76-8 RBM

QEI 400 Fuel Additive: Emissions and Fuel Economy Effects on a Light Duty Gasoline Powered Vehicle

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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 QEI company of Washington, D.C. first contacted the Emission Control Technology Division (ECTD) in January 1975 concerning a fuel additive (blending agent) called QEI 400 which they had developed for use in gasoline powered vehicles. Test data were submitted on several fleet vehicles run with and without the additive indicating significant fuel economy improvements with the additive. On the basis of these data, EPA agreed to evaluate the effect on exhaust emissions and fuel economy of the QEI gasoline additive. Due to a lack of available EPA test vehicles and the heavy summer work load at the EPA laboratory, the test program was not started until September 1975; the program was completed in November.

The Environmental Protection Agency receives information about many devices and additives for which emission reduction or fuel economy improvement claims are made. In some cases, both claims are made for a single device or additive. In most cases, these products are being recommended or promoted for retrofit to existing vehicles although some represent advanced systems for meeting future standards.

The EPA is interested in evaluating the validity of the claims for all such devices or additives because of the obvious benefits to the Nation of identifying products that live up to their claims. For that reason the EPA invites proponents of such products to provide to the EPA complete technical data on the product's principle of operation, together with test data on the product made by independent laboratories. In those cases in which review by EPA technical staff suggests that the data submitted show promise of confirming the claims made for the product, confirmatory tests are scheduled at the EPA Emissions Laboratory at Ann Arbor, Michigan. The results of all such confirmatory test projects are set forth in a series of Technology Assessment and Evaluation Reports, of which this report is one.

The conclusions drawn from the EPA confirmatory tests are necessarily of limited applicability. A complete evaluation of the effectiveness of a product in achieving its claimed 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 confirmatory test projects conducted by EPA. 1/ For promising products it is necessary that more extensive test programs be carried out.

1/ See Federal Register 38 FR 11334, 3/27/74, a description of the test protocols proposed for definitive evaluations of the effectiveness of retrofit devices.

The conclusions from the EPA confirmatory test can be considered to be quantitatively valid only for the specific type of vehicle used in the EPA confirmatory test program. Although it is reasonable to extrapolate the results from the EPA confirmatory 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, reliably quantify results on other types of vehicles.

In summary, a device or additive that lives up to its claims in the EPA confirmatory test must be further tested according to protocols described in footnote 1/, to quantify its beneficial effects on a broad range of vehicles. A product which when tested by EPA does not meet the claimed results would not appear to be a worthwhile candidate for such further testing from the standpoint of the likelihood of ultimately validating the claims made. However, a definitive quantitative evaluation of its effectiveness on a broad range of vehicle types would equally require further tests in accordance with footnote 1/.

Description of Additive

According to the manufacturer, the QEI gasoline additive (QEI 400) is a 100% petroleum based product containing deicers, solvents, combustion catalysts and detergents; it is designed to clean many parts of the engine, including fuel systems and combustion chambers, and to improve combustion of the fuel. It is mixed in the ratio of .7 ounce (20 ml) per gallon of gasoline (1:200). A more specific analysis of the additive was not made available to EPA.

Test Procedure

Exhaust emissions tests were conducted according to the 1975 Federal Test Procedure described in the Federal Register of November 15, 1972. Additional tests included the EPA Highway Cycle. The vehicle used in the test program was a 1971 Ford Galaxie with a 351 CID (5753 cc) engine and automatic transmission (a complete vehicle description is given on the following page). All tests were conducted using an inertia weight of 4500 pounds (2041 kg) with a road load setting of 12.7 horsepower (9.47 kW) at 50 miles per hour (80.5 km/hr).

The test vehicle was first tuned to the manufacturer's specifications; the idle fuel-air mixture was set using the lean idle speed roll-off method. No adjustments were made to the vehicle after the program began; all specifications remained at the initial settings throughout the program (they were checked before each test series). Exhaust emissions and EPA Highway Cycle tests were conducted at the conditions and mileage intervals shown below. Mileage was accumulated on the Motor Vehicle Manufacturers Association (MVMA) driving schedule described in the Federal Register. As a reference, the point at which the additive was first used is termed zero miles.

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1971 Ford Galaxie
Emission control system -

Engine

type	4 stroke Otto cycle, OHV, V-8
bore x stroke	4.00 x 3.50 in/102 x 89mm
displacement	351 cu in./5753cc
compression ratio	9.0/1
maximum power @ rpm	240 hp 179 kW at 4600 rpm
fuel metering	2 barrel carburetor
fuel requirement	91 RON

Drive Train

transmission type	automatic (3 forward gears)
final drive ratio	2.75:1

Chassis

type	body/frame, front engine, rear wheel drive
tire size	H 78 x 15
curb weight	4130 lbs/1873 kg
inertia weight	4500 lb/2041 kg
passenger capacity	six

Emission Control System

basic type	engine modifications, PCV

Engine Specifications (at Idle in Drive)

speed	600 rpm
dwell angle	27°
CO concentration	0.2% (stayed constant throughout program)
spark timing	6°BTDC
manifold vacuum	15.5" Hg

Test Program	Miles With Additive in Fuel
1. Baseline tests (without additive)	-680 to -593
2. Accumulate mileage on MVMA cycle (without additive)	
3. More baseline tests (without additive)	-111 to -30
4. Accumulate mileage on MVMA cycle (with additive)	
5. Tests (with additive)	904 to 994
6. Accumulate mileage on MVMA cycle (with additive)	
7. Tests (with additive).	1791 to 1846

Part of the mileage accumulated between each test series was due to driving the vehicle to and from the test track (about 50 miles each way) and to vehicle preparation before testing.

The reason for running steps No. 2 and 3 in the program was that the vehicle had not been involved in a test program for several months and had not been driven under any normal operating conditions for that time. Therefore, it was felt necessary to drive the vehicle on the MVMA cycle before establishing a baseline. The MVMA cycle consists of specified accelerations, cruise conditions, decelerations, and idle conditions.

The fuel used for all testing, with and without the additive, was Indolene Clear gasoline, which the vehicle had been run on since new.

The test vehicle used in the program was chosen by EPA because it is representative of a large number of vehicles sold in this country in terms of power-to-weight ratio and vehicle size. Vehicles in the 4500 lb. inertia weight class have accounted for about 24% of all new car sales for the last 10 years and this is the weight class in which vehicles are purchased more frequently than any other class (see Figure 1 showing the distribution for model years 1974-1976 as an example). Vehicles with V-8 engines account for over 75% of all vehicles in the U.S. Representatives from QEI indicated to EPA that they anticipate the best results from their product will occur in a vehicle that has a low power-to-weight ratio (such as some smaller cars), in a vehicle that is heavily loaded and whose engine, therefore, must work harder, or in an older vehicle that has many miles accumulated on it and whose engine has a large quantity of deposits in it. Older vehicles with high mileage would account for the majority of these types of vehicles. Assuming an 80,000 mile cutoff point, about 20% of the vehicles in use would be considered high mileage with a large quantity of deposits. Although this is a substantial amount of the vehicle population, EPA felt that it is more useful to the public and to the Nation to test the effectiveness of a device or additive on a vehicle that is more representative of the vehicle population. If the additive were found to be effective on the test vehicle, the test program could later be expanded to include other vehicles.

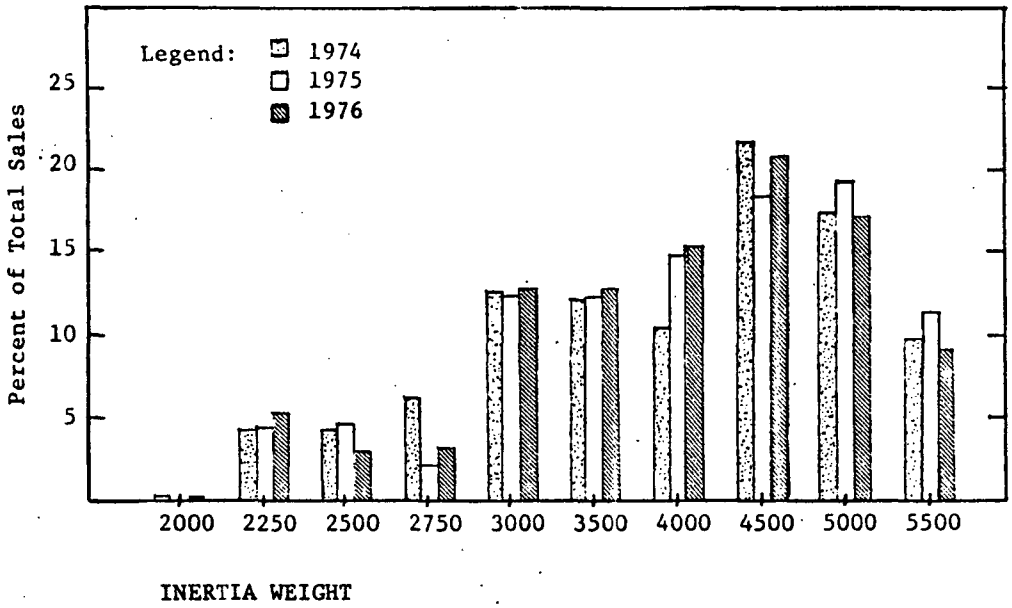


Figure 1 - Model Mix Distributions

Although the Ford used in the test program had accumulated relatively little mileage (about 13,000 miles at the beginning of the program), combustion chamber deposits are known to stabilize at lower mileage than this and remain fairly constant for at least the first 50,000 miles. Therefore, this engine should not be any different from one in a vehicle which has seen more service.

Test Results

Exhaust emissions and fuel economy data are summarized in Tables 1 and 2 below:

Table 1

'75 FTP Composite Mass Emissions
grams per mile
(grams per kilometre)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Baseline - mean of last 3 tests	2.58 (1.60)	11.0 (6.8)	3.54 (2.19	14.20 miles/gal (16.56 litres/100Km)
Additive - mean of last 3 tests	2.87 (1.78)	13.7 (8.5)	3.37 (2.09)	14.63 miles/gal (16.08 litres/100Km)
% change	+11%	+25%	-5%	+3% (in miles per gal) -3% (in litres/100Km)

Table 2

EPA Highway Cycle
grams per mile
(grams per kilometre)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Baseline - mean of last 3 tests	.99 (.61)	3.35 (2.08)	4.18 (2.59)	20.00 (11.76 litres/100Km)
Additive - mean of last 3 tests	1.06 (.66)	3.54 (2.19)	4.33 (2.68)	20.56 (11.44 litres/100Km)
% Change	+7%	+6%	+4%	+3% (in miles/gal) -3% (in litres/100Km)

A statistical "t" test was performed on the tests comparing the second baseline group of tests with the last additive group to determine if there was a significant difference between the two groups. At the 90% confidence level the only significant difference between the two groups was in carbon monoxide emissions, in which there was an increase with the additive. No significant difference was found in any of the other emissions or in fuel economy, in either the FTP or Highway Cycle tests. The second group of baseline tests were used in this comparison because it was at this point that the vehicle was considered to be in a stabilized running condition. The vehicle had not recently been involved in a test program nor had it recently been driven on the MVMA cycle prior to this test program, and thus had required a few hundred miles of driving to stabilize its condition.

The first group of additive tests was not included in the comparison because they were at lower mileage, lower than the point at which the manufacturer says the additive has had its full effect, which would be about 1000-1500 miles for the test vehicle (4-5 tankfuls). These tests were conducted to discover if a trend was developing.

No difference in driveability was noticed due to the additive and no visible smoke was emitted.

Conclusions

In tests conducted according to the '75 FTP and EPA Highway Cycle, the QEI 400 gasoline additive produced no significant changes in either exhaust emissions or fuel economy on the EPA test vehicle. The increase in CO emissions noted with the additive was probably due to vehicle variability.

Due to the lack of effectiveness of the additive on the test vehicle, EPA could not justify extending the test program to include other vehicles. Tests on other vehicles would have to be run to determine if the QEI additive has an effect on vehicles that have a low power-to-weight ratio, are heavily loaded, or are older with high mileage and may have an excessively large accumulation of engine deposits. The vehicle used in this program is typical of a large number of vehicles currently in use, but is not representative of these 3 other types of vehicles - vehicles which the manufacturer claims will benefit the most from QEI 400.

APPENDIX

Table 1-A

'75 FTP Composite Results
Mass Emissions, gpm
Fuel Economy, mpg

1. Without Additive

Date	Test No.	Test Type	HC	CO	NOx	Fuel Economy	Odometer
9-23	2328	Baseline	2.59	15.3	3.90	12.99	12,701
9-24	2327	Baseline	2.58	12.5	3.68	13.29	12,733
9-25	2359	Baseline	2.60	12.7	3.45	13.48	12,776
		Mean	2.59	13.5	3.68	13.25	
After MVMA Cycle Mileage Accumulation							
10-16	2587	Baseline	2.51	11.1	3.46	14.18	13,270
10-17	2488	Baseline	2.69	11.6	3.85	14.04	13,300
10-21	2638	Baseline	2.54	10.3	3.31	14.37	13,357
		Mean	2.58	11.0	3.54	14.20	

Additive use begun 10-23 at Odometer Reading of 13,381

2. With Additive

After First Mileage Accumulation							
10-31	2794	Additive	2.63	11.4	3.57	13.50	14,285
11-3	2796	Additive	2.68	14.0	3.48	14.00	14,323
11-5	2884	Additive	2.99	11.9	3.70	13.95	14,364
		Mean	2.77	12.4	3.58	13.81	
After Second Mileage Accumulation							
11-19	3083	Additive	2.65	12.3	3.23	14.79	15,172
11-20	3084	Additive	3.04	13.9	3.54	14.32	15,195
11-21	3156	Additive	2.91	14.9	3.33	14.80	15,227
		Mean	2.87	13.7	3.37	14.63	

Table 2-A

'75 FTP Individual Bag Results
Mass Emissions, grams per mile
Fuel Economy, miles per gallon

Test Number	Bag 1 Cold Transient					Bag 2 Hot Stabilized					Bag 3 Hot Transient				
	HC	CO	CO_2	NOx	Fuel Economy	HC	CO	CO_2	NOx	Fuel Economy	HC	CO	CO_2	NOx	Fuel Economy
Baseline 1															
2328	3.32	52.28	714	4.86	11.0	2.49	5.48	665	3.07	13.0	2.23	6.28	577	4.76	14.9
2327	3.14	38.89	690	4.73	11.7	2.44	4.55	653	2.84	13.3	2.42	7.63	580	4.51	14.8
2359	3.28	36.96	671	4.19	12.0	2.54	6.45	647	2.73	13.3	2.18	6.17	568	4.27	15.2
Baseline 2															
2587	3.01	31.91	652	4.38	12.5	2.46	5.28	607	2.73	14.2	2.22	6.34	546	4.16	15.8
2488	3.04	29.71	651	4.63	12.6	2.55	6.76	617	3.17	14.0	2.71	7.28	549	4.55	15.6
2638	3.15	27.99	637	4.23	12.8	2.47	5.00	600	2.58	14.4	2.20	7.04	546	4.02	15.7
Additive 1															
2794	3.26	32.00	682	4.70	12.0	2.49	5.83	647	2.76	13.4	2.41	6.39	564	4.27	15.2
2796	3.32	40.31	641	4.21	12.4	2.53	7.01	611	2.73	14.1	2.49	7.62	561	4.37	15.3
2884	3.45	33.75	640	4.45	12.6	2.99	5.80	568	3.07	15.1	2.63	6.91	538	4.35	15.9
Additive 2															
3083	3.33	35.25	621	4.31	12.9	2.57	6.24	580	2.47	14.8	2.30	6.70	521	3.86	16.5
3084	4.06	34.00	645	4.57	12.5	2.83	8.24	596	2.69	14.4	2.67	9.69	529	4.40	16.0
3156	3.43	42.02	633	4.20	12.5	2.89	7.73	568	2.69	15.1	2.55	8.24	517	3.90	16.5

Table 3-A

EPA Highway Cycle
Mass Emissions, gpm
Fuel Economy, mpg

1. Without Additive

Date	Test No.	Test Type	HC	CO	NOx	Fuel Economy	Odometer
9-24	2327	Baseline	.94	3.21	4.84	19.16	12,745
9-24	2328	Baseline	.91	3.06	4.72	19.38	12,766
9-25	2359	Baseline	.90	3.55	4.48	19.61	12,788
		Mean	.92	3.27	4.68	19.38	
After AMA Cycle Mileage Accumulation							
10-16	2587	Baseline	.92	3.10	4.44	20.13	13,281
10-17	2488	Baseline	1.06	3.83	4.02	20.29	13,312
10-21	2638	Baseline	.99	3.13	4.07	19.58	13,369
		Mean	.99	3.35	4.18	20.00	
Additive Use Begun 10-23 at Odometer Reading of 13,381							

2. With Additive

After First Mileage Accumulation							
10-31	2795	Additive	.97	3.09	4.26	20.31	14,297
11-3	2797	Additive	1.00	3.58	4.30	20.36	14,334
11-5	2885	Additive	1.01	3.30	4.22	20.19	14,375
		Mean	.99	3.32	4.26	20.29	
After Second Mileage Accumulation							
11-19	3086	Additive	1.05	3.21	4.38	20.76	15,183
11-20	3085	Additive	1.07	3.78	4.43	20.24	15,208
11-21	3156	Additive	1.05	3.64	4.18	20.68	15,238
		Mean	1.06	3.54	4.33	20.56	

MASS EMISSIONS (FTP)

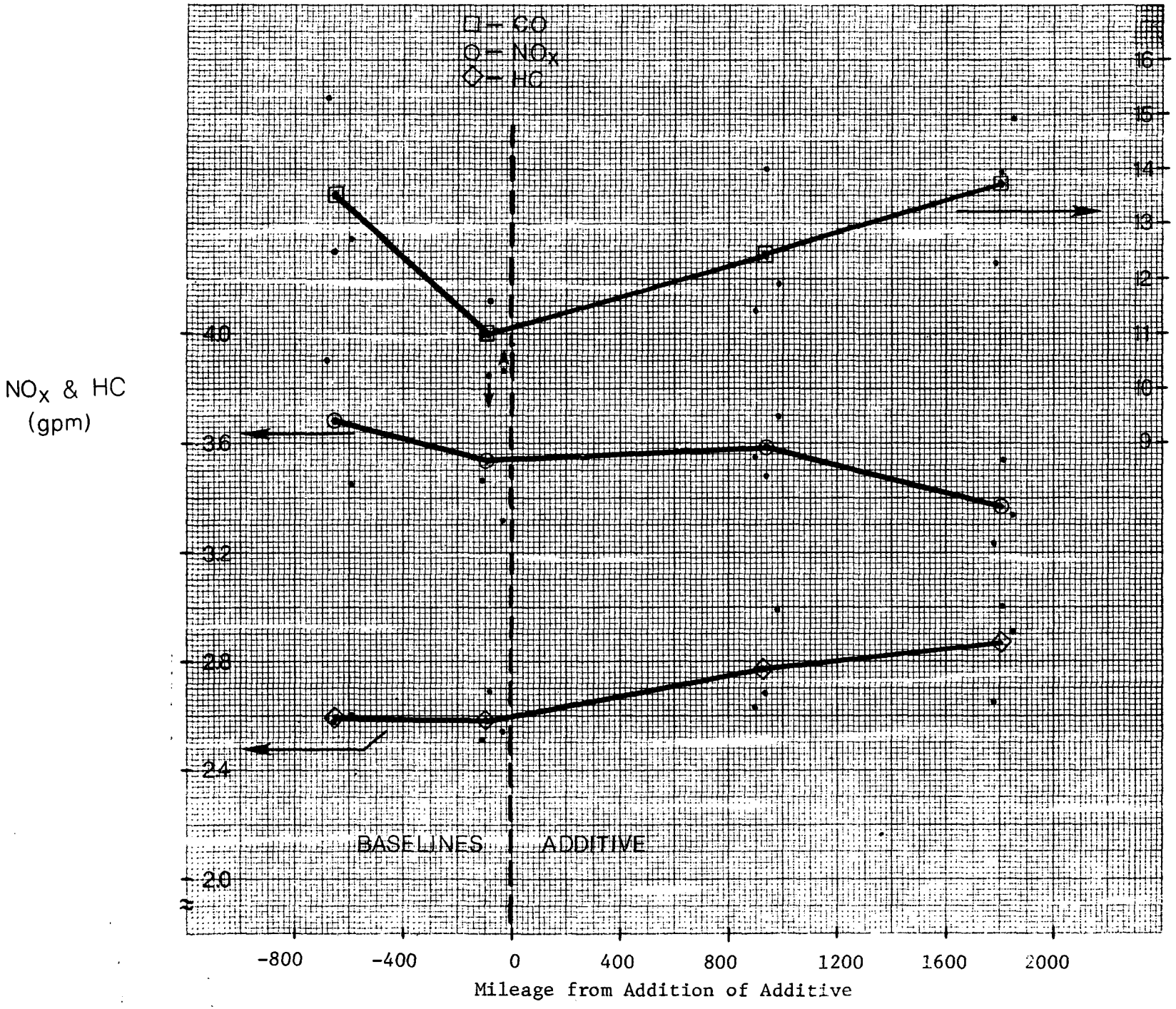
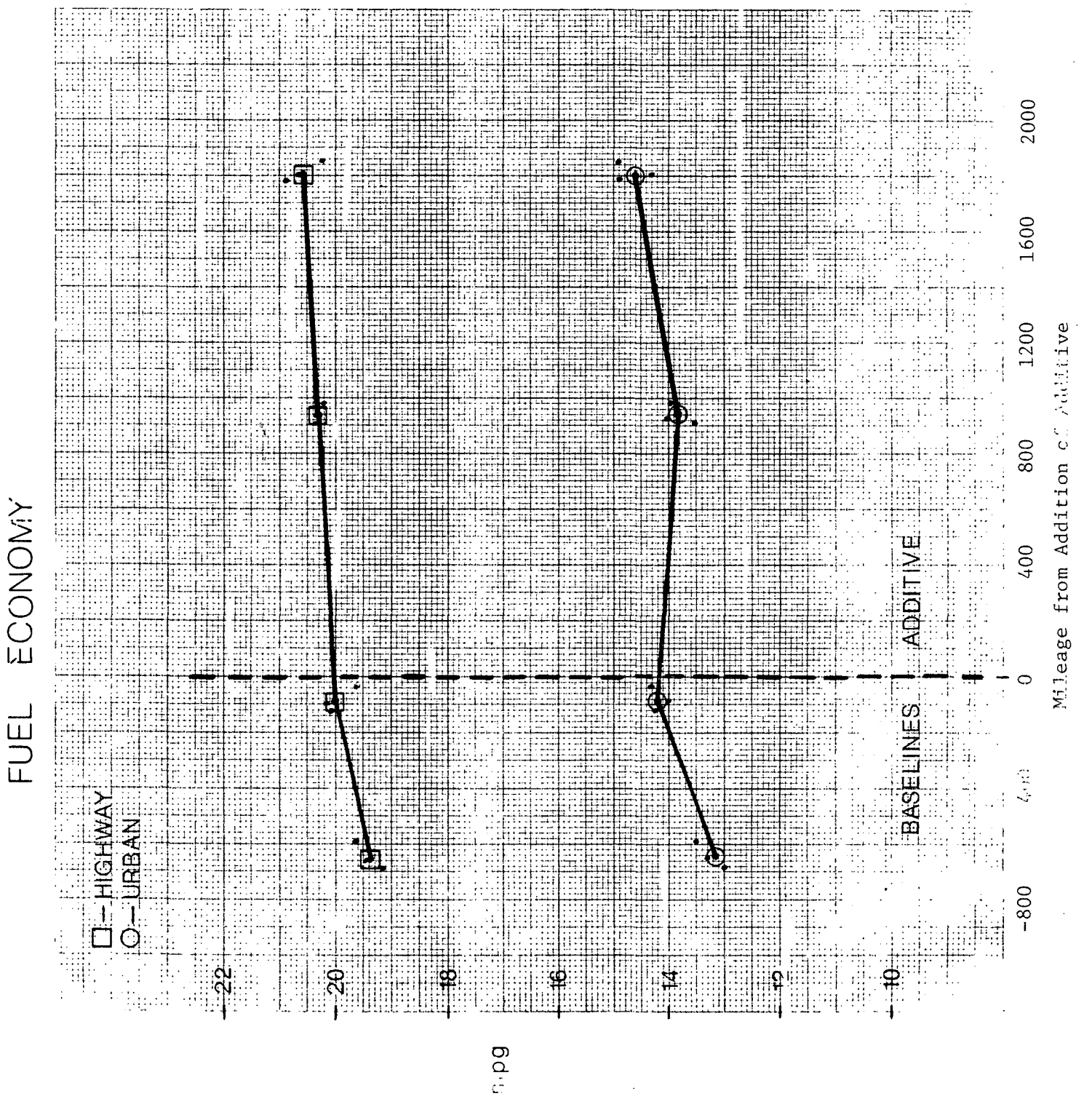


Figure 1

Figure 2



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