Control of Emissions from Marine SI and Small SI Engines, Vessels, and Equipment

Final Regulatory Impact Analysis

Chapter 7
Cost Per Ton

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This Chapter will present the cost effectiveness analysis we completed for our proposed small spark ignition engine (<19 kW) and recreational marine (personal water craft, sterndrive/inboard and outboard) emission standards. Under Clean Air Act section 213, we are required to promulgate standards which reflect the greatest degree of emission reduction achievable, giving appropriate consideration to cost, energy, and safety factors. The standards setting process is not necessarily premised on setting the most cost effective standards, even though this is a significant factor. Cost-effectiveness is a useful tool in evaluating the appropriateness of our standards.

The cost-effectiveness analysis described in this chapter relies in part on cost information from Chapter 6 and emissions information from Chapter 3 to estimate the dollars per ton of emission reductions produced from our proposed standards. We have calculated the cost effectiveness using a 30-year net present value approach that accounts for all costs and emission reductions over a 30-year period. Finally, this chapter compares the cost effectiveness of the new provisions with the cost effectiveness of other control strategies from previous and potential future EPA programs.

Section 7.1 describes the calculation behind the 30 year net present value cost effectiveness and Section 7.2 lists the results of the calculations for our combined small spark ignition standards (exhaust and evaporative) and marine engines (exhaust and evaporative). Table 7.2-.5 lists the results for the 30-year net present value cost effectiveness analysis for Small SI and Marine. The results of the cost-effectiveness of comparative programs are listed in Table 7.2-6.

7.1 30-Year Net Present Value Cost Effectiveness (Cost per Ton)

We have calculated the cost effectiveness of our program using a “30-year net present value” approach that includes all nationwide emission reductions and costs for a 30 year period. This timeframe captures both the early period of the program when only the new equipment/engines meeting our standards will be in the fleet, and the later period when essentially all vehicles/engines in the fleet will meet our standards. The 30-year net present value approach does have one important drawback in that it includes the engine costs for engines sold 30 years after the program goes into effect, but includes almost none of the emission benefits from those engines. Thus the 30-year net present value approach does not necessarily match all costs with all the emission reductions that those costs are intended to produce. It is presented here, nevertheless, as a reasonable means by which to assess the cost effectiveness of these programs.

We have calculated this “30-year net present value” cost-effectiveness using the net present value of the annual emission reductions and costs described in Chapters 3 and 6, respectively. The calculation of 30-year net present value cost-effectiveness follows the pattern described above for the per-engine analysis:

$$DNAE = \sum (NE)_i / (1.07)^{i-2008}$$

Where:

DNAE	= Reduction in nationwide 30-year net present value emissions in tons
$(NE)_i$	= Reduction in nationwide emissions in tons for year i of the program
i	= Year of the program, counting from year 1 to year 30

and

$$DNAC = \sum (NC)_i / (1.07)^{i-2008}$$

Where:

DNAC	= Nationwide 30-year net present value costs in dollars
$(NC)_i$	= Nationwide costs in dollars for year i of the program
i	= Year of the program from year 1 to year 30

The 30-year net present value cost-effectiveness is produced by dividing DNAC by DNAE. The nationwide reductions in emissions for each year are given in Chapter 3. The results are given in Tables within the following section.

7.2 Results

We calculated the cost-effectiveness of our program on a 30-year net present value basis separately for our proposed Small SI standards <19kW and recreational marine standards. To do this, we summed net present value of total costs from Chapter 6, and divided by the sum of the net present value of tons reduced from Chapter 3. These costs and emission reductions are repeated in Appendices 7-A and 7-B. The results are given in Table 7.2-1 to 7.2-2 for Small SI engines and equipment and 7.2-3 and 7.2-4 for recreational marine engines and vessels.

Table 7.2-1: 30-year Net Present Value Cost-effectiveness of the Standards for Small SI Engines <19kW Without Fuel Savings (7 percent discount rate)

Pollutants HC+NOx	*NPV Costs (million $)*	*NPV Reduction (tons)*	*Cost per Ton*
Exhaust	$2,257	1,785,000	$1,264
Evaporative	$809	1,098,000	$736
Exhaust + Evap	$3067	2,883,000	$1,063

Table 7.2-2: 30-year Net Present Value Cost-effectiveness of the Standards for Small SI Engines <19kW With Fuel Savings (7 percent discount rate)

Pollutants HC+NOx	*NPV Costs (million $)*	*NPV Reduction (tons)*	*Cost per Ton*
Exhaust	$1,959	1,785,000	$1,097
Evaporative	$151	1,098,000	$137
Exhaust + Evap	$2,110	2,883,000	$856

Table 7.2-3: 30-year Net Present Value Cost-effectiveness of the Standards for Marine Engines Without Fuel Savings (7 percent discount rate)

Pollutants HC+NOx	*NPV Costs (million $)*	*NPV Reduction (tons)*	*Cost per Ton*
Exhaust	$1,521	1,826,000	$833
Evaporative	$270	461,000	$585
Exhaust + Evap	$1,790	2,287,000	$783

Table 7.2-4: 30-year Net Present Value Cost-effectiveness of the Standards for Marine Engines With Fuel Savings (7 percent discount rate)

Pollutants HC+NOx	*NPV Costs (million $)*	*NPV Reduction (tons)*	*Cost per Ton*
Exhaust	$823	1,826,000	$451
Evaporative	($6)	461,000	--
Exhaust + Evap	$817	2,287,000	$357

Because many of the benefits and costs are manifest in future years, we apply discounting methods to adjust the dollar values of these effects to reflect the finding that society as a whole typically values the realization (or avoidance) of a given effect differently depending on when the effect occurs. In the discounting calculations used to produce the net present values that were used in our cost-effectiveness calculations, we used a discount rate of 7 percent, consistent with the 7 percent rate reflected in the cost-effectiveness analyses for other recent mobile source programs. OMB Circular A-94 requires us to generate benefit and cost estimates reflecting a 7 percent rate.

However, the cost and cost-effectiveness estimates for future proposed mobile source programs could also reflect a 3 percent discount rate. The 3 percent rate is in the 2 to 3 percent range recommended by the Science Advisory Board's Environmental Economics Advisory Committee for use in EPA social benefit-cost analyses, a recommendation incorporated in EPA's new *Guidelines for Preparing Economic Analyses (November 2000)*. Therefore, we have also calculated the overall cost-effectiveness of today's rule based on a 3 percent rate to facilitate comparison of the cost-effectiveness of this rule with future proposed rules which use the 3 percent rate. The results are shown in Tables 7.2-5 through 7.2-8.

Table 7.2-5: 30-year Net Present Value Cost-effectiveness of the Standards for Small SI Engines <19kW Without Fuel Savings (3 percent discount rate)

Pollutants HC+NOx	*NPV Costs (million $)*	*NPV Reduction (tons)*	*Cost per Ton*
Exhaust	$3,718	3,227,000	$1,152
Evaporative	$1,327	1,932,000	$687
Exhaust + Evap	$5,044	5,159,000	$978

Table 7.2-6: 30-year Net Present Value Cost-effectiveness of the Standards for Small SI Engines <19kW With Fuel Savings (3 percent discount rate)

Pollutants HC+NOx	*NPV Costs (million $)*	*NPV Reduction (tons)*	*Cost per Ton*
Exhaust	$3,181	3,227,000	$986
Evaporative	$170	1,932,000	$88
Exhaust + Evap	$3,351	5,159,000	$650

Table 7.2-7: 30-year Net Present Value Cost-effectiveness of the Standards for Marine Engines Without Fuel Savings (3 percent discount rate)

Pollutants HC+NOx	*NPV Costs (million $)*	*NPV Reduction (tons)*	*Cost per Ton*
Exhaust	$2,407	3,425,000	$703
Evaporative	$444	885,000	$502
Exhaust + Evap	$2,852	4,310,000	$662

Table 7.2-8: 30-year Net Present Value Cost-effectiveness of the Standards for Marine Engines With Fuel Savings (3 percent discount rate)

Pollutants HC+NOx	*NPV Costs (million $)*	*NPV Reduction (tons)*	*Cost per Ton*
Exhaust	$1,100	3,425,000	$321
Evaporative	($86)	885,000	--
Exhaust + Evap	$1,014	4,310,000	$235

Because one primary purpose of cost-effectiveness is to compare our program to alternative programs, we listed the cost effectiveness of several previous EPA actions for controlled emissions from mobile sources for NOx and NMHC in Table 7.2-9. The programs shown in these tables are those for which cost-effectiveness was calculated in a similar manner allowing for a comparison. (Note: costs adjusted to 2005 dollars.)

Table 7.2-9: Cost-effectiveness of Recent Mobile Source Exhaust Emission Programs for HC+NOx, 2005$ (7 percent discount with fuel savings)

Program	$/ton
2002 HH engines Phase 2	840
2001 NHH Engines Phase 2	neg*
1998 Marine SI engines	1900
2004 Comm Marine CI	200
2007 Large SI exhaust	80
2006 ATV exhaust	300
2006 off-highway motorcycle	290
2006 recreational marine CI	700
2010 snowmobile	1430
2006 <50cc highway motorcycle	1860
2010 Class 3 highway motorcycle	1650

* fuel savings outweigh engineering/hardware costs
Costs adjusted to 2005$ using http://www1.jsc.nasa.gov/bu2/inflateGDP.html

Permeation and other evaporative emission control measures we have implemented for highway and off-highway motorcycles, large SI engines, ATVs, and snowmobiles have all had cost effectiveness values of less than $0/ton due to the fuel savings.

The analyses supporting the values in Table 7.2-6 were conducted over the past ten years and thus not all were done on a purely identical basis in terms of their analytical approach (e.g., factors such as cost streams and cost recovery). By comparing values in Table 7.2-6 for NOx+HC to those presented above we can see that the cost-effectiveness of our proposed Small SI and recreational Marine SI standards fall within the range of these other programs. Some previous programs have been more cost effective (lower $/ton) than the program we are proposing today. However, it should be expected that the next generation of standards will be more expensive than the last, because earlier reductions are usually easier and less expensive to achieve and the least costly means for reducing emissions is generally pursued first.

This proposed rule also will bring environmental benefits related to reductions in carbon monoxide (CO) emissions and emissions of direct particulate matter (PM). We have elected to base our cost effectiveness analysis solely on HC+NOx for two reasons. First, with regard to PM and CO, no new or additional technology beyond that needed to achieve the proposed HC+NOx standards is expected to be required. These reductions will occur as part of the technology and related efforts to meet the HC+NOx standards. Second, in the case of PM, we are not setting standards but do expect reductions to occur as a result of engine changes and in some cases the use of aftertreatment. In neither case is significant additional effort needed.