

the broad application variation (e.g., lawn equipment through large mining trucks) that exists in the nonroad industry makes it difficult to present here an estimated cost for every possible engine and/or piece of equipment. Nonetheless, for illustrative purposes, we present some example per engine/equipment cost impacts throughout this discussion. This analysis is presented in detail in Chapter 6 of the draft RIA. We are also considering doing a sensitivity analysis on cost/engine data, which would be put into the docket for comment.

It is important to note that the costs presented here do not reflect any savings that are expected to occur because of the engine ABT program and the equipment manufacturer transition program, both of which are discussed in Section VII. As discussed in the draft RIA, these optional programs have the potential to provide significant savings for both engine and equipment manufacturers. We request comment with supporting data and/or analysis on the cost estimates presented here and the underlying analysis presented in chapter 6 of the draft RIA.

#### 1. Engine Cost Impacts

Estimated engine costs are broken into fixed costs (for research and development, retooling, and certification), variable costs (for new hardware and assembly time), and life-cycle operating costs. Total operating costs include the estimated incremental cost for low-sulfur diesel fuel, any expected increases in maintenance costs associated with new emission control devices, any costs associated with increased fuel consumption, and any decreases in operating cost (*i.e.*, maintenance savings) expected due to low-sulfur fuel. Cost estimates presented here represent an expected incremental cost of engines in the model year of their introduction. Costs in subsequent years would be reduced by several factors, as described below. All engine and equipment costs are presented in 2001 dollars.

##### a. Engine Fixed Costs

##### i. Engine and Emission Control Device R&D

The technologies described in section III represent those technologies we believe will be used to comply with the proposed Tier 4 emission standards. These technologies are part of an ongoing research and development effort geared toward compliance with the 2007 heavy-duty diesel highway emission standards. The engine manufacturers making R&D

expenditures toward compliance with highway emission standards will have to undergo some additional R&D effort to transfer emission control technologies to engines they wish to sell into the nonroad market. These R&D efforts will allow engine manufacturers to develop and optimize these new technologies for maximum emission-control effectiveness with minimum negative impacts on engine performance, durability, and fuel consumption. Many nonroad engine manufacturers are not part of the ongoing R&D effort toward compliance with highway emissions standards because they do not sell engines into the highway market. These manufacturers are expected to benefit from the R&D work that has already occurred and will continue through the coming years through their contact with highway manufacturers, emission control device manufacturers, and the independent engine research laboratories conducting relevant R&D.

Several technologies are projected for complying with the proposed Tier 4 emission standards. We are projecting that NO<sub>x</sub> adsorbers and catalyzed diesel particulate filters (CDPFs) would be the most likely technologies applied by industry to meet our proposed emissions standards for >75 horsepower engines. The fact that these technologies are being developed for implementation in the highway market prior to the implementation dates in this proposal, and the fact that engine manufacturers would have several years before implementation of the proposed Tier 4 standards, ensures that the technologies used to comply with the nonroad standards would undergo significant development before reaching production. This ongoing development could lead to reduced costs in three ways. First, we expect research will lead to enhanced effectiveness for individual technologies, allowing manufacturers to use simpler packages of emission control technologies than we would predict given the current state of development. Similarly, we anticipate that the continuing effort to improve the emission control technologies will include innovations that allow lower-cost production. Finally, we believe that manufacturers would focus research efforts on any drawbacks, such as fuel economy impacts or maintenance costs, in an effort to minimize or overcome any potential negative effects.

We anticipate that, in order to meet the proposed standards, industry would introduce a combination of primary technology upgrades. Achieving very low NO<sub>x</sub> emissions would require basic research on NO<sub>x</sub> emission control technologies and improvements in

engine management to take advantage of the exhaust emission control system capabilities. The manufacturers are expected to take a systems approach to the problem of optimizing the engine and exhaust emission control system to realize the best overall performance. Since most research to date with exhaust emission control technologies for nonroad applications has focused on retrofit programs, there remains room for significant improvements by taking such a systems approach. The NO<sub>x</sub> adsorber technology in particular is expected to benefit from re-optimization of the engine management system to better match the NO<sub>x</sub> adsorber's performance characteristics. The majority of the dollars we have estimated for research is expected to be spent on developing this synergy between the engine and NO<sub>x</sub> exhaust emission control systems. Therefore, for engines requiring both a CDPF and a NO<sub>x</sub> adsorber (*i.e.*, >75 horsepower), we have attributed two-thirds of the R&D expenditures to NO<sub>x</sub> control, and one-third to PM control.

In the 2007 HD highway rule, we estimated that each engine manufacturer would expend \$35 million for R&D to redesign their engines and apply catalyzed diesel particulate filters (CDPF) and NO<sub>x</sub> adsorbers. For their nonroad R&D efforts on engines requiring CDPFs and NO<sub>x</sub> adsorbers (*i.e.*, >75 horsepower), engine manufacturers selling into the highway market would incur some level of R&D effort but not at the level incurred for the highway rule. In many cases, the engines used by highway manufacturers in nonroad products are based on the same engine platform as those used in highway products. However, horsepower and torque characteristics are often different so some effort will have to be expended to accommodate those differences. For these manufacturers, we have estimated that they would incur an R&D expense of \$3.5 million. This \$3.5 million R&D expense would allow for the transfer of R&D knowledge from their highway experience to their nonroad engine product line. Two-thirds of this R&D is attributed to NO<sub>x</sub> control and one-third to PM control.

For those manufacturers that sell engines only into the nonroad market, and where those engines require a CDPF and a NO<sub>x</sub> adsorber, we believe that they will incur an R&D expense nearing that incurred by highway manufacturers for the highway rule, although not at the level incurred by highway manufacturers for the highway rule. Nonroad manufacturers would be able to learn from the R&D efforts already