquid-cooled.[39] The fuel system used on these engines are almost exclusively carburetors. Two-stroke engines lubricate the piston and crankshaft by mixing oil with the air and fuel mixture. This is accomplished by most contemporary 2-stroke engines with a pump that sends two-cycle oil from a separate oil reserve to the carburetor where it is mixed with the air and fuel mixture. Some less expensive two-stroke engines require that the oil be mixed with the gasoline in the fuel tank. Four-stroke engines inject oil via a pump throughout the engine as the means of lubrication. With the exception of those vehicles certified in California, most of these engines are unregulated and thus have no emission controls. In fact, because performance and durability are such important qualities for recreational vehicle engines, they all operate with a ''rich'' air and fuel mixture. That is, they operate with excess fuel, which enhances performance and allows engine cooling which promotes longer lasting engine life. However, rich operation results in high levels of HC, CO, and PM emissions. Also, two-stroke engines tend to have high scavenging losses, where up to a third of the unburned air and fuel mixture goes out of the exhaust resulting in high levels of raw HC.

TABLE III–2.—TYPICAL RANGE OF EXHAUST EMISSIONS FOR RECREATIONAL VEHICLES

Recreational vehicle type	Engine type	HC	CO	NO_X	PM	Units
Snowmobiles	2-stroke	67–200	196–400	0.3–1.62	0.7–6.1	g/hp-hr
Off-highway Motorcycles/ATVs	2-stroke	8–26	16–37	0.01–0.1	0.002–0.025	g/km [a]
	4-stroke	0.4–3	7–50	0.03–0.2	0.006–0.025	g/km

[a] Emission measurement for motorcycles is in grams per kilometer rather than grams per mile because the motorcycle industry, as well as Federal, California, and international motorcycle emission standards use ''Systeme International d'Unites'' or SI units, which measure distance in kilometers rather than miles.

2. What Technology Approaches Are Available To Control Emissions?

A number of approaches are available to control emissions from recreational vehicles. The simplest approach would consist of modifications to the base engine, fuel system, cooling system, and recalibration of the air and fuel mixture. These could, for example, consist of changes to valve timing for four-stroke engines, changing from air to liquid cooling, and the use of advanced carburetion techniques and electronic fuel injection (EFI) in lieu of traditional carburetion systems. Other approaches could include using an oxidation catalyst alone or in conjunction with secondary air. The engine technology that may have the most potential for maximizing emission reductions from two-stroke engines is the use of direct fuel injection (DI). Direct fuel injection is able to reduce or even eliminate scavenging losses by pumping only air through the engine and then injecting fuel into the combustion chamber after the intake and exhaust ports have closed. The use of oxidation catalysts in conjunction with direct injection could potentially reduce emissions even further. Finally, because four-stroke engines emit significantly lower levels of HC than two-stroke engines, the conversion of two-stroke engine technology to four-stroke engine technology could be a desirable approach.

We request comment as to whether there are any other approaches to emission reduction for recreational vehicles that have not been discussed here. We are interested in information on feasibility, cost and corresponding emission reduction potential, and other issues associated with the above and other technologies. Specifically, we request comment on the effectiveness and durability of oxidation catalysts for these applications, the cost, corresponding emission reductions, and feasibility of direct fuel injection for two-stroke engine applications, and the cost and feasibility of switching from 2-stroke to 4-stroke engines. Any data on engines similar to those used in recreational equipment using these technologies is also requested.

3. What Level of Control May Be Feasible?

Calibration changes and engine modifications can reduce HC and CO emissions somewhat, in the range of 10 to 30 percent. While the precise level of control anticipated from recreational vehicles is not yet known, further HC reductions in the 70 to 90 percent range may be achievable from current two-stroke engines. We expect that the bulk of the HC reductions would occur through the elimination of scavenging losses, with additional reductions possible through the use of an oxidation catalyst. Because four-stroke engines already have low HC emissions relative to two-stroke engines, we would expect more modest HC reductions from four-stroke engines as a result of new emission standards. Control strategies that would reduce HC emissions would also generally reduce PM and toxics. This is especially true for 2-stroke engines where high levels of PM and toxics are the result of scavenging losses.

We believe that similar levels of control can be expected for CO emissions as for HC emissions. The bulk of CO reductions will come from improvements to the fuel system, either through enleanment (i.e., less fuel) of the air and fuel mixture, from now on referred to as A/F ratio, or the improvement of fuel atomization (i.e., smaller fuel droplets), with additional reductions possible through the use of an oxidation catalyst.[40–41] Such strategies are also likely to reduce HC and PM emissions as well.

The NO_X levels emitted from recreational vehicles, especially for those equipped with two-stroke engines, are very low since most recreational vehicles typically operate using a ''rich'' calibration (i.e., with excess fuel) for performance and durability purposes.

Some emission reduction techniques such as changes in engine design and calibration aimed at reducing HC and CO emissions may increase NO_X. However, we expect that any increases

[39] The engines are small relative to automotive engines. For example, automotive engines typically range from one liter to well over five liters in displacement, whereas off-highway motorcycles would range from 0.05 liters to 0.65 liters.

[40–41] Fuel atomization refers to the size of individual fuel droplets. The smaller the fuel droplet is, the better it is combusted or burned.

resulting from HC and CO standards would be minimal. To ensure continued low NO_X performance, we request comment on the appropriateness of setting a capping standard for NO_X emissions or combining NO_X control with HC by setting a HC + NO_X standard.

We request comment on the various strategies available to reduce emissions and the costs and potential corresponding emissions reductions of those strategies.

C. Standards and Program Approaches

Although off-highway motorcycles, ATVs, and snowmobiles are all categorized as recreational vehicles, we expect to establish separate emissions standards for them. The most fundamental reason for varying standards is that the operating characteristics are significantly different. Since we typically try to evaluate and control emissions performance under normal operating conditions, it is likely we will adopt different test procedures for the different applications. Also, the level of stringency and the timing of the standards may vary depending on the types of emissions control technology available, cost impacts, industry make-up, and other factors that we must consider in establishing the program. We request comments on the appropriateness of separate emission standards for off-highway motorcycles, ATVs, and snowmobiles.

Generally, we will be considering what level of emissions control is appropriate and the lead-time necessary for manufacturers to achieve those emissions reductions. There are a number of approaches that have been used in programs for other nonroad engines to effectively reduce emissions, both in the near term and long term. These approaches often incorporate some level of flexibility into the program which has allowed manufacturers to achieve lower overall emissions levels, perhaps at less cost. Programs have been tailored to the particulars of the engine categories and industries being regulated to achieve the overall goals of the program.

In many programs, we have established either a single set (tier) of standards, or multiple tiers of standards that progressively achieve further reductions over a number of years. We have also established corporate-average standards, including declining fleet averages where manufacturers must calculate fleet average emissions levels and reduce those emissions incrementally each year over several model years. Also, in some cases, standards have been phased-in over a number of years as a percentage of sales or by an engine characteristic such as size. Some programs also include averaging, banking and trading, discussed below in section III.C.4.

We have used such mechanisms, in part, to allow manufacturers to plan their research, development, and product introductions. Such program approaches may allow manufacturers to achieve long-term emission reductions that may not otherwise be achievable. For example, a declining fleet average approach over several years may provide near term reductions and also provide manufacturers with lead-time needed to employ advanced technology in an orderly and efficient manner. Also, averaging can provide flexibility by allowing manufacturers to certify some engines to levels above the standard as long as excess emissions are offset by sales of engines certified to emissions levels below the standard. However, such approaches may be of limited value to small businesses or companies offering only a few models and may not be justified for some programs. We encourage you to consider these approaches, and any others, in commenting on the standards discussed below.

1. Off-Highway Motorcycles and ATVs

We are considering establishing HC, NO_X, and CO standards for off-highway motorcycles and ATVs. PM is discussed separately in section III.C.3, below. We expect the largest benefit in terms of reducing the ozone precursors NO_X and HC to come from reducing HC emissions from two-stroke engines. Two-stroke engines have very high HC emissions levels. Baseline NO_X levels are relatively low for engines used in these applications and therefore initial NO_X standards may serve to cap NO_X emissions. CO reductions can be expected from both 2-stroke and 4-stroke engines, as CO levels are somewhat similar for the two engine types.

HC Standard. In the current off-highway motorcycle and ATV market, consumers can choose between 2-stroke and 4-stroke models in most sizes and categories. Each engine type offers unique performance characteristics. Some manufacturers specialize in 2-stroke or 4-stroke models while others offer a mix of models.

The HC standard is likely to be a primary determining factor for what technology manufacturers choose to employ to meet emissions standards overall. As described in the previous section, a variety of technological approaches appear promising to control HC emissions. HC emissions can be reduced substantially by switching from 2-stroke to 4-stroke engines. The California emissions control program for off-highway vehicles provides ample data on the emissions performance capability of 4-stroke engines in off-highway motorcycles and ATVs. Off-highway motorcycles certified to California standards for the 2000 model year have HC certification levels ranging from 0.4 to 1.0 g/km. The motorcycles have engines ranging in size from 50 cc to 650 cc and none of these motorcycles are equipped with catalyst technology.

Technologies are also available for the two stroke engine that may reduce HC emissions levels to near those provided by 4-stroke engines. Technologies such as direct fuel injection and catalysts have been applied to 2-stroke engines used in other applications, such as personal watercraft and outboard marine engines, in response to emissions control requirements. However, only vehicles equipped with 4-stroke engines have been certified to the California standards. Two stroke models are sold in California, but only under California's allowance for the sales and use of uncertified products under certain circumstances (discussed above in section III.A.5).

In determining what standards to propose, we will be carefully examining the feasibility and cost of both 2-stroke and 4-stroke technologies. Modest reductions (up to 30 percent) appear feasible through the use of engine modifications and calibration changes. We are also interested in approaches that would reduce HC emissions substantially (for example, 75 to 90 percent) from baseline 2-stroke engine levels. Clearly, switching to 4-stroke engines achieves this goal and some manufacturers would likely choose this approach to meeting such standards.

However, some manufacturers may want an opportunity to achieve HC reductions through the use of advanced technology 2-stroke engines. This approach may require more time and investment in research and development than switching to 4-stroke engines entirely, but could result in more cost effective emissions control in the long term. Also, if such engines were developed, consumers may benefit from having a variety of engine types from which to choose. We request comment on whether EPA should attempt to set standards in a manner that would encourage the development of clean 2-stroke technology, and if so, how that objective could best be accomplished.

We request comments on the appropriate level of HC control for off-highway motorcycles and ATVs. We are interested in perspectives on whether an HC standard should be based on the capabilities of 4-stroke or 2-stroke engine emissions control technologies. We are also interested in comment on establishing separate standards for the two engine types. In making their recommendations, commenters are encouraged to consider the level of emission reductions currently achieved under the California emissions control program, described above, and the need and opportunity for further emissions reductions. Commenters are also encouraged to consider the benefits of aligning highway motorcycle HC standards, discussed in section IV below, with the HC standards for off-highway motorcycles and ATVs. We are interested in comments on technology, cost, corresponding emission reduction potential, necessary lead-time, phase-in, and performance implications, including supporting rationale and data, where possible. Commenters are also invited to address the cost and corresponding emissions reductions of various other potential strategies.

As described above, we may propose averaging approaches such as corporate-average standards and averaging, banking, and trading. We request comment on the appropriateness of averaging ATVs and off-highway motorcycles together, assuming they are required to meet the same standards, or standards of similar stringency. Comments on other aspects of averaging as it might apply to HC compliance are requested (for example, averaging recreational vehicles with other engines identified in this document).

NO_X standard. While the focus of the program would be on achieving HC reductions, we also request comment on the need for and appropriateness of NO_X control for these engines. We are considering standards in the form of HC plus NO_X. We would expect a small NO_X increase when going from uncontrolled two-stroke engines to engine designs which meet new emissions standards. This NO_X increase is due to engine efficiency improvements and emission control strategies available for 2-stroke engines. A NO_X plus HC standard recognizes this trade-off. Also, 4-stroke engines typically have higher NO_X emissions than 2-stroke engines.

When we established the HC plus NO_X standard for personal watercraft, we adjusted the level of the standard to account for the inclusion of NO_X. We request comment on this approach for establishing an HC plus NO_X limit for motorcycles and ATVs. We also request comment on how much of an adjustment to the standard is needed to account for NO_X emissions or what level would be appropriate for a NO_X cap. We also request comment on a NO_X plus HC standard in the context of averaging approaches for compliance. Finally, we request comment on the cost implications and corresponding emission reduction potential of NO_X control strategies.

CO standard. We expect to establish a CO limit for motorcycles and ATVs, along with HC and NO_X standards. We will be considering the levels established by California for these vehicles and the standards for highway motorcycles. We request comment on what level of CO control would be appropriate for these vehicles, considering costs (and other statutory factors). We also request comment on whether or not the CO standard should be established as a separate technology driver or based on the performance of technologies likely to be needed to achieve low HC emissions levels. We request comment on the cost implications and corresponding emission reduction potential of CO control strategies. As with HC and NO_X, we are interested in the usefulness of considering averaging approaches for CO emissions compliance.

Test procedures. The form and numeric level of the standards depend on the test procedures and test cycle over which emissions are measured. As described above in section III.A.5., California off-highway motorcycle and ATV standards are based on the highway light-duty vehicle test procedure (the FTP). This is a chassis-based test procedure, which requires the vehicle to be tested rather than only the engine.

Some manufacturers have noted that they do not currently have chassis-based test facilities capable of testing ATVs. California provides manufacturers with the option of certifying ATVs using the engine-based, utility engine test procedure (SAE J1088), and most manufacturers use this option for certifying their ATVs. Manufacturers have facilities to chassis test motorcycles and therefore California does not provide an engine testing certification option for motorcycles. Manufacturers have noted that requiring chassis-based testing for ATVs would require them to invest in additional testing facilities which can handle ATVs, since ATVs do not fit on the same roller(s) as motorcycles used in chassis testing.

Currently, for off-highway motorcycles and ATVs, we are planning to use the FTP test cycle, as it appears to be the best available test cycle for these vehicles. We will be carefully examining the potential pros and cons of using an engine-based test procedure for ATVs and request comment on this issue. We request comment on whether or not the approach taken by California is suitable for the federal program, including the use of the above test procedures and their effectiveness in ensuring in-use emissions reductions.

We are particularly interested in comments on the use of the utility engine cycle for ATVs, and whether or not a different engine-based test cycle, such as the one being considered for snowmobiles (discussed below), may be more suitable. The utility engine cycle is a 5-mode steady-state test cycle which includes testing at only one engine speed (85 percent of rated speed). Such a test procedure is appropriate for engines used in lawn and garden applications, but may not be appropriate for engines used in vehicle applications. The snowmobile engine test procedure is also a 5-mode steady-state test procedure but the engine speed varies by mode along with torque. We believe this is generally more representative of how an engine behaves in a vehicle application.

2. Snowmobiles

Emissions standards established by EPA through this rulemaking will be the first for snowmobiles. Unlike off-highway motorcycles and ATVs, there are no emissions standards for snowmobiles in California to use as a point of reference. Snowmobiles are almost entirely equipped with two-stroke engines which have very high HC and CO emission levels. Our focus for snowmobiles will be to reduce those emission levels. NO_X emissions are much less of a concern because of the seasonal nature of snowmobile use and low baseline levels.

CO standard. CO emissions may be a larger concern for snowmobiles than for off-highway motorcycles and ATVs due to their high CO emissions levels and the general concern of high ambient CO level in some areas during cold weather. In initial discussions with the International Snowmobile Manufacturers Association (ISMA), manufacturers have suggested setting standards that would result in CO reductions of 10 to 30 percent, phased in over model years 2004–2006. As described in section III.B. above, promising technologies are available which have the potential to reduce emissions to significantly lower levels. These technologies go beyond minor engine modifications and calibration changes and may require additional lead time to implement. However, with appropriate lead time, further CO emission reductions may be reasonably achievable.

We will be evaluating potential technologies and the costs of those technologies during the development of our proposal for snowmobiles. We will consider the timing of the standards in the context of the level of stringency we propose, recognizing that more lead-time would likely be needed to apply and prove-out the application of certain advanced technologies. Also, as described above, we will consider the value of implementation flexibilities such as averaging and phase-in schedules in allowing manufacturers to meet more stringent standards in an orderly manner. We request comment on what level of CO emissions control is feasible and appropriate for snowmobiles, on the cost and corresponding emissions reduction potential of various strategies, on the lead time needed to achieve new standards, and on the usefulness of implementation flexibility in meeting the standards.

HC standard. As mentioned in section II, we received comments indicating that HC control for snowmobiles for purposes of reducing ozone may not be necessary due to their seasonal use. However, we believe that there may be a need to control HC emissions from snowmobiles. In particular, even if we accept the commenters' argument regarding ozone, HC emissions may result in increased exposure to air toxics. As discussed in section II, hydrocarbons are made up of numerous components, some of which have been identified as toxic air pollutants.

We anticipate that many of the technology approaches available to manufacturers to reduce CO emission levels would also reduce HC emissions levels. The two-stroke engines used in snowmobiles have very high HC levels and we believe that establishing standards to reduce those levels would be appropriate. Manufacturers have suggested an HC reduction of up to 30 percent by 2008, in addition to the 30 percent reduction in CO by 2006, discussed above. As with CO, we believe technology is likely to be available to achieve a greater degree of control, especially with several years lead time or phase-in. Reductions in CO and HC of 70 percent or more may be feasible.

We request comment on what level of HC emissions control is feasible and appropriate for snowmobiles, the cost and corresponding emissions reductions associated with such levels of emissions control, the lead time needed to achieve new standards, and the usefulness of implementation flexibility in meeting the standards. In particular, we request comment on the appropriateness of requiring any control of HC for snowmobiles given the seasonal nature of their use versus air toxic concerns for riders.

Test Procedures. Snowmobile manufacturers, in conjunction with Southwest Research Institute, have developed a test procedure for measuring snowmobile emissions.[42] This effort was undertaken due to increasing interest in snowmobile engine emission levels and a lack of a test procedure based on a representative duty-cycle. The test cycle is a 5-mode steady-state cycle, with different engine speed and torque points chosen and weighted to reflect in-use engine operation (see table below). The study also found that the utility engine cycle (J1088), which had previously been used, was not appropriate for snowmobiles.

TABLE III–3.—SNOWMOBILE ENGINE TEST CYCLE

(SAE paper 982017)

mode	1	2	3	4	5
normalized speed	1.0	0.85	0.75	0.65	idle
normalized torque	1.0	0.51	0.33	0.19	0
Weight, %	12	27	25	31	5

We request comment on the use of this test procedure as the basis of future snowmobile standards. This test procedure appears to be the best currently available for snowmobiles, but we request comment on the need for additional tests or test modes to ensure in-use emissions control. For example, idle CO emissions have been highlighted as a particular concern for snowmobiles and we request comment on the need for additional emphasis on idle CO emissions within the test procedure.

3. The Need for PM Standards

As discussed in section II, Air Quality, we are very concerned about current high particulate matter levels in snowmobile exhaust. High PM levels are primarily attributable to the use of traditional 2-stroke engines. PM emissions are also a concern for off-highway motorcycles and ATVs to the extent that 2-stroke engines are used in those applications.

We believe that the technology changes that would be needed to significantly reduce CO and HC levels, such as direct injection or 4-stroke engines, may also dramatically reduce PM levels. If HC and CO standards were established at a level only requiring minor modifications to the engines, PM could remain a problem for snowmobiles and a PM standard may be necessary. We request comment on whether or not we should establish a PM standard for snowmobile engines and what level of stringency would be appropriate. We also request comment on the cost implications (equipment costs, etc.) associated with measuring PM as part of the certification procedure.

4. Averaging, Banking, and Trading

Depending on the structure of the proposed program, the level of stringency of the proposed standards, and other considerations, we may propose averaging, banking, and trading provisions (ABT) for recreational vehicles/engines. We have established ABT programs in many of our engine-based emissions control programs in cases where we have set standards that require significant technology changes. The ABT programs allow manufacturers

[42] "Development and Validation of a Snowmobile Engine Emission Test Procedure," Christopher W. Wright and Jeff J. White, SAE Paper 982017.

to earn credits by introducing clean engines sooner than required or by certifying engines to levels below the standards. Manufacturers may use the credits to certify engines to levels above the standards in the same model year (averaging), keep the credits for use in a later model year (banking), or transfer the credits to another manufacturer (trading).

In some cases, we have not established ABT programs because we believed the standards we were adopting were achievable without the additional flexibility. In such cases, EPA found that the added complexity inherent in having an ABT program, both for EPA and the manufacturers, would outweigh the potential benefits of the program.

ABT can be beneficial in providing incentive to manufacturers for the early introduction of new technologies, allowing certain engine families to be trail blazers for new technology. This flexibility can allow us to consider a more stringent program than would otherwise be appropriate under CAA section 213. The programs also provide flexibility to manufacturers for product planning and can provide opportunity for more cost effective introduction of product lines. ABT is tailored to meet the specific needs of standards and programs being established. This is necessary to avoid issues such as windfall credits and the potential of stockpiling credits which could result in a significant delay of the standards being adopted or future standards not yet considered. We request comment on integrating ABT into the programs for recreational vehicles. We are interested in comment on the scope of ABT, including any particular issues we should consider in developing such a program, and whether or not credit trading among different vehicle types should be allowed.

D. Additional Program Considerations

1. Competition Off-Highway Motorcycles

Currently, a large portion of off-highway motorcycles are marketed as competition/racing motorcycles. These models often represent a manufacturer's high performance offerings in the off-highway market. Most such motorcycles are of the motocross variety,[43] although some high performance enduro models[44] are marketed for competition use. These high performance motorcycles are largely powered by 2-stroke engines, though some 4-stroke models have been introduced in recent years.

When used for competition, motocross motorcycles are mostly involved in closed course or track racing. Other types of off-highway motorcycles are usually marketed for trail or open area use. When used for competition, these models are likely to be involved in point-to-point competition events over trails or stretches of open land. There are also specialized off-highway motorcycles that are designed for competitions such as ice racing, drag racing, and observed trials competition. A few races involve professional manufacturer sponsored racing teams. Amateur competition events for off-highway motorcycles are also held frequently in many areas of the U.S.

Clean Air Act sections 216 (10) and (11) exclude engines and vehicles "used solely for competition" from nonroad engine and vehicle regulations. For purposes of past nonroad engine emissions control regulatory programs (for example, the nonroad CI, recreational marine, and Small SI programs), EPA has defined the term "used solely for competition" as follows:

Used solely for competition means exhibiting features that are not easily removed and that would render its use other than in competition unsafe, impractical, or highly unlikely.

If retained for the recreational vehicles program, the above definition may be useful for identifying certain models that are clearly used only for competition. For example, there are motorcycles identified as "observed trials" motorcycles which are designed without a standard seat because the rider does not sit down during competition. This feature would make recreational use unlikely. Most motorcycles marketed for competition, however, do not appear to have physical characteristics that constrain their use to competition. Without such distinguishing characteristics, determining that a vehicle is used solely for competition becomes more challenging.

Manufacturers have recommended that EPA use the definition for competition motorcycle that EPA has previously established for purposes of exempting motorcycles from its noise regulations, as follows:

Competition motorcycle means any motorcycle designed and marketed solely for use in closed course competition events.[45]

Manufacturers further recommended that closed course competition include "any organized competition event covering a closed, repeated, or defined route intended for easy viewing of the route by spectators. Such events could include, but are not limited to, motocross, enduro, hare scrambles, observed trials, short track, dirt track, drag race, hill climb, ice race, and land speed trials * * *". Manufacturers recommended that EPA require labels designating the vehicles for competition use only.[46]

Based on confidential sales information, we believe that vehicles designated for competition by manufacturers could exceed 50 percent of total sales under their recommended approach. We believe that many "competition" style motorcycles are likely to also be used, at least by many end users, primarily or often for recreational riding. Section 216(10) of the Act excludes from the definition of nonroad engines vehicles used solely for competition. We are concerned that the approach suggested by manufacturers may be overly broad and therefore would not meet the conditions of this exclusion.

In a recent rulemaking for marine diesel engines, we addressed competition engines by providing exclusions for engines used in professional competitions only.[47] Engines used for amateur competition or occasional competition are not excluded under that rule. The exclusion is available both to manufacturers and to someone modifying an engine for professional competition use (normally, we would prohibit someone from making changes to a certified engine in ways that adversely affect emissions control). This would be one possible

[43] A motocross bike is typically a high performance off-highway motorcycle that is designed to be operated in motocross competition. Motocross competition is defined as a circuit race around an off-highway closed-course. The course contains numerous jumps, hills, flat sections, and bermed or banked turns. The course surface usually consists of dirt, gravel, sand, and mud. Motocross bikes are designed to be very light for quick handling and easy manueverability. They also come with large knobby tires for traction, high fenders to protect the rider from flying dirt and rocks, aggressive suspension systems that allow the bike to absorb large amounts of shock, and are powered by high performance engines. They are not equipped with lights.

[44] An enduro bike is very similar in design and appearance to a motocross bike. The primary difference is that enduros are equipped with lights and have slightly different engine performance that is more geared towards a broader variety of operation than a motocross bike. An enduro bike needs to be able to cruise at high speeds as well as operate through tight woods or deep mud.

[45] 40 CFR 205.151(a)(3).

[46] "MIC Recommended Definitions for Pending EPA Recreation Vehicle Exhaust Emissions Proposal," Motorcycle Industry Council, Draft, June 1, 2000. Docket A–2000–01.

[47] 64 FR 73305, December 29, 1999.

approach to address the competition use issue for recreational vehicles.

We are very interested in receiving input on the competition exemption issue described above. We request comment on ways the program can be established to provide an exclusion for motorcycles used solely for competition, consistent with the Act, without excluding vehicles that are often used for other purposes. Ideally, the program can be established in a way that provides reasonable certainty at time of certification. However, approaches could include reasonable measures at time of sale or in-use that would provide assurance that the competition exemption is being applied appropriately. We request information and data on the use of off-highway motorcycles for competition and recreation that would inform the rulemaking process.

2. Crankcase Emissions From Recreational Vehicles

We will be considering proposing the elimination of crankcase emissions from recreational vehicles. Venting the crankcase to the atmosphere is a source of HC emissions that has been cost effectively controlled in many other engine applications. Rather than venting these emissions to the atmosphere, they can be routed back to the engine for combustion. We believe that any effect on exhaust emission levels due to the additional hydrocarbons which are routed to the engine through the crankcase emissions control system can be substantially reduced, if not eliminated, through the recalibration of the engine. We are not aware of any issues particular to closing the crankcase on engines used in recreational vehicles. California has required the elimination of crankcase emissions on off-highway motorcycles and ATVs as part of their program. We request comments on the costs, emission reductions, and any other issues associated with requiring the elimination of crankcase emissions from recreational vehicles.

3. Compliance Measures

Along with emissions standards, we will be considering requirements to ensure in-use compliance with those standards over the useful life of the recreational vehicles/engines. The goal of these measures would be to promote high quality engine design, production, and in-use emissions performance. Compliance programs typically include certification, production line testing, and in-use testing components. Under these programs, manufacturers must submit data and other information prior to introducing the engine into commerce certifying that the engine meets applicable standards, and there is the ability to verify compliance through engine testing at the production line and in-use. We expect to examine the structure and effectiveness of compliance programs contained in other nonroad emissions control programs in determining what types of measures would be most appropriate for recreational vehicles.

Because of similarities in the applications, engine characteristics, and production volumes, we will carefully consider whether the compliance programs for recreational vehicles should be modeled after the programs adopted to control emissions from marine outboard engines and personal watercraft.[48] Some manufacturers making these marine products also make recreational vehicles, and are therefore familiar with the structure of the marine engines program.

We encourage interested parties to review the compliance program in place for outboard engines and personal watercraft and provide input to EPA on the potential for applying the same types of compliance measures to these other recreational vehicles. In particular, we are interested in comments on requirements for manufacturer production line and in-use testing. For outboard engines and personal watercraft, the production line testing program requires manufacturers to test engines as they leave the production line. This process is used to provide a quality control check on the manufacturer's production processes to ensure that engines are routinely assembled in a way such that they continue to meet emission performance requirements when coming off the assembly line. The manufacturer in-use testing program requires manufacturers to select engines from the in-use fleet and test a portion of their engine families each year. These requirements focus resources on ensuring in-use compliance and are key components to the overall compliance program we have established for recreational marine engines.

4. Consumer Modifications

We are aware that consumers sometimes modify engines and exhaust systems on their recreational vehicles. Some of these changes are done to enhance operating performance. Others are to maintain optimal performance under varying operating conditions (*i.e.,* changes in altitude, weather, etc.). We request information on the types of modifications that are common for the different types of recreational vehicles and any information on their impact on emission performace. We are especially interested in those modifications that would affect the emissions performance of the vehicle, and could be considered tampering under the Act for engines certified to emissions standards. We also request information that would help us better understand how common these practices are for the different types of vehicles. Understanding the scope of these practices will help us establish standards and program requirements that achieve in-use emissions reductions.

[48] 61 FR 52088, October 4, 1996.

5. Useful Life

For highway motorcycles, we currently have three distinct useful life categories that are based on engine displacement. The useful life for all three categories are five years or 12,000 km, 18,000 km, or 30,000 km depending on which category the motorcycle falls under. California has established a useful life of 5 years or 10,000 km for off-highway motorcycles and ATVs. For some of our nonroad engine regulations, we have based useful life on time (*i.e.,* hours). We request information that would help us determine the most appropriate method for establishing useful life for recreational vehicles. For example, a certain number of hours may be appropriate for snowmobiles and possibly ATVs, whereas a useful life similar to that used for highway motorcycles or California off-highway motorcycles may be more appropriate for off-highway motorcycles. We request comment on what the appropriate useful life levels and values would be for the various types of recreational vehicles.

6. Consumer Labeling

We request comment on the potential for a consumer labeling program for recreational vehicles. We are also interested in comment on this topic for recreational marine engines, as discussed in section V.E.10. The purpose of a labeling program would be to educate consumers so that they could make informed decisions concerning engine emissions when they purchase a recreational vehicle. One example of a consumer labeling program is the California Air Resources Board's requirement that personal watercraft and outboard engines sold in California starting in 2001 be labeled as either low, very-low, or ultra-low depending on their emission levels.

We request comment on the merit and cost of including such a program in our proposal for recreational vehicles and whether the program should be voluntary or mandatory. We also request comment on programmatic aspect of labeling such as the content of the label, the number of tiers that would be useful in distinguishing among recreational vehicle models, and the pollutant(s) that should be used in establishing those tiers. Finally, we request comment on any other appropriate incentives for introducing new clean technologies that may be available.

IV. Highway Motorcycles

In addition to the nonroad vehicles and engines noted above, today's ANPRM also reviews EPA requirements for highway motorcycles. The emissions standards for highway motorcycles were established twenty-three years ago. California recently adopted new emissions standards for highway motorcycles and new standards have also been proposed internationally. There may be opportunities to reduced emissions in a way that also allows manufacturers to benefit from harmonized requirements, which may reduce product lines and production costs. In addition, we believe it is important to consider the emissions standards for highway motorcycles in the context of setting standards for off-highway motorcycles. We are interested in providing regulatory programs for off-highway and highway motorcycles that are consistent, which may also allow for the transfer of technology across product lines for manufacturers. Consequently, we request comment on the appropriateness of examining and potentially revising the highway motorcycle emission standards in the same time frame, and in the same rulemaking, in which we plan to address emission standards for recreational vehicles.

A. What Is a Highway Motorcycle, and Who Makes Them?

Motorcycles come in a variety of two- and three-wheeled configurations and styles. For the most part, however, they are two-wheeled self-powered vehicles. Federal regulations currently define a motorcycle as ''any motor vehicle with a headlight, taillight, and stoplight and having: two wheels, or three wheels and a curb mass less than or equal to 680 kilograms (1499 pounds).'' (See 40 CFR 86.402–86.478). Vehicles that otherwise meet the motorcycle definition but have engine displacements less than 50 cubic centimeters (cc) (generally, youth motorcycles, most mopeds, and some motor scooters) are currently not covered by federal regulations. Also currently excluded are motorcycles which, ''with an 80 kg (176 lb) driver, * * * cannot: (1) Start from a dead stop using only the engine; or (2) Exceed a maximum speed of 40 km/h (25 mph) on level paved surfaces' (*e.g.,* some mopeds). Most scooters and mopeds have very small engine displacements and are typically used as short-distance commuting vehicles. Motorcycles with larger engine displacement are more typically used for recreation (racing or touring) and may travel long distances. Both EPA and California regulations further sub-divide highway motorcycles into classes based on engine displacement. Table IV–1 shows how these classes are defined.

The currently regulated highway category includes motorcycles termed ''dual-use'' or ''dual-sport,'' meaning that their designs incorporate features that enable them to be reasonably competent on and off road. Dual-sport motorcycles generally can be described as street-legal dirt bikes, since they tend to bear a closer resemblance in terms of design features and engines to true off-highway motorcycles than to highway cruisers or sport bikes. However, another category of motorcycle, referred to as ''enduros,'' are very similar in appearance to dual-sport motorcycles, but are typically equipped with higher performance engines and have traditionally been categorized as nonroad motorcycles and not been subject to the highway emission standards. Therefore, we request comment as to how we can better determine which motorcycles are street-legal and which are not.

Throughout this ANPRM the term ''highway motorcycle'' is intended to include all motorcycles covered by the current federal regulations; thus, dual-sport motorcycles are included in this definition. We currently believe that all highway motorcycle engines sold in the U.S., including those that power dual-sport motorcycles, are four-stroke engines.

TABLE IV–1.—MOTORCYCLE CLASSES

Motorcycle class	Engine displacement (cubic centimeters)
Class I	50—169.
Class II	170—279.
Class III	280 and greater.

Highway motorcycles are dominated by larger engines, with engine displacements exceeding 1000 cc for the most powerful ''superbikes.'' According to the Motorcycle Industry Council (MIC), in 1998 there were about 5.4 million highway motorcycles in use in the United States (only 565,000 of these were dual-sport), more than three-fourths of which had an engine displacement of over 449 cc.[49] Sixty percent had an engine displacement greater than 749 cc. Inclusion of the dual-sport motorcycles in this figure tends to skew the numbers somewhat, even despite the fact that their total numbers are relatively small, because their dirt bike heritage leads them to be weighted towards smaller engines. According to the MIC data, three-fourths of dual-sport motorcycles had an engine displacement of less than 350 cc, whereas two-thirds of the remaining motorcycles (those purely designed for road use) had a displacement of over 749 cc. Total sales in 1998 of highway motorcycles was estimated to be about 411,000, or about 72 percent of motorcycle sales. About 13,000 of these were dual-sport motorcycles. The remaining 28 percent of sales were strictly off-highway motorcycles, which are currently unregulated.

We are aware of a half-dozen companies, Honda, Harley Davidson, Yamaha, Kawasaki, Suzuki, and BMW, which account for near 95 percent of all motorcycles sold. Dozens of other minor players make up the remaining few percent. Based on available information, over half of all motorcycles sold in 1998 were made by Honda and Harley Davidson, with the two companies maintaining almost equal market shares of about 25 percent each.

B. What Is the Regulatory History?

1. Environmental Protection Agency Regulations

In 1974 EPA issued an advance notice of proposed rulemaking that discussed the possible implementation of emission controls for highway motorcycles for the first time and requested comment on a number of issues. Taking into account the comments received on the ANPRM, EPA issued an NPRM the following year for the control of exhaust and crankcase emissions from new motorcycles. The proposal addressed standards for HC, CO, and NO_X, proposing a set of interim standards for 1978 and 1979 and final standards equivalent to the light-duty vehicle standards in effect at that time. The NPRM was followed by a Final Rule promulgated in 1977 (42 FR 1126, Jan. 5, 1977) which established interim standards effective for the 1978 and 1979 model years and ultimate standards effective starting with the 1980 model year. The interim standards ranged from 5.0 to 14.0 g/km HC depending upon engine displacement,

[49] ''1999 Motorcycle Statistical Annual,'' Motorcycle Industry Council.

while the CO standard of 17.0 g/km applied to all motorcycles. The 1980 standards, which were more lenient than those that were proposed and which lacked a NO_X standard, are essentially those that remain in effect today. While the final standards did not differ based on engine displacement, the useful life over which these standards must be met ranged from 12,000 km (7,456 miles) for Class I motorcycles to 30,000 km (18,641 miles) for Class III motorcycles. These standards were updated in 1989 to include methanol-fueled motorcycles starting with the 1990 model year, then again in 1994 to include natural gas-fueled and liquefied petroleum gas-fueled motorcycles starting with the 1997 model year. Crankcase emissions from motorcycles are also prohibited. There are no current federal standards for evaporative emissions from motorcycles. The current federal standards are shown in Table IV–2.

TABLE IV–2.—CURRENT FEDERAL EXHAUST EMISSION STANDARDS FOR MOTORCYCLES

Engine size	HC (g/km)	CO (g/km)
All	5.0	12.0

2. Regulation by the California Air Resources Board

Motorcycle emission standards in California were originally identical to the federal standards that applied to the 1978 through 1981 model years. The definitions of motorcycle classes used by California continue to be identical to the federal definitions. However, California has revised their standards several times to bring them to their current levels. In 1982 the standards were modified to reduce the HC standard from 5.0 g/km to 1.0 or 1.4 g/km, depending upon engine displacement. California adopted an evaporative emission standard of 2.0 g/test for 1983 and later model year motorcycles. In 1984 California amended the regulations for 1988 and later model year motorcycles to further lower emission standards and provide additional compliance flexibility to manufacturers. The 1988 and later standards could be met on a corporate-average basis, and the larger (Class III) bikes (280 cc and above) were split into two separate categories: 280 cc to 699 cc and 700 cc and greater. These are the standards being met in California today. Like the federal standards, there are no currently applicable NO_X standards for highway motorcycles in California. Under the corporate-averaging scheme, no individual engine family is allowed to exceed a cap of 2.5 g/km. Like the federal program, California also prohibits crankcase emissions.

TABLE IV–3.—CURRENT CALIFORNIA HIGHWAY MOTORCYCLE EXHAUST EMISSION STANDARDS

Engine size (cc)	HC (g/km)	CO (g/km)
50–279	1.0	12.0
280–699	1.0	12.0
700 and above	1.4	12.0

In 1998 the California Air Resources Board (CARB) proposed new standards for Class III highway motorcycles that would take effect in two phases—a ‘‘Tier 1’’ to start with the 2004 model year, followed by a ‘‘Tier 2’’ that would take effect starting with the 2008 model year. These standards were finalized with minor modifications on November 22, 1999. Existing California standards for Class I and II motorcycles remained unchanged. As with the current standards, manufacturers will be able to meet the requirements on a corporate-average basis. Perhaps most significantly, this recent CARB action brings some level of NO_X control to motorcycles by establishing a combined $HC+NO_X$ standard. No changes were made by the CARB action to the CO standard, which remains at 12.0 g/km. In addition, CARB is providing an incentive program to encourage the introduction of motorcycles compliant with the Tier 2 standard prior to the 2008 model year. This incentive program allows the accumulation of credits that manufacturers can use to meet the 2008 standards. Like the federal program, these standards will also apply to dual sport motorcycles.

TABLE IV–4.—TIER 1 AND TIER 2 CALIFORNIA CLASS III HIGHWAY MOTORCYCLE EXHAUST EMISSION STANDARDS

Model year	Engine displacement	$HC+NO_X$ (g/km)	CO (g/km)
2004 through 2007 (Tier 1)	280 cc and greater	1.4	12.0
2008 and subsequent (Tier 2)	280 cc and greater	0.8	12.0

California also adopted a new definition of small volume that would take effect with the 2008 model year. Historically, California had a definition of small volume that applied to the 1984 through 1987 model years (5,000 units per model year), but no definition that has applied since. Thus, for the 1988 through 2007 model years, all manufacturers must meet the standards, regardless of production volume. Small volume manufacturers, defined in CARB's recent action as a manufacturer with combined California sales of Class I, Class II, and Class III motorcycles not greater than 300 units, do not have to meet new standards until the 2008 model year, at which point the Tier 1 standard applies. CARB intends to evaluate whether the Tier 2 standard should be applied to small volume manufacturers in the future.[50]

3. European Regulations

The European Commission recently proposed a new phase of motorcycle standards, which would start in 2003, and are considering a second in 2006. Whereas the current European standards make a distinction between two-stroke and four-stroke engines, the proposed standards would apply to all motorcycles regardless of engine type, leading to a technology-independent regulatory framework. The 2003 standards would require emissions to be below the values shown in Table IV–5, as measured over the European ECE–40 test cycle. The phase of standards being considered for 2006 are still in a draft form and have not yet been officially proposed, but in addition to taking another step in reducing motorcycle emissions, the 2006 standards are expected to incorporate an improved motorcycle test cycle, as noted in Section IV.D.2 below.

[50] CARB, October 23, 1998 ‘‘Proposed Amendments to the California On-Road Motocycles Regulation’’ Staff Report: Initial Statement of Reasons.

TABLE IV–5.—EUROPEAN COMMISSION PROPOSED 2003 MOTORCYCLE EXHAUST EMISSION STANDARDS

HC (g/km)	CO (g/km)	NO_X (g/km)
1.2	5.5	0.3

C. Highway Motorcycle Emission Control Technology

1. Federal Standards

While highway motorcycles have had to apply some low-level control technologies to meet the current standards, the current federal standards require a technology mix comparable to the pre-catalyst stage for passenger cars. The standards that took effect starting in the 1980 model year precipitated the elimination of highway two-stroke engines and a transition to a fleet composed entirely of four-stroke engines. In general, the standards prompted the use of leaner air-fuel mixtures, electronic ignition systems, improvements in manufacturing tolerances in the carburetor and fuel handling systems, PCV valves to control crankcase emissions, and some engine redesign and modifications (changes to the camshaft, valve and ignition timing, and combustion chamber design).

2. California Standards

Despite the greater stringency of the current California standards (*i.e.,* those that apply in the current model year), most manufacturers have been able to comply without the use of catalytic converters, and only a few expensive high-performance motorcycles have used fuel injection systems. The majority of motorcycles have been able to meet these standards by using, in addition to the measures noted above for the federal standards, engine modifications and more advanced calibration strategies, with air injection systems being commonly used in the larger motorcycle models. A few models have been certified with 3-way catalytic converters and fuel injection systems.

The Tier 1 and Tier 2 standards taking effect in California in 2004 and 2008, respectively, will require some additional technologies.[51] Many of the control technologies that have been applied successfully to four-stroke engines in passenger cars may have some potential application to four-stroke motorcycle engines. Some, such as fuel injection and catalytic converters, have already been successfully used on some motorcycle engines, as noted above. Other passenger car technologies may arrive on motorcycles soon due to the upcoming California requirements. However, California did not base the Tier 1 standard effective in 2004 on the widespread application of catalytic converters. California has determined the 1.4 g/km $HC+NO_X$ standard will be largely feasible by reducing engine-out emissions using mostly engine systems (*e.g.*, fuel injection, pulse air injection, valve overlap changes), rather than relying on catalytic after-treatment. According to California, the Tier 2 standard will be more of a challenge to industry and existing technologies are likely to be modified and optimized for motorcycle application to achieve 0.8 g/km $HC+NO_X$. They claim that such technologies could include computerized fuel injection, high-efficiency closed-loop two- or three-way catalytic converters, precise air-fuel ratio controls, programmed secondary pulse-air injection, low-thermal capacity exhaust pipes, and others which are available today or in the foreseeable near future. California has also suggested that some manufacturers may be able to meet the Tier 2 standards on some models without the use of catalytic converters.

D. Standards and Program Approaches

We have identified a number of key issues and decision points that may impact any action we may take regarding standards for highway motorcycles. We request detailed comments and data regarding the issue areas described in this section.

1. Exhaust Emission Standards

In general we request comment on the technological feasibility, cost, and appropriateness of implementing new more stringent emission standards for highway motorcycles. We also request comment on technologies that might enable reductions in motorcycle emissions, and the potential magnitude of such reductions. We request comment on the appropriate time frame for implementing new emission standards for highway motorcycles. In addition, we request detailed comments on the following specific issue areas.

Harmonization with California. In many program areas, including light-duty and heavy-duty vehicles and engines, harmonization with California has frequently been a significant objective, and is often a desirable outcome for industry. When federal and California compliance programs are harmonized, manufacturers are more easily able to produce engine families that comply with both programs, rather than having to consider whether or how to design and market engine families separately for California and the remaining 49 states. In addition, historically any time the California program is significantly more stringent than the federal program there is a possibility that some individual states will elect to enforce the California program (as several states currently do with light-duty vehicles), further complicating compliance, marketing, and distribution for the manufacturers. Given that California has recently put in place technologically challenging standards for Class III motorcycles in a time frame that we would be likely to consider for a possible federal program, we are likely to look very closely at the pros and cons of harmonizing the federal program with the recently finalized California standards. We request comment on all aspects of the California program and whether the California standards are appropriate for a nationwide federal program. Commenters should address technological feasibility, cost, corresponding potential emissions reductions, appropriate time frame, structure (*e.g.*, a fleet average approach vs. something else), and potential advanced emission control technologies associated with California-level standards and with any other level of standards a commenter may consider appropriate.

As noted earlier, the recent action by California did not address emissions from Class I and Class II motorcycles. We request comment on the need to consider emission reductions from all classes of motorcycles, including Class I and Class II.

Harmonization with off-highway motorcycles. Since we will be promulgating emission standards for off-highway motorcycles for the first time, it may make sense to have standards that apply to both, off-highway and on-highway motorcycles. This could be beneficial for manufacturers that produce both types of motorcycles, since they could spread their resources across both programs. In addition, the experience and knowledge used in developing emission compliant highway motorcycles could possibly be transferred to off-highway motorcycle applications. However, we also acknowledge that many off-highway motorcycles use two-stroke engines, where two-stroke engines are no longer used in highway applications and some of the information used in meeting highway standards may not be applicable. Therefore, we request comment on the appropriateness of harmonization of highway and off-

[51] California Air Resources Board, ''Final Statement of Reasons for Rulemaking,'' December 10, 1998.

highway motorcycle emission standards and the costs and corresponding emissions reductions associated with this approach.

2. Test Cycle

The test cycle currently used to for compliance with the motorcycle emission standards, in both the federal and California programs, is the FTP–75. Motorcycles are tested on a specialized motorcycle chassis dynamometer on the traditional FTP, the same cycle used for light-duty vehicles and trucks, although the driving schedule speeds and accelerations are reduced for Class I and II motorcycles. It is now widely acknowledged that the traditional FTP does not adequately represent some high-emission modes that vehicles experience in actual use. When the cycle was first adopted for passenger cars in the early 1970's, the limited capabilities of the chassis dynamometers at that time made it necessary to limit the speeds and acceleration rates of the driving cycle. Thus, the top speed and acceleration rates seen on the FTP are much less than most vehicles—especially motorcycles—can achieve on the road. Consequently, we request comment on whether the existing US06 driving cycle for light-duty vehicles and trucks—or some other more representative driving cycle—may be appropriate for highway motorcycles, and if so, what standards might be appropriate. We request data on how motorcycles are driven in actual use that might support or reject the appropriateness of a high-speed/high-acceleration driving cycle for motorcycles.

In addition, there is an effort underway under the auspices of the United Nations/Economic Commission for Europe (UN/ECE) to develop a global harmonized world motorcycle test cycle (WMTC). The objective of this work is to develop a scientifically supported test cycle that accurately represents the in-use driving characteristics of motorcycles. The United States is also a participating member of UN/ECE. EPA has stated that present levels of environmental protection will not be lowered in order to achieve regulatory harmonization. In its recent proposal, the European Commission has announced its intention to consider a global test cycle for the second phase of its proposed standards, expected to take effect in 2006. We request comment on all issues related to pursuing a globally harmonized test cycle.

3. Evaporative Emission Standards

As noted earlier, the existing federal program does not require compliance with a limit on evaporative emissions from motorcycles, while California does. We request comments and supporting information on the appropriateness of harmonization with the California evaporative standards or whether other evaporative emission standards might be an appropriate element of the federal program. We also request comment on the costs and corresponding emissions reductions associated with adopting evaporative emission standards.

E. Additional Program Considerations

1. Addressing Currently-Excluded Vehicles

In addition, we may consider developing appropriate standards for those types of vehicles now excluded from compliance with emission standards. This would include mopeds and scooters that are under 50 cc or that otherwise can not meet the applicability criteria in the regulations (a mix of two- and four-stroke engines). As noted earlier, some of these vehicles do not meet the regulatory definition of motor vehicle by not being able to exceed 25 mph, thus it may be appropriate to consider such vehicles as nonroad vehicles and may be appropriate to regulate them under the recreational vehicle regulations. We request comment on the appropriateness, technological feasibility, and cost of implementing emission standards for these currently unregulated vehicles. We request comment on approaches to reducing emissions from these types of vehicles, and on the technologies that might be used to reduce emissions, both for two- and four-stroke models.

2. Consumer Modifications

A significant issue that emerged in the context of the new California standards is the rate at which consumers make modifications to their motorcycles, often using aftermarket parts, to enhance performance, sound, and/or appearance. The Motorcycle Industry Council expressed a concern to California that standards which result in the widespread use of catalysts will achieve less benefits than projected due to consumer tampering with the exhaust systems. Such tampering, which can frequently involve the replacement of exhaust pipes that may include the removal of the catalytic converter, can clearly offset a significant portion of the emission benefits. We request comment on this issue, and in particular request any data that may demonstrate the magnitude of these consumer practices. We request comment on approaches to standard-setting that may mitigate this problem while also enabling motorcycles to take advantage of proven technologies such as catalytic converters.

3. Small Volume Manufacturers

The issue of how to define a small volume manufacturer by regulation was also a significant one that arose in the context of the new California standards. Motorcycle manufacturers with fewer than 500 employees meet the current definition of a small business under the classifications established by the Small Business Administration. The current federal regulations define a small volume motorcycle manufacturer as one whose projected U.S. sales of motorcycles is less than 10,000 units. We request comment on how the existing federal definition may interact with the new California definition, and whether, in the context of the new California definition (described earlier), any inequities are created between the two motorcycle compliance programs. We request comment on the appropriateness of the existing federal definition, and, in the context of revised federal standards, what types of compliance flexibilities might be appropriate for those manufacturers defined as small volume.

4. Useful Life

As noted earlier, the current federal standards were put in place more than twenty years ago. An important aspect of the overall emission standards, in addition to the numerical limits, is the vehicle useful life over which applicability with the standards must be demonstrated when the vehicle is certified. The current useful life definitions, like the numerical emission limits, were put in place twenty years ago. In conjunction with evaluating the possibility of revising emission standards for highway motorcycles, we believe it may be appropriate to reevaluate the useful life definitions in the context of current technology and driving habits. As is clearly the case with passenger cars, motorcycles may have evolved in the last twenty years to last longer and be driven more miles. Congress found it necessary to increase the useful life of passenger cars in the 1990 Clean Air Act Amendments from 50,000 miles to 100,000 miles based on the longevity of newer passenger cars. It may be time for a similar adjustment for highway motorcycles as design and manufacturing improvements may have extended the typical operating life of highway motorcycles. We request comments and supporting data that may support or refute the need to evaluate and possibly extend the useful life of highway motorcycles. The current useful life definitions are shown in Table IV–6.

TABLE IV–6.—USEFUL LIFE DEFINITIONS FOR MOTORCYCLE CLASSES

Motorcycle class	Useful life
Class I	5 years or 12,000 km (7,456 miles).
Class II	5 years or 18,000 km (11,185 miles).
Class III	5 years or 30,000 km (18,641 miles).

V. Recreational Marine Engines

A. Background

1. What Marine Engines Are Already Covered by EPA Programs?

We originally proposed emission standards for all marine engines in 1994.[52] This included outboard and personal watercraft engines, sterndrive and inboard spark-ignition engines, and recreational and commercial compression-ignition engines. EPA then decided to set standards for marine diesel engines in a separate rulemaking because of the many unique issues related to those engines. Because uncontrolled sterndrive and inboard spark-ignition engines appeared to be a low-emission alternative to outboard engines in the marketplace, even after outboard emission standards were fully phased in, we decided to set emission standards only for outboard and personal watercraft engines.[53] Outboard and personal watercraft engines were almost all two-stroke engines with much higher emission rates compared to the sterndrive and inboard engines which were all four-stroke engines. We are now working to conclude the effort to set emission standards for SI marine engines as we develop a different set of requirements for sterndrive and inboard SI engines.

Following the 1994 proposal, we set Tier 2 and Tier 3 standards for land-based nonroad diesel engines and marine diesel engines rated below 37kW.[54] This led us to propose comparable emission control requirements for larger marine diesel engines.[55] Although all marine diesel engines were included in the 1998 ANPRM, EPA decided to subdivide marine diesel engines further to accommodate the special concerns that apply to engines used in recreational marine applications.[56] These special concerns included high power-to-weight ratios needed for planing vessels and potential small business impacts. We have finalized emission standards for commercial marine diesel engines and are now developing requirements for recreational marine diesel engines.[57]

2. What Marine Engines Are Included in This Rulemaking?

In this action, we are giving advance notice for our proposal to establish emission standards for new spark-ignition sterndrive and inboard marine engines and new compression-ignition recreational marine engines at or above 37 kW. For spark-ignition engines, this includes jet boat and air boat engines, as these can be similar to sterndrive and inboard engines and thus are part of the sterndrive/inboard (SD/I) class. These are the only recreational marine engines for which we have not yet promulgated emission standards.

For the compression-ignition engines, we are focusing on reductions in oxides of nitrogen and particulate matter emissions. For the spark-ignition engines we are focusing on reductions in oxides of nitrogen and hydrocarbon emissions.

References to ''marine diesel engines'' in this document are intended to cover compression-ignition marine engines. CI engines are typically operated on diesel fuel although other fuels, such as compressed natural gas, may also be used. Similarly, all references to ''gasoline marine engines'' in this document are intended to include all spark-ignition marine engines regardless of fuel type. For SI engines, we include all of the engines listed above without making a distinction between recreational and commercial applications. However, as a shorthand for this document, we are using ''recreational marine engines'' to mean recreational marine diesel engines and all of the gasoline SD/I engines.

Boat builders could also be affected by this emission control program. If engine changes significantly increase the external size, increase heat rejection, or reduce the power of the engine, boat builders could have to change the packaging of the engine in the vessel. Engine builders may raise the price of the engine to boat builders to cover the increased costs of developing, certifying and building new compliant engines. Also we are requesting comment on evaporative emission control which could affect boat designs.

B. Technology

1. What Technologies Appear To Be Available for Recreational Marine Diesel Engines?

We anticipate that significant emissions reductions from recreational marine diesel engines can be achieved primarily with technology that will be applied to land-based nonroad engines and commercial marine engines. Much of this technology already has been established in highway applications and is being used in some land-based nonroad and marine applications.

If emissions standards were not to go into place until the 2005–2006 time frame, engine manufacturers would have substantial lead time for developing, testing, and implementing emission control technologies. This lead time, coupled with the opportunity to use emission control technologies already developed for land-based nonroad engines, should allow time for a comprehensive program to integrate the most effective emission control approaches into the manufacturers' overall design goals related to durability, reliability, and fuel consumption. We request comment on the amount of lead time that would be appropriate for emission standards for recreational marine diesel applications.

Engine manufacturers have already shown some initiative in producing limited numbers of low-NO_X marine diesel engines. More than 80 of these engines have been placed into service in California through demonstration programs.[58] [59] Through the demonstration programs, we were able to gain insight into what technologies can be used to achieve significant emission reductions. Emission data from these engines supported adoption of emission standards for commercial marine diesel engines (see Table V–1).

Highway engine manufacturers have been the leaders in developing and applying new emission control technology for diesel engines. Because of the similar engine designs in land-based nonroad and marine diesel engines, we expect that much of the technological development that has led to lower emitting highway engines can be transferred or adapted for use on land-based nonroad and marine engines. Much of the improvement in emissions

[52] *See* 59 FR 55929 (November 9, 1994).

[53] *See* 61 FR 52088 (October 4, 1996).

[54] *See* 63 FR 56968 (October 23, 1998).

[55] *See* 63 FR 68508 (December 11, 1998).

[56] *See* 63 FR 28309 (May 22, 1998).

[57] *See* 64 FR 73300 (December 29, 1999).

[58] Memorandum from Jeff Carmody, Santa Barbara County Air Pollution Control District, to Mike Samulski, U.S. Environmental Protection Agency, ''Marine Engine Replacement Programs,'' July 21, 1997 (Docket A–97–50; document II–G–10).

[59] Facsimile from Eric Peterson, Santa Barbara County Air Pollution Control District, to Mike Samulski, U.S. Environmental Protection Agency, ''Marine Engine Replacement Programs,'' April 1, 1998 (Docket A–97–50; document II–D–14).

from these engines comes from ''internal'' engine changes such as variation in fuel injection variables (injection timing, injection pressure, spray pattern, rate shaping), modified piston bowl geometry for better air-fuel mixing, and improvements intended to reduce oil consumption. Introduction and ongoing improvement of electronic controls have played a vital role in facilitating many of these improvements.

Other technological developments that are expected to be used on land-based nonroad engines would require a greater degree of development before they could be applied to marine diesel engines. Turbocharging is widely used now in marine applications because it improves power and efficiency by compressing the intake air. Turbocharging may also be used to decrease particulate emissions in the exhaust. Today, marine engine manufacturers generally have to rematch the turbocharger to the engine characteristics of the marine version of a nonroad engine and often will add water cooling (jacketing) around the turbo housing to keep surface temperatures low. Once the Tier 2 nonroad engines are available to the marine industry, matching the turbochargers for the engines would be an important step in achieving low emissions.

Aftercooling is a well established technology that can be used to reduce NO_X by reducing the temperature of the charge air after it has been heated during compression. Reducing the charge air temperature directly reduces the peak cylinder temperature during combustion, which is the primary cause of NO_X formation. Air-to-water and water-to-water aftercoolers are well established for land-based applications. For engines in marine vessels, there are two different types of aftercooling used: jacket-water and raw-water aftercooling. With jacket-water aftercooling, the coolant to the aftercooler is cooled through a heat exchanger by ambient water. This cooling circuit may be either the same circuit used to cool the engine or a separate circuit. By moving to a separate circuit, marine engine manufacturers would be able to achieve further reductions in the intake charge temperature. This separate circuit could result in even lower temperatures by using raw water as the coolant. This means that ambient water is pumped directly to the aftercooler. Raw-water aftercooling is currently being used widely in recreational applications. Because of the access that marine engines have to a large ambient water cooling medium, we anticipate that marine CI engine manufacturers will largely achieve reductions in NO_X emissions through the use of aftercooling.

To meet potential emission standards, recreational marine diesel engine manufacturers could use many of the strategies discussed above. Electronic controls also offer great potential for improved control of engine parameters for better performance and lower emissions. Unit pumps or injectors would allow higher-pressure fuel injection with rate shaping to carefully time the delivery of the whole volume of injected fuel into the cylinder. Marine engine manufacturers should be able to take advantage of modifications to the routing of the intake air and the shape of the combustion chamber of nonroad engines for improved mixing of the fuel-air charge. Separate circuit jacket- and raw-water aftercooling will likely gain widespread use in turbocharged engines to increase performance and lower NO_X. We request comment on the technological approaches discussed here and on other emission control technology that could effectively be used on recreational marine diesel engines. We also request comment on the costs associated with these technologies.

2. What Technologies Appear To Be Available for Spark Ignition SD/I Marine Engines?

At least three primary technologies could be used by marinizers to reduce emissions from SD/I engines.[60] These three technologies are electronic fuel injection, exhaust gas recirculation, and two-way or three-way catalysts. Electronic control gives manufacturers more precise control of the air/fuel ratio in each cylinder thereby giving them greater flexibility in how they calibrate their engines. With the addition of an oxygen sensor, electronics give manufacturers the ability to use closed loop control which is especially valuable when a catalyst is used. Three-way catalysts operate best near stoichiometric conditions in the exhaust.

Exhaust gas recirculation can be used for meaningful reductions in NO_X. The recirculated gas acts as a diluent in the fuel-air mixture which reduces combustion temperature. These lower temperatures significantly reduce formation rate of NO_X, but HC is increased slightly due to lower temperatures for HC burn-up during the late expansion and exhaust strokes. Depending on the burn rate of the engine and the amount of recirculated gases, EGR can improve fuel consumption. Although EGR slows the burn rate (which tends to decrease peak power), it can offset this effect with some benefits for engine efficiency. EGR reduces pumping work since the addition of recirculated gas increases intake pressure. Because the burned gas temperature is decreased, there is less heat loss to the exhaust and cylinder walls. In effect, EGR allows more of the chemical energy in the fuel to be converted to useable work.

Most engines sold to the marine market are primarily designed for automotive use. Marinizers then take the basic engine blocks and adapt them to be better suited for the marine environment. These engines are generally already equipped with a port in the manifold for EGR. This port is capped because EGR is not currently used in marine engines. However, EGR has been used as an effective NO_X control strategy in automotive applications for more than 20 years. Today's automotive applications use levels of 15–17 percent EGR. Through the use of high swirl, high turbulence combustion chambers, manufacturers could increase the burn rate of the engine. By increasing the burn rate, the amount of EGR could be increased to 20–25 percent. In our lab, we calibrated a heavy-duty highway gasoline engine for emissions over the ISO E4 marine duty cycle.[61] We achieved a 47 percent reduction in NO_X without significantly changing HC or CO emissions. The result was 9.9 g/kW-hr HC+NO_X and 24.3 g/kW-hr CO.

With regard to emissions reductions through catalytic control, we are considering various designs that involve packaging small catalysts in the exhaust manifold with only small changes in the size of the exhaust manifold. By placing the catalysts here, costs to the manufacturer may be reduced compared to a large catalyst downstream especially when considering the packaging of the system in a boat. Engine manufacturers water jacket the exhaust manifold to meet temperature safety protocol then mix the water into the exhaust to protect the exhaust couplings and muffle noise. By placing the catalyst in the exhaust manifold, it is upstream of where the water and exhaust mix. However, placing the catalyst in the exhaust manifold limits the catalyst size. Using a small catalyst,

[60] We use the term ''marinizers'' to mean manufacturers who take engine blocks designed for land-based applications and prepare them for marine applications.

[61] Memo from J. McDonald and M. Samulski, ''EGR Test Data from a Heavy-Duty Gasoline Engine on the E4 Duty Cycle,'' July 12, 1999.

in turn, limits potential emissions reductions. We request comment on the potential emission reductions available by a small catalyst placed in or directly adjacent to the exhaust manifold.

There have been concerns that aspects of the marine environment could result in unique durability problems for catalysts. The primary aspects that could affect catalyst durability are sustained operation at high load, salt water effects on catalyst efficiency, thermal shock from cold water coming into contact with a hot catalyst, engine vibration, and shock effects in rough water associated with marine applications.

Three-way catalysts may be an effective control strategy for gasoline marine engines. Three-way catalysts act as both an oxidation catalyst to reduce HC, CO and as a reduction catalyst to control NO_X. They are most effective when coupled with an oxygen sensor and a feedback loop to maintain a stoichiometric exhaust mixture. As an alternative, a two-way oxidation catalyst could be used effectively with less precise control of the air fuel ratio in the exhaust. Today's catalysts perform well at temperatures higher than would be seen in a marine exhaust manifold and have been shown, in the lab, to withstand the thermal shock of being immersed in water. Use of catalysts in automotive, motorcycle, and hand-held equipment has shown that catalysts can be packaged to withstand the vibration in the exhaust manifold in varied applications. We request comment on how the operation of marine engines would affect catalyst durability.

The key to using this technology in these marine applications is to ensure that salt water does not reach the catalyst so that salt does not accumulate on the catalyst and reduce its efficiency. Placement of the catalyst close to the exhaust manifolds may help protect it from salt water. Manufacturers already strive to design their exhaust systems to prevent water from reaching the exhaust ports. If too much water reaches the exhaust ports in today's designs, significant durability problems would result from corrosion or hydraulic lock. We request comment on potential design modifications which could eliminate or significantly minimize water intrusion into the exhaust which could deteriorate the performance of the catalyst.

In highway applications, catalysts are designed to operate in gasoline vehicles for more than 100,000 miles. This translates to about 5,000 hours of use on the engine/catalyst. We estimate that, due to low annual hours of operation (50–100 hours/year), the average running time of SD/I engines is less than one-third of this value. This is another reason we believe catalysts are likely to be durable in marine applications. However, unlike cars, boats often experience shock effects from waves even when the engine is not running which could affect the durability of a catalyst that was not packaged appropriately.

We have been working with the U.S. Coast Guard to identify potential safety problems with using catalysts in marine applications. The Coast Guard has told us that they have two concerns. First, they want to make sure that any additional heat load in the engine compartment will not add to the risk of fires, other safety hazards, or other detrimental impacts on the engine or components. Second, they want to make sure that exhaust systems with catalysts will not lead to CO leaks due to additional joints in or maintenance of the exhaust system.

Through a joint effort with the California Air Resources Board (ARB), Southwest Research Institute (SwRI), engine manufacturers/marinizers, catalyst manufacturers, and a marine exhaust manifold manufacturer, we are in the process of developing and testing a comprehensive emissions control system on a SD/I engine. This system includes both EGR and catalyst technology. The goal of this testing is proof of concept, but as part of this testing, temperatures and pressures relevant to safety, durability, and performance will be measured. Also, we are focusing on an exhaust manifold design that will prevent water reversion to the catalyst.

We request comment on the feasibility of applying electronic fuel injection, exhaust gas recirculation, and catalysts on SD/I engines and on other technology that could effectively be used to reduce emissions from these engines. We also request comment on the costs and corresponding potential emission reductions from using such technology, as well as the potential effects on engine performance, safety and durability using these technologies.

C. Standards and Program Approaches

1. Recreational Marine Diesel Engines

One approach for reducing emissions from recreational CI marine engines would be to propose standards similar to the Tier 2 standards for commercial CI marine engines. The commercial marine emission limits are presented in Table V–1 and are based on the ISO E3 duty cycle. For recreational marine engines the ISO E5 duty cycle may be more appropriate because it is designed for smaller craft. Recreational CI marine engines can likely use the same technologies projected for the Tier 2 commercial marine standards. Many recreational CI marine engines are already using these technologies including electronic fuel management, turbocharging, and separate circuit aftercooling. In fact, because recreational engines have much shorter design lives than commercial engines, it is likely to be easier to apply raw water aftercooling to these engines.

TABLE V–1.—EMISSION STANDARDS FOR COMMERCIAL MARINE DIESEL ENGINES OVER 37 kW

Subcategory	$HC+NO_X$ g/kW-hr	PM g/kW-hr	CO g/kW-hr
disp < 0.9	7.5	0.40	5.0
0.9 ≤ disp < 1.2	7.2	0.30	5.0
1.2 ≤ disp < 5.0	7.2	0.20	5.0

Engine manufacturers will generally increase the fueling rate in recreational engines, compared to commercial engines, to gain power from a given engine size. This extra power from a given sized engine helps bring a planing vessel on to the water surface and increases the maximum vessel speed without increasing the weight of the vessel. This difference in how recreational engines are designed and used has an effect on emissions. However, as discussed in the technology section below, emission data suggest that recreational marine diesel engines can meet the levels required for commercial marine engines. We request comment on the appropriateness of the commercial marine emission limits for recreational marine engines. We also request comment on the appropriate test duty cycle for these limits.

Diesel engine manufacturers have commented that they would need time after the commercial marine standards go into place to transfer technology from commercial to recreational marine engines. The standards for the commercial marine rule go into effect in the following model years by engine cylinder displacement: 2004 for 0.9 to 2.5 liters per cylinder, 2005 for smaller engines, and 2007 for larger engines. These dates are after those for the nonroad land-based standards which gives manufacturers time to transfer the land-based technology to marine applications.

An implementation date of 2005 for engines with displacement less than 2.5 liters/cylinder would give a year of lead time beyond the emission standards for commercial engines. However, this lead time may not be necessary because much of the technology that could be used to reduce emissions is already used in some recreational marine diesel engine models; these engines would just need to be calibrated for reduced emissions. Many recreational marine diesel engines with displacement over 2.5 liters/cylinder in many cases also already use the anticipated emission-control technologies. An implementation date of 2007 for these engines may therefore provide adequate lead time, even though the emission standards for commercial engines start at the same time. We request comment on appropriate implementation dates for recreational marine diesel engines.

2. SD/I Marine Engines

In determining potential $HC+NO_X$ standards for sterndrive and inboard SI marine engines, we will be evaluating emission reductions that can be achieved using electronic fuel injection, exhaust gas recirculation, and catalysts designed to work in marine applications. Catalyst exhaust systems designed for marine applications would have to ensure that salt-water did not reach the catalyst. In addition, it would be preferable for the exhaust system to be compact so that it would fit in current boat designs. This may necessitate locating a small catalyst in the exhaust manifold or directly adjacent to it, limiting the catalyst size and therefore its ability to reduce engine emissions.

Even if only a small, low-efficiency catalyst could be packaged into SD/I exhaust systems, an $HC+NO_X$ standard of 5–7 g/kW-hr may be feasible based in the ISO E4 duty cycle. Given the information in Table V–1, a standard of 7.2 g/kW-hr for $HC+NO_X$ would provide some level of equity of emission control for gasoline and diesel engines. However, if larger, more efficient catalysts were used such as in automotive applications, much larger emission reductions could be achieved. In its September 19, 2000 workshop, the California Air Resources Board proposed standards of 9.4 g/kW-hr $HC+NO_X$ and 134 g/kW-hr CO in 2003 and 4 g/kW-hr $HC+NO_X$ and 50 g/kW-hr CO in 2007. We request comment on the potential use of larger, more efficient catalysts in SD/I applications and on appropriate emission limits.

We are in the process of developing and testing a catalyst system for SD/I engines, but we do not have data from the tests at the time of this notice. Our projected emission reductions from catalyst systems are based on our evaluation of information from catalyst manufacturers and observations of the success of catalytic control in land-based applications. Because we do not yet have complete data, we request comment on basing emissions standards on technology packages with and without catalytic control. Using electronic fuel injection and exhaust gas recirculation, an emission limit of 9–10 g/kW-hr of $HC+NO_X$ may be appropriate.

We will be evaluating varying levels of CO control. With the application of electronic fuel injection and electronic control, CO from SD/Is can be reduced, potentially to the range of 40–50 g/kW-hr. If manufacturers can produce engines that achieve these CO emission reductions over many years of operation, this may reduce the exposure of individual boaters to elevated ambient CO concentrations. In particular, this could reduce the occurrence of CO poisoning from people on or swimming near a boat while the engine is idling. Because reducing CO emissions could help reduce incidents of CO poisoning among boaters, we are also considering the need for a CO standard which would achieve significant CO reductions. With a catalyst, CO could be reduced further, perhaps to the range of 15–20 g/kW-hr. At a minimum, we see no reason for expecting emissions to increase. Therefore, we request comment on capping CO emission at baseline levels, approximately 130 g/kW-hr, to prevent backsliding. We also request comment on the technical feasibility and benefits from reducing CO levels and on what appropriate CO standards would be for SI SD/I engines.

We are considering the 2005 or 2006 time frame for the implementation of standards for SD/I engines. These dates are similar to the ones discussed above for recreational marine diesel engines. However, we recognize that SD/I marinizers would need time to apply new technologies to their engines and optimize the systems for emissions control. Depending on the level of eventual standards, this may be especially difficult for SD/I manufacturers because they may need to apply technologies, such as EGR and catalysts, that they have never applied to their engines. Therefore, we request comment on what lead time would be appropriate for SD/I engines.

D. Additional Program Considerations

1. Not-To-Exceed Requirements

Our goal is to achieve control of emissions over the broad range of in-use speed and load combinations that can occur on a recreational marine engine so that real-world emission control is achieved, rather than just controlling emissions under certain laboratory conditions. An important tool for achieving this goal is an in-use program with an objective standard and an easily implemented test procedure. Therefore we are requesting comment on extending the not-to-exceed requirements in place for commercial marine engines to recreational marine engines.

The not-to-exceed (NTE) concept includes an area under the torque map where an engine could reasonably be expected to operate in use. Within this area the engine can not exceed a fixed limit. The limit may be different for different areas of the NTE zone. The NTE zone not only includes a wide range of operation, but also a wide range of ambient conditions.

We expect that NTE requirements for recreational CI marine engines would be very similar to those for commercial CI marine engines (64 FR 73300) because the engines are similar. However, the limits may need to be different within the NTE zone due to differences in the engine applications. For example, a higher limit near full power may be necessary for recreational engines. For SI engines, the NTE zone would likely need to be a different shape to coincide with the differences between the ISO E5 and ISO E4 test procedures. Also, because EGR technology is not as efficient at high power as at lower power, a higher limit may be necessary at high power. We request comment on how the NTE concept could be applied to recreational marine engines. We also request comment on alternative approaches for ensuring real world emission control from recreational marine engines.

2. Evaporative Emissions

We request comment on whether or not we should propose evaporative emission requirements for recreational marine engines and what those requirements should be. Vessels using gasoline marine engines emit high amounts of volatile hydrocarbons per gallon of fuel consumed. According to our calculations, these evaporative emissions are several times higher than exhaust HC emissions. For diesel engines, evaporative emissions are very low due to the low vapor pressure of diesel fuel.

When the fuel is subject to increasing temperatures, such as daily temperature variation or engine heat, lighter hydrocarbon molecules evaporate and, if not stored or trapped in some fashion, will escape into the atmosphere. Marine fuel tanks are vented to the atmosphere to prevent pressure build up in the tank. Vapor levels on a boat can be so high that, for fire safety reasons, blowers are often needed to remove gasoline vapors from the engine compartment prior to starting the engine. Also vapors are displaced from the gas tank to the atmosphere during refueling. Finally, some emissions come from spillage during refueling.

In automotive applications, vapors generated in the fuel system are passed through a canister designed to capture evaporated hydrocarbons. When the engine is running, these hydrocarbons are drawn back into the engine and burned. However, this emission control technology would not be practical for marine applications. A boat may sit for weeks without being used while typical automotive canisters are only designed to capture a few hot days worth of evaporative emissions. After this amount of time, the canister must be purged to the engine. A canister/fuel system that could collect weeks worth of vapors and burn them in a few hours of operation probably would not be practical due to the canister size required.

Still, there may be practical alternatives to a canister system for boats. One such system could be a bladder-type fuel tank such as those used in race cars. The bladder contracts as the fuel is used to prevent a vapor space from forming.

Another technology that could reduce evaporative emissions to a lesser degree are non-permeable fuel lines. By replacing rubber fuel lines with non-permeable lines, the evaporative emissions through the fuel lines can be prevented. An added benefit is that these non-permeable lines are non-conductive and can prevent the buildup of static charges. Although non-permeable lines are used in automotive applications, these fuel lines would have to meet Coast Guard specifications for flame resistance and flexibility to be used in marine applications. We request comment on if non-permeable fuel lines exist that would meet the Coast Guard specifications and what their cost would be.

Currently, fuel systems on boats are vented to the atmosphere to prevent pressure buildup. The Coast Guard requires that fuel systems not be pressurized. If a low-pressure (2 psi) pressure relief valve were used with a closed system, much of the evaporative emissions could be reduced. This would still prevent the fuel system from building up too much pressure. We request comment on the effectiveness of this strategy with respect to ambient temperature, especially on hot days when the fuel tank pressure may be higher. Note that any eventual requirements related to fuel system pressure would need to be consistent with Coast Guard policies and requirements.

We request comment on safe pressures in fuel tanks and what typical fuel tank pressures would be if they were not vented to the atmosphere. We also request comment on the cost and effectiveness of non-permeable fuel lines, pressure relief valves, and other systems for reducing evaporative emissions. We also request comment on potential strategies for reducing emissions due to refueling or spillage. We request comments on any evaporative emission control systems such as those described above as well as comment on potential strategies for reducing emissions due to refueling or spillage.

Additionally, we request comment on how we could structure provisions to confirm the effectiveness of these systems. We would prefer to set up a performance-based standard such as the test procedures already in place for automobiles because it gives a better indication of control effectiveness that a design-based standard and it gives more design flexibility to the manufacture. However, we request comment on appropriate performance-based test procedures and on an appropriate design-based requirement.

3. Crankcase Emissions

We are requesting comment on whether or not to require that new recreational marine engines be built with closed crankcases to eliminate crankcase emissions. Crankcase controls have been required on cars and trucks. Controlling crankcase vapors requires a fairly simple and inexpensive technological strategy. A line is routed from the crankcase to the intake manifold with a pressure control valve which will prevent crankcase overpressure and will prevent air from flowing into the crankcase. Some SI marine engine already route crankcase vapor to the air intake to minimize vapor buildup in the engine compartment.

For turbocharged diesel engines, there is some concern that routing the crankcase vapor upstream of the turbocharger could foul the turbocharger. In addition, it would be more costly to route the low pressure crankcase vapor downstream of the turbocharger because an extra pump would be necessary. An alternative would be to allow turbocharged recreational compression-ignition marine engines to be built with open crankcases, provided the crankcase ventilation system is designed to allow crankcase emissions to be measured. For engines with open crankcases, we could require crankcase emissions to be either routed into the exhaust stream to be included in the exhaust measurement, or to be measured separately and added to the measured exhaust mass. These measurement requirements might not add significantly to the cost of testing, especially where the crankcase vent is simply routed into the exhaust stream prior to the point of exhaust sampling. This concept is consistent with our previous regulation of crankcase emissions from such diverse sources as commercial marine engines, locomotives and passenger cars. We request comment on the above concepts.

4. Regulatory Flexibility

Marinizers are engine manufacturers that take land-based engines and convert them to be used in marine applications. In some cases, marinizers use certified land-based engines and make changes without changing their emission levels. We consider these marinizers to be ''engine dressers,'' and we believe that forcing these manufacturers to certify their engines may be unnecessary. We intend to offer similar engine dresser provisions for recreational marine engine marinizers as exist for commercial marine engine marinizers who are not required to certify (40 CFR part 94). We request comment on these provisions as they apply to recreational marine engine marinizers.

The scope of this advance notice also includes a number of engine marinizers that have not been subject to our regulations or certification process and would not qualify as engine dressers.

The majority of these marinizers are small businesses for which a typical regulatory program may be overly burdensome. One challenge of this rule is to implement a flexible regulatory program while still ensuring significant emission reductions. We request comment on appropriate regulatory flexibility strategies for small volume engine marinizers that will minimize harmful impact on the environment.

We request comment on what should be the definition of a small volume engine manufacturer/marinizer for the purpose of potential regulatory flexibility. The Small Business Administration defines a small business (manufacturing internal combustion engines) as one that employs less than 1000 people. Because the purpose of the regulatory flexibility is to reduce the burden on companies for which fixed costs cannot be distributed over a large number of engines, we believe that the small volume engine manufacturer definition should also consider the number of engines for sale in the U.S. in a year. This production count would include all engines (automotive, other nonroad, etc.) and not just recreational marine engines. Based on confidential sales information supplied by engine marinizers and our own evaluations of certification and development costs, we estimate that the upper limit for the numbers of engines that a company could produce and still be considered a small volume engine manufacturer might be in the range of 8,000 to 12,000 units per year. This would include the majority of marinizers. To establish this threshold, we would make an assessment of the ability of these companies to amortize development costs over smaller sales volumes.

The large number of boat builders and their relative inexperience with emission control requirements also suggest a need for a flexible implementation process. Although boat builders would not be directly subject to emission standards under a potential program unless evaporative emission control were required, it would still be possible for them to need to redesign the engine compartments on some boats if engine designs were to change significantly. We request comment on how to best determine the extent to which engine technologies discussed above would necessitate changes in boat design. We also request comment on regulatory flexibility strategies for small volume boat builders that will minimize harmful impact on the environment.

We request comment on what should be the definition of a small volume boat builder for the purpose of potential regulatory flexibility. Because the flexibility is designed to reduce the burden on companies for which fixed costs cannot be distributed over a large number of vessels, we believe it may be appropriate to include in the definition of a small volume boat builder an upper limit on the production of boats for sale in the U.S. in one year. This production count would include all power craft recreational boats. We request comment on this approach.

We have been in contact with several small volume engine marinizers and boat builders in an attempt to develop concepts that would reduce the burden of emissions standards while minimizing environmental loss. In fact, we convened a Small Business Advocacy Review Panel under section 609(b) of the Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act of 1996. To date, these efforts have identified several flexibility concepts for small volume engine manufacturers and for small volume boat builders. We presented several flexibility concepts to small-business representatives during the SBREFA process.[62] These concepts are listed in Table V–2. We request comment on the appropriateness of these ideas and on others for minimizing burden on small businesses while still reaching the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available, giving appropriate consideration to cost, lead time, noise, energy, and safety factors.

TABLE V–2.—SMALL BUSINESS REGULATORY FLEXIBILITY CONCEPTS FOR RECREATIONAL MARINE

Small volume engine marinizers	Small volume boat builders
Broaden engine families	Percent of production exemption.
Minimize compliance requirements	Small volume allowance. Existing inventory and replacement engine allowance.
Expand engine dresser flexibility	
Design-based certification	Hardship provisions
Delay standards for 5 years	
Hardship provisions	
Use of emission credits	

[62] "Preliminary EPA Staff Assessment of Small Business Flexibility Concepts," June 16, 1999, Docket A–2000–01, document II–B–03.

5. Definition of Recreational CI Marine Engines

When we finalized standards for commercial marine engines last year, we included a definition of recreational compression-ignition marine engines. This was based on the U.S. Coast Guard definition of recreational vessels. This definition states that a compression-ignition propulsion marine engine intended by the manufacturer to be installed on a recreational vessel and labeled as a recreational engine would be considered recreational for EPA regulations in 40 CFR part 94. A recreational vessel is one that is intended by the vessel manufacturer to be operated primarily for pleasure but does not include the following vessels:

—Vessels less than 100 gross tons that carry six or more paying passengers
—Vessels greater than 100 gross tons that carry one or more paying passengers
—Vessels used solely for competition

Diesel engine manufacturers have since commented that they would like to see a less restrictive definition of recreational vessel. Their proposed definition is as follows: "Recreational marine engine means a propulsion marine engine that is intended by the manufacturer to be installed on a recreational vessel. Recreational vessel means a vessel that is intended by the vessel manufacturer to be operated primarily for pleasure or leased, rented or chartered to another for the latter's pleasure." We request comment on the appropriate definition of a recreational marine engine.

6. Useful Life

When we set emission standards, we require that manufacturers produce engines that comply over their full useful life. For recreational marine engines, a useful life that lasts either ten years or until the engine accumulates at least 500 operating hours (or some other value of hours specified in a certificate of conformity), whichever occurs first, may be appropriate. In general, we would expect that the regulatory useful life should be at least as long as the operating lifetime for which the engine is designed. We request comment on this view.

Our current view that the appropriate minimum useful life may be at least 500 hours is based on manufacturer comments that typical recreational marine engines are used about 50 hours per year and for at least 10 years. However, Coast Guard survey data suggests that typical recreational marine engines are used about 100 hours per year.[63] In addition, we expect that typical recreational marine diesel engines are used more than this, especially those rated at several hundred horsepower. Purchasers of the more powerful marine diesel engines usually choose them over lower cost gasoline engines because diesel engines are generally designed to be more durable. Actual useful lives of existing engines are likely to vary with respect to application as well. Thus, we could propose a series of minimum useful life values based on rated application, engine cycle (*e.g.,* spark-ignited or diesel), or rated horsepower. However, we request information on in-use engine life and comment on the appropriate emissions compliance useful life for SI engines and CI engines; these useful life values may vary with engine size, especially for diesel engines.

In our emissions inventory calculations presented earlier in this document, we used a function of the engine population, load factors, annual hours of use, rated power, emission factors, turnover, and growth rates. For CI engines we used 200 hours per year and for SD/I engines, we used 48 hours per year. We are interested in more information, especially data, on the appropriateness of these estimates. Studies and industry comments have shown a wide range of average annual use—from 50 to 500 hours per year. We request information, especially reliable field data, on the annual and lifetime operating hours for these engines which may depend on SI versus CI design, engine size, and application.

7. Averaging, Banking, and Trading Credit Programs

We are considering an emissions averaging, banking and trading (ABT) program for recreational marine engines. This is a voluntary program which would allow a manufacturer to certify one or more engine families at emission levels above the applicable emission standards, provided that the increased emissions are offset by one or more engine families certified below the applicable standards. The average of all emissions for a particular manufacturer's production would have to be at or below the level of the applicable emission standards. In addition, credits could be traded with other companies or banked for future use.

An ABT program is an important factor that EPA takes into consideration in setting emission standards that are appropriate under section 213 of the Clean Air Act. ABT would allow us to consider a lower emissions standard, or one that otherwise results in greater emissions reductions, because ABT reduces the cost and improves the technological feasibility and cost-effectiveness of achieving a standard. For example, it could help to ensure the attainment of the standards earlier than would otherwise be possible. Manufacturers gain flexibility in product planning and the opportunity for a more cost-effective introduction of product lines meeting a new standard. ABT also creates an incentive for the early introduction of new technology, which allows certain engine families to act as trail blazers for new technology. This can help provide valuable information to manufacturers on the technology before manufacturers need apply the technology throughout their product line. This early introduction of clean technology improves the feasibility of achieving the standards and can provide valuable information for use in other regulatory programs that may benefit from similar technologies.

For recreational marine diesel engines, an ABT program would be similar to the one for commercial marine engines. We request comment on all aspects of an ABT program that would apply for recreational marine diesel engines.

We are concerned that an ABT program may not be appropriate for SI SD/I marine engines for three primary reasons. First, there are many small businesses which produce SI engines for the recreational marine market. There are also very few large businesses producing SI engines for this market. While the large businesses tend to have broad product offerings and could readily take advantage of the provisions of an ABT program, the small businesses tend to have much narrower product lines and would therefore be unlikely to benefit from ABT provisions. We are concerned that this situation would allow the large businesses a competitive advantage.

Similarly, we are concerned that most manufacturers of recreational SI engines do not have a broad enough product line to take advantage of an ABT program. Therefore, it may not be useful to the majority of businesses.

Third, the emission control technology discussed above appear to be equally applicable to all engines. Therefore, an ABT program may not be necessary except, perhaps, as a tool to help phase-in new technology. Adopting an ABT program in the long term may make sense if we were to conclude that a more stringent standard is feasible at least for some engines. We request comment on whether we should consider an ABT program for SI engines, and what, if any, restrictions we should place on such a program.

8. Applicability of MARPOL Annex VI

On September 27, 1997, the International Maritime Organization (IMO) adopted a new Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) and opened the Annex for acceptance by its members. This Annex, which contains regulations for the prevention of air pollution from ships, will go into force internationally one year after fifteen countries, representing at least 50 percent of the gross tonnage of the world's merchant shipping fleet, have ratified it. The Annex will acquire the force of law in the United States after it goes into force internationally and it is ratified by the United States, following approval of the Senate.

Regulation 13 of Annex VI requires that each diesel engine with a power output of more than 130 kW which is installed on a ship constructed on or after 1 January 2000, or each diesel engine with a power output of more than 130 kW which undergoes a major conversion on or after 1 January 2000 meet the NO_X limits described by the following formula:

17.0 g/kW-hr when n is less than 130 rpm

$45.0 * n^{(-0.2)}$ g/kW-hr when $130 \leq n < 2000$ rpm

9.8 g/kW-hr when $n \geq 2000$ rpm

Where n is rated engine speed (crankshaft revolutions per minute)

One of the issues that will be considered in our notice of proposed rulemaking is how these emission limits affect recreational engines and vessels. Because recreational vessels are included in the MARPOL definition of "ship," prudent recreational vessel manufacturers should have begun installing MARPOL-compliant engines in their newly-constructed vessels on January 1, 2000, even though the Annex has not yet gone into force.[64] This is because the Annex may be enforceable retroactive to January 1, 2000 once it goes into effect internationally. To facilitate this process, EPA established a voluntary compliance program whereby engine manufacturers may obtain a Statement of Voluntary Compliance from EPA after they provide evidence

[63] "1998 National Recreational Boating Survey Data Book," JSI Research & Training Institute, prepared for the U.S. Coast Guard, February 2000.

[64] Article 2 of MARPOL 73/78 defines "ship" as "a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms."

that their engine meets the Annex VI NO_X limits.[65]

To help us prepare our proposal for recreational engine emission requirements, we request comment on several questions. First, we request input on the extent to which recreational vessel builders are aware of the MARPOL requirements for marine diesel engines, and the extent to which they are attempting to comply with them. Second, we request comment on how many times a vessel with a marine diesel engine over 130 kW can be expected to change owners over its life. This information is important for compliance purposes. Third, we request comment on whether meeting the Annex VI NO_X limits will interfere with an engine manufacturer's ability to meet the more stringent national recreational marine diesel emission standards under consideration.

9. Harmonization With the European Commission

The European Commission has proposed emission limits for recreational marine engines, including both diesel and gasoline engines. These requirements would apply to all new engines sold in member countries. The numerical emission limits, shown in Table V–2, consist of the Annex VI NO_X limit for small marine diesel engines and the rough equivalent of Tier 1 nonroad emission levels for HC and CO. Emission testing is to be conducted using the ISO D2 duty cycle for constant-speed engines and the ISO E5 duty cycle for all other engines. Table V–2 also includes the proposed limits for gasoline engines tested on the ISO E4 duty cycle.

Industry and others have commented to us on the value of harmonization of emission standards. Manufacturers who sell engines in several countries can minimize costs by designing to a single set of standards. In setting standards under section 213 of the Act, EPA is required to consider technology, cost, energy, and other factors to achieve the greatest degree of emissions reductions achievable. We are concerned that these standards would do no more than cap emissions at baseline levels and are not the kind of appropriate technology-forcing standards that would allow us to achieve the greatest achievable reductions from this category. According to our data on 20 recreational CI marine engines (tested for both NO_X and PM) and 10 SI SD/I engines, average baseline emission levels already meet the proposed European limits. These baseline averages are included in Table V–3. We request comment on the level of stringency of the proposed European emission limits.

TABLE V–3.—PROPOSED EUROPEAN EMISSION LIMITS AND EPA BASELINE DATA FOR RECREATIONAL MARINE ENGINES (G/KW-HR)

Pollutant	CI limit[a]	CI baseline	SI limit[b]	SI baseline
NO_X	9.8	8.9	15	9.2
PM	1.4	0.2		
HC	1.5	0.3	6.4	5.7
CO	5.0	1.3	152	145

[a] HC limit increases slightly with increasing engine power rating.
[b] For 300 kW engine; HC and CO limits increase slightly with decreasing power rating.

10. Consumer Labeling

We request comment on the need for, effectiveness of, and alternatives to a consumer labeling program. The purpose of this program would be to educate consumers so that they could make informed decisions concerning engine emissions when they purchase a boat. One example of a consumer labeling program is the California Air Resources Board's requirement that personal watercraft and outboard engines sold in California starting in 2001 be labeled as either low, very-low, or ultra-low depending on their emission levels. We request comment on whether or not a program such as this should be voluntary or mandatory. We also request comment on how this should be implemented considering that most boats and engines are produced by separate manufacturers.

VI. Large Spark Ignition Engines

A. Background

1. What Engines Are Included in This Rulemaking?

This section applies to most nonroad spark-ignition engines rated over 19 kW (''Large SI engines''). These engines power equipment such as forklifts, sweepers, pumps, and generators. This would include marine auxiliary engines, but not marine propulsion engines or engines used in snowmobiles, motorcycles, or other recreational applications. The applications not addressed in this section are addressed elsewhere in this document.

Our most recent rulemaking for nonroad diesel engines finalized a definition of ''compression-ignition'' that was intended to include diesel-derived natural gas engines under that program.[66] However, according to the manufacturers of these engines, they do not meet the definition of compression-ignition engines. All nonroad engines are defined as either compression-ignition or spark-ignition engines. So, if these natural gas engines are not subject to emission standards for nonroad diesel engines, they will instead be covered by the emission standards for Large SI engines. We are currently reviewing the claims of these manufacturers regarding how their engines should be classified. We request comment on whether we should revise the definitions that differentiate between these types of engines.

Most Large SI engines have a total displacement greater than one liter. The design and application of the few Large SI engines currently being produced with displacement less than one liter are very similar to those of engines rated below 19 kW, which are typically used for lawn and garden applications. As described in the most recent rulemaking for these smaller engines, we intend to propose that manufacturers may certify engines above 19 kW with total displacement of one liter or less to the requirements we have already adopted in 40 CFR part 90 for engines below 19 kW.[67] These engines would then be exempt from the requirements contemplated in this document. This

[65] See the fact sheet ''Frequently Asked Questions: MARPOL 73/78 Annex VI Marine Diesel Engine Requirements,'' EPA420–F–99–038, October 1999, www.epa.gov/otaq/marine.htm.

[66] See 63 FR 56968 (October 23, 1998).

[67] See 65 FR 24268 (April 25, 2000).

would be consistent with the California ARB rulemaking. This approach would allow manufacturers of small air-cooled engines to certify their engines rated over 19 kW with the program adopted for the comparable engines with slightly lower power ratings.

We are concerned that treating all engines less than one liter as Small SI engines may be inadequate. For example, lawn and garden engines generally don't use turbochargers or other technologies to achieve very high power levels. However, it may be possible for someone to design an engine under one liter with unusually high power, which would more appropriately be grouped with other Large SI engines rather than with Small SI engines. To address this concern, we may propose a maximum power level for engines to qualify for treatment as Small SI engines. A power rating of 30 kW seems to represent a maximum reasonable power output that is possible from SI engines under one liter with technologies typical of lawn and garden engines. We request comment on the suggested power threshold and on any other approaches to addressing the concern for properly constraining this provision.

2. Who Makes Large SI Engines?

The companies producing Large SI engines are typically subsidiaries of automotive companies. In most cases, these companies modify car and truck engines for industrial applications. However, the Large SI industry has historically taken a much less centralized approach to designing and producing engines. Engine manufacturers often sell dressed engine blocks without manifolds or fuel systems. Fuel system suppliers have played a big role in designing and calibrating nonroad engines, sometimes participating directly in engine assembly. Several equipment manufacturers, mostly forklift producers, also play the role of an engine manufacturer by calibrating engine models and completing engine assembly.

Sales volumes are another important contrast with automotive production. Total Large SI engine sales are about 150,000 per year in the U.S. Sales are distributed rather evenly among several companies, so typical sales volumes for each company range generally from 10,000 to 25,000 engines per year. These sales volumes and the overall size of the companies limit the amount of research and development available to meet new emission standards.

3. What Is the Regulatory History?

Currently no federal emission standards exist for Large SI engines. We have, however, adopted successively more stringent standards for the automotive engines from which most Large SI engines are derived. Heavy-duty highway otto-cycle engines provide the most direct comparison. We have adopted emission standards for 2005 and later model year engines and proposed more stringent standards for 2007 and later model year engines. We request comment on the degree to which these technologies can be readily transferred or adapted to the counterpart nonroad engines.

The California ARB in 1998 adopted requirements that apply to new Large SI engines produced for California starting in 2001. We are considering similar requirements for these engines in the near term. In the longer term, we are also considering revised emission standards reflecting the emission reductions achievable with available technology, as described below.

While we have not yet set emission standards for this category of engines, the industry has some experience complying with standards through the requirements for forklifts set by Underwriters Laboratories.[68] These standards, which focus primarily on ensuring safety, require the industry to conduct testing and submit plans for approval, much like certifying to emission standards.

An additional important consideration for Large SI engines is the workplace air contaminant limits adopted by the Occupational Safety and Health Administration for CO and NO_2. Facility managers, not engine or equipment manufacturers, are responsible for meeting these limits. However, concerns for high indoor pollutant concentrations have created a small but distinct demand for aggressive emission controls on forklifts. These emission controls have become commonplace in Europe, even in the absence of emission standards.

B. Technology

Although Large SI engines are often derived from automotive engines, manufacturers have generally not incorporated the technological advances from cars and trucks. Most fuel systems in gasoline engines have carburetors with no feedback controls. LPG and natural gas engines typically use mixer technology that has changed little over the last several decades.

Some Large SI engine models have no automotive counterpart; many of these use air-cooling instead of a conventional radiator system. Air-cooled engines can use the same emission-control technologies as water-cooled engines, but they have operating characteristics that can increase the challenge of reaching low emission levels. For example, uneven heating of the engine block can cause distortion of the cylinders, increasing the possibility of hydrocarbon emissions from unburned fuel.

The standards for spark-ignition engines would apply for all fuel types. The majority of Large SI engines use liquefied petroleum gas (LPG). Engines running on LPG can use fuel cylinders or draw fuel directly from a pipeline. Gasoline is also used in many applications. Natural gas is less common, but serves in several niche markets.

The California ARB emission standards were developed based on the expected capabilities of three-way catalytic converters with electronic fueling systems to control emissions. A limited number of forklifts have been operating with these emission-control technologies for several years. In addition to controlling emissions, these emission-control technologies can significantly reduce fuel consumption. In a high-use application, the fuel savings can fully offset the increased price for the emission controls within one year or less. The redesigned engines also hold promise for improving engine performance, for example with more reliable starting and better torque characteristics.

Both EPA and California ARB have pursued emission testing to determine the capabilities of emission-control technologies for Large SI engines. This effort will also help us establish emission standards that correspond with the degree of emission control achievable from the anticipated technologies over the full operating life of industrial equipment. We believe that manufacturers can optimize their engines to substantially reduce CO, NO_X, and HC emissions at a reasonable cost with these redesigned engines.

C. Standards and Program Approaches

We are considering emission standards for Large SI engines based on what manufacturers can achieve with available technology. This may include a combination of near-term standards similar to California ARB's and long-term standards for optimized systems. In addition, we are considering new procedures for measuring emissions, including a transient duty cycle and

[68] "Industrial Trucks, Internal Combustion Engine-Powered," UL558, ninth edition, June 28, 1996.

provisions to test for ''off-cycle'' emissions. These are described further in the following sections.

We do not presently intend to propose particulate matter emission standards because of the low levels of particulate matter associated with well maintained SI engines, as well as the substantial cost of technologies designed to regulate particulate matter directly from these engines. However, we expect that the incorporation of the projected emission-control technologies would reduce particulate matter emissions. This is similar to the approach we have taken for highway gasoline engines.

We request comment on this approach to setting standards, including the technology basis for controlling emissions, the combination of near-term and long-term standards, and the approach to addressing PM emissions.

1. Near-Term Emission Standards

We are considering near-term emission standards, including standards consistent with those adopted by California ARB. These standards are 4 g/kW-hr (3 g/hp-hr) for NMHC+ NO_X emissions and 50 g/kW-hr (37 g/hp-hr) for CO emissions. California ARB specifies the ISO C2 duty cycle for measuring emissions from variable-speed engines, and the ISO D2 duty cycle for testing constant-speed engines. The C2 duty cycle consists mostly of intermediate-speed points, while all the D2 test points are at rated speed. We request comment on establishing standards consistent with those in California, including using the duty cycles in the same way. We also request comment on the appropriateness of requiring certification testing on both of these duty cycles for engine models that may ultimately be used in both variable-speed and constant-speed applications.

California ARB adopted its emission standards based on the capabilities of three-way catalytic converters and electronically controlled fuel systems. These systems would be similar to those used for many years in highway applications, but not necessarily with the same degree of sophistication. Adopting California ARB's emission standards would allow near-term introduction of low-emission technologies for substantial emission reductions. The manufacturers would in this case also be able to more easily amortize their development costs by spreading these costs over larger production volumes.

The California ARB standards will be fully phased in by 2004. With a current expectation of completing an EPA final rule by September 2002, we believe manufacturers may have enough lead time to expand production of California-compliant engines to a nationwide market. If EPA and California standards were consistent, manufacturers may not need to do any additional development work or repeat any certification testing to meet the federal standards. We request comment on whether we should propose near-term standards for 2004 model year engines, or if manufacturers will need additional time to manage full production of low-emission engines.

As described for the long-term standards below, we are interested in the possibility of adopting standards based on total hydrocarbon emissions, rather than nonmethane hydrocarbon. We request comment on proposing standards based on total hydrocarbon measurement. This would potentially save manufacturers the expense of measuring methane emissions for certification, production-line, or in-use testing. Since methane is largely nonreactive in the atmosphere, we have often set emission standards excluding methane measurement. We could adjust the standard as needed to reflect typical methane concentrations in controlled engines. This would apply to gasoline- and LPG-fueled engines. Natural gas-fueled engines would continue to have a standard based on nonmethane emissions because the large majority of their total hydrocarbon emissions consist of methane. We request comment on this approach.

2. Long-Term Duty-Cycle Emission Standards

We believe that, given additional time, manufacturers would be able to optimize designs to control emissions to lower levels using the same emission-control technologies used to meet the near-term standards. Therefore, we are also requesting comment on more stringent emission standards using more robust measurement procedures, as described below.

General standards. Manufacturers have used electronically controlled fuel systems with three-way catalysts in automotive applications for many years. During this time, these systems and components have undergone substantial improvements in their ability to reduce emissions with minimal degradation during field operation. Recent testing by Southwest Research Institute shows that these systems can reduce NO_X, HC, and CO emissions by 90 percent or more over several thousand hours of normal operation.[69–70] While the test data help us select emission standards, we first need to address several open issues. These issues are summarized here and described in greater detail in the technical memoranda referenced in this document.

—*The combination of duty cycles for testing.* Emission measurements at Southwest Research Institute have shown that engines can achieve effective control on a wide variety of duty cycles, but that good performance on one duty cycle does not guarantee good performance on another. Thus, it is important that we select the appropriate duty cycles to provide a reasonable assurance that systems will control emissions when operating in the field.

—*Consideration of cold-start effects.* Engine emissions immediately after starting can be much higher than emissions from a hot engine. We need to determine the appropriate treatment of cold-start effects in the test procedure before we can propose emission standards.

—*The achievable precision of control software.* Electronic systems for automotive applications have reached a high level of sophistication for monitoring a wide variety of engine variables to maintain effective control of combustion and after treatment processes. While Large SI engine manufacturers can benefit from these developments, the cost and complexity of these systems at some point may no longer be appropriate for the more cost-sensitive, low-volume nonroad applications.

—*Fuel specifications.* As described further below, we need to evaluate in-use fuel quality before proposing fuel specifications for emission testing.

With this wide range of test and design variables, we request comment on long-term emissions standards ranging from 1.5 to 2.5 g/kW-hr (1 to 2 g/hp-hr) HC+ NO_X and from 4 to 10 g/kW-hr (3 to 7.5 g/hp-hr) CO. We are interested in comments as to potentially appropriate standards within these ranges, as well as comments on the appropriateness of the ranges themselves. The range of possible CO emission standards is especially wide because CO emission levels are sensitive to the degree of engine warm-up at the beginning of the test. This range of standards is based on test data showing the emission levels that Large SI engines can achieve with steady-state and transient duty cycles.[71] We request comment on the capability of Large SI

[69–70] ''Evaluation of Emissions Durability of Off-Road LPG Engines Equipped with Three-Way Catalysts,'' by Vlad Ulmet, Southwest Research Institute, November 2000, (Docket A–2000–01, document II–A–07).

[71] *See* ''Emission Data and Procedures for Large SI Engines'' for more information (Docket A–2000–01; document II–B–1).

engines to meet these emission levels, on the associated costs for these emission-control systems, and on the corresponding estimated emission reductions estimated to be achieved therefrom. We also request comment on the applicability of the underlying test data.

In another rulemaking, we are pursuing even lower emission levels for heavy-duty highway engines starting in 2008, including otto-cycle (or spark-ignition) engines. We have proposed changing these emission standards to 0.20 g/hp-hr (0.26 g/kW-hr) for NO_X emissions and 0.14 g/hp-hr (0.19 g/kW-hr) for NMHC emissions.[72] We request comment on whether Large SI engines would be able to apply the associated highway-engine technologies at a reasonable cost.

Emission standards for different fuel types. Most of the emission data on which we are likely to base the proposed emission standards was generated from engines using liquefied petroleum gas (LPG). We could take California ARB's approach of applying the same numerical emission standards regardless of fuel, except for the special treatment of methane emissions from natural gas engines. Gasoline engines have very different fuel systems than LPG or natural gas engines. Engines built from automotive engine blocks can readily adopt port fuel injection, which provides a great advantage over gaseous mixer technology in controlling emissions. Also, the emission levels described above are consistent with the requirements that apply to heavy-duty highway otto-cycle engines starting in 2005.

A possible exception to common emission standards may be for CO emissions. Uncontrolled CO emission levels from gasoline engines can be much higher than are typically found from LPG engines. We believe, however, that a separate CO standard for gasoline engines may not be necessary for two reasons. First, highway gasoline engines have been controlling CO emissions to lower levels for many years. Second, fuel systems and catalysts can be designed and calibrated for a very high CO conversion efficiency. We request comment on the need to accommodate higher CO emission levels from gasoline engines. Data supporting such an argument should include engine-out CO emission levels at stoichiometric operation and information regarding conversion efficiencies available for gasoline engine emission-control equipment. We also request comment on the advantages of having identical standards for all fuels.

Special cases. The above discussion applies generally to Large SI engines. However, there are special concerns that warrant further attention.

Air-cooled engines. Some air-cooled engines are designed to operate in applications where water-cooled engines may not function effectively. These engines are most commonly used in industrial saws or chippers where ambient dust levels prevent the use of radiators to cool the engine. Air-cooled Large SI engines share some important design features and operating characteristics with smaller air-cooled engines that are commonly used in lawn and garden applications. As described above, air-cooled engines face unique constraints for controlling emissions. These constraints seem to be especially problematic for CO emissions, causing manufacturers to add a greater degree of emission-control technology than that needed for water-cooled engines to meet California ARB standards.

We have identified three possible approaches to proposing emission standards for air-cooled engines. First, we could require them to meet the same emission standards as water-cooled engines. Especially for any long-term emission standards, this would require an extensive development effort to apply emission-control technologies in a way that would adequately control emissions. This would prevent any unfair competitive advantages by giving special treatment to a higher-emitting engine type.

Second, we could propose that all air-cooled engines meet the emission standards we have adopted for nonroad SI engines under 19 kW. The largest engines under 19 kW (nonhandheld Class II) must meet standards of 12.1 g/kW-hr for NO_X+HC emissions and 610 g/kW-hr for CO emissions. Since engines under 19 kW are almost all air-cooled, they share some important design characteristics with Large SI engines that are air-cooled.

Third, we could propose the same NO_X+HC for both air-cooled and water-cooled engines, but to allow air-cooled engines to meet less stringent CO emission standards. To avoid giving air-cooled engines a broad competitive advantage in applications where they are seldom used today, we could limit this less stringent CO standard to engines used predominantly in severe-duty applications. Under this approach, we would consider an application severe-duty if the majority of engines used in that application do not use water-cooling systems. Currently available data would suggest an adjusted CO standard of 75 to 100 g/kW-hr (55 to 75 g/hp-hr) CO for these engines.

We request comment on these and other potential approaches to proposing emission standards from air-cooled engines.

Equipment Used Predominantly Indoors. Operators of Large SI engines can today install emission-control systems with extremely low CO emission levels. CO emission levels can be especially low in these current systems where manufacturers are not required to simultaneously control for NO_X and HC emissions. We are concerned that emission standards requiring simultaneous control of all the regulated pollutants will limit manufacturers ability to continue to supply engines with very low CO emission levels. With increased concern for exposing individuals to engine exhaust in confined spaces, this may be especially problematic. We therefore request comment on alternate long-term standards that would allow the manufacturer to better balance emission levels of the various pollutants to offer low-CO engines for predominantly indoor applications.

One possible scenario would be increasing the HC+NO_X emission standard somewhat (for example, to 3 or 4 g/kW-hr), while tightening the CO emission standard (for example, to 1 or 2 g/kW-hr). We request comment on the need for such an alternate standard and on the emission standards that should apply. We also request comment on whether there would be any need to (1) adopt provisions to ensure that these engines are indeed operated predominantly in sensitive, indoor applications; (2) limit the number of these engine sales; or (3) adopt any other provisions to ensure that these alternate emission standards are not used to avoid the general standards.

Another alternative would be to adopt fuel-specific standards. Since LPG and natural gas are more likely to be used in enclosed areas, we could focus on adopting very stringent CO emission levels for these engines, with less of an emphasis on NO_X and HC emission levels. Since gasoline engines are not commonly used indoors, their emission standards could maximize NO_X and HC reductions, with less aggressive control of CO emissions. We request comment on adopting fuel-specific emission standards to address concerns for indoor air quality.

3. Supplemental Emission Standards

To address concerns for controlling emissions outside of the discrete procedures adopted for certification, we

[72] *See* 65 FR 35430 (June 2, 2000).

are considering requirements that would apply to a wider range of normal engine operation. We generally refer to this as off-cycle emissions.

Our goal is to achieve control of emissions over the broad range of in-use speed and load combinations that can occur in a Large SI engine to achieve real-world emission control, rather than just controlling emissions under certain laboratory conditions. An important tool for achieving this goal is an in-use program with an objective standard and an easily implemented test procedure. No single test procedure can cover all real-world applications, operations, or conditions. Yet, to ensure that emission standards are providing the intended benefits in use, we should have a reasonable expectation that emissions under real-world conditions reflect those measured on the test procedure.

Because the projected duty-cycles include specific operating modes (engine speeds and loads), we are concerned that an engine designed only to duty-cycle standards would not necessarily have the same emission performance in use. In contrast, an engine operating in any given piece of equipment may often operate at speed and load combinations not included in the certification duty cycle. Emission levels at speed and load points not represented in the duty cycles could be significantly higher than those measured with the duty cycles. Also, if manufacturers design engines to control emissions only under relatively narrow laboratory conditions, this does not ensure that the engines will control emissions under the wide range of ambient temperature, pressure, and humidity the engines will experience in the field. Testing by Southwest Research Institute highlighted this concern, showing that steady-state emission levels can increase ten-fold or more at speed-load points not included in the duty cycles.[73]

''Not-to-exceed'' testing would be one option for ensuring that emissions are controlled from Large SI engines over the full range of speed and load combinations seen in the field. Under not-to-exceed testing, we would specify an emission standard that applies more broadly than the traditional duty-cycle standard. The not-to-exceed standard would apply to all regulated pollutants (NO_X, HC, and CO) during a wide range of normal operation. In other programs where we have adopted not-to-exceed standards, the testing includes a broad range of in-use ambient conditions (*i.e.,* temperature, pressure, and humidity), but excludes measurement during any kind of abnormal operation.

The recent testing at Southwest Research Institute (SwRI) would appear to support not-to-exceed emission standards of 1.0 to 3.5 g/kW-hr (1.3 to 2.6 g/hp-hr) for NO_X+HC emissions and 7 to 13 g/kW-hr (5 to 10 g/hp-hr) for CO emissions. We would intend to allow considerable development time for manufacturers to meet any not-to-exceed provisions. If we adopt alternate emission standards for severe-duty engines, gasoline engines, or engines used in indoor applications, as described above, any corresponding not-to-exceed emission standards would be higher than the duty-cycle standards to serve as a cap on varying emission levels that result from different engine operation or ambient conditions.

D. Additional Program Considerations

1. Compliance Program Elements

In general, we expect to align our certification and compliance programs with those adopted by California ARB to the greatest extent possible. In particular, any near-term emission standards we may adopt should require no additional development or testing beyond what manufacturers are already doing to produce compliant engines for California. While long-term standards and other additional provisions may go beyond what California has already adopted, we expect to design the program to limit the additional burden. Nevertheless, these additional requirements would be important enhancements and would lead to a much more effective control program.

We request comment on the details of the compliance program adopted by California ARB, and whether the details of the compliance program are appropriate for use in the federal program. This includes several elements, such as production-line testing and in-use testing by manufacturers; useful life, deterioration factors, and warranty requirements; and several other provisions. The principal provisions under consideration that California ARB has not already adopted include:

—Procedures for testing emissions in the field in lieu of laboratory dynamometer testing.
—Specification of basic engine diagnostics to keep engines operating in their certified configuration.
—Concepts for manufacturers to control evaporative emissions.
—Provisions for engine rebuilders to bring engines back to their low-emission configuration when they are rebuilt.

2. Field Testing

One possible provision that should be highlighted is the possibility of adopting field-measurement procedures. As described above, we are considering proposing California ARB's requirement for manufacturers to test their in-use engines. Under this program, manufacturers remove in-use engines from equipment for testing in the laboratory. However, if we adopt field-measurement procedures, manufacturers would be allowed to show that they meet emission standards with in-use engines by measuring emissions directly from engines without removing them from the equipment. There are significant advantages to testing engines in the field. The reduced testing effort could substantially reduce the cost of in-use emission testing, both for manufacturers and for the Agency. Also, testing would capture real in-use engine operation, rather than relying on a surrogate duty cycle in the laboratory. We request comment on the desirability of developing measurement procedures to allow field testing of Large SI engines.

One constraint of measuring emissions in the field is the difficulty in measuring methane. Because of this, we are interested in proposing emission standards based on total hydrocarbon measurements, at least for field testing. We request comment on proposing total hydrocarbon standards also for laboratory testing. For gasoline and LPG engines, methane generally accounts for less than 10 percent of uncontrolled emissions, so this can easily be accounted for in selecting emission standards. As described above, we would need to rely on a nonmethane hydrocarbon emission standard for natural gas engines. This may limit the possibility of testing natural gas engines in the field.

3. In-Use Fuel Quality

In addition, manufacturers have raised the concern that in-use LPG fuels have highly varying quality. It is not clear that different LPG fuel compositions would have a direct effect on tailpipe emission levels. However, lower-quality fuels have a tendency to cause fuel condensation, and eventually gumming, on fuel system components. Since fuel systems play a central role in an engine's emission control system, this can eventually affect an engine's ability to accurately meter fuel, resulting in increased emission levels. We request comment on the need for and possibility of developing an industry-wide specification for in-use LPG fuels to

[73] See ''Emission Data and Procedures for Large SI Engines'' for more information (Docket A–2000–01; item II–B–1).

address this problem. In addition, we request comment on the possibility of applying engine technology to limit condensation of impurities or heavy-end hydrocarbon molecules from lower-quality fuel.

VII. Public Participation

We are committed to a full and open regulatory process with input from a wide range of interested parties. As part of any rulemaking, opportunities for input will include a formal public comment period and a public hearing.

With today's action, we open a comment period for this advance notice. We will accept comments until February 5, 2001. We encourage comment on all issues raised here, and on any other issues you consider relevant. The most useful comments are those supported by appropriate and detailed rationales, data, and analyses. All comments, with the exception of proprietary information, should be directed to the docket (see **ADDRESSES**). If you wish to submit proprietary information for consideration, you should clearly separate such information from other comments by (1) labeling proprietary information ''Confidential Business Information'' and (2) sending proprietary information directly to the contact person listed (see **FOR FURTHER INFORMATION CONTACT**) and not to the public docket. This will help ensure that proprietary information is not inadvertently placed in the docket. If you want us to use a submission of confidential information as part of the basis for a proposal, then a nonconfidential version of the document that summarizes the key data or information should be sent to the docket.

We will disclose information covered by a claim of confidentiality only to the extent allowed and in accordance with the procedures set forth in 40 CFR Part 2. If no claim of confidentiality accompanies the submission, it will be made available to the public without further notice to the commenter.

VIII. Regulatory Flexibility

Section 605 of the Regulatory Flexibility Act (RFA), 5 U.S.C. 601 *et seq.* requires the Administrator to assess the economic impact of proposed rules on small entities. The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996, Public Law 104–121, amended the RFA to strengthen its analytical and procedural requirements and to ensure that small entities are adequately considered during rule development. The Agency accordingly requests comment on the potential impacts on a small business of the program described in this notice. These comments will help the Agency meet its obligations under SBREFA and will suggest how EPA can minimize the impacts of this rule for small companies that may be adversely affected.

Depending on the number of small entities identified prior to the proposal and the level of any contemplated regulatory action, we may convene a Small Business Advocacy Review Panel under section 609(b) of the Regulatory Flexibility Act as amended by SBREFA. The purpose of the Panel (or multiple Panels, as necessary) would be to collect the advice and recommendations of representatives of small entities that could be affected by the eventual rule. If we determine that a panel is not warranted, we would intend to work on a less formal basis with those small entities identified.

We request information on small entities potentially affected by this rulemaking. Information on company size, number of employees, annual revenues and product lines would be especially useful. Confidential business information may be submitted as described in section VII. The following sections address several specific issues for different industries.

A. Recreational Vehicles and Highway Motorcycles

We anticipate that industries related to recreational vehicles and highway motorcycles that may be affected by this rulemaking will largely fall within the categories listed in Table VIII–1 below. We request comment on the completeness and accuracy of the list, and on the suitability for this rulemaking of the definitions of small business established by SBA. We may propose to change these definitions, if such changes would better suit the particular industries and regulations being considered.

TABLE VIII–1.—RECREATIONAL VEHICLE INDUSTRIES WITH SMALL BUSINESSES

Industry	NAICS [a] codes	Defined by SBA as a Small Business If:[b]
Gasoline engine and parts manufacturers	336312	<750 employees.
Motorcycles and motorcycle parts manufacturers	336991	<500 employees.
Snowmobile and ATV manufacturers	336999	<500 employees.
Independent Commercial Importers of Vehicles and parts	421110	<100 employees.

Notes:
a. North American Industry Classification System.
b. According to SBA's regulations (13 CFR part 121), businesses with no more than the listed number of employees or dollars in annual receipts are considered ''small entities'' for purposes of a regulatory flexibility analysis.

B. Large SI

Table VIII–2 lists the industry segments that relate to companies that may need to meet emission standards and other requirements for Large SI engines. Two engine manufacturers qualify as small businesses. Both of these companies plan to produce engines that meet the standards adopted by California ARB in 2004. Since we don't expect the near-term standards contemplated in this document to add any significant requirements to the California ARB program, these standards would impose very little new burden for these and other manufacturers. If we adopt long-term standards, this would require manufacturers to do additional calibration and testing work. If we adopt new test procedures (including transient operation), there may also be a cost associated with upgrading test facilities. If we set emission standards to mirror the levels proposed for 2007 highway heavy-duty engines, this would also require extensive hardware and product development to reduce emissions.

In addition, we are considering recordkeeping requirements for companies that rebuild Large SI engines. These would be very similar to the requirements we have already adopted for highway engines, nonroad diesel engines, and commercial marine diesel engines. Many of these companies qualify as small businesses, but we expect the added burden to be very small.

TABLE VIII–2.—LARGE SI INDUSTRIES WITH SMALL BUSINESSES

Industry	NAICS code	Defined by SBA as a small business if:
Nonroad SI engines	333618	<1,000 employees.
Industrial trucks	333924	<750 employees.
Engine repair and maintenance	811310	<$5 million revenues.

C. Recreational Marine

The recreational marine sector includes a variety of engine and boat manufacturers that are small businesses. We convened a Small Business Advocacy Review Panel under section 609(b) of the Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act of 1996. We describe the rulemaking issues related to these small businesses in section V.D.4.

IX. Administrative Designation and Regulatory Analysis

Under Executive Order 12866 (58 FR 51735 (Oct. 4, 1993)), the Agency must determine whether this regulatory action is ''significant'' and therefore subject to Office of Management and Budget (OMB) review and the requirements of the Executive Order.

The order defines ''significant regulatory action'' as any regulatory action (including an advance notice of proposed rulemaking) that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or,

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

This Advance Notice was submitted to OMB for review. Any written comments from OMB and any EPA response to OMB comments are in the public docket for this Notice.

X. Statutory Provisions and Legal Authority

Section 213(a)(1) of the Clean Air Act, 42 U.S.C. 7547(a), requires that we study the emissions from all categories of nonroad engines and equipment (other than locomotives) to determine, among other things, whether these emissions ''cause or significantly contribute to air pollution which may reasonably be anticipated to endanger public health and welfare.'' Section 213(a)(2) further requires us to determine, through notice and comment, whether the emissions of carbon monoxide (CO), volatile organic compounds (VOCs), and oxides of nitrogen (NO_X) found in the above study significantly contributes to ozone or CO concentrations in more than one ozone or CO nonattainment area. With such a determination of significance, section 213(a)(3) requires us to establish emission standards applicable to CO, VOC, and NO_X emissions from classes or categories of new nonroad engines and vehicles that cause or contribute to such air pollution. Moreover, if we determine that any other emissions from new nonroad engines contribute significantly to air pollution, we may promulgate emission standards under section 213(a)(4) regulating emissions from classes or categories of new nonroad engines that we find contribute to such air pollution.

As directed by the Clean Air Act, we conducted a study of emissions from nonroad engines, vehicles, and equipment in 1991.[74] Based on the results of that study, referred to as NEVES, we determined that emissions of NO_X, HC, and CO from nonroad engines and equipment contribute significantly to ozone and CO concentrations in more than one nonattainment area (see 59 FR 31306, June 17, 1994).[75] Given this determination, section 213(a)(3) of the Act requires us to promulgate emissions standards for those classes or categories of new nonroad engines, vehicles, and equipment that in our judgment cause or contribute to such air pollution. We have found that the nonroad engines included in this ANPRM ''cause or contribute'' to such air pollution.[76]

Where we determine that other emissions from nonroad engines, vehicles, or equipment significantly contribute to air pollution that may reasonably be anticipated to endanger public health or welfare, section 213(a)(4) authorizes us to establish (and from time to time revise) emission standards from those classes or categories of new nonroad engines, vehicles, and equipment that we determine cause or contribute to such air pollution, taking into account cost, noise, safety and energy factors associated with the application of technology used to meet the standards. We have made this determination for emissions of particulate matter (PM) and smoke from nonroad engines (see 59 FR 31306, June 17, 1994). In that rulemaking, we found that smoke emissions from nonroad engines significantly contribute to such air pollution based on smoke's relationship to the particulate matter that makes up smoke as well as smoke's effect on visibility and soiling of urban buildings and other property. Particulate matter can be inhaled into the lower lung cavity, posing a potential health threat. We cited recent studies associating PM with increased mortality.[77] We also promulgated standards for emissions of PM and smoke from nonroad diesel engines in that rulemaking. We have also found that emissions of PM from nonroad engines included in this ANPRM ''cause or contribute'' to such air pollution.

Section 202 (a)(3)(E) provides EPA with authority to revise highway motorcycle emissions standards, establishing standards which reflect the greatest degree of emission reduction achievable, taking cost and other factors into consideration. EPA may promulgate new standards based on the effects of the air pollutants on public health and welfare. EPA may also reclassify motorcycles as light-duty vehicles or classify them as a separate class or

[74] ''Nonroad Engine and Vehicle Emission Study—Report and Appendices,'' EPA–21A–201, November 1991 (available in Air docket A–96–40).

[75] The terms HC (hydrocarbon) and VOC (volatile organic carbon) refer to similar sets of chemicals and are generally used interchangeably.

[76] *See* Final Finding, ''Control of Emissions from New Nonroad Spark-Ignition Engines Rated above 19 Kilowatts and New Land-Based Recreational Spark-Ignition Engines'' elsewhere in today's Federal Register for EPA's finding for Large SI engines and recreational vehicles. EPA's findings for marine engines are contained in 61 FR 52088 (October 4, 1996) for gasoline engines and 64 FR 73299 (December 29, 1999) for diesel engines.

[77] The nonroad study (NEVES) found that nonroad sources are responsible for approximately 5.55 percent of the total anthropogenic inventory of PM emissions and over one percent of total PM emissions in six to ten of the thirteen nonattainment areas surveyed.

category. In such case that motorcycles are a separate class or category, the Act directs EPA to consider the need to achieve equivalency or emission reductions between motorcycles and other vehicles to the maximum extent practicable. We request comment on how any potential regulatory programs would be consistent with these sections.

List of Subjects

40 CFR Part 86

Environmental protection, Administrative practice and procedure, Confidential business information, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 94

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Penalties, Reporting and recordkeeping requirements, Vessels, Warranties.

40 CFR Part 1048

Environmental protection, Administrative practice and procedure, Gasoline, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 1051

Environmental protection, Administrative practice and procedure, Gasoline, Motor vehicle pollution, Reporting and recordkeeping requirements.

Dated: November 20, 2000.

Carol M. Browner,

Administrator.

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