

range beginning in 2008. At this time, we are not proposing further reductions in the NO_x standards for engines between 25 and 75 hp.

As discussed in section III.B.1.d, engines ≥75 hp are similar to, or are direct derivatives of, highway HDDEs. As discussed in section III.E.1–III.E.3, NO_x adsorber technology is being developed today in order to comply with the 2007 highway heavy-duty standards. However, NO_x adsorber technologies will require additional development beyond what has occurred at this time in order to achieve the 2007 highway standards. Section III.E.1–III.E.3 also discuss the high degree of complexity and engine/aftertreatment integration which will be required in order for NO_x adsorbers to be applied successfully to nonroad diesel engines.

As discussed above, and as illustrated in Table III.E–3, engines <75 hp include a significant fraction of naturally aspirated engines and engines with indirect-injection fuel systems, and we are not predicting a significant shift away from IDI technology engines. Given the relatively unsophisticated level of technology used in this power category today, as well as our prediction that even in the 2011–13 time frame these engines will lag significantly behind the ≥75 hp engines, we believe it is appropriate not to propose NO_x adsorber based standards at this time. Rather, as discussed in section III.H, we have proposed to undertake a technology assessment in the 2007 time frame which would evaluate the status of emission control technologies for engines less than 75 hp, and such a review would revisit this issue. In addition, section VI of this proposal contains additional discussion regarding our analysis of applying NO_x adsorbers to engines in the 25–75 hp category. EPA invites further comment on the above discussion, and also solicits comment on the cost impacts of NO_x aftertreatment devices, including unit costs, on these engines.

5. Are the Standards Proposed for Engines <25 hp Feasible?

As discussed in section III.B, our proposal for standards for engines less than 25 hp is a new PM standard of 0.30 g/bhp–hr beginning in 2008. As discussed below, we are not proposing to set a new standard more stringent than the existing Tier 2 NMHC+NO_x standard for this power category at this time. This section describes:

- What makes the <25 hp category unique;
- Engine technology currently used in the <25 hp category;

- Why the proposed standards are technologically feasible; and,
- Why EPA has not proposed more stringent standards at this time.

a. What Makes the <25 hp Category Unique?

Nonroad engines less than 25 hp are the least sophisticated nonroad diesel engines from a technological perspective. All of the engines currently sold in this power category lack electronic fuel systems and turbochargers (see Table III.E–3). Nearly 50 percent of the products have two-cylinders or less, and 14 percent of the engines sold in this category are single-cylinder products, a number of these have no batteries and are crank-start machines, much like today's simple walk behind lawnmower engines. In addition, given what we know today and taking into account the Tier 2 standards which have not yet been implemented, we are not projecting any significant penetration of advanced engine technology, such as electronically controlled fuel systems, into this category in the next 5 to 10 years.

We have proposed a PM standard for engines in the <25 hp category which is higher than the standard proposed for engines in the 25–75 hp category (0.30 g/bhp–hr vs. 0.22 g/bhp–hr). We have done this for a number of reasons. First, the existing Tier 2 PM standards specifies standards which become numerically higher for the smaller power categories. Specifically, for engines >175 hp, the Tier 2 PM standard is 0.15 g/bhp–hr, which increases to 0.30 g/bhp–hr for engines in the 50–100hp range, 0.45 g/bhp–hr for engines in the 25–50hp range, and finally 0.60 g/bhp–hr for engines <25 hp. In the Tier 2 time frame, engines in the higher power categories are expected to use more sophisticated technologies such as turbocharging and high pressure electronically controlled fuel systems. These technologies are more capable of reducing PM emissions as compared to naturally aspirated engines with lower pressure mechanical fuel systems. To some extent this same trend is expected to continue in the 2008 time frame. As discussed above, we expect that many engines in the 25–75hp engine category will use turbocharging, and some engines will have electronic fuel systems. However, we are not predicting that any engines in the <25hp category will use either of these technologies. In addition, very small diesel engines present a number of unique challenges for reducing PM emissions. First, the smaller engines inherently have high combustion chamber surface-to-volume

ratios. This results in higher heat loss, which results in a quenching of the oxidation process earlier than for larger engines, and therefore higher PM emission rates. In addition, the small diesel engines are more limited in the PM reduction which can be achieved by higher fuel injection pressures. Due to the very small size of the combustion chamber, high pressure injection (which is intended to improve fuel atomization and mixing, both of which lower PM emissions) will result in fuel impaction on the combustion chamber, which will not improve fuel atomization. The benefits of higher pressure fuel injection as a PM reduction technology therefore reaches a point of diminishing returns with higher and higher pressures, and this point of diminishing returns is reached much quicker for the smaller engines than for the larger engines. For these reasons we have proposed a 2008 PM standard for engines <25 hp which is higher than the proposed 2008 PM standard for engines in the 25–75 hp category.

b. What Engine Technology is Currently Used in the <25 hp category?

In the 1998 nonroad diesel rulemaking we established Tier 1 and Tier 2 standards for these products. Tier 1 was implemented in model year 2000, and Tier 2 will be implemented in model year 2005. As discussed in EPA's recent Staff Technical Paper, we project the Tier 2 standards will be met by basic engine-out emission optimization strategies.²⁰⁴ We are not predicting that Tier 2 will require electronic fuel systems, EGR, or turbocharging. As discussed in the Staff Technical Paper, a large number of engines in this power category already meet the Tier 2 standards by a wide margin.²⁰⁵

Two basic types of engine fuel injection technologies are currently present in the less than 25 hp category, mechanical indirect injection (IDI) and mechanical direct injection (DI). As discussed in section III.D.4, the IDI system injects fuel into a pre-chamber rather than directly into the combustion chamber as in the DI system. This difference in fuel systems results in substantially different emission characteristics, as well as several important operating parameters. In general, as noted earlier, the IDI engine has lower engine-out PM and NO_x

²⁰⁴ See section 3 of "Nonroad Diesel Emission Standards—Staff Technical Paper", EPA Publication EPA420–R–01–052, October 2001. Copy available in EPA Air Docket A–2001–28.

²⁰⁵ See Table 3–2 in "Nonroad Diesel Emission Standards—Staff Technical Paper", EPA Publication EPA420–R–01–052, October 2001. Copy available in EPA Air Docket A–2001–28.