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Exhaust Emissions and Fuel Economy of a Diesel-Powered Postal Van

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Technology Assessment and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Environmental Protection Agency

Background

The Environmental Protection Agency receives information about many systems which appear to offer potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles. EPA's Emission Control Technology Division is interested in evaluating all such systems, because of the obvious benefits to the Nation from the identification of systems that can reduce emissions, improve fuel economy, or both.

If a system demonstrates the ability to improve fuel economy or reduce exhaust emissions, EPA will attempt to schedule confirmatory tests at the EPA Emission Laboratory at Ann Arbor, Michigan. The results of all such test projects are set forth in a series of Technology Assessment and Evaluation Reports, of which this is one.

The conclusions drawn from the EPA evaluation tests are necessarily of limited applicability. A complete evaluation of the effectiveness of an emission control system in achieving performance improvements on the many different types of vehicles that are in actual use requires a much larger sample of test vehicles than is economically feasible in the evaluation test projects conducted by EPA. For promising systems it is necessary that more extensive test programs be carried out.

The conclusions from the EPA evaluation test can be considered to be quantitatively valid only for the specific test car used, however, it is reasonable to extrapolate the results from the EPA test to other types of vehicles in a directional or qualitative manner, i.e., to suggest that similar results are likely to be achieved on other types of vehicles.

At the request of the EPA, the U.S. Postal Service agreed to make available for EPA tests a Postal Delivery Van powered by a Diesel engine. Data obtained from the Postal Service indicated a substantial improvement in fuel economy over the standard Postal Van which is powered by a gasoline-fueled, spark ignition engine.

Based on past experience with light-duty Diesel vehicles, it was expected that the exhaust emissions from the uncontrolled Diesel Postal Van would probably be lower than the emissions from the comparable Otto cycle Postal Van (controlled to 1975 Federal Emission Standards).

Test Vehicle Description

The test vehicle is a 1975 AM General Postal Delivery Van. The vehicle has a conventional powertrain layout, with a front-mounted engine and rear wheel drive. The steering is on the right side.

Seating is provided only for the driver; the remainder of the interior space is for carrying parcels. The vehicle was tested at an inertia weight of 3000 lbs.

The engine is a 4-cylinder Perkins Diesel engine, with a cast iron block and Perkins "H" combustion system (prechamber type). The displacement of the engine is 165 cu. in. (2700cc). For cold starting at low ambient temperatures, a measured amount of starting fluid is injected into the intake manifold by pushing a button on the dashboard. No glow plugs are fitted.

The transmission is a Chrysler 3-speed automatic. The final drive ratio is 3.07:1.

Engine and vehicle characteristics are listed on the Test Vehicle Description sheet at the end of this report.

Test Program

A series of tests were run on the Postal Van to characterize exhaust emissions and fuel economy. Exhaust emission tests were conducted according to the 1975 Federal Test Procedure ('75 FTP) for light-duty Diesel vehicles (Federal Register, October 22, 1974, Vol. 39 No. 205, Part III). In addition to the '75 FTP, testing included the EPA Highway Fuel Economy Test (HFET), the EPA Sulfate Cycle (SC-7), steady states, and measurement of acceleration times.

A brief description of the sulfate test sequence is given on page 10. A more complete sulfate test description can be found in SAE publication Number 760034 titled "Sulfuric Acid Emissions from Light Duty Vehicles". The fuel used for the sulfate tests as well as the other emission tests was #2 Diesel fuel containing 0.21 wt.% sulfur.

Steady state emissions and fuel economy were measured at idle, 15, 30, 45 and 60 mph.

Test Results

The following exhaust emissions and fuel economy were measured according to the 1975 Federal Test Procedure.

'75 FTP Mass Emissions in grams per mile (grams per kilometer)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Average of 2 tests	0.30 (0.19)	1.30 (0.81)	2.41 (1.50)	30.1 miles/gal. (7.8 liters/100km)

The exhaust emissions are within the 1976 interim Federal Emission Standards for light duty trucks (HC-2.0 gpm, CO-20 gpm, NOx-3.1 gpm) for light duty trucks.

Exhaust emissions and fuel economy measured during the EPA Highway Fuel Economy Test are presented in the following table.

EPA Highway Fuel Economy Test
Mass Emissions in
grams per mile
(grams per kilometer)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Average of 3 tests	0.33 (0.21)	1.03 (0.64)	2.20 (1.37)	37.7 miles/gal. (6.2 liters/100km)

Sulfuric acid emissions measured over the EPA Sulfate Cycle are presented in Table V, along with sulfuric acid emissions measured from other light-duty Diesel vehicles tested by EPA.

Steady state emissions and fuel economy are presented in Table IV. It should be noted that steady state driving is not representative of real-world driving conditions. Steady state emission tests are conducted to give insight into the operational differences and exhaust emission and fuel economy variations among different vehicles.

Acceleration tests gave an average time to accelerate from 0 to 60 mph of 20.6 seconds.

Conclusions

Compared to the standard 1975 Postal Van (powered by a spark ignition, gasoline-fueled engine), the Diesel-powered Postal Van demonstrated lower exhaust emissions (except NOx) and higher fuel economy with some loss in performance. The following table contains the certification results for the 1975 gasoline-engine Postal Van.

'75 FTP Mass Emissions in
grams per mile
(grams per kilometer)

HC	CO	NOx	Fuel Economy (Fuel Consumption)
1.1 (0.68)	17. (10.6)	1.7 (1.1)	17 miles/gal. (13.8 liters/100km)

The Highway fuel economy for the gasoline vehicle was 24 miles/gal. (9.8 liters/100km).

The gasoline-engine Postal Van was tested at an inertia weight of 2750 lbs. Data submitted by the Post Office indicates that the gasoline-engine vehicle accelerates from 0-55 mph in 14.5 seconds with a payload of 700 lbs. This contrasts with an acceleration time from 0-60 mph of 20.6 seconds for the Diesel Postal Van with only a driver (about 150 lbs).

Sulfuric acid emissions from the Diesel Postal Van are similar to those measured from other light-duty Diesel vehicles.

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1975 AM General Postal Van
Emission control system - None

Engine

type	4 stroke, Diesel,I-4, ohv, indirect injection
bore x stroke	3.62 x 4.00 in./92 x 101.6mm
displacement	165 cu. in./2700cc
compression ratio	21:1
maximum power @ rpm	70 bhp at 3600 rpm/52.2kW at 3600 rpm
fuel metering	mechanical fuel injection
fuel requirement	#2 Diesel fuel

Drive Train

transmission type	3 speed automatic
final drive ratio	3.07:1

Chassis

type	Front engine, rear wheel drive
tire size	CR78 x 15 M&S
curb weight	2736 lbs/1241 kg
inertia weight	3000 lbs.
passenger capacity	one

Emission Control System

basic type	none
durability accumulated on system.	100 miles/161 km.

Table I

1975 Federal Test Procedure
Mass Emissions in
grams per mile
(grams per kilometer)

Test #	HC	CO	CO_2	NOx	miles/gallon (liters/100 kilometers)
77-634	0.30 (0.19)	1.29 (0.80)	335. (208.)	2.41 (1.50)	30.1 (7.8)
77-659	0.29 (0.18)	1.30 (0.81)	335. (208.)	2.41 (1.50)	30.1 (7.8)
Average	0.30 (0.19)	1.30 (0.81)	335. (208.)	2.41 (1.50)	30.1 (7.8)

Table II

EPA Highway Driving Cycle
Mass Emissions in
grams per mile
(grams per kilometer)

Test #	HC	CO	CO_2	NOx	miles/gallon (liters/100 kilometers)
77-633	0.34 (0.21)	1.09 (0.68)	267. (166.)	2.11 (1.31)	37.8 (6.2)
77-635	0.34 (0.21)	0.99 (0.62)	268. (167.)	2.21 (1.37)	37.7 (6.2)
77-692	0.32 (0.20)	1.01 (0.63)	269. (167.)	2.29 (1.42)	37.5 (6.3)
Average	0.33 (0.21)	1.03 (0.64)	268. (167.)	2.20 (1.37)	37.7 (6.2)

Table III

Individual Bag Emissions in grams per mile

	Bag 1: Cold Transient					Bag 2: Stabilized					Bag 3: Hot Transient				
Test #	HC	CO	CO_2	NOx	MPG	HC	CO	CO_2	NOx	MPG	HC	CO	CO_2	NOx	MPG
77-634	0.33	1.45	374.	2.66	27.0	0.26	1.24	325.	2.35	31.1	0.36	1.28	323.	2.35	31.2
77-659	0.31	1.51	380.	2.75	26.5	0.26	1.27	322.	2.32	31.3	0.33	1.19	323.	2.33	31.2

Table IV

Steady State Mass Emissions in
grams per mile
(grams per kilometer)

	HC	CO	CO_2	NOx	mpg (1/100km)
Idle/300 sec.	0.19gms	0.91gms	262.gms	2.08gms	
15mph/24kph	0.10 (0.06)	0.80 (0.50)	208. (129.)	1.61 (1.00)	48.5 (4.9)
30mph/48kph	0.31 (0.19)	1.23 (0.76)	201. (125.)	1.20 (0.75)	50.0 (4.7)
45mph/72kph	0.23 (0.14)	0.88 (0.55)	231. (144.)	1.71 (1.06)	43.6 (5.4)
60mph/97kph	0.15 (0.09)	0.77 (0.48)	283. (176.)	2.61 (1.62)	35.8 (6.6)

Table V

EPA Sulfate Cycle
Sulfuric Acid Emissions in
milligrams per mile

	H_2SO_4 Emissions	% Conversion of Fuel Sulfur to SO_4
	10.8	1.7
	10.3	1.7
	10.6	1.7
	8.7	1.4
Average	10.1	1.6

Comparative Data:

Volkswagen Diesel-powered Rabbit

Average of 8 tests	9.4	2.4

Diesel-powered Ford Pinto

Average of 8 tests	8.6	1.8

Diesel Postal Van
Procedure used to Measure Sulfate Emissions

1. The fuel was drained from the test vehicle. The vehicle was refueled with #2 Diesel fuel containing 0.21 wt. % sulfur. This fuel was used throughout the sulfate testing.

2. The vehicle was driven over one LA-4 cycle with the test fuel in preparation for the test series.

3. The following sequence of test cycles was used to measure sulfate emissions.

   a) Cold start '75 FTP
   b) Two hot start sulfate cycles
   c) One EPA Highway Driving cycle
   d) Two hot start sulfate cycles.

   This sequence was run on two consecutive days.

4. The barium chloranilate procedure was used to determine the concentration of sulfates in the exhaust.