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Technical Report

An Evaluation of the Particulate Levels Occurring Under 1.0/1.2 g/mi NOx standards for LDDVs and LDDTS

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NOTICE

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I. Introduction

The Diesel Particulate Study (DPS)[1] examined the level of NOx and particulate emissions that would be present for three different NOx scenarios: 1) 1.0/1.2 g/mi, 2) 1.5/1.7 g/mi, and 3) 2.0/2.3 g/mi NOx standards for LDDVs and LDDTs, respectively. Chapter 1 of the study estimated the particulate emission level as a function of a changing NOx emission level. This relationship was based on the certification test results for LDDVs and LDDTs from 1982 and 1983 model years. The methodology to estimate the particulate levels will be described in the following section. The purpose of this report is to compare the particulate emissions estimated under the low NOx level (i.e., 1.0/1.2 g/mi) to the actual 1984 California and 50-state certification particulate levels that are now available at these low NOx levels.

It is important to make this comparison because the particulate emissions at low NOx emission levels were based on data at higher NOx levels. Thus, the derived NOx/particulate relationship was extrapolated to obtain the low NOx levels. The 1984 California standard is at a 1.0/1.2 g/mi NOx level, allowing the opportunity to examine the particulate emission levels of certified LDDVs and LDDTs at these NOx standards. Without accurate estimates, it is not possible to project what the manufacturers' corporate average particulate standard levels will be with a 1.0/1.2 g/mi NOx standard. Nor will it be possible to judge just how many vehicles will require traps for this scenario. This report will examine the accuracy of the estimates and the resulting projections.

II. Previous Methodology

In order to estimate particulate standard levels under a NOx standard of 1.0 g/mi for LDDVs and 1.2 g/mi for LDDTs, a NOx/particulate relationship was developed through the use of NOx/particulate tradeoff curves. The data for these curves were supplied by 1983 model year low mileage levels. (Test results from 1982 were used when 1983 results were not available.) Light-duty diesel vehicles were divided into three categories based on engine size: 1) small (1.6-4.3 liters displacement), 2) medium (2.0 to 2.8 liters displacement) and 3) large (3.0 to 5.7 liters displacement). The tradeoff curves for these engine sizes resulted in three respective slopes for NOx values less than 1.35 g/mi: 1) -.033, 2) -.201, and 3) -.400 g/mi particulate/g/mi NOx. Light-duty diesel trucks were divided into only two categories: 1) small (1.6 to 2.5 liters displacement), and 2) full-size (6.2 liters displacement). The slopes for LDDTs are the same as for small and large LDDVs, respectively.

The low-mileage LDDV particulate and NOx emission values are listed in Table 1; the LDDT data are in Table 2. These values were projected by using the known 1983 certification emission data for each engine family and the appropriate NOx/particulate tradeoff curve slope (applied down to a low-mileage NOx level of 0.90 g/mi).

The standard levels for both NOx and particulates were determined by multiplying the low-mileage emission levels by their deterioration factors (DF) and the safety factor. The deterioration values (DF) were the certification DFs for the 1983 model year. A safety margin of 10 percent was used for this study. The estimated LDDV particulate standard levels under the 1.0 g/mi NOx standard are listed in Table 3, the LDDT values are included in Table 4.

III. <u>1984 Certification Levels</u>

The methodology just described is potentially biased in its accuracy of predicting particulate standard levels at low NOx levels because the emission data that were used in the DPS were 1983 certification values (i.e., emission values under a 1.5/2.3 g/mi NOx standard). At the time of the study, there were no other data available, nor was the effect technology changes would have on the NOx/particulate relationship known. Since that time, the 1984 California standards of 1.0 g/mi NOx for LDDVs and 1.2 g/mi for some LDDTs have gone into effect and the projections can be evaluated. It should be noted that the majority of the LDDV engine families that were certified federally in 1983 were not certified in 1984 in California. Only those 1983 federal engine families which had identical, or nearly identical, 1984 California counterparts were included in this evaluation.

The certification levels were obtained from the 1984 summary sheets of the California and 50-state certification applications. The actual emission levels listed in Tables 1 and 2 were calculated by dividing the certification emission levels by their DF's and adjusting for the 10 percent safety factor.

It's difficult to make a comparison of these particulate values to the estimated particulate emission values because the actual NOx emission levels are less than the .9 g/mi low-mileage level of a 1.0 g/mi NOx standard for LDDVs. In order to make a comparison it was necessary to adjust the actual emission levels so that the NOx low-mileage level was also equal to 0.90 g/mi. To do this, ideally, new NOx/particulate tradeoff curves should be plotted and new slopes measured from the 1984 emission data. This procedure

Table 1

Comparison of LDDV Low-Mileage,
Low-NOx, Particulate Emissions (g/mi)

			Estimated - DPS		Actual	
Mfr.	Engine Disp.	Configu-ration	NOx Test Level	Particulate Test Level	NOx Test Level	Particulate Test Level
GM	1.8L	M5,2500	.90	.18	.56	.18
GM	4.3L	L3*,3500	.90	.33	.74	.26
Isuzu	1.8L	M5,2750	.90	.19	.72	.21
Isuzu	1.8L	A3,2750	.90	.17	.70	.24
Mercedes Benz	3.0L	A4,4000	.90	.51	.80	.50
Nissan	1.7L	M5,2500	.90	.23	.52	.23
Peugeot	2.3L	A3,3500	.90	.32	.69	.34
Volks-wagen	1.6L	M5,2250**	.90	.19-.23	.65-.90	.13-.28
Volks-wagen	1.6L	5A,2250	.90	.18	.87-.9	.15-.18
Volvo	2.4L	M4***3500	.90	.38	.65	.27

* The transmission of the 1984 GM 4.3L is L4.

** The inertia weight of the 1984 1.6L, MS Volkswagon varies from 2375-2500.

*** The transmission of the 1984 Volvo is L4.

Table 2

Comparison of LDDT Low-Mileage, Low-NOx, Particulate Emissions (g/mi)

			Estimated		Actual	
Mfr.	Engine Disp.	Trans-mission	NOx Test Level	Particulate Test Level	NOx Test Level	Particulate Test Level
GM	6.2L	L4	1.08	.51	1.16	.46
GM	6.2L	L4	1.08	.53	1.60	.34
Isuzu	2.2L	M4	1.08	.27	.68	.28
Isuzu	2.2L	M5	1.08	.26	.76	.26
Mitsu-bishi	2.3L	M5	1.08	.39	.60	.30
Mitsu-bishi	2.3L	M5	1.08	.37	.70	.22
Nissan	2.5L	M5	1.08	.30	.68	.16
Toyota	2.4L	M5	1.08	.27	.68	.20
Toyo-Kogyo	2.2L	M5	1.08	.27	.75	.14

was not followed because there were not enough data points available; the slopes from the 1983 NOx/particulate curves were used to adjust the emission levels. The particulate standard levels under a 1.0 g/mi NOx standard were calculated using the 1984 DFs and the safety factors; these values are listed in Table 3. A similar procedure was followed for LDDTS; the results are listed in Table 4.

IV. Comparison

The difference between the estimated and the adjusted actual LDDV particulate standard levels is listed in terms of percent for each engine family in Table 3; the corresponding percentages for LDDTs are presented in Table 4. The estimated LDDV particulate levels are greater than the values derived from the 1984 low NOx data for all but three engine families. The range is quite large, varying from a five to a fifty percent difference; the comparison of the two particulate levels for LDDTs is similar.

From this analysis it is clear that the DPS generally overestimated the manufacturers' corporate average particulate standard levels at low NOx standards for both LDDVs and LDDTs, based on the 1983 standard levels. The difference is an average of approximately 5 percent for LDDVs and nearly 25 percent for LDDTs. For LDDTs, the differences occur nearly entirely with small LDDTs. (The projection for the GM 6.2L engine was very accurate.) It follows that the projected number of vehicles requiring traps for this scenario is also overestimated, particularly for LDDTs, if the same engine families and the same number of engine families are certified under a 1.0/1.2 g/mi national NOx standard as were certified for the California and the 50-State standard in 1984. The estimated values in the DPS should, thus, be considered as somewhat conservative for LDDVs, but very conservative for LDDTs.

Table 3

Comparison of Estimated vs. Adjusted "Actual" LDDV
Particulate Standards Levels Under the 1.0 g/mi NOx Standard

Mfr.	Engine Disp.	Config.	Est. Particulate Standard (g/mi)	Adjusted "Actual" Particulate Standard (g/mi)	Percent Difference
GM	1.8L	M5,2500	.21	.20	-4.8
GM	4.3L	L3,3500	.37	.24	-35.1
Isuzu	1.8L	M5,2750	.23	.24	+4.3
Isuzu	1.8L	A3,2750	.21	.27	+28.6
MB	3.0L	A4,4000	.57	.51	-10.5
Nissen	1.7L	M5,2500	.29	.31	+6.9
Peugeot	2.3L	A3,3500	.36	.34	-5.6
VW	1.6L	M5,2250	.21-.29	.14-.36	-33.3-+24.1
VW	1.6L	SA,2250	.21	.18-.21	-14.3-0.0
Volvo	2.4L	M4,3500	.47	.24	-48.9

Table 4

Comparison of Estimated vs. Adjusted "Actual" LDDT
Particulate Standard Levels Under the 1.2 g/mi NOx Standard

Mfr.	Engine Disp.	Trns.	Est. Particulate Standard (g/mi)	Adjusted "Actual" Particulate Standard (g/mi)	Percent Difference
GM	6.2L	M4	.56	.54	-3.6
GM	6.2L	L4	.59	.61	+3.3
Isuzu	2.2L	M4	.34	.32	-5.9
Isuzu	2.2 L	M5	.33	.30	-9.1
Mits	2.3L	M5	.43	.31	-27.9
Mits	2.3L	M5	.41	.23	-43.9
Nissan	2.5L	M5	.37	.18	-51.4
Toto	2.4L	M5	.30	.25	-16.7
Toko	2.2L	M5	.30	.14	-53.3

References

1. "Diesel Particulate Study," U.S. EPA, ECTD, October 1983