EPA/AA/CTAB/TA/82-1

Knock Sensor
Vehicle Test Program

by

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Office of Mobile Source Air Pollution Control
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Background

This test program was designed to explore the impact of an ignition system with spark knock sensing and spark retard on regulated emissions, fuel economy, and power as a function of the research octane number (RON) of the test fuel.

Currently, General Motors (GM) incorporates a spark knock sensor in a feedback ignition system on their turbocharged vehicles. This type of spark timing system is well suited to turbocharged engines because of their wide range of spark timing requirements.

GM and others are also currently producing naturally aspirated engines equipped with knock sensors. The feedback aspect of this type of ignition system could allow the vehicle to automatically compensate the timing for the octane of the fuel being consumed. This technology could improve fuel economy of vehicles in service.

It is conceivable that some vehicles incorporating a knock sensor timing system could have lower exhaust emissions and higher fuel economy using EPA standard test fuel (Indolene HO III) compared to operating with lower octane commercial unleaded gasolines. The knock sensor can be integrated into a spark timing system in a variety of fashions. This design variability precludes any generalized conclusions about the effects of varying the fuel octane rating.

Conclusions

Comparing the data generated using the standard test fuel (97 RON) to that generated by using a lower octane fuel (90 RON or 91 RON), from the data generated in this program we find:

1. A slight reduction in HC emissions on the FTP and HFET with reduced octane (down 1.1 and 7.5% respectively),

2. A statistically significant increase in CO emissions on the HFET (up 567%) and a less significant increase in CO on the FTP cycle (up 1.8%) going from the standard test fuel to lower octane fuel,

3. Slight increases in FTP and HFET NOx emissions resulting from the use of lower octane fuel, and

4. Virtually no effect on fuel economy.

Based on the GM and Chrysler certification data and octane reductions from 97 to 91 RON, we find:

1. Increases in HC emissions for both the FTP and HFET. The maximum increases were 50.9% on the FTP and about 1500% on the HFET.

2. Increases in CO emissions on both the FTP and HFET. Maximum increases were 154% and 378% respectively.

3. Both increases and decreases in NOx emissions on the FTP and HFET. Changes in FTP NOx emissions ranged from -19.2% to 29.5%.

4. Little effect on fuel economy. The biggest change was a 5.1% decrease.

<u>Test Program</u>

This program tested a single production vehicle, a turbocharged 1980 Buick Regal equipped with a knock sensor. A complete description of the test vehicle can be found in Table 1. Testing included several test fuels with an octane range inclusive of the majority of commercially available unleaded gasolines. The test cycles which were performed are:

1. The 75 FTP,

2. The "unclipped" cold start LA-4 (a cycle with slightly higher maximum acceleration rates than the 75 FTP, this cycle is designated "BBB" in Appendix A, and a comparison between this cycle and the FTP can be found in Appendix D),

3. The highway cycle (HFET), and

4. 50 MPH steady state at wide open throttle (WOT).

Five different test fuels were used:

1. Indolene HO III standard test fuel with a research octane number (RON) of 97.00 and with motor octane number (MON) of 86.66,

2. Indolene HO III blended with heptane to produce a fuel with 90.35 RON,

3. Indolene HO III blended with heptane to produce a fuel with 82.10 RON,

4. Commercial premium unleaded, and

5. Commercial unleaded regular.

Although the octane of the commerical fuels was not measured, we have estimated, based on survey data (17)*, that for the premium fuel the RON was 96, and 94 for the regular. Also, it is possible that the Indolene/Heptane blends did not have the sensitivity that would be expected from typical commercial fuels. Finally, calculating fuel economy from emission data requires detailed analysis of the individual fuels. Therefore, the fuel economy results of tests using the commercial fuels (Appendix A) are <u>not</u>

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*Numbers in parentheses designate References at the end of this paper.

Table 1

TEST VEHICLE DESCRIPTION

1980 TURBOCHARGED BUICK REGAL

VEHICLE SERIAL NUMBER - 4K473AH105868

Engine

type	Otto Cycle, 90° V-6
bore x stroke	3.8 x 3.40 in.
displacement	3.8 Liter/ 231 CID
compression ratio	8.0: 1
maximum power @ rpm	170 horsepower @ 4000 rpm
fuel metering	4 venturi open-loop carburetor

Drive Train

transmission type	3 speed automatic*

Chassis

type	2 door sport coupe*
tire size	P205/70R14*
test weight	3625 pounds
dynamometer horsepower	11.6

Emission Control System

basic type	air injection back pressure EGR oxidation catalyst

* This information was obtained from a visual inspection; the remaining data were obtained from GM's Application for Certification for engine family 04E4BD.

accurate. Additionally, because of different hydrogen/carbon ratios, the fuel economies of tests using the Indolene/Heptane blends (Appendix A) must be reduced by 0.5% and 1.2% for the 90 RON and 82 RON fuels respectively.

It should be noted that this test vehicle, unlike vehicles used in other studies, was not optimized (e.g., compression ratio changed) for each fuel.

The number of combinations of test cycles and fuels which were actually performed (excluding voided tests) are detailed below in Table 2.

Table 2

Number of Tests Performed

Test Cycle	97 RON	90 RON	82 RON	Commercial Regular	Commercial Premium
FTP	3	3	3	2	2
Unclipped LA-4	1	2	1	1	1
HFET	3	3	3	2	2
WOT at 50 MPH	1	0	1	1	0

In addition to this test program, the Certification Division of EPA's Office of Mobile Source Air Pollution Control had requested several manufacturers (including GM and Chrysler) to perform testing, during the spring and summer of 1980, with both the standard test fuel and lower octane (91 RON) fuel on several of their 1981 model year emission data vehicles equipped with knock sensors. These additional test data have also been included in this report.

Test Vehicle Spark Timing Control System Description

The test vehicle, a 1980 model year turbocharged 231 C.I.D. Buick Regal (described in Table 1) was equipped with a closed-loop electronic spark control (ESC) system that was developed by GM to meet the requirements of detonation control by spark timing adjustments. There are three basic components in this system:

1. Detonation Sensor
2. Turbo Control Center
3. High Energy Ignition (HEI) Distributor

The knock sensor (Figure 1) used in this vehicle is a magnetostrictive transducer with an output voltage that is proportional to the vibration level at the "knock frequency." The sensor reacts to all inlet manifold vibrations, such as those caused by normal engine cylinder firings, valve closing, and push rod operation. These would appear as background noise. When detonation (i.e. knock) occurs, the sensor output voltage increases over the background noise signal. (4)(6)

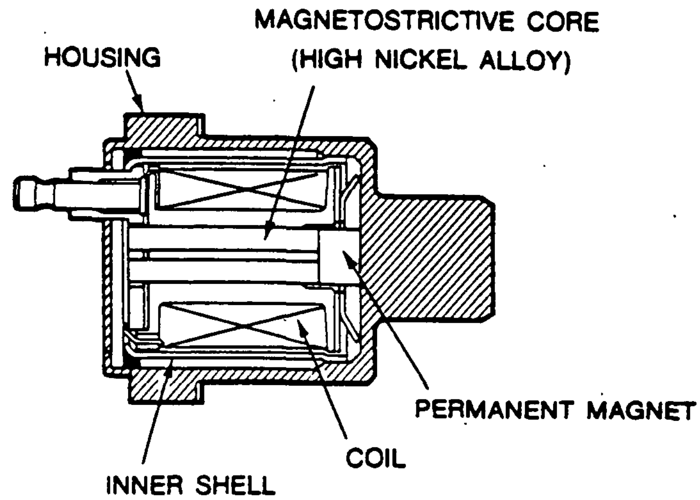


Fig. 1 - Detonation Sensor (6)

The turbo control center processes the sensor signal, filters the signal to remove some of the background noise, and then provides an appropriate command signal to the distributor to determine actual spark timing. The electronic logic is illustrated below (Figure 2). (4)

By design, the ESC system has a maximum limit of spark retard capability. The final centrifugal spark advance curve (Figure 3) appears below:

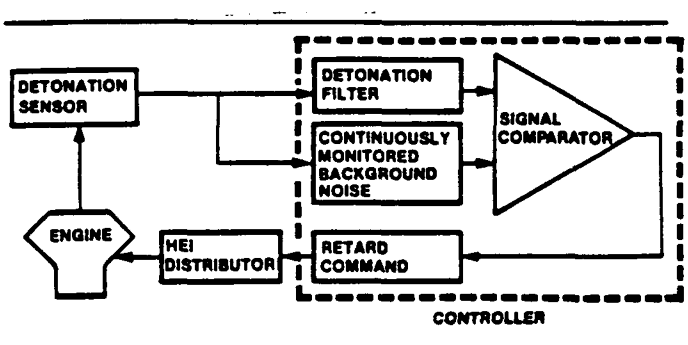


Figure 2. Electronic Logic (4)(6)

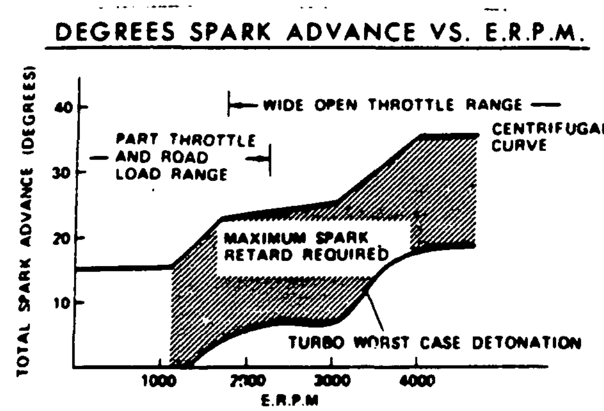


Figure 3. Final Centrifugal spark advance configuration (4)

This knock control system quickly retards the spark advance to limit knock and then readvances the spark at a much slower rate. It is important to note that this system only retards from the spark curve of the distributor and does not advance timing to seek out knock. (6)

Summary of the Test Results

The emissions and fuel economy data generated in the previously mentioned 13 FTPs, 6 unclipped LA-4s, and 13 HFETs can be found in Appendix A. Graphical representations of these data appear in Figures 4 through 7. Two variable linear regression analyses indicate that as the octane level of the fuel decreased from 97 to 82 RON:

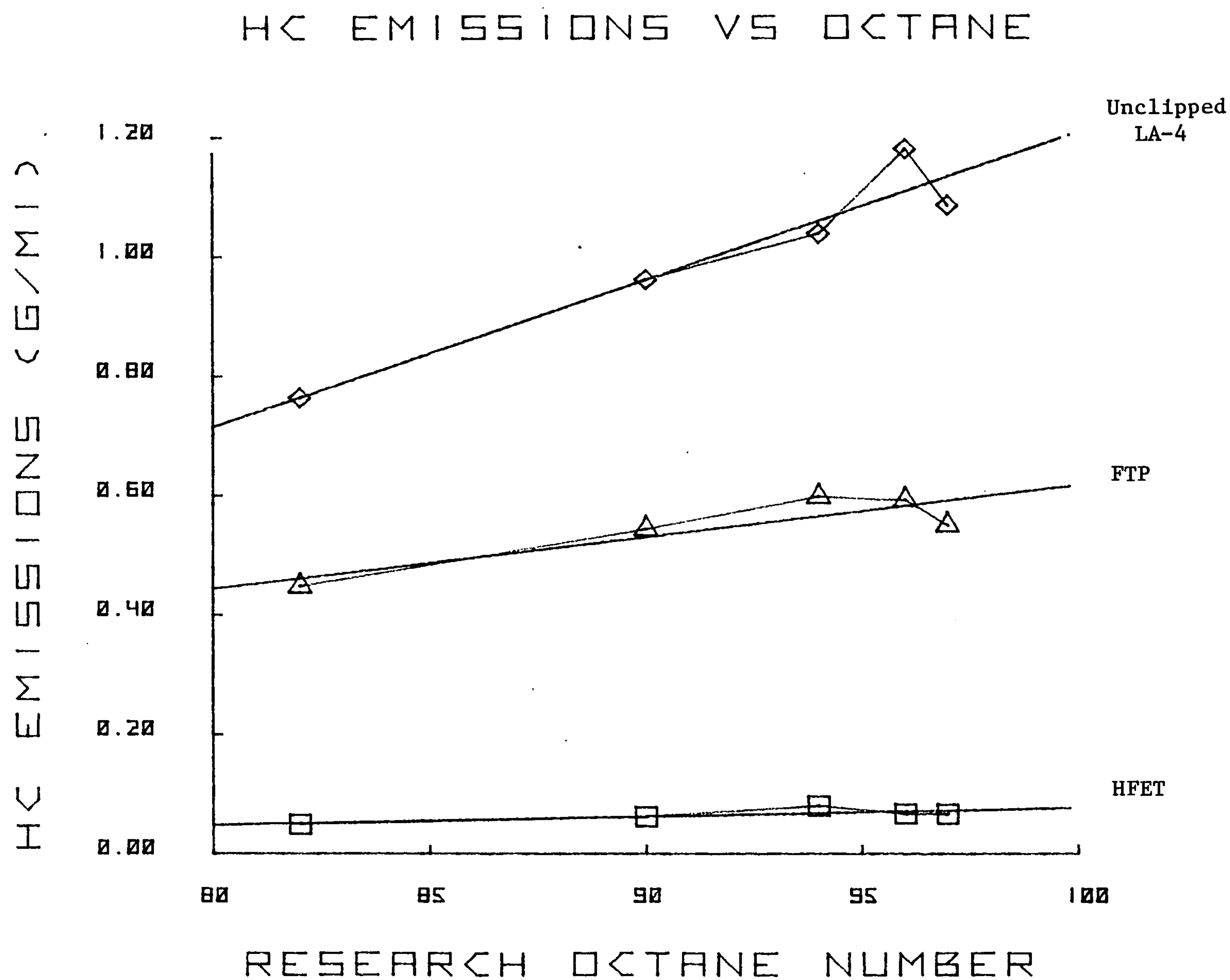
1. HC emissions decreased,
2. CO emissions decreased (except on the HFET cycle which exhibited a small absolute increase),
3. NOx emissions increased, and
4. Fuel economy increased on the FTP and decreased on the unclipped LA-4 cycle. In order to compute fuel economy, from the emission values, we must know the density and hydrogen/carbon ratio of the fuel; thus, fuel economy results for the commercial fuels were not plotted.

However, the differences among most of the measurements of HC, CO, NOx, and MPG using the five different fuels were not significant at the 95 percent confidence level (applying Student's t-test). The sample means which could be distinguished at the 95 percent confidence level are:

1. For the FTP tests, the mean of the HC emissions from using the 82 RON fuel is significantly different from the means using the other four fuels.

2. For the unclipped LA-4 tests (using as variance the pooled estimate of the variance of the FTP and LA-4 samples), the means of the HC emissions for the RON 82 and 90 RON fuels were distinctly different from each other and from the remaining three fuels.

Figure 4


HC EMISSIONS VS OCTANE
HC EMISSIONS (G/MI)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
80
85
90
95
100
RESEARCH OCTANE NUMBER
Unclipped LA-4
FTP
HFET

-8-

Figure 5

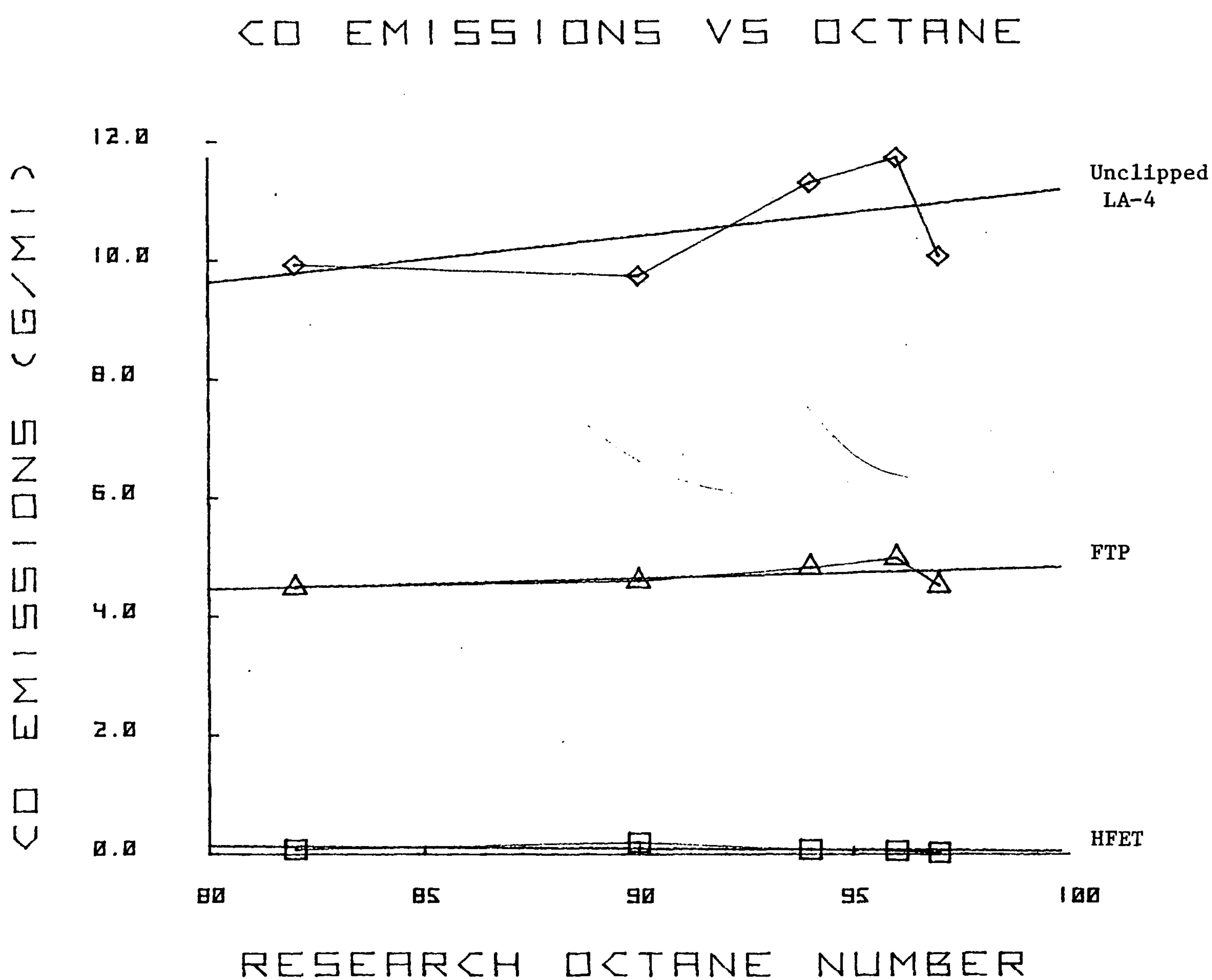

CO EMISSIONS VS OCTANE
CO EMISSIONS (G/MI)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
80
85
90
95
100
RESEARCH OCTANE NUMBER
Unclipped LA-4
FTP
HFET

Figure 6

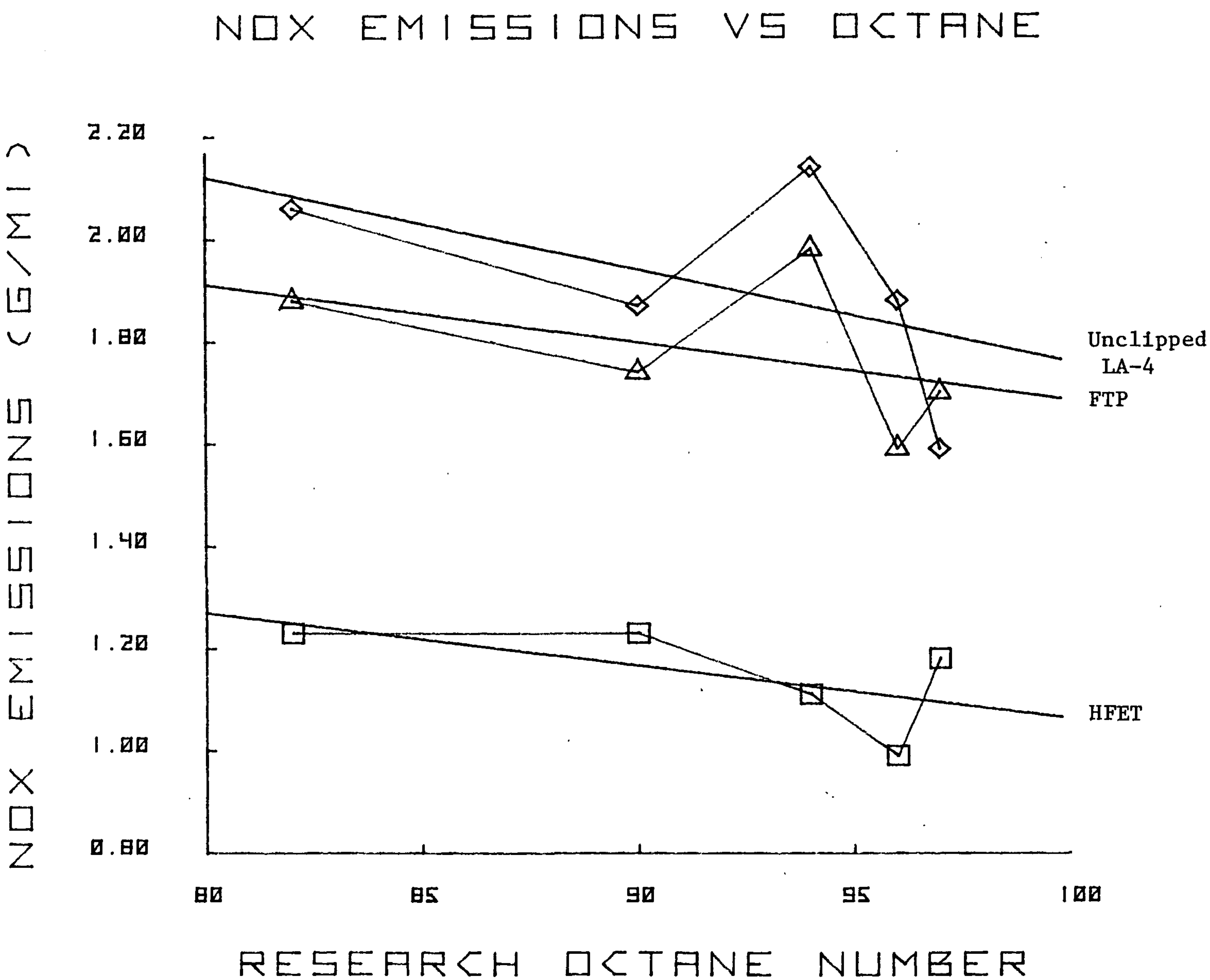
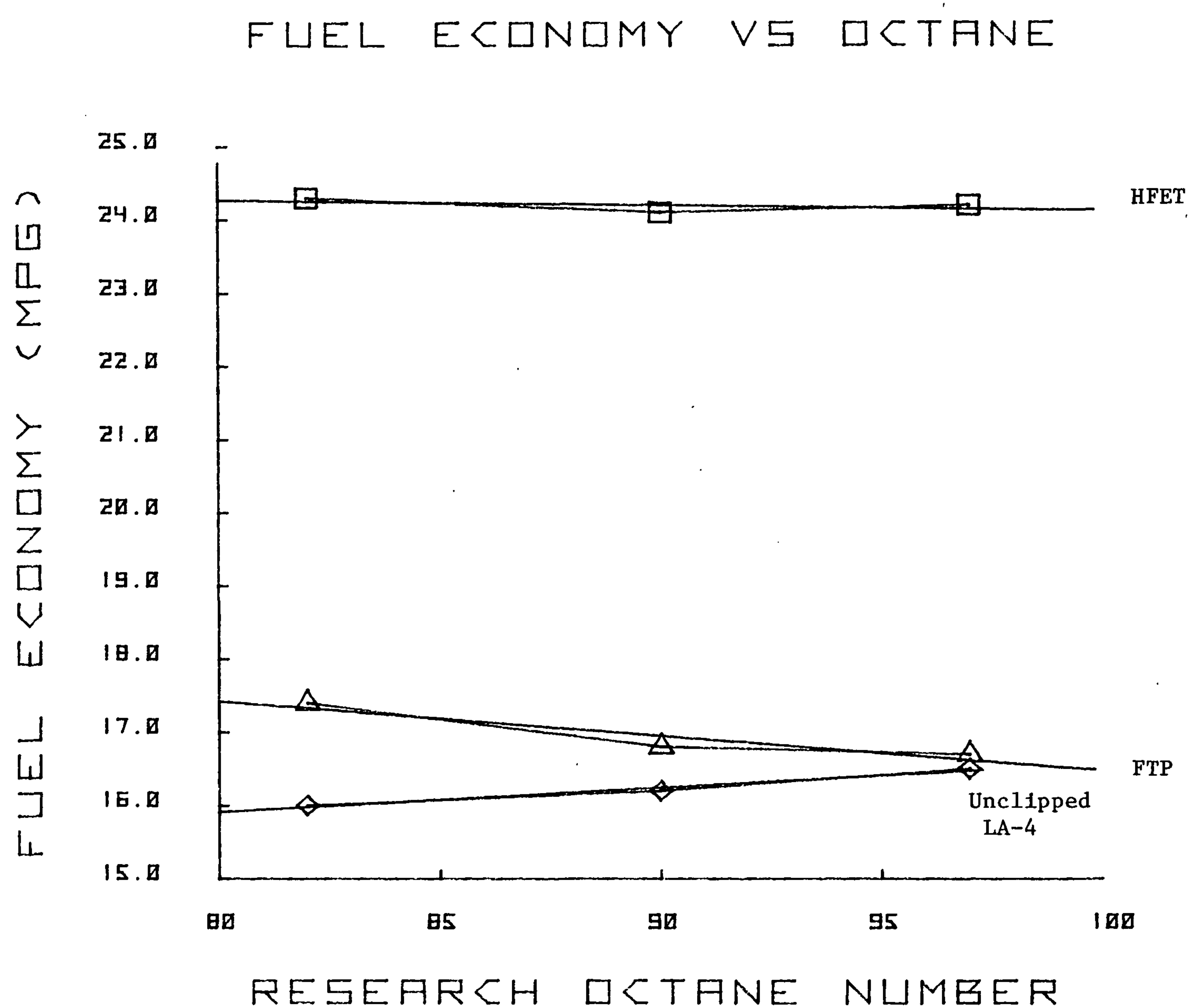

NOX EMISSIONS VS OCTANE
NOX EMISSIONS (G/MI)
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
80
85
90
95
100
RESEARCH OCTANE NUMBER
Unclipped
LA-4
FTP
HFET

Figure 7


FUEL ECONOMY VS OCTANE
FUEL ECONOMY (MPG)
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0
HFET
FTP
Unclipped
LA-4
80
85
90
95
100
RESEARCH OCTANE NUMBER

3. For the HFET:

   a) The means of the HC emissions from using the commercial unleaded and 82 RON fuels are distinct from each other and from the remaining three fuels.

   b) The means of the CO emissions from using the 97 RON and 90 RON fuels are distinct from each other but not from the other three fuels.

   c) The means of the NOx emissions from using the commercial premium fuel is distinct from using either the 90 RON or 82 RON fuels.

Interestingly enough, fuel economy is missing from the above list. Thus, for any given test cycle, we cannot state (with even 90 percent confidence) that the mean of the fuel economy results with one fuel is different from that of any other fuel.

Wide open throttle (WOT) testing indicated a loss in power associated with reduced octane levels. Data from the WOT testing is summarized in Table 3.

Table 3

Horsepower at Wide Open Throttle at 50 MPH

Fuel	Vehicle Speed (MPH)	Engine Speed (RPM)	Horse-Power	Audible Knock ?
RON 97	50	2900	90	No
Commerical Unleaded	52	2800	67	Yes
RON 82	50	2750	71	Yes

During the spring and summer of 1980, and at the request of EPA, GM tested five of its passenger cars and two of its light duty trucks on both 97 RON and 91 RON fuels. (See Appendix B.) Similarly, Chrysler tested five of its passenger cars on both 97 RON and 91 RON fuels. (See Appendix C.) The results of those tests are summarized in Tables 4 and 5. At the 90 percent confidence level, the increases in CO emissions for GM's five passenger cars are significant on both the FTP and HFET test cycles. Also, for Chrysler's five passenger cars, the increases in HC and CO emissions on the highway cycle are significant at the 90 percent confidence level.

In a series of letters sent to the Certification Division of EPA's Office of Mobile Air Pollution Control, GM stated that, with respect to Buick's 1978 model year ESC system:

> The electronic spark control system is designed to operate only when engine detonation is detected. The latest design and calibration parameters are such that engine detonation will not occur during the Federal test procedure [when using 91 RON fuel]. (19)

And, similarily, for their 1979 model year system, GM stated:

> General Motors Corporation believes that Buick's Electronic Spark Control will also not affect the fuel economy representativity for 1979 [as they believed for 1978]. As before, the ESC is designed to operate only when engine detonation is detected. The 1979 calibrations will not produce sufficient detonation to cause the ESC to retard the spark with 91 RON fuel during FTP conditions. (20)

Other Studies

GM conducted a study (6) in which a 4000 pound inertia weight vehicle with a 305 CID engine with a 8.4:1 compression ratio was equipped with a closed-loop knock control system. The vehicle was then tested using a number of fuels from 82 to 100 RON. Comparing the test results using 91 and 98 RON fuel, GM reported:

> [This] vehicle did not have significant spark retard [with the 91 RON fuel] during the EPA test; therefore, no change in fuel economy would be expected due to increasing fuel octane over 91 RON.
>
> ... The performance [as measured by a zero to 60 MPH acceleration time] was not affected greatly by a decrease from 100 to 90 RON fuel. Below 90 RON the acceleration times began to increase markedly.

TABLE 4

PERCENTAGE INCREASE IN GOING FROM RON 97 TO RON 91
FOR 1981 MODEL YEAR GM EMISSION DATA VEHICLES AND TRUCKS
TESTED AT GM'S EMISSION LABORATORY

VEHICLE	HC		CO		NOX		MPG		
I.D.	FTP	HFET	FTP	HFET	FTP	HFET	FTP	HFET	COMB.
PASSENGER CARS:									
B5083	36.0	10.7	34.0	300.0	0.0	-1.4	-2.4	-1.3	-2.0
B80116	-19.1	6.7	38.4	134.8	8.3	0.0	1.7	1.1	1.5
B80117	7.4	50.9	84.2	378.9	-6.7	0.0	-2.4	-0.4	-1.7
P0775	21.3	18.8	43.2	81.8	2.7	0.0	1.7	0.3	1.2
P0794	32.4	-4.3	154.2	175.0	0.0	7.9	-2.0	-0.9	-1.6
MEAN	15.6	16.6	70.8	214.1	0.9	1.3	-0.7	-0.2	-0.5
ST.D.	22.4	20.9	50.7	122.3	5.4	3.7	2.2	1.0	1.7
TRUCKS:									
C0C215	22.4	12.5	37.0	22.6	-19.2	-14.5	-1.8	-3.0	-2.3
C0K169	1.8	0.0	2.4	0.0	-1.7	2.3	-0.6	4.1	1.1
MEAN	12.1	6.2	19.7	11.3	-10.4	-6.1	-1.2	0.6	-0.6
ST.D.	14.6	8.8	24.5	16.0	12.4	11.9	0.8	5.0	2.4

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FOR COMPARISON:

IN-HOUSE TEST VEHICLE: *4K473AH105868

	-1.1	-7.5	1.8	566.6	2.4	4.2	0.8	-0.4	0.3

TABLE 5

PERCENTAGE INCREASE IN GOING FROM RON 97 TO RON 91
FOR 1981 MODEL YEAR CHRYSLER EMISSION DATA VEHICLES
TESTED AT CHRYSLER'S EMISSION LABORATORY

VEHICLE	HC		CO		NOX		MPG		
I.D.	FTP	HFET	FTP	HFET	FTP	HFET	FTP	HFET	COMB.
D250	50.9	1566.7	23.7	116.7	29.5	-28.1	0.6	2.1	1.1
D254	45.0	54.5	50.0	33.3	-13.1	11.1	-0.6	-3.2	-1.5
D280	1.6	53.6	-13.2	24.3	-6.4	23.3	-1.2	-1.2	-1.2
D282	35.0	43.8	100.0	56.1	20.0	18.6	-1.9	-0.8	-1.5
F180	-10.4	20.0	3.6	45.2	4.8	0.0	-0.7	-5.1	-2.3
MEAN	24.4	43.0*	32.8	55.1	7.0	5.0	-0.8	-1.6	-1.1
ST.D.	27.2	16.1*	44.3	36.5	17.8	20.5	0.9	2.7	1.3

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* EXCLUDING D250

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FOR COMPARISON:

IN-HOUSE TEST VEHICLE: *4K473AH105868

-1.1	-7.5	1.8	566.6	2.4	4.2	0.8	-0.4	0.3

> ... Based on both full throttle and part throttle octane requirements, the system can reduce the vehicle octane requirement for trace knock levels by 8 to 10 RON.

An Exxon study (2) (18), funded by EPA, in which a GM vehicle with a 350 CID engine was equipped with a closed-loop knock control system, reached much the same conclusion:

> Emissions and fuel economy testing using fuel that produces trace knock on WOT accelerations does not cause spark retard on the FTP and HFET cycles, thus not affecting fuel economy or emissions for normal driving.

Finally, in a Department of Energy (DOE) study (14), a 1977 Volvo 242 DL with a 2.1-liter engine equipped with a K-Jetronic fuel injection system, a Lambda-Sond system, and a three-way catalyst which was fitted with Buick's knock-control system was tested using 84, 92, and 101 RON fuels. The study found that as the octane level of the fuel decreased:

1. Both FTP and HFET fuel economy increased slightly with most of the increase coming with the change from 92 to 84 RON fuel.

2. The FTP NOx emissions had an increase of between 15 and 45 percent going from the 101 to 92 RON fuels.

The HFET emissions were not reported in the DOE study, and the other FTP emissions displayed no consistent trends.

These preceding studies appear to be in agreement with the data in this report. That is:

1. As the research octane number of the fuel decreases from about 97 to 90 RON, there are only slight changes (in absolute value, not in percent change) in fuel economy. This result is probably due to the small amount of timing retard (both in time and in degrees) that occurs on the EPA test cycles using approximately 90 RON fuel.

2. As the octane level of the fuel drops below 90 RON, the occurrence of knock may increase on the EPA test cycles, and thus necessitate some spark retard. Since this knock-control system has a limit (23°) to the amount of retard from the basic spark timing curve, it is possible that a low level of knock may be present when using 82 RON fuel. This trace knock could possibly account for the increase in fuel economy (5) with 82 RON fuel as well as the slight increase in HC emissions (1).

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13. J.E. Rydquist, "A Turbocharged Engine with Microprocessor Controlled Boost Pressure," SAE Paper No. 810060, February 1981.

14. D.E. Koehler and W.F. Marshall, "Maximizing Efficiency of Fuel Production and Utilization," SAE Paper No. 810062, February 1981.

15. "The Effect of Ignition Timing Modifications on Emissions and Fuel Economy," U.S. EPA, Office of Mobile Source Air Pollution Control, Emission Control Technology Division, Technology Assessment and Evaluation Branch, Paper No. 76-4 AW, October 1975.

16. R.J. Hosey and J.D. Powell, "Closed Loop, Knock Adaptive Spark Timing Control Based on Cylinder Pressure," ASME Publication 78-WA/DSC-15.

17. "MVMA National Gasoline Survey", Summer Season - October 15, 1980, Sampling Date - July 15, 1980.

18. United States Patent number 4,153,020, Assignee: U.S. Environmental Protection Agency, May 8, 1979.

19. Letter to J.M. Marzen, Chief, Light-Duty Vehicle Certification Branch, EPA, From D.A. Olds, Current Product Engineering, GM, letter number ML-8G129, dated June 28, 1977.

20. Letter to J.H. Murphy, Acting Team Leader, Light-Duty Vehicle Certification Branch, EPA, from D.A. Olds, Field Product Engineering, GM, letter number ML-9G229, dated September 20, 1978.

APPENDIX A

In-House Test Data

Due to changes in the hydrogen/carbon ratio and the density of the fuels, the calculated fuel economy (FE):

1. Should be reduced by 0.5% for 90 RON fuel,

2. Should be reduced by 1.2% for 82 RON fuel, and

3. Is not accurate for either the commercial regular or commercial premium unleaded fuels.

TURBO BUICK TEST DATA PROCESSED: SEP 11, 1980

FUEL RON=97 VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: FTP SITE: D002

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
5/30/80	803504	0.627	4.780	1.438	532.570	16.3	D208	4126.0	8.9	28.85	72.5	69.52	0.97	36603
6/ 3/80	803506	0.564	4.566	1.443	523.520	16.6	D208	4166.0	8.9	28.90	70.5	72.58	0.98	22136
8/ 6/80	804930	0.460	4.215	2.216	511.510	17.1	D002	4757.0	9.3	29.10	74.0	55.00	0.91	36603
	MEAN	0.550	4.519	1.698	522.533	16.67				28.95		65.70	0.954	
	STD. DEVIATION	0.084	0.285	0.447	10.559	0.40				0.13		9.39	0.039	
	MAX. 95% ERROR	0.155	0.523	0.822	19.398	0.74				0.24		17.25	0.073	
		(GRAMS/MILE)				(MPG)				(IN-HG)		(GR/LB)		

FTP BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			(GRAMS/MILE)				(MPG)
5/30/80	803504	BAG 1	2.216	22.457	2.539	540.2	15.2
		BAG 2	0.179	0.0	0.880	554.6	16.0
		BAG 3	0.286	0.588	1.673	484.9	18.2
6/ 3/80	803506	BAG 1	2.044	21.468	2.342	536.0	15.4
		BAG 2	0.174	0.0	0.998	542.8	16.3
		BAG 3	0.193	0.529	1.612	477.3	18.5
8/ 6/80	804930	BAG 1	1.457	19.061	2.159	535.3	15.6
		BAG 2	0.171	0.079	2.293	520.0	17.0
		BAG 3	0.253	0.842	2.113	477.4	18.5

TURBO BUICK TEST DATA PROCESSED: SEP 11, 1980

FUEL RON=97 VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: HFET SITE: D002

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
5/30/80	803505	0.069	0.025	1.226	374.310	23.7	D208	4147.0	8.9	28.85	72.5	69.52	0.97	36603
6/ 3/80	803507	0.068	0.009	1.256	369.640	24.0	D208	4197.0	8.9	28.90	68.5	66.59	0.96	22136
8/ 7/80	804931	0.066	0.047	1.050	354.940	25.0	D002	4789.0	9.3	29.05	74.2	57.94	0.92	36603
	MEAN	0.067	0.026	1.177	366.296	24.23				28.93		64.68	0.949	
	STD. DEVIATION	0.002	0.018	0.110	10.107	0.68				0.10		6.02	0.025	
	MAX. 95% ERROR	0.004	0.034	0.203	18.569	1.25				0.19		11.06	0.047	
		<-------(GRAMS/MILE)			--------->	(MPG)				(IN-HG)		(GR/LB)		

HFET BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			<-------(GRAMS/MILE)			--------->	(MPG)
5/30/80	803505	BAG 1	0.069	0.025	1.226	374.3	23.7
6/ 3/80	803507	BAG 1	0.068	0.009	1.256	369.6	24.0
8/ 7/80	804931	BAG 1	0.066	0.047	1.050	354.9	25.0

TURBO BUICK TEST DATA PROCESSED: SEP 11, 1980

FUEL RON=97 VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: BBB SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
6/ 6/80	803508	0.0	0.0	0.0	0.0	0.0	D208	4207.0	8.9	28.78	73.0	73.69	0.99	22136
6/ 9/80	803509	1.086	10.072	1.593	518.910	16.5	D208	4223.0	8.9	28.72	71.5	73.89	0.99	22136
	MEAN	1.086	10.071	1.593	518.909	16.50				28.75		73.79	0.989	
	STD. DEVIATION	0.000	0.000	0.000	0.000	0.00				0.04		0.13	0.002	
	MAX. 95% ERROR	0.000	0.000	0.000	0.000	0.00				0.12		0.40	0.008	
		(GRAMS/MILE)				(MPG)				(IN-HG)		(GR/LB)		

BBB BAG DATA

DATE	TEST NUMBER		HC (GRAMS/MILE)	CO (GRAMS/MILE)	NOX (GRAMS/MILE)	CO2 (GRAMS/MILE)	FE (MPG)
6/ 6/80	803508	BAG 1	1.163	12.230	1.653	528.6	16.1
6/ 9/80	803509	BAG 1	1.086	10.072	1.593	518.9	16.5

FUEL RON=90 VEHICLE: *4K473AH105868 INERTIA WT: 3625 TYPE: FTP SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
6/10/80	803510	0.525	4.386	1.597	517.390	16.9	D208	4239.0	8.9	28.97	71.5	73.12	0.99	36603
6/11/80	803881	0.559	4.562	1.676	520.760	16.7	D208	4281.4	8.9	29.32	72.3	77.45	1.01	36603
8/ 8/80	805270	0.549	4.856	1.956	509.920	17.1	D208	4812.0	8.7	29.02	68.9	64.27	0.95	36603
	MEAN	0.544	4.601	1.743	516.023	16.90				29.10		71.61	0.980	
	STD. DEVIATION	0.017	0.237	0.188	5.537	0.20				0.19		6.72	0.029	
	MAX. 95% ERROR	0.031	0.435	0.345	10.173	0.37				0.35		12.34	0.054	
		(GRAMS/MILE)				(MPG)				(IN-HG)		(GR/LB)		

FTP BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			(GRAMS/MILE)				(MPG)
6/10/80	803510	BAG 1	1.851	20.220	2.318	525.3	15.8
		BAG 2	0.173	0.048	1.255	539.2	16.4
		BAG 3	0.198	0.748	1.708	469.8	18.8
6/11/80	803881	BAG 1	2.029	21.444	2.452	530.4	15.5
		BAG 2	0.171	0.088	1.372	537.3	16.5
		BAG 3	0.190	0.376	1.672	481.9	18.4
8/ 8/80	805270	BAG 1	1.865	21.768	2.252	525.7	15.7
		BAG 2	0.172	0.0	1.962	525.0	16.9
		BAG 3	0.280	1.431	1.721	469.2	18.8

TURBO BUICK TEST DATA　　　　PROCESSED: SEP 11, 1980

FUEL RON=90　　VEHICLE: *4K473AH105868　　INERTIA WT: 3625　　TYPE: HFET　　SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
6/10/80	803511	0.064	0.151	1.208	365.350	24.3	D208	4260.0	8.9	28.97	67.8	66.17	*NONE*	36603
6/11/80	803882	0.059	0.0	1.260	364.840	24.3	D208	4291.0	8.9	29.32	70.3	75.88	1.00	36603
8/ 8/80	805269	0.066	0.241	1.212	368.360	24.1	D208	4832.0	8.7	28.93	67.8	65.84	*NONE*	36603
	MEAN	0.062	0.196	1.226	366.183	24.23				29.07		69.30	0.970	
	STD. DEVIATION	0.004	0.063	0.028	1.914	0.11				0.21		5.70	0.025	
	MAX. 95% ERROR	0.007	0.192	0.053	3.517	0.21				0.39		10.47	0.046	
		(GRAMS/MILE)				(MPG)				(IN-HG)		(GR/LB)		

HFET BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			(GRAMS/MILE)				(MPG)
6/10/80	803511	BAG 1	0.064	0.152	1.208	365.4	24.2
6/11/80	803882	BAG 1	0.059	0.0	1.260	364.8	24.3
8/ 8/80	805269	BAG 1	0.066	0.241	1.212	368.4	24.0

FUEL RON=90 VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: BBB SITE: 0208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
6/12/80	803863	0.943	10.101	1.870	533.330	16.1	0208	4301.9	8.9	29.36	71.5	71.93	0.98	22136
6/13/80	803864	0.983	9.384	1.871	529.470	16.2	0208	4309.0	8.9	29.24	71.2	74.67	0.99	36603
	MEAN	0.962	9.742	1.870	531.399	16.15				29.30		73.30	0.987	
	STD. DEVIATION	0.027	0.506	0.005	2.738	0.07				0.08		1.93	0.008	
	MAX. 95% ERROR	0.084	1.540	0.015	8.332	0.21				0.25		5.88	0.025	
		(GRAMS/MILE)				(MPG)				(IN-HG)		(GR/LB)		

BBB BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			(GRAMS/MILE)				(MPG)
6/12/80	803863	BAG 1	0.943	10.101	1.870	533.3	16.1
6/13/80	803864	BAG 1	0.983	9.385	1.871	529.5	16.2

FUEL PON=82 VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: FTP SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
7/22/80	803878	0.447	4.308	1.821	510.150	17.1	D208	4573.2	8.7	28.94	70.0	66.33	0.96	22136
7/23/80	804874	0.420	4.115	1.889	512.610	17.0	D208	4606.0	8.7	29.06	72.5	76.02	1.00	22136
8/12/80	805356	0.477	5.029	1.937	462.460	18.8	D208	4851.6	8.7	29.06	71.5	65.86	0.95	36003
	MEAN	0.448	4.483	1.882	495.073	17.63				29.02		69.40	0.970	
	STD. DEVIATION	0.028	0.481	0.058	28.269	1.01				0.07		5.73	0.025	
	MAX. 95% ERROR	0.052	0.884	0.106	51.934	1.86				0.12		10.53	0.047	
		|<-------- (GRAMS/MILE)			--------->|	(MPG)				(IN-HG)		(GR/LB)		

FTP BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			|<------ (GRAMS/MILE)			------>|	(MPG)
7/22/80	803878	BAG 1	1.607	20.661	2.585	529.5	15.6
		BAG 2	0.153	0.0	1.426	525.0	16.9
		BAG 3	0.136	0.253	2.005	466.9	19.0
7/23/80	804874	BAG 1	1.420	19.396	2.516	532.7	15.6
		BAG 2	0.172	0.103	1.602	526.4	16.8
		BAG 3	0.140	0.251	1.966	471.1	18.8
8/12/80	805356	BAG 1	1.585	20.696	1.563	408.1	19.9
		BAG 2	0.164	0.256	2.192	502.9	17.6
		BAG 3	0.239	2.297	1.734	426.5	20.6

FUEL RON=82 VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: HFET SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
7/22/80	803879	0.052	0.012	1.299	369.240	24.0	D208	4594.9	8.7	28.94	71.5	75.60	1.00	22136
7/23/80	804875	0.047	0.0	1.268	357.940	24.8	D208	4626.0	8.7	29.06	68.5	68.40	0.97	22136
8/12/80	805357	0.049	0.155	1.120	353.740	25.0	D208	4873.0	8.7	29.05	67.5	66.43	*NONE*	36603
	MEAN	0.049	0.083	1.229	360.306	24.60				29.02		70.14	0.973	
	STD. DEVIATION	0.003	0.101	0.095	8.020	0.53				0.07		4.82	0.021	
	MAX. 95% ERROR	0.006	0.307	0.175	14.735	0.97				0.12		8.86	0.039	
		<---------(GRAMS/MILE)--------->				(MPG)				(IN-HG)		(GR/LB)		

HFET BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			<----------(GRAMS/MILE)---------->				(MPG)
7/22/80	803879	BAG 1	0.052	0.012	1.299	369.2	24.0
7/23/80	804875	BAG 1	0.047	0.0	1.268	357.9	24.8
8/12/80	805357	BAG 1	0.049	0.155	1.120	353.7	25.0

FUEL RON=82 VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: BBB SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
7/24/80	804924	0.764	9.932	2.062	530.177	16.2	D208	4637.7	8.7	29.14	71.0	68.73	0.97	36603
MEAN		0.764	9.932	2.062	530.177	16.20				29.14		68.73	0.966	
		|<---------(GRAMS/MILE)--------->|				(MPG)				(IN-HG)		(GR/LB)		

BBB BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			|<---------(GRAMS/MILE)--------->|				(MPG)
7/24/80	804924	BAG 1	0.764	9.932	2.062	530.2	16.2

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TURBO BUICK TEST DATA PROCESSED: SEP 11, 1980

FUEL PREMIUM VEHICLE: *4K473AH105868 INERTIA WT: 3625 TYPE: FTP SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
7/16/80	803873	0.605	5.208	1.571	520.150	16.7	D208	4493.6	8.7	28.85	72.5	69.52	0.97	22136
7/17/80	803875	0.578	4.742	1.605	517.730	16.8	D208	4527.0	8.7	28.94	73.0	73.18	0.99	22136
	MEAN	0.591	4.975	1.588	518.939	16.75				28.89		71.35	0.978	
	STD. DEVIATION	0.019	0.329	0.023	1.732	0.07				0.06		2.59	0.011	
	MAX. 95% ERROR	0.058	1.002	0.070	5.270	0.21				0.19		7.88	0.034	
		<--- (GRAMS/MILE)			--->	(MPG)				(IN-HG)		(GR/LB)		

FTP BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			<--- (GRAMS/MILE)			--->	(MPG)
7/16/80	803873	BAG 1	2.091	23.148	2.431	533.4	15.4
		BAG 2	0.149	0.0	1.260	533.1	16.6
		BAG 3	0.364	1.706	1.523	485.3	18.1
7/17/80	803875	BAG 1	1.925	21.073	2.464	541.3	15.3
		BAG 2	0.144	0.0	1.296	528.7	16.8
		BAG 3	0.395	1.505	1.548	478.9	18.4

FUEL PREMIUM VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: HFET SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
7/16/80	803874	0.070	0.082	0.980	381.200	23.3	D208	4515.7	8.7	28.84	72.5	69.55	0.97	22136
7/17/80	803876	0.064	0.040	0.993	371.910	23.8	D208	4547.8	8.7	29.85	71.5	72.83	0.99	22136
MEAN		0.067	0.061	0.986	376.554	23.55				29.34		71.19	0.977	
STD. DEVIATION		0.005	0.029	0.008	6.564	0.35				0.71		2.32	0.010	
MAX. 95% ERROR		0.015	0.090	0.026	19.973	1.07				2.17		7.06	0.031	
		<--------(GRAMS/MILE)			--------->	(MPG)				(IN-HG)		(GR/LB)		

HFET BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			<----------(GRAMS/MILE)			---------->	(MPG)
7/16/80	803874	BAG 1	0.070	0.082	0.980	381.2	23.2
7/17/80	803876	BAG 1	0.064	0.040	0.993	371.9	23.8

TURBO BUICK TEST DATA PROCESSED: SEP 11, 1980

FUEL PREMIUM VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: BBB SITE: D208

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
7/18/80	803877	1.180	11.721	1.885	544.734	15.6	D208	4565.0	8.9	29.10	70.0	70.45	0.97	36603
MEAN		1.180	11.721	1.885	544.733	15.60				29.10		70.45	0.974	
		<---------(GRAMS/MILE)--------->				(MPG)				(IN-HG)		(GR/LB)		

BBB BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			<------------(GRAMS/MILE)------------>				(MPG)
7/18/80	803877	BAG 1	1.180	11.721	1.885	544.7	15.6

FUEL COMMERCIAL VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: FTP SITE: D006

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
7/30/80	804925	0.620	4.745	2.014	503.170	17.3	D006	4460.0	9.2	29.00	75.0	58.15	0.92	36603
7/31/80	804927	0.576	4.885	1.958	501.820	17.3	D006	4692.0	9.2	28.88	75.0	58.50	0.92	36603
MEAN		0.598	4.815	1.985	502.494	17.30				28.94		58.32	0.921	
STD. DEVIATION		0.030	0.098	0.038	0.935	0.01				0.08		0.24	0.002	
MAX. 95% ERROR		0.093	0.300	0.118	2.846	0.03				0.26		0.74	0.008	
		|<--------(GRAMS/MILE)			--------->|	(MPG)				(IN-HG)		(GR/LB)		

FTP BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			|<------------------	(GRAMS/MILE)		------------------>|	(MPG)
7/30/80	804925	BAG 1	2.064	19.992	2.336	528.7	15.7
		BAG 2	0.196	0.225	2.015	514.7	17.2
		BAG 3	0.336	1.827	1.767	461.8	19.0
7/31/80	804927	BAG 1	1.835	22.019	2.263	524.6	15.7
		BAG 2	0.183	0.0	1.979	513.4	17.3
		BAG 3	0.368	1.159	1.690	462.8	19.0

FUEL COMMERCIAL VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: HFET SITE: D006

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
7/30/80	804926	0.079	0.077	1.116	362.560	24.4	D006	4681.0	9.2	29.02	75.0	58.10	0.92	36603
7/31/80	804928	0.081	0.089	1.100	365.710	24.2	D006	4707.0	9.2	28.85	74.5	61.66	0.94	36603
	MEAN	0.080	0.083	1.107	364.135	24.30				28.93		59.88	0.928	
	STD. DEVIATION	0.003	0.008	0.010	2.215	0.14				0.12		2.52	0.009	
	MAX. 95% ERROR	0.010	0.028	0.031	6.739	0.43				0.36		7.68	0.030	
		|<---------(GRAMS/MILE)			---------->|	(MPG)				(IN-HG)		(GR/LB)		

HFET BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			|<---------(GRAMS/MILE)			---------->|	(MPG)
7/30/80	804926	BAG 1	0.079	0.077	1.116	362.6	24.4
7/31/80	804928	BAG 1	0.081	0.089	1.100	365.7	24.2

FUEL COMMER. VEHICLE: #4K473AH105868 INERTIA WT: 3625 TYPE: BBB SITE: D006

DATE	TEST NUMBER	HC	CO	NOX	CO2	FE	DYNO	ODOMETER	IHP	BARO	TEMP	HUM	NOX FAC	DRIVER
8/ 1/80	804929	1.039	11.297	2.140	518.753	16.4	D006	4723.0	9.2	28.95	75.5	59.77	0.93	36603
MEAN		1.039	11.297	2.140	518.752	16.40				28.95		59.77	0.927	
		|<---------(GRAMS/MILE)--------->|				(MPG)				(IN-HG)		(GR/LB)		

BBB BAG DATA

DATE	TEST NUMBER		HC	CO	NOX	CO2	FE
			|<-----------(GRAMS/MILE)----------->|				(MPG)
8/ 1/80	804929	BAG 1	1.039	11.297	2.140	518.8	16.4

APPENDIX B

GM Test Data

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
GENERAL MOTORS	P0775	BV	(V)FIREBIRD	EGR/PMP/OXD/3CL/	CAN	4.9 L

ACTIVE YEAR	MODEL YEAR
1981	1981

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	HC	CO	CO2	NOX	EVAP	FUEL ECON	FUEL TYPE
*-ENG FAM:12S4AB					EVAP FAM:1B4S-2			ENG CODE:3					ETW: 4000 DYNO H.P.:08.6 TRANS:L3 O/D:1 AXLE:3.08 N/V: 39.1
3-25-80	12981	FTP	3790	03787		73.0	00.210	02.38	0571.	00.40	01.20	15.4	STANDARD TEST FUEL
3-25-80	12982	HFET	3801	03798		72.0	00.049	00.24	0404.	00.29	.	21.9	STANDARD TEST FUEL
6- 3-80	18844	FTP	4259	04256		72.0	00.255	02.55	0589.	00.34	.	14.9	STANDARD TEST FUEL
6- 3-80	18845	HFET	4270	04267		72.0	00.052	00.20	0417.	00.27	.	21.2	STANDARD TEST FUEL
6- 4-80	18846	FTP	4302	04299		70.5	00.282	03.53	0569.	00.38	.	15.4	LOW OCTANE FUEL
6- 4-80	18847	HFET	4313	04310		70.5	00.060	00.40	0409.	00.28	.	21.6	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
GENERAL MOTORS	B5083	FV	(V) MONTE CARLO	EGR/PMP/OXD/3CL/	CAN	3.8 L

ACTIVE YEAR	MODEL YEAR
1981	1981

*-ENG FAM:14E4NBD (TURBO) EVAP FAM:184-4 ENG CODE:1 ETW: 3750 DYNO H.P.:10.6
TRANS:L3 O/D:1 AXLE:2.73 N/V: 37.4

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	HC	CO	CO2	NOX	EVAP	FUEL ECON	FUEL TYPE
5-26-80	16611	FTP	3909	03791		73.0	00.300	02.82	0465.	00.66	01.32	18.9	STANDARD TEST FUEL
5-26-80	16612	HFET	3920	03801		73.0	00.048	00.00	0322.	00.36	.	27.5	STANDARD TEST FUEL
6-24-80	18019	FTP	4271	04142		72.0	00.341	02.79	0471.	00.66	01.44	18.6	STANDARD TEST FUEL
6-24-80	18020	HFET	4282	04153		71.0	00.055	00.01	0323.	00.35	.	27.4	STANDARD TEST FUEL
6-26-80	18021	FTP	4316	04186		73.0	00.436	03.76	0476.	00.66	.	18.3	LOW OCTANE FUEL
6-26-80	18022	HFET	4327	04196		72.5	00.057	00.02	0327.	00.35	.	27.1	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
GENERAL MOTORS	880116	FV	(V)ELECTRA	EGR/PMP/OXD/3CL/	CAN	4.1 L

ACTIVE YEAR	MODEL YEAR
1981	1981

*-ENG FAM:14F4AE EVAP FAM:1B4S-4 ENG CODE:3 ETW: 4250 DYNO H.P.:10.8 TRANS:L4 O/D:2 AXLE:3.23 N/V: 26.5

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	EMISSION RESULTS HC	CO	CO2	NOX	EVAP	FUEL ECON	FUEL TYPE
5-26-80	16613	FTP	3752	03788		72.0	00.283	01.72	0512.	00.48	.	17.2	STANDARD TEST FUEL
5-26-80	16614	HFET	3763	03799		72.0	00.060	00.23	0312.	00.27	.	28.4	STANDARD TEST FUEL
6-25-80	18842	FTP	4095	04134		73.0	00.229	02.38	0501.	00.52	.	17.5	LOW OCTANE FUEL
6-25-80	18843	HFET	4106	04145		71.5	00.064	00.54	0308.	00.27	.	28.7	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	CONTROL SYSTEMS EVAP	DISPLACEMENT
GENERAL MOTORS	B80117	CV	(V)DEVILLE/BROUGHAM	EGR/PMP/OXD/3CL/	CAN	4.1 L

ACTIVE YEAR	MODEL YEAR
1981	1981

*-ENG FAM:14F4AEJ EVAP FAM:184S-4 ENG CODE:3 ETW: 4250 DYNO H.P.:11.3
TRANS:L4 O/D:2 AXLE:3.23 N/V: 27.1

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	EMISSION RESULTS HC	CO	CO2	NOX	EVAP	FUEL ECON	FUEL TYPE
6- 5-80	17044	FTP	3830	03828		71.0	00.269	02.53	0523.	00.60	01.35	16.8	STANDARD TEST FUEL
6- 5-80	17045	HFET	3841	03839		72.0	00.055	00.38	0346.	00.27	.	25.6	STANDARD TEST FUEL
6-26-80	18831	FTP	4093	04091		72.0	00.289	04.66	0532.	00.56	.	16.4	LOW OCTANE FUEL
6-26-80	18832	HFET	4104	04102		72.0	00.083	01.82	0344.	00.27	.	25.5	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	CONTROL SYSTEMS EVAP	DISPLACEMENT
GENERAL MOTORS	P0794	BV	(V)FIREBIRD	EGR/PMP/OXD/3CL/	CAN	4.9 L

ACTIVE YEAR	MODEL YEAR
1981	1981

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	EMISSION RESULTS HC	CO	CO2	NOX	EVAP	FUEL ECON	FUEL TYPE
*-ENG FAM:12S4ABD (TURBO)					EVAP FAM:1B4S-2			ENG CODE:1					ETW: 4000 DYNO H.P.:08.6 TRANS:L3 O/D:1 AXLE:3.08 N/V: 39.1
7-23-80	19612	HFET	3810	03847		72.0	00.070	00.04	0412.	00.38	.	21.5	STANDARD TEST FUEL
7-25-80	27366	FTP	3844	03881		71.0	00.278	00.72	0585.	00.59	01.18	15.1	STANDARD TEST FUEL
8- 6-80	20188	FTP	4096	04136		72.0	00.368	01.83	0596.	00.59	.	14.8	LOW OCTANE FUEL
8- 6-80	20189	HFET	4107	04147		73.0	00.067	00.11	0415.	00.41	.	21.3	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
GENERAL MOTORS	COC215	FT	(T)C10 P/U 2WD	EGR/OXD/	CAN	5.0 L

ACTIVE YEAR	MODEL YEAR
1981	1981

*-ENG FAM:18Y4HGN (TRUCK) EVAP FAM:1D4D-8 ENG CODE:2 ETW: 4500 DYNO H.P.:16.6
TRANS:L3 O/D:1 AXLE:2.56 N/V: 33.2

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	HC	CO	CO2	NOX	EVAP	FUEL ECON	FUEL TYPE
6-30-80	18319	FTP	3757	03788		72.0	00.530	05.80	0523.	02.18	.	16.6	STANDARD TEST FUEL
6-30-80	18320	HFET	3768	03799		72.0	00.070	01.10	0384.	03.05	.	23.0	STANDARD TEST FUEL
7-11-80	18716	FTP	3898	03930		73.0	00.630	06.90	0529.	01.93	.	16.4	STANDARD TEST FUEL
7-11-80	18717	HFET	3909	03941		73.0	00.090	02.00	0382.	02.80	.	23.0	STANDARD TEST FUEL
7-15-80	18929	FTP	3953	03985		72.0	00.710	08.70	0530.	01.66	.	16.2	LOW OCTANE FUEL
7-15-80	18930	HFET	3964	03997		73.0	00.090	01.90	0394.	02.50	.	22.3	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
GENERAL MOTORS	COK169	FT	(T)K10 P/U 4WD	EGR/PMP/OXD/	CAN	5.0 L

ACTIVE YEAR	MODEL YEAR
1981	1981

*-ENG FAM:1RL4HANA (TRUCK) EVAP FAM:1O4D-8 ENG CODE:5 ETW: 4750 DYNO H.P.:15.6
TRANS:L3 O/D:1 AXLE:2.56 N/V: 30.8

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	HC	CO	CO2	NOX	EVAP	FUEL ECON	FUEL TYPE
6-26-80	18210	FTP	3729	03794		71.0	00.560	06.50	0546.	01.80	01.29	15.8	STANDARD TEST FUEL
6-28-80	18211	HFET	3739	03805		71.0	00.100	00.10	0400.	02.14	.	22.1	STANDARD TEST FUEL
7-18-80	33235	HFET	3981	04051		73.0	00.100	00.10	0385.	02.190	.	23.0	LOW OCTANE FUEL
7-18-80	33236	FTP	4013	04084		72.0	00.570	08.70	0551.	01.770	.	15.7	LOW OCTANE FUEL

APPENDIX C

Chrysler Test Data

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
CHRYSLER	D250	BV	(V)NEWPORT/NEW YORK	EGR/PMP/OXD/3CL/	CAN	318.

ACTIVE YEAR	MODEL YEAR
1981	1981

*-ENG FAM:BCR5.2V4HC1 EVAP FAM:BCRKF ENG CODE:A-3

ETW: 4250 DYNO H.P.:12.1
TRANS:L3 O/D:1 AXLE:2.45 N/V: 31.6

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	EMISSION RESULTS HC	CO	CO2	NOX	EVAP	FUEL ECON	COMMENTS
5-13-80	16158	FTP	3712	3802	650	74.	0.110	1.56	556.	0.61	1.15	15.9	STANDARD TEST FUEL
5-13-80	16159	HFET	3723	3813		73.	0.012	0.06	365.	0.89	.	24.3	STANDARD TEST FUEL
5-15-80	16160	FTP	3796	3888	670	74.	0.166	1.93	550.	0.79	0.97	16.0	LOW OCTANE FUEL
5-15-80	16161	HFET	3807	3900		73.	0.20	0.13	357.	0.64	.	24.8	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
CHRYSLER	D254	BV	(V)DIPLOMAT	EGR/PMP/OXD/3CL/	CAN	318.

ACTIVE YEAR	MODEL YEAR
1981	1981

*-ENG FAM:BCR5.2V4HC1   EVAP FAM:BCRKF   ENG CODE:A-1   ETW: 3875 DYNO H.P.:11.5 TRANS:L3 O/D:1 AXLE:2.45 N/V: 32.1

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	HC	CO	CO2	NOX	EVAP	FUEL ECON	COMMENTS
5-24-80	16814	FTP	3807	3813	710	75.	0.109	1.98	546.	0.61	.	16.1	STANDARD TEST FUEL
5-24-80	16815	HFET	3818	3824		74.	0.022	0.21	359.	0.27	.	24.7	STANDARD TEST FUEL
5-28-80	16816	FTP	3850	3856	710	80.	0.158	2.97	549.	0.53	.	16.0	LOW OCTANE FUEL
5-28-80	16817	HFET	3861	3867		82.	0.034	0.28	370.	0.30	.	23.9	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
CHRYSLER	D280	FV	(V)IMPERIAL	EGR/PMP/OXD/3CL/	CAN	318.

ACTIVE YEAR	MODEL YEAR
1981	1981

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	HC	CO	CO2	NOX	EVAP	FUEL ECON	COMMENTS
*-ENG FAM:BCR5.2V9FAX					EVAP FAM:BCRKG			ENG CODE:A-2					ETW: 4250 DYNO H.P.:11.3 TRANS:L3 O/D:1 AXLE:2.24 N/V: 28.7
7- 3-80	19157	FTP	4623	4748	570	77.	.127	2.04	532.	.78	.	16.6	STANDARD TEST FUEL
7- 3-80	19158	HFET	4634	4759		77.	.028	.70	343.	.43	.	25.8	STANDARD TEST FUEL
7- 7-80	19159	FTP	4663	4789	580	76.	.129	1.77	538.	.73	.	16.4	LOW OCTANE FUEL
7- 7-80	19160	HFET	4674	4800		75.	.043	.87	346.	.53	.	25.5	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	EVAP	DISPLACEMENT
CHRYSLER	D282	CV	(V) IMPERIAL	EGR/PMP/OXD/3CL/	CAN	318.

ACTIVE YEAR	MODEL YEAR
1981	1981

DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	EMISSION RESULTS HC	CO	CO2	NOX	EVAP	FUEL ECON	COMMENTS
*-ENG FAM:BCR5.2V9FF6						EVAP FAM:BCRKG			ENG CODE:A-2				ETW: 4250 DYNO H.P.:11.3 TRANS:L3 O/D:1 AXLE:2.24 N/V: 28.7
7- 9-80	19851	FTP	4238	4166	555	77.	.117	1.20	550.	.40	.	16.1	STANDARD TEST FUEL
7- 9-80	19852	HFET	4249	4176		74.	.032	.57	353.	.43	.	25.1	STANDARD TEST FUEL
7-11-80	19854	FTP	4343	4269	580	77.	.158	2.40	557.	.48	.	15.8	LOW OCTANE FUEL
7-11-80	19855	HFET	4354	4280		77.	.046	.89	355.	.51	.	24.9	LOW OCTANE FUEL

VEHICLE TEST DATA LOG

MANUFACTURER	VEHICLE ID	SC	CARLINE	CONTROL SYSTEMS EMISSION	CONTROL SYSTEMS EVAP	DISPLACEMENT
CHRYSLER	F180	BV	(V)SPECIAL	EGR/PMP/OXD/3CL/	CAN	318.

ACTIVE YEAR	MODEL YEAR
1982	1982

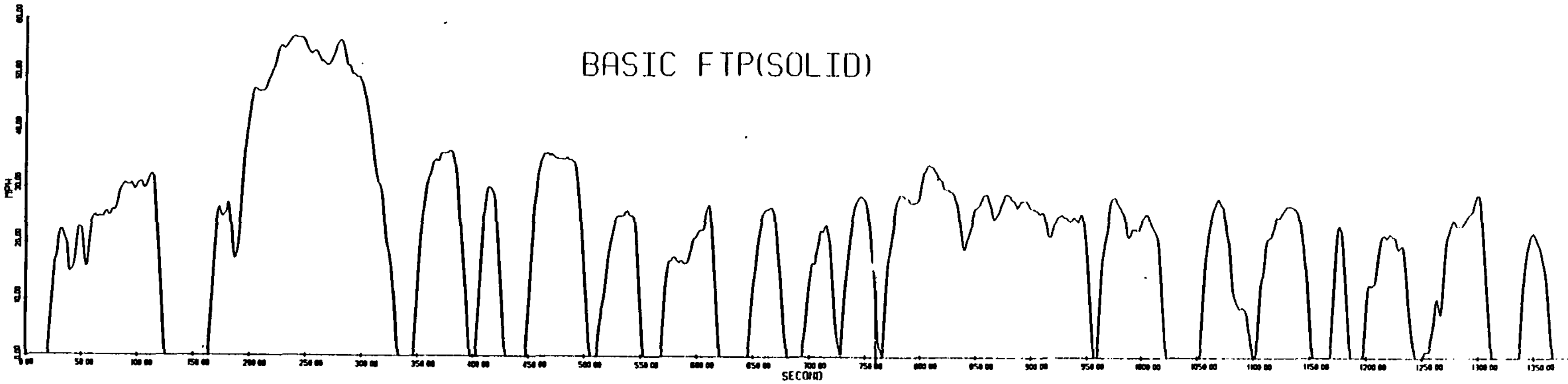
*-ENG FAM:CCR5.2V4HAL1 EVAP FAM:CCRKE ENG CODE:A-1 ETW: 4250 DYNO H.P.:12.0 TRANS:L3 O/D:1 AXLE:2.94 N/V: 38.0

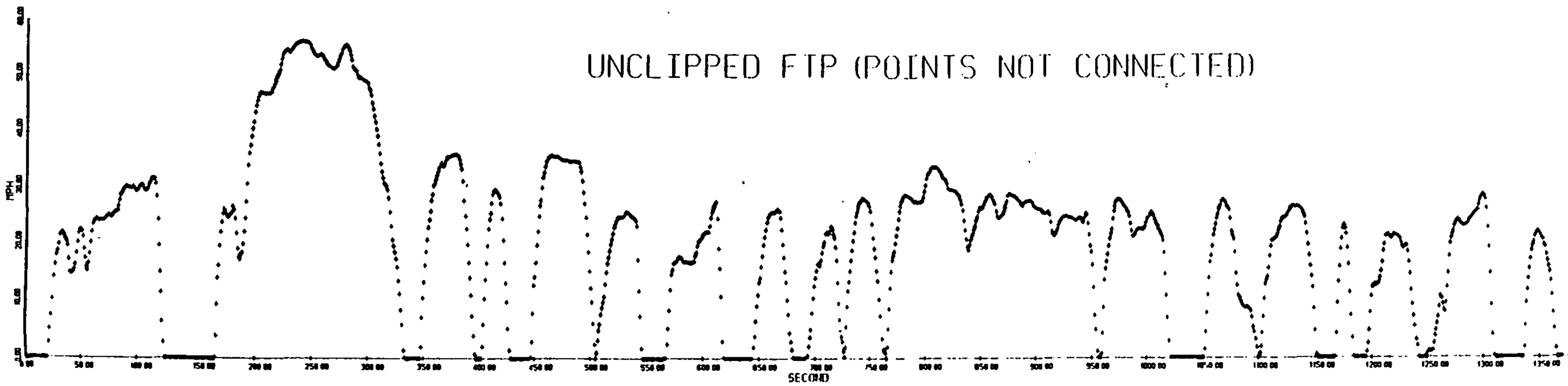
DATE	TEST #	TEST CYCLE	ODOM MILES	SYST MILES	IDLE RPM	AMB TEMP	EMISSION RESULTS HC	CO	CO2	NOX	EVAP	FUEL ECON	COMMENTS
4- 2-81	26058	FTP	3864	3787	660	75.	.182	1.92	660.	.42	1.17	13.4	STANDARD TEST FUEL
4- 2-81	26059	HFET	3876	3798		71.	.035	.42	446.	.37	.	19.8	STANDARD TEST FUEL
4- 6-81	26200	FTP	3910	3832	650	75.	.163	1.99	664.	.44	.	13.3	LOW OCTANE FUEL
4- 6-81	26201	HFET	3921	3843		74.	.042	.61	470.	.37	.	18.8	LOW OCTANE FUEL

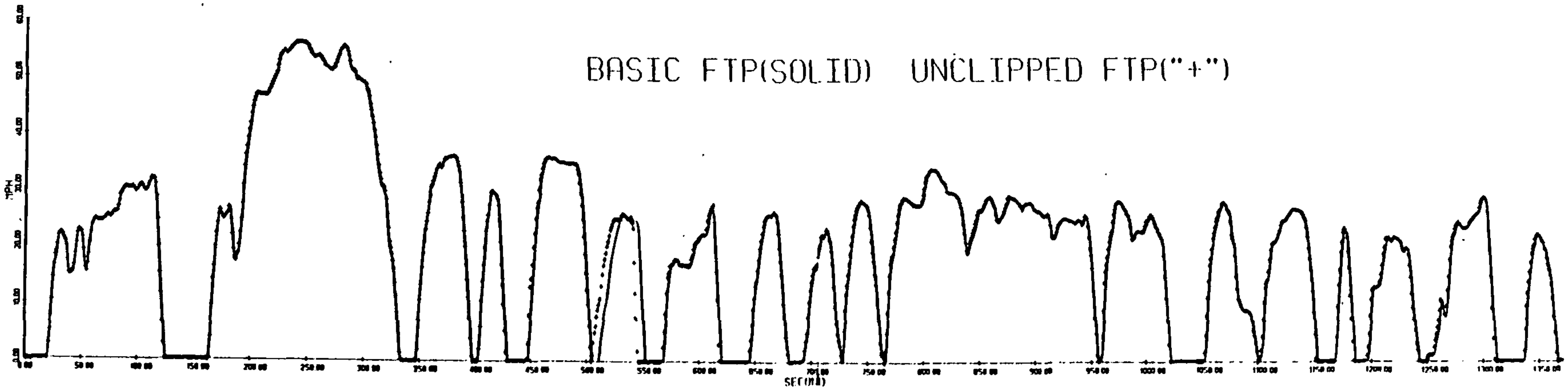
APPENDIX D

Comparison between Unclipped LA-4* and Bags 1 and 2 of the FTP

* A description (speed versus time) of the unclipped LA-4 was published in the Federal Register of July 15, 1970 (35 FR 11357).


BASIC FTP(SOLID)
MPH
SECOND


UNCLIPPED FTP (POINTS NOT CONNECTED)
MPH
SECOND


BASIC FTP(SOLID) UNCLIPPED FTP("+")
MPH
SECOND