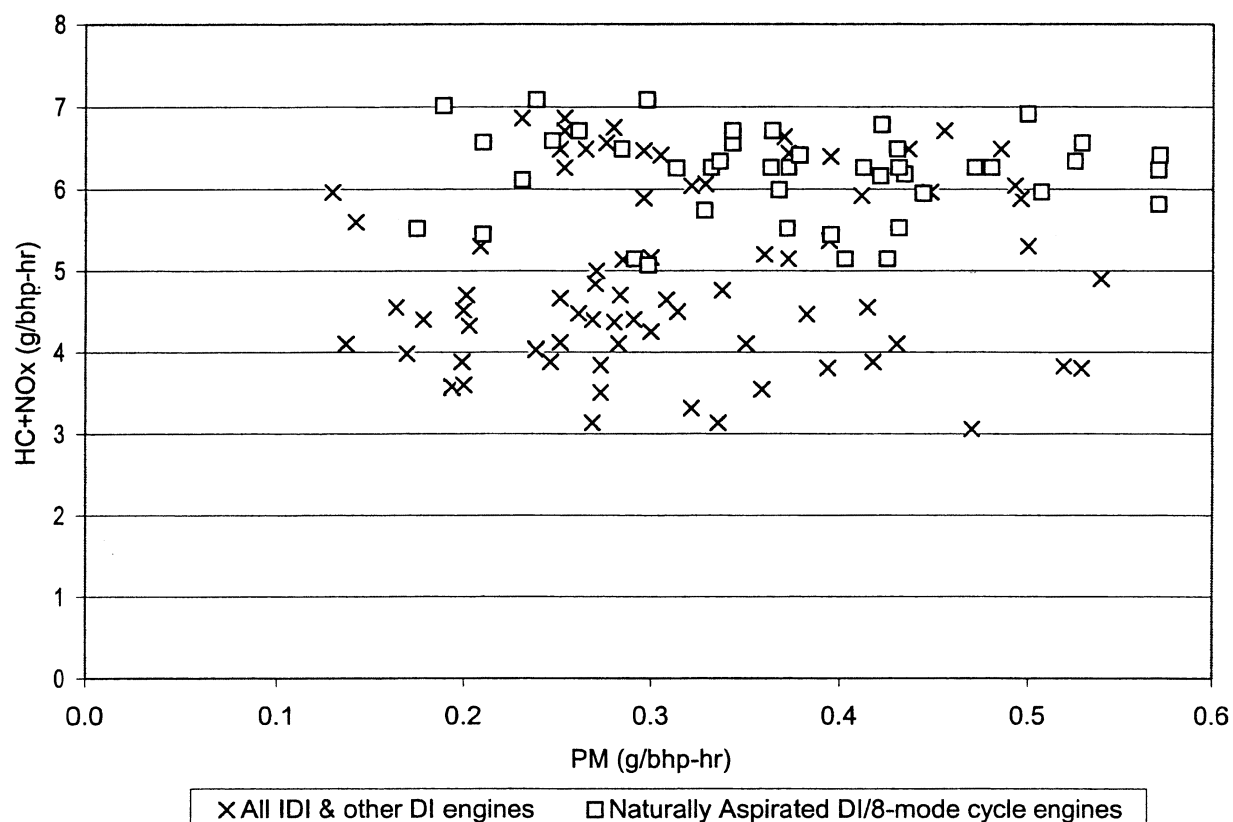


FIGURE III.E-1 -- EMISSION CERTIFICATION DATA FOR 25-50 HP MODEL YEAR 2002 ENGINES

For those engines which do not already meet the proposed 2008 Tier 4 PM standard, a number of engine-out technologies are available to achieve the standards by 2008. In our recent Staff Technical Paper on the feasibility of the Tier 2 and Tier 3 standards, we projected that in order to comply with the Tier 3 standards, engines greater than 50 hp would rely on some combination of a number of technologies, including electronic fuel systems such as electronic rotary pumps or common-rail fuel systems.¹⁹⁰ In addition to enabling the Tier 3 NMHC+NO_x standards, electronic fuel systems with high injection pressure and the capability to perform pilot-injection and rate-shaping, have the potential to substantially reduce PM emissions.¹⁹¹ Even for mechanical fuel

systems, increased injection pressures can reduce PM emissions substantially.¹⁹² As discussed above, we are projecting that the Tier 3 engine technologies used in engines between 50 and 75 hp, such as turbocharging and electronic fuel systems, will make their way into engines in the 25–50 hp range. However, we do not believe this technology will be required to achieve the proposed 2008 PM standard. As demonstrated by the 2002 certification data, engine-out techniques such as optimized combustion chamber design, fuel injection pressure increases and fuel injection timing can be used to achieve the proposed standards for many of the engines in the 25–75 hp category without the need to add turbocharging or electronic fuel systems.

For those engines which are not able to achieve the proposed standards with known engine-out techniques, we project that diesel oxidation catalysts can be used to achieve the proposed standards. DOCs are passive flow-through emission control devices which

are typically coated with a precious metal or a base-metal washcoat. 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.¹⁹³

Certain DOC formulations can be sensitive to diesel fuel sulfur level, and depending on the level of emission reduction necessary, sulfur in diesel fuel can be an impediment to PM reductions. As discussed in section III.E.1.a, precious metal oxidation catalysts can oxidize the sulfur in the fuel and form particulate sulfates. However, even with today's high sulfur nonroad fuel, some manufacturers have demonstrated that a properly formulated DOC can be used to achieve the existing Tier 2 PM standards for larger engines (*i.e.*, the 0.15 g/bhp-hr standard).¹⁹⁴ However, given the high level of sulfur in nonroad fuel today, the use of DOCs

¹⁹⁰ 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.

¹⁹¹ Ikegami, M., K. Nakatani, S. Tanaka, K. Yamane: "Fuel Injection Rate Shaping and Its Effect on Exhaust Emissions in a Direct-Injection Diesel Engine Using a Spool Acceleration Type Injection System", SAE paper 970347, 1997. Dickey D.W., T.W. Ryan III, A.C. Matheaus: "NO_x Control in Heavy-Duty Engines—What is the Limit?", SAE paper 980174, 1998. Uchida N, K. Shimokawa, Y. Kudo, M. Shimoda: "Combustion Optimization by

Means of Common Rail Injection System for Heavy-Duty Diesel Engines", SAE paper 982679, 1998.

¹⁹² "Effects of Injection Pressure and Nozzle Geometry on DI Diesel Emissions and Performance," Pierpont, D., and Reitz, R., SAE Paper 950604, 1995.

¹⁹³ 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.

¹⁹⁴ 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.