Executive Summary

EPA is proposing new standards for emissions of oxides of nitrogen, hydrocarbons, and carbon monoxide from several categories of engines. This Draft Regulatory Support Document provides technical, economic, and environmental analyses of the proposed emission standards for the affected engines. The anticipated emission reductions would translate into significant, long-term improvements in air quality in many areas of the U.S. Overall, the proposed requirements would dramatically reduce individual exposure to dangerous pollutants and provide much needed assistance to states and regions facing ozone and particulate air quality problems that are causing a range of adverse health effects, especially in terms of respiratory impairment and related illnesses.

Chapter 1 reviews information related to the health and welfare effects of the pollutants of concern. Chapter 2 contains an overview of the affected manufacturers, including some description of the range of engines involved and their place in the market. Chapter 3 covers a broad description of engine technologies, including a wide variety of approaches to reducing emissions. Chapter 4 summarizes the available information supporting the specific standards we are proposing, providing a technical justification for the feasibility of the standards. Chapter 5 applies cost estimates to the projected technologies. Chapter 6 presents the calculated contribution of these engines to the nationwide emission inventory with and without the proposed standards. Chapter 7 compares the costs and the emission reductions for an estimate of the cost-effectiveness of the rulemaking.

There are five sets of engines and vehicles that would be covered by the proposed standards. The following paragraphs describe the different types of engines and vehicles and the standards that apply.

Proposed Emission Standards

Large industrial spark-ignition engines

These are spark-ignition nonroad engines rated over 19 kW used in commercial applications. These include engines used in forklifts, electric generators, airport ground service equipment, and a variety of other construction, farm, and industrial equipment. Many Large SI engines, such as those used in farm and construction equipment, are operated outdoors, predominantly during warmer weather and often in or near heavily populated urban areas where they contribute to ozone formation and ambient CO and PM levels. These engines are also often operated in factories, warehouses, and large retail outlets throughout the year, where they contribute to high exposure levels to personnel who work with or near this equipment as well as to ozone formation and ambient CO and PM levels. For the purpose of this proposal, we are calling these “Large SI engines.” Table 1 shows the proposed emission standards for Large SI engines. This includes alternate emission standards for lower NOx emissions and higher CO emissions for engines that don’t operate in enclosed areas. The table also distinguishes between

standards for duty-cycle testing and for field-testing.

Table 1
Proposed Emission Standards for Large SI Engines (g/kW-hr)

Model Year	Testing Type	Emission standards		Alternate emission standards	
		HC+NOx	CO	HC+NOx	CO
2004 - 2006	Duty-cycle testing	4.0	37.0	—	—
2007 and later	Duty-cycle testing	3.4	3.4	1.3	27
	Field-testing	4.7	5.0	1.8	41

Nonroad recreational engines and vehicles

These are spark-ignition nonroad engines used primarily in recreational applications. These include off-highway motorcycles, all-terrain-vehicles (ATVs), and snowmobiles. Some of these engines, particularly those used on ATVs, are increasingly used for commercial purposes within urban areas, especially for hauling loads and other utility purposes. These vehicles are typically used in suburban and rural areas, where they can contribute to ozone formation and ambient CO and PM levels. They can also contribute to regional haze problems in our national and state parks. Table 2 shows the proposed emission standards that apply to recreational vehicles.

Table 2
Recreational Vehicle Exhaust Emission Standards

Vehicle	Model Year	Emission standards		Phase-in
		HC g/kW-hr	CO g/kW-hr	
Snowmobile	2006	100	275	100%
	2010	75	200	100%
		HC+NOx g/km	CO g/km	
Off-highway Motorcycle	2006	2.0	25.0	50%
	2007 and later	2.0	25.0	100%
ATV	2006	2.0	25.0	50%
	2007 and 2008	2.0	25.0	100%
	2009	1.0	25.0	50%
	2010 and later	1.0	25.0	100%

Recreational marine diesel engines

These are marine diesel engines used on recreational vessels such as yachts, cruisers, and other types of pleasure craft. Recreational marine engines are primarily used in warm weather and therefore contribute to ozone formation PM levels, especially in marinas, which are often located in nonattainment areas.

Table 3
Proposed Recreational Marine Diesel Emission Limits and Implementation Dates

Subcategory	Implementation Date	HC+NOx g/kW-hr	PM g/kW-hr	CO g/kW-hr
power ≥ 37 kW 0.5 ≤ disp < 0.9	2007	7.5	0.40	5.0
0.9 ≤ disp < 1.2	2006	7.2	0.30	5.0
1.2 ≤ disp < 2.5	2006	7.2	0.20	5.0
2.5 ≤ disp	2009	7.2	0.20	5.0

Projected Impacts

The following paragraphs and tables summarize the projected emission reductions and costs associated with the proposed emission standards. See the detailed analysis later in this document for further discussion of these estimates.

Table 6 contains the projected emissions from the engines subject to this proposal. Projected figures compare the estimated emission levels with and without the proposed emission standards for 2020.

Table 6
2020 Projected Emissions Inventories (thousand short tons)

Category	Exhaust CO			Exhaust NOx			Exhaust HC**		
	base case	with proposed standards	percent reduction	base case	with proposed standards	percent reduction	base case	with proposed standards	percent reduction
Industrial SI >19kW	2,991	231	92	486	77	84	346	50	86
Snowmobiles	609	227	63	2	2	0	229	85	63
ATVs	4,589	3,041	34	25	25	0	1,301	205	84
Off-highway motorcycles	208	154	26	1	1	0	154	77	50
Recreational Marine diesel*	6	6	0	39	32	17	1.3	1.0	25
Total	8,404	3,658	56	552	137	75	2,032	418	79

* We also anticipate a 6 percent reduction in direct PM from a baseline of inventory of 1,470 tons in 2020 to a control inventory of 1,390 tons.
** The Industrial SI >19 kW estimate includes both exhaust and evaporative emissions.

Table 7 summarizes the projected costs to meet the proposed emission standards. This is our best estimate of the cost associated with adopting new technologies to meet the proposed emission standards. The analysis also considers total operating costs, including maintenance and fuel consumption. In many cases, the fuel savings from new technology are greater than the cost to upgrade the engines. All costs are presented in 2001 dollars.

Table 7
Estimated Average Cost Impacts of Proposed Emission Standards

Engine Type	Standard	Increased Production Cost per Engine*	Lifetime Operating Costs per Engine (NPV)
Large SI	2004	$600	$-3,985
Large SI	2007	$45	—
Snowmobiles	2006	$55	—
Snowmobiles	2010	$216	$-509
ATVs	2006	$60	$-102
ATVs	2009	$52	—
Off-highway motorcycles	2006	$151	$-98
Marine diesel	2006	$443	—

*The estimated long-term costs decrease by about 35 percent. Costs presented for second-phase standards for Large SI, and ATVs are incremental to the first-phase standards.

We also calculated the cost per ton of emission reductions for the proposed standards. For snowmobiles, this calculation is on the basis of CO emissions. For all other engines, we attributed the entire cost of the proposed program to the control of ozone precursor emissions (HC or NOx or both). A separate calculation could apply to reduced CO or PM emissions in some cases. Assigning the full compliance costs to a narrow emissions basis leads to cost-per-ton values that underestimate of the value of the proposed program.

Table 8 presents the discounted cost-per-ton estimates for the various engines (factoring in the effect of reduced operating costs). Reduced operating costs more than offset the increased cost of producing the cleaner engines for Large SI and ATV engines. The overall fuel savings associated with the proposal are greater than the total projected costs to comply with the proposed emission standards.

Table 8
Estimated Cost-per-Ton of the Proposed Emission Standards

Engine Type	Standard	Discounted Reductions per Engine (short tons)*	Discounted Cost per Ton of HC+NOx		Discounted Cost per Ton of CO	
			Without Fuel Savings	With Fuel Savings	Without Fuel Savings	With Fuel Savings
Large SI (Composite of all fuels)	2004	3.14	$220	$0	—	—
Large SI (Composite of all fuels)	2007	0.56	$80	$80	—	—
Snowmobiles	2006	1.18	—	—	$50	$50
Snowmobiles	2010	0.32	—	—	$670	$0
ATVs	2006	0.88	$70	$0	—	—
ATVs	2009	0.09	$550	$550	—	—
Off-highway motorcycles	2006	0.37	$310	$110	—	—
Marine diesel	2006	0.68	$580	$580	—	—
Aggregate	—	—	$140	$0	$100	$0

* HC+NOx reductions, except snowmobiles which are CO reductions.