

adsorber is also applied, or a two percent fuel consumption increase where no NO_x adsorber is applied (refer to chapter 6, section 6.2.3.3).

Maintenance costs associated with the new emission controls on the engines are expected to increase since these devices represent new hardware and, therefore, new maintenance demands. For CDPF maintenance, we have used a maintenance interval of 3,000 hours for smaller engines and 4,500 hours for larger engines and a cost of \$65 through \$260 for each maintenance event. For closed-crankcase ventilation (CCV) systems, we have used a maintenance interval of 675 hours for all engines and a cost per maintenance event of \$8 to \$48 for small to large engines. Offsetting these maintenance cost increases would be a savings due to an expected increase in oil change intervals because low sulfur fuel would be far less corrosive than is current nonroad diesel fuel. Less corrosion would mean a slower acidification rate (*i.e.*, less degradation) of the engine lubricating oil and, therefore, more operating hours between needed oil changes. As discussed in section V.B, the use of 15 ppm sulfur fuel can extend oil change intervals by as much as 35 percent for both new and existing nonroad engines and equipment. We have used a 35 percent increase in oil change interval along with costs per oil change of \$70 through \$400 to arrive at estimated savings associated with increased oil change intervals.

These operating costs are expressed as a cent/gallon cost (or savings). As a result, operating costs are directly proportional to the amount of fuel consumed by the engine. We have estimated these operating costs, inclusive of fuel-related costs, to be 3.4 cents/gallon for a 150 horsepower engine and 4.2 cents/gallon for a 500 horsepower engine. More detail on operating costs can be found in chapter 6 of the draft RIA.

The existing fleet will also benefit from lower maintenance costs due to the use of low sulfur diesel fuel. The operating costs for the existing fleet are discussed in Section V.B.

2. Equipment Cost Impacts

In addition to the costs directly associated with engines that incorporate new emission controls to meet new standards, we expect cost increases due to the need to redesign the nonroad equipment in which these engines are used. Such redesigns would probably be necessary due to the expected addition of new emission control systems, but could also occur if the engine has a different shape or heat rejection rate, or

is no longer made available in the configuration previously used. Based on their past experiences, equipment manufacturers have told EPA that a major concern with a new standard is their ability to redesign a large number of applications in a short period of time. Therefore, we have provided equipment manufacturers transition flexibility provisions to help them avoid business disruptions resulting from the changes associated with new emission standards. These flexibility provisions are presented in detail in Section III.E.4.

In assessing the economic impact of the new emission standards, EPA has made a best estimate of the modifications to equipment that relate to packaging (installing engines in equipment engine compartments). The incremental costs for new equipment would be comprised of fixed costs (for redesign to accommodate new emission control devices) and variable costs (for new equipment hardware and for labor to install new emission control devices). Note that the fixed costs do not include certification costs, as did the engine fixed costs, because equipment is not certified to emission standards. We have attributed all changes in operating costs (*e.g.*, additional maintenance) to the cost estimates for engines. Included in section V.C.3 is a discussion of several example pieces of equipment (*e.g.*, skid/steer loader, dozer, etc.) and the costs we have estimated for these specific example pieces of equipment. Full details of our equipment cost analysis can be found in chapter 6 of the draft RIA. All costs are presented in 2001 dollars.

a. Equipment Fixed Costs

The most significant changes anticipated for equipment redesign are changes to accommodate the physical changes to engines, especially for those engines that add PM traps and NO_x adsorbers. The costs for engine development and the emission control devices are included as costs to the engines, as described above. *What remains to be quantified for equipment manufacturers is the effort to integrate the engine and emissions control devices into the overall functioning of the equipment.* What remains to be quantified for equipment manufacturers is the effort to integrate the engine and emissions control devices into the overall functioning of the equipment. We have allocated extensive engineering time for this effort.

The costs we have estimated are based on engine power and whether an application is non-motive (*e.g.*, a generator set) or motive (*e.g.*, a skid steer loader). The designs we have

considered to be non-motive are those that lack a propulsion system. In addition, the proposed emission standards for engines rated under 25 horsepower and the proposed 2008 standards for 25–75 horsepower engines are projected to require no significant equipment redesign beyond that done to accommodate the Tier 2 standards. We expect that these engines would comply with the proposed Tier 4 standards through either engine modifications to reduce engine-out emissions or through the addition of a DOC. We have projected that engine modifications would not affect the outer dimensions of the engine and that a DOC would replace the existing muffler. Therefore, either approach taken by the engine manufacturer should have minimal to no impact on the equipment design. Nonetheless, we have conservatively estimated their redesign costs at \$50,000 per model.

A number of equipment manufacturers have shared detailed information with us regarding the investments made for Nonroad Tier 2 equipment redesign efforts, as well as redesign estimates for significant changes such as installing a new engine design. These estimates range from approximately \$50,000 for some lower powered equipment models to well over \$1 million dollars for high horsepower equipment with very challenging design constraints. Based on that input, for the proposed Tier 4 standards, we have estimated that equipment redesign costs would range from \$50,000 per model for 25 horsepower equipment up to \$750,000 per model for 300 horsepower equipment and above. We have attributed only a portion of the equipment redesign costs to U.S. sales in a manner consistent with that taken for engine R&D costs and engine tooling costs. In addition, we expect manufacturers to incur some fixed costs to update service and operation manuals to address the maintenance demands of new emission control technologies and the new oil service intervals which we estimate to be between \$2,500 and \$10,000 per equipment model.

These equipment fixed costs (redesign and manual updates) were then allocated appropriately to each new model to arrive at a total equipment fixed cost of \$697 million. We have assumed that these costs would be recovered over a ten year period at a seven percent interest rate.

b. Equipment Variable Costs

Equipment variable cost estimates are based on costs for additional materials to mount the new hardware (*i.e.*, brackets and bolts required to secure the