

and steady-state test procedures.¹⁸¹ Given that typical engine-out NMHC is expected to be in the 0.40 g/bhp-hr range or lower for engines meeting the Tier 3 standards, this level of NMHC reduction will mean that under lean conditions emission levels will be well below the standard.

The NO_x regeneration strategies for the NO_x adsorber technology may prove difficult to control precisely, leading to a possible increase in NMHC emissions under the rich operating conditions required for NO_x regeneration. Even with precise control of the regeneration cycle, NMHC slip may prove to be a difficult problem due to the need to regenerate the NO_x adsorber under net rich conditions (excess fuel) rather than the stoichiometric (fuel and air precisely balanced) operating conditions typical of a gasoline three-way catalyst. It seems possible therefore, that in order to meet the NMHC standards we have proposed, an additional clean up catalyst may be required. A diesel oxidation catalyst, like those applied historically for NMHC and partial PM control, can reduce NMHC emissions (including toxic HCs) by more than 90 percent.¹⁸² This amount of additional control along with optimized NO_x regeneration strategies will ensure very low NMHC emissions. Our cost analysis described in section V includes the cost for the application of a clean-up DOC catalyst for all engines which must comply with the 0.3 g/bhp-hr NO_x standard.

Test results from a prototype integrated NO_x/PM and NMHC control system for diesel engines documented in the draft RIA show that NMHC emissions can be controlled below 0.14 g/bhp-hr under transient and steady-state test conditions for highway diesel engines while simultaneously controlling NO_x emissions below 0.2 g/bhp-hr and PM emissions below 0.01 g/bhp-hr. Since the slip of hydrocarbon emissions are predominantly a function of the NO_x regeneration event and not engine transient events, the level of control demonstrated in this testing is expected to be the same for other operating conditions as represented by the proposed NRTC cycle and the NTE provisions of this rulemaking. Based on our engineering judgement and experience testing integrated NO_x

adsorber and PM filter systems with DOC clean-up catalyst technologies, we can conclude that the 0.14 g/bhp-hr NMHC standard will be feasible in the Tier 4 time frame.

The proposed standards include a cold start provision with the transient test procedures. This means that the results of a cold start transient test will be weighted with the emissions of a hot start test in order to calculate the emissions for compliance against the proposed standards. The proposed weightings are 1/10 cold start and 9/10 for the hot start as described more fully in chapter 4.2 of the draft RIA. Because exhaust temperatures are so important to catalyst performance the cold start provision is an important tool to ensure that the emissions realized in use are consistent with the expectations of this program and represents an additional technical challenge for NO_x control and to a lesser extent CO and NMHC control. PM control with a CDPF is not expected to be significantly impacted by cold-start provisions. NO_x control in the period before temperatures exceed the catalyst light-off temperature are reduced significantly. As a result, exhaust stack NO_x emissions will be higher over the cold start portion of the test. However, we believe that this increase in NO_x emissions will not be high enough to preclude compliance with the proposed NO_x standard once the 1/10 weighting is applied.

There are a number of technologies available to the engine manufacturer to promote rapid warmup of the exhaust and emission control system. These include retarding injection timing, increasing EGR, and potentially late cycle injection all of which are technologies we expect manufacturers to apply as part of the normal operation of the NO_x adsorber catalyst system. These are the same technologies we expect highway engine manufacturers to use in order to comply with the highway cold start FTP provision which weights cold start emissions more heavily with a 1/7 weighting. As a result, we expect the transfer of highway technology to be well matched to accomplish this control need for nonroad engines as well. Using these technologies we expect nonroad engine manufacturers to be able to comply with the proposed NO_x, NMHC and CO emissions including the cold start provisions of the transient test procedure.

We did not set new Tier 3 emission standards for >750 hp nonroad engines in the 1998 Tier 2/3 rulemaking because of the long lead time we believed appropriate, given the long product redesign cycles typical of these large

engines and their low sales volumes. The Tier 2 standards set in that rulemaking for >750 hp engines do not go into effect until 2006. We reasoned in the Tier 2/3 rule that the uncertainties involved in setting a Tier 3 standard for >750hp nonroad engines that wouldn't go into effect before 2010 would be too large. Therefore, we deferred setting new standards for these engines at that time. Given new technology enabled by low sulfur diesel fuel, we believe that it is now appropriate to project the technologies which will be available for these engines in the future (*i.e.*, CDPFs and NO_x adsorbers) and to set new standards accordingly.

Although we have proposed a unique phase-in schedule for >750hp engines as explained in section III.B, we do not doubt that these engines, like engines <750hp, can be developed to meet the standards proposed today. These large engines are fundamentally similar to other nonroad engines. The project emissions control mechanisms are the same. Retrofits of PM filter systems have been applied to large locomotives and other similar size engines. We are unaware of any fundamental difference in technology function that would lead us to conclude that the proposed standards are inappropriate for engines >750hp. However, given the need to apply both new engine-out control technologies (*i.e.*, Tier 3 type technologies) in addition to the new catalyst based technologies in order to comply with the proposed standards, and given the low sales volumes for these engines, we do believe it is appropriate to have a different phase-in structure for these engines. We invite comment supported by data on this issue, particularly if a commenter believes there are fundamental technology differences which would make alternate standards more appropriate for >750hp nonroad engines.

The standards that we have proposed today for nonroad engines with rated horsepower levels ≥75 horsepower are based upon the same emission control technologies, clean 15ppm or lower sulfur diesel fuel, and relative levels of emission control effectiveness as the HD 2007 emission standards. We have given consideration to the diversity of nonroad equipment for which these technologies must be developed and the timing of the Tier 3 emissions standards in determining the appropriate timing for the Tier 4 standards we have proposed today. Based upon the availability of the emission control technologies, the proven effectiveness of the technologies to control diesel emissions to these levels, the technology

¹⁸¹ "The Impact of Sulfur in Diesel Fuel on Catalyst Emission Control Technology," report by the Manufacturers of Emission Controls Association, March 15, 1999, pp. 9 & 11. Copy available in EPA Air Docket A-2001-28.

¹⁸² "Demonstration of Advanced Emission Control Technologies Enabling Diesel-Powered Heavy-Duty Engines to Achieve Low Emission Levels", Manufacturers of Emissions Controls Association, June 1999. Copy available in EPA Air Docket A-2001-28.