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A Study of Emissions From Twenty High Mileage 1980 Model Year Passenger Cars Equipped with the GM 350 CID Diesel Engine

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ABSTRACT

This report describes the results of an exhaust emission testing program conducted by EPA on twenty diesel-powered General Motors passenger cars. Each was a full size 1980 model equipped with a 350 CID engine (family designation: 03J9ZG). The primary purpose of this program was to assess the emission durability of this engine which in 1980 was equipped with an EGR system and technological improvements to reduce hydrocarbon, NO_x, and particulate emissions. A secondary objective was the gathering of samples for subsequent Ames Test analyses.

Test vehicles were recruited from the general public within 20 miles of the MVEL using direct mail solicitation. Names were drawn at random from the State motor vehicle registration lists. Only vehicles with over 40,000 miles were sought. This resulted in an average odometer reading for the test fleet of 70,000 miles. The program began in July, 1983 and was completed in September, 1983. Testing was performed at the EPA's Motor Vehicle Emission Laboratory in Ann Arbor.

Only 20% of the vehicles met their standards; however, the average emission levels for CO and NO_x were very close to those resulting from the Certification process at 4,000 miles. Particulate and hydrocarbon levels, on the other hand, did show some deterioration, by a factor of about two.

INTRODUCTION

Although the diesel engine has been recognized as a durable and fuel-efficient powerplant, its use in passenger cars has been limited due to weight and initial cost. However, its inherently high fuel efficiency has brought it into much wider use with a resultant need to regulate particulate emissions. In an effort to meet the regulatory requirements and improve the durability of the engine, several technological changes have occurred with the GM 350 CID diesel. For the 1980 model year, General Motors added an EGR system to reduce the NO_x emissions, and also changed the type of injectors*, to reduce the HC and particulate levels.

PURPOSE

On the basis of the facts above, an EPA test program was designed to measure the emission durability of both the EGR and new injection systems to project future emission levels of these engines.

PROGRAM DESIGN

The program employed the normal Emission Factor procedures in terms of the solicitation of test vehicles. Each vehicle selected was to undergo a single FTP test by the EPA laboratory. An underhood inspection of emission-related components was to follow each test. Vehicles equipped with the 350 CID engine were combined to form a single "universe." The sample area consisted of those zip codes within a 20 mile radius of the Motor Vehicle Emission Laboratory. These lists were compiled by EPA's Enforcement Division from registration data obtained from the State of Michigan Department of Motor Vehicles. The resultant sample size was 1634 vehicles. The list of owners was then randomized and printed on mailing labels for ease of procurement. To obtain the required number of vehicles, 300 letters were mailed in two blocks of 150 each. The actual procurement function was accomplished by EG&G Automotive Research under contract to EPA. All of the testing was performed by EPA in the E&D laboratory. A list of the vehicles tested is shown in Appendix A.

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* Prior to 1980, pencil type injectors were used by GM. In mid-1979 GM began experimenting with a "poppet" type injector to avoid a constant drip associated with the pencil type injectors. With the start of the 1980 model year, GM used the poppet type of injector exclusively. This new fuel delivery system was designed to reduce levels of particulates below the 1982 standard of .6 gm/mi.

PARTICIPANT PROFILE

Each owner was asked a number of questions regarding his/her use and maintenance of the vehicle. Almost all of the vehicle owners said they were involved in sales or commuted long distances to work. Most were concerned with fuel economy. Most owners were satisfied with the performance of their vehicle's engine although some had experienced major problems with injector pumps, injectors, or other minor annoyances such as oil leaks. Most felt they had maintained their vehicles in accordance with the manufacturer's recommendations.

VEHICLE TESTING

Once each vehicle was delivered for testing by the procurement contractor, an E&D technician preconditioned the vehicle for testing the following day. Other than topping off low fluid levels (oil, water, brake fluid) no other maintenance was performed on the vehicles prior to testing. Several vehicles had to have their exhaust systems repaired or replaced due to significant leaks prior to testing. The leaks were due to fatigue and rust and were found along the various flanges and hangers of the exhaust system. The leaks were not of sufficient size to be a noise or health problem to the driver but were of a size to inhibit the collection of a valid sample during a test. Following replacement, 50 miles of preconditioning were accumulated on the vehicle.

Each vehicle was drained of its "as received" fuel and filled to standard volume (40%) with EPA's Diesel #2 fuel from laboratory stock. Each vehicle was tested only once.

EMISSION TEST RESULTS

Complete FTP results for each vehicle are shown in Appendix A. Despite their high mileage (70,000 miles), the average CO and NO_x emission levels of these vehicles are not very different from the levels of Emission Data vehicles tested at 4,000 miles. The average HC emissions of 0.57 gm/mi, however, exceed the standard of 0.41 gm/mi by 0.16 grams per mile. This 0.57 gm/mi level is approximately twice the Certification level of 0.32 gm/mi for these engines. Listed in Table 1 are the average emissions of: 1) the original certification tests of this family, 2) the vehicles tested in this program, 3) vehicles in this program with less than 50,000 miles, 4) vehicles in this program with over 50,000 miles, and 5) the results from a previous EPA program on 1978 GM high mileage diesels. Figure 1 displays the pass/fail outcome of the fleet in this program.

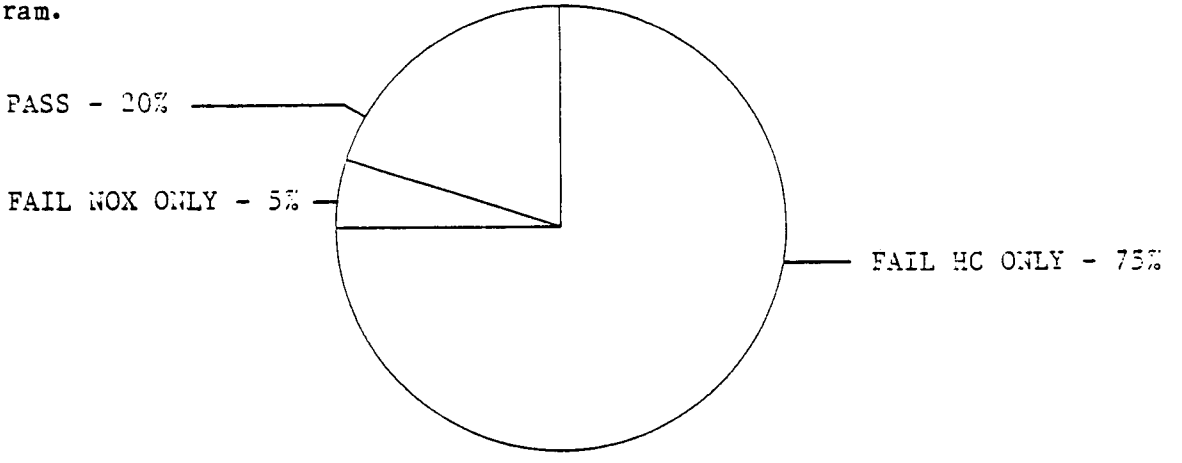

FIGURE 1

Table 1
Federal Test Procedure (gm/mi)
Emission Levels of 1980 MY 350 CID GM Diesels

	N	Odom	HC	CO	NOx	Particulate	City MPG	% Passing
Certification	4	4,000	.32	1.3	1.65	*	22.0	100
1980 Stds.			.41	7.0	2.0			
This program	20	70,006	.57	1.4	1.64	.70	20.9	20
This program under 50K	7	45,169	.42	1.1	1.56	.47	21.7	15
Over 50K	13	83,379	.62	1.5	1.72	.74	20.5	5
For Comparison 1978 MY**	18	48,782	.80	1.6	1.35	.85	21.5	94

*Not available

**Results from EPA-AA-TEB-80-11 (March 1980) for comparison.

As these results show, levels of particulate emissions from these high mileage vehicles are below the 1982 standard of .6 gm/mi for their "useful life" (i.e., 50,000 miles). NO_x emission levels are below the 2.0 gram standard even though 15 of the 20 vehicles exhibited some form of EGR problem. Figure 2 displays the results of this program versus mileage.

The problems with the EGR system on many of these vehicles were primarily due to carbon build-up, preventing the valve from sealing properly. Thus, the failure resulted in EGR flow during all phases of operation rather than a complete failure to operate. This may be due to their advanced mileage and the inherently dirty diesel exhaust. Vehicle 15 and

vehicle 18 have particulate versus mileage results which are opposite, one lower, one higher, than all the others. A review of the inspection forms revealed that vehicle 15 had a leaky injection pump while vehicle 18 had its pump recently replaced with a new one. This could explain the differences.

A secondary objective of this program was the collection of samples for AMES testing. These samples have been collected and are in storage awaiting the backlog of analyses.

CONCLUSIONS

Hydrocarbon and particulate levels at high mileage exhibit greater increases than CO and NO_x. The absolute levels of HC and particulates increased by about a factor of two from 4,000 mile data. The changes GM made to its fuel delivery system were successful in achieving particulate levels below the 1982 standard. The durability of the EGR system on diesel engines is questionable, although the NO_x generally remained below the standard.

Appendix A

1980 High Mileage GM 350 CID Diesels

		Mile	HC	CO	NOx	Part	MPG
*1.	Bonneville	46910	.62	1.21	1.37	.52	22.8
2.	Toronado	46086	.21	0.84	1.89	.42	23.8
*3.	Toronado	51519	1.16	1.80	1.41	.66	20.2
*4.	Caprice S/W	83516	.92	1.70	1.55	.69	18.4
*5.	Cutlass	48496	.47	1.22	1.08	.48	22.9
6.	Delta 88	71074	.31	1.07	1.41	.51	21.5
*7.	Cutlass LS	47177	.38	0.86	2.03	.38	24.1
*8.	Cutlass	118645	.66	2.23	1.14	1.13	21.5
*9.	98	67254	.44	1.04	1.66	.52	21.9
*10.	Cutlass LS	91553	1.00	1.89	1.65	.89	21.1
11.	Custom Cruiser S/W	118970	.55	1.56	1.92	1.22	19.3
*12.	Bonneville	51170	.62	1.32	1.50	.56	21.6
*13.	Park Avenue	43424	.28	0.95	1.58	.48	21.4
*14.	Seville	43439	.42	1.22	1.34	.57	20.8
15.	Caprice S/W	40654	.96	2.29	1.16	1.33	17.7
*16.	Delta 88	90761	.24	1.95	3.13	1.17	17.3
17.	98	78802	.53	1.24	1.87	.75	20.5
*18.	Delta 88	109441	.54	1.29	1.66	.45	21.1
*19.	Delta 88	76652	.62	1.03	1.96	.71	21.2
*20.	Cutlass LS	74572	.48	1.21	1.54	.38	22.2
Average		70006	0.57	1.40	1.64	.70	20.9

*Vehicles with EGR problems.