

use of a CDPF, the PM emissions emitted by the filter are primarily derived from the fuel sulfur. The smaller power category engines tend to have higher fuel consumption than larger engines. This occurs for a number of reasons. First, the lower power categories include a high fraction of IDI engines which by their nature consume approximately 15 percent more fuel than a DI engine. Second, as engine displacements get smaller, the engine's combustion chamber surface-to-volume ratio increases. This leads to higher heat-transfer losses and therefore lower efficiency and higher fuel consumption. In addition, frictional losses are a higher percentage of total power for the smaller displacement engines which also results in higher fuel consumption. Because of the higher fuel consumption rate, we expect a higher particulate sulfate level, and therefore we have proposed a 0.02 g/bhp-hr standard.

Test data confirm that this proposed standard is achievable. In 2001, EPA completed a test program run by a contractor on two small nonroad diesel engines (a 25 hp IDI engine and a 50 hp IDI engine) which demonstrated the proposed 0.02 g/bhp-hr standard can be achieved with the use of a CDPF.²⁰⁰ This test program included testing on the existing 8-mode steady-state test cycle as well as the nonroad transient cycle proposed in today's action. The 0.02g/bhp-hr level was achieved on each engine over both test cycles. One of the engines was also tested on the proposed constant speed, variable load transient cycle with a particulate filter, and this engine also met the proposed 0.02 g/bhp-hr PM standard.²⁰¹ This test program also demonstrates why EPA has proposed a slightly higher PM standard for the 25–75 hp category (0.02 g/bhp-hr vs 0.01). The data from the test program described above showed fuel consumption rates over the 8-mode test procedure between 0.4 and 0.5 lbs/bhp-hr, while typical values for a modern turbocharged DI engine with 4-valves per cylinder in the ≥75 hp categories are on the order of 0.3 to 0.35 lbs/hp-hr. However, the data is less conclusive with respect to the proposed NTE standard. The test program at SwRI included a number of individual steady-

state emission points which are within the proposed NTE control zone for nonroad diesel engines. For most of these points, the emissions were well below the proposed NTE standard for both engines. However, both engines included as a test point the maximum torque test point, and in each case the emissions were above the proposed NTE standard. For one engine, the engine-out emissions were 1.2 g/bhp-hr PM and when equipped with a CDPF the emissions were 0.05 g/bhp-hr. While this is more than a 95 percent reduction in PM, 0.05 is above our proposed NTE standard of 0.03 g/bhp-hr. The second test engine at the maximum torque mode produced an engine-out PM value of 0.35 g/bhp-hr, and when equipped with a CDPF the results were 0.04g/bhp-hr. While this is nearly a 90 percent reduction in PM, the engines do not meet the proposed NTE standard. We believe these results are a combination of high engine-out PM emissions as well as high exhaust gas temperature. While a CDPF is very effective at reducing PM emissions, it is not 100 percent effective. These engines would likely require additional engine-out PM reductions at the maximum torque mode in order to comply with the proposed NTE standard. In addition, the peak torque mode is one of the highest exhaust gas temperature mode, and therefore one of the highest particulate-sulfate generating modes when equipped with a CDPF. More careful management of the engine-out temperature at this mode, such as by altering the engines air-fuel ratio, may be necessary to lower the engine-out temperature and comply with the proposed NTE standard.

NMHC+NO_x Standard

We have proposed a 3.5 g/bhp-hr NMHC+NO_x standard for engines in the 25–50 hp range for 2013. This will align the NMHC+NO_x standard for engines in this power range with the Tier 3 standard for engines in the 50–75 hp range which are implemented in 2008. EPA's recent Staff Technical paper which reviewed the technological feasibility of the Tier 3 standards contains a detailed discussion of a number of technologies which are capable of achieving a 3.5 g/bhp-hr standard. These include cooled EGR, uncooled EGR, as well as advanced in-cylinder technologies relying on electronic fuel systems and turbocharging.²⁰² These technologies are

capable of reducing NO_x emission by as much as 50 percent. Given the Tier 2 NMHC+NO_x standard of 5.6 g/bhp-hr, a 50 percent reduction would allow a Tier 2 engine to comply with the 3.5 g/bhp-hr NMHC+NO_x standard proposed in this action. In addition, because this NMHC+NO_x standard is concurrent with the 0.02 g/bhp-hr PM standards which we project will be achievable with the use of particulate filters, engine designers will have significant additional flexibility in reducing NO_x because the PM filter will eliminate the traditional concerns with the engine-out NO_x vs. PM trade-off. Our recent highway 2004 standard review rulemaking (*see* 65 FR 59896) demonstrated that a diesel engine with advanced electronic fuel injection technology as well as NO_x control technology such as cooled EGR is capable of complying with an NTE standard set at 1.25 times the laboratory based-standard FTP standard. We project that the same technology (electronic fuel systems and cooled EGR) are also capable for engine in the 25–75 hp range of complying with the proposed NTE standard of 4.4 g/bhp-hr NMHC+NO_x (1.25 x 3.5) in 2013. This is based on the broad NO_x reduction capability of cooled EGR technology, which is capable of reducing NO_x emissions across the engine operating map by at least 30 percent even under high load conditions.²⁰³

Based on the information available to EPA and presented here, and giving appropriate consideration to the lead time necessary to apply the technology as well, we have concluded the proposed 0.02 g/bhp-hr PM standard for engines in the 25–75 hp category and the 3.5 g/bhp-hr NMHC+NO_x standards for the 25–50 hp engines are achievable.

d. Why EPA has not Proposed More Stringent Tier 4 NO_x Standards

Today's notice proposes to revise the NMHC+NO_x standard for engines between 25 and 50 hp to a level of 3.5 g/bhp-hr beginning in 2013 (the same numeric level as the Tier 3 standards for engines in the 50–75 hp range). As discussed below, we believe this standard can be met using a variety of technologies, including but not limited to cooled EGR. Similar technologies will be used on engines in the 50–100 hp

²⁰⁰ See Tables 6, 8, and 14 of "Nonroad Emission Study of Catalyzed Particulate Filter Equipped Small Diesel Engines" Southwest Research Institute, September 2001. Copy available in EPA Air Docket A–2001–28.

²⁰¹ See Tables 8 of "Nonroad Emission Study of Catalyzed Particulate Filter Equipped Small Diesel Engines" Southwest Research Institute, September 2001. Copy available in EPA Air Docket A–2001–28. Note that the "AWQ" cycle specified in Table 8 is the same as the proposed constant speed, variable load cycle.

²⁰² See section 2.2 through 2.3 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.

²⁰³ See section 8 of "Control of Emissions of Air Pollution from 2004 and Later Model Year Heavy-Duty Highway Engines and Vehicles: Response to Comments", EPA document EPA420–R–00–011, July 2000, and Chapter 3 of "Regulatory Impact Analysis: Control of Emissions of Air Pollution from Highway Heavy-duty Engines", EPA document EPA420–R–00–010, July 2000. Copies of both documents available in EPA docket A–2001–28.