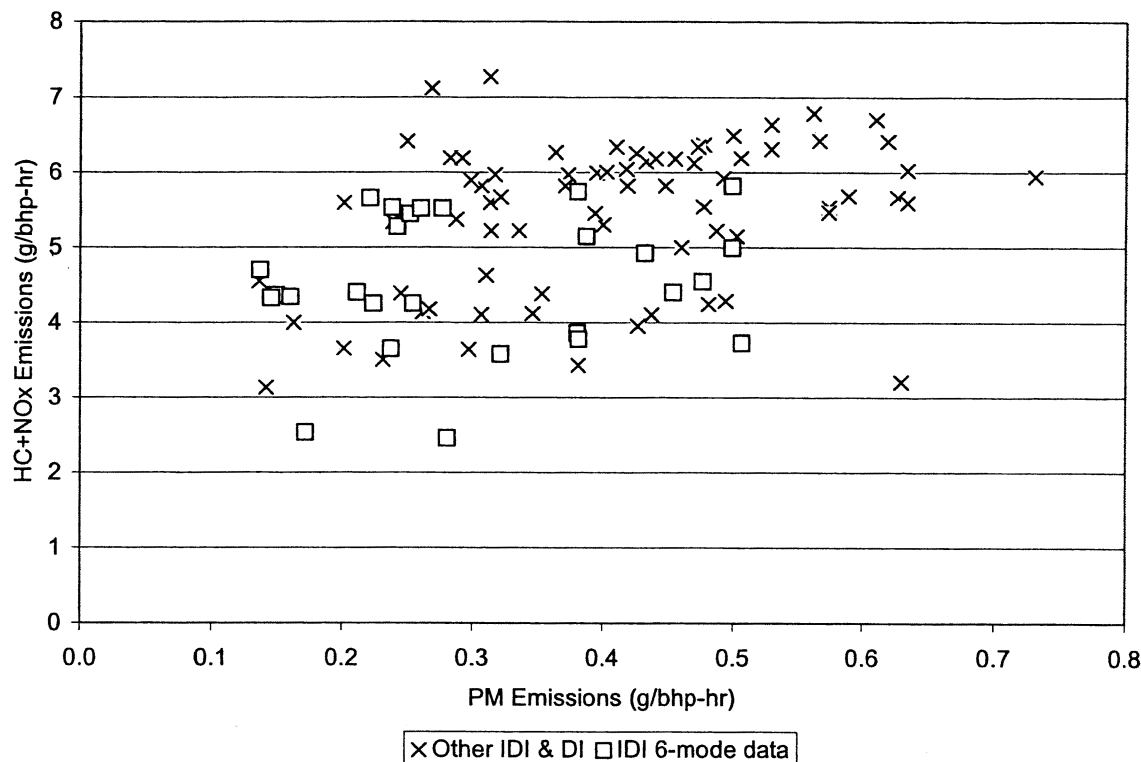


FIGURE III.E-2 -- EMISSION CERTIFICATION DATA FOR <25 HP MODEL YEAR 2002 ENGINES

PM emissions can be reduced through in-cylinder techniques for small nonroad diesel engines using similar techniques as used in larger nonroad and highway engines. As discussed in section III.E.1.a, there are a number of technologies which exist that can influence oxygen content and in-cylinder mixing (and thus lower PM emissions) including improved fuel injection systems and combustion system designs. For example, increased injection pressure can reduce PM emissions substantially.²⁰⁷ The wide-range of emission characteristics present in the existing engine certification data is likely a result of differences in fuel systems and combustion chamber designs. For many of the engines which have higher emission levels, further optimization of the fuel system and combustion chamber can provide additional PM reductions.

Diesel oxidation catalysts (DOC) also offer the opportunity to reduce PM emissions from the engines in this power category. DOCs are passive flow through emission control devices which

are typically coated with a precious metal or a base-metal wash-coat. DOCs have been proven to be durable in-use on both light-duty and heavy-duty diesel applications. In addition, DOCs have already been used to control carbon monoxide on some nonroad applications.²⁰⁸ However, as discussed in section III.E.1.a., certain DOC formulations can be sensitive to diesel fuel sulfur level. Specifically, precious-metal based oxidation catalysts (which have the greatest potential for reducing PM) can oxidize the sulfur in the fuel and form particulate sulfates. Given the high level of sulfur in nonroad fuel today, the use of DOCs as a PM reduction technology is severely limited. Data presented by one engine manufacturer regarding the existing Tier 2 PM standard shows that while a DOC can be used to meet the current standard when tested on 2,000 ppm sulfur fuel, lowering the fuel sulfur level to 380 ppm enabled the DOC to reduce PM by 50 percent from the 2,000 ppm sulfur

fuel.²⁰⁹ Without the availability of 500 ppm sulfur fuel in 2008, DOCs would be of limited use for nonroad engine manufacturers and would not provide the emissions necessary to meet the proposed standards for most engine manufacturers. With the availability of 500 ppm sulfur fuel, DOC's can be designed to provide PM reductions on the order of 20 to 50%, while suppressing particulate sulfate reduction. These levels of reductions have been seen on transient duty cycles as well as highway and nonroad steady-state duty cycles.²¹⁰ As discussed in section III.D, we are proposing to apply supplemental test procedures and standards (nonroad transient test cycle

²⁰⁹ See Table 2-4 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.

²¹⁰ "Demonstration of Advanced Emission Control Technologies Enabling Diesel-Powered Heavy-duty Engines to Achieve Low Emission Levels: Interim Report Number 1—Oxidation Catalyst Technology, copy available in EPA Air Docket A-2001-28. "Reduction of Diesel Exhaust Emissions by Using Oxidation Catalysts," Zelenka et. al., SAE Paper 90211, 1990. See Table 2-4 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.

²⁰⁷ "Effects of Injection Pressure and Nozzle Geometry on DI Diesel Emissions and Performance," Pierpont, D., and Reitz, R., SAE Paper 950604, 1995.

²⁰⁸ EPA Memorandum "Documentation of the Availability of Diesel Oxidation Catalysts on Current Production Nonroad Diesel Equipment", William Charmley. Copy available in EPA Air Docket A-2001-28.