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THE ADOT ALTERNATIVE FUELS STUDY

October 1, 1989

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EXECUTIVE SUMMARY

The Arizona State Legislature in 1987 passed several comprehensive clean air bills. Two of these bills, House Bill 2115 and Senate Bill 1360, mandated that the Arizona Department of Transportation conduct a pilot program on portions of the ADOT fleet. The purpose of this program was to determine the cost of maintaining a vehicle operating on clean-burning fuel, the effect on the miles per gallon of these vehicles, the availability of clean-burning fuels, and the impact of these fuels on motor vehicles emissions. This program was extended for a second year under H.B. 2206, (1988).

The department selected ninety vehicles for the pilot program. Three maintenance camp fueling facilities in Phoenix and one in Tucson were converted to dispense an ethanol blend, a methanol blend, and an MTBE blend. In addition, other selected vehicles were converted to compressed natural gas and propane. Contracts were made with appropriate vendors for a supply of fuel.

In the test period detailed records were kept regarding each of the selected fuel types. Based on this test several findings were determined.

There were no reported cases of vehicle failure, no cases of plugged fuel filters, and no fuel hose deterioration documented as a result of using any of the test fuels. One exception was the methanol blend when the fuel quality deteriorated due to lengthy storage. There was no indication in the mileage comparisons that any particular fuel had a significant advantage throughout the entire range of vehicles. No conclusions as to fuel efficiency were evident from the data collected.

There were no increased maintenance costs directly related to the use of alternative fuels. While there was no significant difference found in tailpipe emissions for the various fuel types, except for CNG, and except for an overall increase in emissions of oxides of nitrogen, it should be noted that statistical significance is influenced by a number of variables. In this pilot project, these variables include vehicle type, vehicle use, maintenance practices, fuel type, ambient temperature conditions, and unique vehicle operating characteristics. Given the presence of this range of variables, the lack of statistical significance is not considered unusual in a test of this complexity.

The differences in results obtained in the ADOT Field Test and the DEQ Laboratory Tests presented in Appendix III are not unusual and in, fact should be expected. The DEQ testing procedure was designed to detect changes in emissions during vehicle operating cycles which could not be examined in the testing procedures used by ADOT. These more sophisticated procedures became available to state researchers only after the DEQ laboratory facilities were completed in February, 1989, and almost 1 1/2 years after the field test was started.

ADOT ALTERNATIVE FUELS STUDY

1. INTRODUCTION

In 1987, during the first regular session of the 38th legislature, several bills were passed pertaining to the broad subject of clean air. Additional legislation requiring continued ADOT involvement in the fleet and emissions testing of clean-burning fuel was passed in the second session of the 38th legislature.

HOUSE BILL 2115

One of these bills, House Bill 2115, mandated that the Arizona Department of Transportation undertake a pilot program to test certain clean-burning fuels in part of ADOT's fleet. A.R.S. 41-2083.D., Sec. 3 was added and reads as follows:

Sec. 3. <u>Department of transportation pilot project on clean-burning fuels; report; definition</u>
A. The department of transportation shall conduct a pilot project to determine the cost and effect of using clean-burning fuels in motor vehicles. The department shall designate certain department of transportation motor vehicles which will be operated with clean-burning fuels and monitor the motor vehicles to determine, among other things:
1. The cost of maintaining a motor vehicle operated with clean-burning fuel.
2. The effect of the miles per gallon of a motor vehicle operated with clean-burning fuels.
3. The availability of clean-burning fuel.
4. The impact of clean-burning fuels on motor vehicle emissions.
B. The department shall submit a report of its findings to the president of the senate and the speaker of the house of representatives on or before October 1, 1988. The report shall include a recommendation on the feasibility of using clean-burning fuels in public or private motor vehicles on a local or stateside basis.
C. For the purpose of this section, "clean-burning fuels" includes compressed natural gas, liquid propane gas or a blend of gasoline and ethyl alcohol or methyl alcohol.

SENATE BILL 1360

A companion bill to H.B. 2115 was the comprehensive Clean Air legislation contained S.B. 1360. Among other things, the bill mandated that the Department of Transportation carry out certain driveability studies. Section 32 states, in part that:

The state...shall conduct a study of ten percent of their non-diesel...vehicle fleets operating in non-attainment areas...to determine how these vehicles perform in respect to driveability, using clean-burning fuels... Vehicles chosen shall be representative of the entire respective fleet.

Each Study shall be conducted for a one-year period beginning October 1, 1987. The department shall submit a report of the findings to the president of the senate and the speaker of the house of representatives on or before November 1, 1988.

HOUSE BILL 2206

This legislation, which became effective in June of 1988, required the Department of Transportation to conduct a pilot project and fleet study on the use of oxygenated and other clean-burning fuels. This bill states, in part, that:

A. The department of transportation shall conduct a project to determine the cost and effect of using oxygenated fuels, compressed natural gas and liquified propane gas in motor vehicles. The department shall designate certain department of transportation motor vehicles to determine, among other things:
1. The cost of maintaining a motor vehicle operated with such fuels.
2. The effect on the miles per gallon of a motor vehicle operated with such fuels.
3. The availability of such fuels.
4. The impact of such fuels on motor vehicle emissions.
B. In conducting the project prescribed by sub section A of this section the department shall test compressed natural gas, liquified propane gas, blends of gasoline with methanol, blends of gasoline with ethanol and blends of gasoline with methyl tertiary butyl ether in order to evaluate the impact of such fuels on motor vehicle emissions. The department shall select the number and type of vehicles tested pursuant to this section in such a manner as to produce scientifically and statistically valid results. Fuels used shall be analyzed with respect to all properties specified in section 41-2083. The department of environmental quality pursuant to section 49-553 shall conduct the emissions testing required by this section.
C. The department shall coordinate all testing done under section 49-405 to ensure that information is gathered and reported on a uniform and scientifically sound basis. The department shall adopt rules to govern the testing in accordance with the standards set forth in this section.
D. The department shall gather and report information showing the amounts and types of oxygenated fuels which are being sold or used within this state and shall report the information as provided in subsection F of this section.
E. The department may hire consultants in order to design, execute and coordinate the tests required by subsections B and C of this section.
F. The department shall submit reports of its studies and findings under this section and the information reported pursuant to sections 49-405 and 49-406 to the president of the senate, the speaker of the house of representatives and the air quality compliance advisory committee established pursuant to section 49-403 on or before October 1, 1988 and on or before October 1 of each year thereafter. The department shall report the information required by subsection D of this section to the president of the senate, the speaker of the house of representatives and the air quality compliance advisory committee established pursuant to section 49-403 each month commencing at the end of the third month after the month in which this section becomes effective.

The remainder of this report contains information relating to the design of the pilot program, implementation of the program, and the results derived from the tests. Also included are results of the driveability study.

II. PROGRAM DESIGN

The design of the pilot program was established through a series of meetings within various sections of ADOT, with legislators and other interested parties in the private sector. Assistance in the development of the program was also obtained through a contract with a statistical consultant. The program was designed in order to minimize the effect on ADOT's normal operations and still provide appropriate data on mileage, maintenance costs, driveability and exhaust emissions.

PILOT STUDY

The following seven points sequentially describe the procedures used in ADOT's program of vehicle testing:

1. The following five types of alternative fuels were selected for the pilot program:

    * Ethanol Blend
    * Methanol Blend
    * Methyl Tertiary Butyl Ether Blend (MTBE)
    * Compressed Natural Gas (CNG)
    * Propane (LPG)

2. Test vehicles were selected so that identical groups (vehicle make, model and year) could be assigned to each of the five test fuels. Six different groups of vehicles were selected, and three different vehicles of each model were assigned to each fuel. There were 90 test vehicles with 18 vehicles tested on each of the five fuels. (The results of this selection process are shown in Table I.)

3. Three liquid-type fueling stations at ADOT maintenance yards in the metropolitan Phoenix are were selected for dispensing the three liquid alternate fuel blends. Contracts were negotiated with suppliers of propane and compressed natural gas to provide these fuels, because facilities for storing and dispensing the fuels did not exist at ADOT's facilities.

4. Each group of 18 vehicles was assigned to a fueling site and to a type of fuel.

5. Each vehicle used in the test was tuned to factory specifications and operated in normal service for a three-month period. This was done, using unleaded fuel, to establish comparative baseline data on mileage, emissions and driveability. Monthly emission tests and daily log sheets completed by the vehicles' operators were the primary data sources.

TABLE I

Vehicle Type[1]	Fuel Type[1] Type I	Type II	Type III	Type IV	Type V
Type A	B726 B729 B759	B719 B721 B735	B724 B741 B747	B727 B745 B750	B738 B746 B749
Type B	B773 B808 B817	B793 B826 B833	B792 B794 B796	B768 B827 B835	B823 B831 B832
Type C	A445 A446 A448	A362 A431 A458	A434 A439 A442	A361 A364 A450	A427 A432 A439
Type D	BC56 B938 B943	BC32 BB70 B888	BC40 BC41 BC65	BB73 BB75 BB85	BC51 B934 B906
Type E	B432 B487 B641	B533 B551 B625	B446 B462 B543	B515 B516 B517	B504 B530 B549
Type F	BC06 BD82 BD09	BD55 BD70 BD39	BD12 BD57 BD08	BD51 BD52 BD61	BD64 BD66 BD74
Type G	Vehicle ID#'s B328, B347, B353, B416, B418 to fuel at different alternate fuel pump each time.				

[1] Appendix IV

VEHICLE IDENTIFICATION NUMBERS BY FUEL TYPE

6. After the three-month baseline period, the three ADOT fueling sites were converted to clean-burning fuel. Eighteen vehicles were converted to propane, and eighteen vehicles were converted to compressed natural gas.

7. The data on emissions, fuel use, driveability, and maintenance were entered into a computer data base for use in analysis at the end of the study period.

The matrix design of the experiment was such that vehicles could be omitted without impacting the validity of the experiment. Ideally, the data for each cell in the matrix would be available to aid in statistical analysis. However, it was recognized that with 90 operators, an emissions testing lab over which the department had no control, and a number of data entry people, human errors undoubtedly would occur.

The experiment was designed to take advantage of ADOT's fueling facilities and work locations throughout the Phoenix metropolitan area. It should be clearly understood that the experiment was a field test and differs greatly from laboratory experiments within a totally controlled environment. In order to prevent misinterpretations of the study's design or conclusions, it is appropriate to review some things this experiment was not designed to accomplish.

First, the experiment used only vehicles available within the existing ADOT fleet. Therefore, the vehicles are 1980 or newer, of American make, and are maintained under a fleet maintenance program. This group of vehicles should not be viewed as representative of the general fleet of privately-owned vehicles in Arizona.

Second, the ADOT vehicles were used as they normally are in ADOT's everyday work environment. This environment is not the same as that for vehicles used in commuter traffic or in other uses commonly associated with private vehicles in the metropolitan area.

Third, no effort was made to duplicate maintenance practices which might commonly occur to privately-owned vehicles.

Fourth, the experiment was designed primarily as a field test. Laboratory emissions test were performed on a select group of the test vehicles as a means to verify the field observations. Overall, the results of this study should not be interpreted as other than a field evaluation.

DRIVEABILITY STUDY

The expanded driveability study basically utilized the same daily log information produced in the more controlled test of the pilot study. In addition, information was obtained from all vehicles using one of the three fueling stations dispensing clean-burning fuel. To obtain an even wider utilization, part of the fueling facility located at the Grant Road maintenance camp in Tucson was converted to clean-burning fuel, and data was collected from all vehicles utilizing this facility.

Fuel usage by this large and diverse group was consistent with expectations of such a field test. Occasionally, operators would use conventional fuel; and conversely, state vehicles from other localities occasionally would be filled with test fuel. This added a dimension to the program which was not designed but which has not been discouraged.

The vehicles were operated during the three-month baseline period on gasoline, and the drivers completed daily log sheets throughout the period. Without this baseline period, no valid comparisons of the vehicles' performance could be made.

III. IMPLEMENTATION

After completion and acceptance of the program's design, work started on the identification of vehicles and fueling sites. In order to minimize the impact on the normal use of vehicles, fueling sites were identified first. Three sites were selected in the Phoenix metropolitan area: Durango, West Georgia and Recker Road. In addition, the Grant Road maintenance yard was selected in Tucson.

Existing vehicle usage was next analyzed, and vehicles were identified which would use the respective fueling sites throughout the study period. Those vehicles which would be converted to either propane or compressed natural gas were also identified. These vehicles were given a status code identifier to allow their activity to be traced through the computer system located within the ADOT Equipment Section. All fueling, maintenance and mileage data were traced both through the daily log sheets completed by the drivers and through the Equipment Section's computer records.

When the fueling sites were identified, the baseline testing procedure began. Daily driver's logs were designed and printed, arrangements were made for emissions testing with Hamilton Test facility on 7th Street, and meetings were held at various ADOT locations to familiarize drivers and supervisors with the testing program and to solicit their cooperation.

All 90 of the pilot study's vehicles were tuned to factory specifications for the purpose of gathering baseline data on unleaded gasoline. While this process was ongoing, preparations continued for the testing of the clean-burning fuels. Each of the fueling facilities were analyzed to determine the compatibility of the tanks and dispensing equipment with oxygenated Necessary fuels. Repairs or alterations were made and by mid-December each fueling facility was ready to handle the test fuels.

Next, bid sheets were prepared by ADOT Purchasing to acquire the gasoline blends and arrangements were made to purchase propane on an as-needed basis from several suppliers. A contract was negotiated with Southwest Gas to obtain the needed compressed natural gas.

The bid process for the gasoline blends proved somewhat disappointing when only three firms responded with offers to sell the ethanol blend, two responded to furnish the MTBE blend and no one responded regarding methanol. Because the first bid call specified an oxinol blend for methanol, it was decided to try a second time with specifications for any blend meeting the EPA waiver. Again, no response was received for the methanol blend.

Contracts for delivery of the ethanol and MTBE blends were negotiated while members of the Purchasing Department, the Equipment Section, and the Arizona Transportation Research Center contacted various suppliers and producers of both methanol and blended fuels with methanol. A supply of methanol-blended fuel finally was located in Texas, and arrangements for purchase were conducted. Due to transportation costs, this fuel was relatively expensive to acquire.

Throughout this same period bidding and contracting was undertaken for the conversion of vehicles to propane and compressed natural gas. Vehicle conversion began in mid-December 1987, and all 36 vehicles had been converted by January 22, 1988.

Delivery of the oxygenated fuel began January 8, 1988, with the receipt of the ethanol shipment. The MTBE blends arrived January 17 and 18. Due to the difficulty in obtaining gasoline blends with methanol, delivery was not made on this fuel type until January 26, 1988. Because of the variance in delivery schedules, it was decided that emissions data for the month of January would not be used in the final analysis.

Using emission test data starting in February ensured that no unusual or "cross-fueled" data was used. Overall accuracy of the results were improved, therefore, through the elimination of possible incorrect data caused by unforeseen confusion during the transition period between baseline and oxygenated fuel.

The use of the test fuels continued through August of 1989 with monthly emissions tests being performed throughout the period. Additionally, beginning in February of 1989, the Arizona Department of Environmental Quality tested a representative group of vehicles in their newly commissioned emissions testing laboratory. These tests were more extensive and much better controlled than the field tests and were undertaken for comparative purposes.

IV. RESULTS

Based on the data collected in the pilot program, results were determined on driveability, mileage, emissions and cost of operating the test vehicles.

DRIVEABILITY

Data concerning vehicle performance was obtained from daily log sheets completed by drivers. These entries described the frequency and severity of each of nine symptoms commonly associated with fuel-related performance.

These nine symptoms are listed, and a summary of their occurrence is presented for both baseline and test fuel operation in Appendix 1. Note that even on the baseline unleaded fuel, some vehicles consistently report problems, although drivers did not think the severity of the condition warranted sending the vehicle to the shop for repair. This occurred with some degree of regularity among a fleet of vehicles where no financial liability accrued to the driver if the vehicle was sent to the shop for repair. How often vehicles in the privately-owned fleet might be operated with known performance deficiencies is a matter of conjecture, but due to the financial burden of repair, it is expected that such occurrences would be more frequent and of longer duration than was the case in the ADOT fleet. This hypothesis is supported by looking at the inconvenience associated with vehicle repair in terms of lost work time, travel distance and the uncertainty of vehicle availability as a result of repairs.

During the baseline test period, various performance anomalies were noted for each vehicle being observed for driveability characteristics. These were then compared to any reported problems experienced during operation on clean-burning fuel.

A major finding of the field study was that there were no reported cases of total vehicle failure, no cases of plugged fuel filters, and no hose or elastomer deterioration documented as a result of using any of the test fuels during the period from January 1988 through September 1989.

The driveability records received for the test vehicles have been summarized by fuel type and vehicle category. This summary is presented in Appendix 1.

In addition to the pilot study's test vehicles, beginning in January 1988 other vehicles operated in the Phoenix area and an additional group in Tucson operated on clean-burning fuels. Vehicles from the Phoenix facility used the same fuel blend that was available in the Tucson facility, and for simplicity of reporting all data is presented together. Ninety-eight supplementary vehicles regularly submitted driveability logs.

MILEAGE

During the operation of the pilot study test program, approximately 189,000 miles were driven on gasoline for baseline mileage, and an additional 742,000 miles were driven on the various test fuels. The results of the computation of miles per gallon for each vehicle type and for each fuel are illustrated in Table II.

There is no indication in the mileage comparisons that any particular fuel had a significant advantage over the entire range of vehicles. The vehicles reported in this study are operated as part of the ADOT fleet, and any differences in mileage may be attributed to the manner in which they were operated during the course of the two year observation period. Therefore, the observed reduction in fuel economy on the alternative fuels should be interpreted with caution.

EMISSIONS

Early in the emissions testing program, even while testing for baseline values, several observations were made by the investigating team. First, successive emissions test on the same vehicle often gave carbon monoxide or hydrocarbon concentrations which were different from previous readings on the same automobile. While this is not necessarily an unusual situation, it creates the potential for wide variance and therefore requires a much larger sample size for any statistical reliability.

Because the fleet of vehicles used in this study is involved in a major, ongoing construction program, there were instances when the operators were unable to bring the vehicles to the testing facility. Thus, over the two year duration of the study, it was fairly certain that all ninety vehicles would not complete the program and that others would be missing observations. Seventy-nine of the 90 test vehicles completed enough testing sequences to be used statistically. several others had partial data but had sufficient observations to be helpful. This created some problems for statistical comparison, because equal observations were not available for all vehicles.

Only one testing device for nitrogen oxides was available for use. This created a condition of vulnerability; and several times during the testing sequence, the equipment failed and was out of service. This added to the problem of incomplete data and unequal cell size for the statistical analysis.

Analysis of the emission data was an extremely complex undertaking due to the lack of equal cell sizes and the large variance in the data. An attempt was made to reduce the statistical variance by removing data which represented unusually large or small recorded observations. This effort resulted in a possible bias in the data because there were more unusually large observations to be removed. Also, automobiles may occasionally operate in a high pollution mode, and to remove those observations may well generate false reliability in the data and seriously

Table II

Vehicle Type[1]	Type I	Type II	Type III	Type IV	Type V
	Fuel Type [1]				
Type A					
Baseline	16	14	16	16	17
ALT Fuel	15	13	15	13	11
Type B					
Baseline	16	18	16	13	16
ALT Fuel	15	18	16	11	13
Type C					
Baseline	21	22	17	21	20
ALT Fuel	19	21	16	14	15
Type D					
Baseline	16	14	18	12	12
ALT Fuel	15	14	18	14	11
Type E					
Baseline	11	11	10	07	09
ALT Fuel	11	10	10	06	10
Type F					
Baseline	15	14	19	16	16
ALT Fuel	15	15	19	14	11

[1] Appendix IV

MILEAGE COMPARISONS

understate automotive pollution levels when those vehicles operated under everyday driving conditions.
Since the performance of alternative fuels in terms of emissions can only be evaluated in this study by analyzing the data gathered, it is important to note several factors which seem to create wide variation in the recorded emissions data and which make arriving at a definitive conclusion very difficult.

First, repetitive tests on the same vehicle are often radically different. This source of variation seems to come from the inherent operating characteristics of vehicles themselves.

Secondly, groups of vehicles composed of an identical mix of vehicles often exhibited significantly different test results.

Thirdly, vehicle type had a significant impact on emissions. This might be expected but since these 1980 and newer vehicles supposedly meet EPA specifications for emissions, a smaller difference between vehicle type would seem logical.

Fourthly, there was an observed seasonal variation in tailpipe emissions with the highest levels occurring during winter and mid-summer months.

In general, and as previously mentioned, definitive conclusions were difficult to formulate. However, among the alternative fuels tested, CNG performed well throughout (with the exception of oxides of nitrogen) and that performance may have been partly due to the rather high level of observed emissions during the baseline testing period.

All fuels exhibited an increase in nitrogen oxides and it appears that a marginal reduction in carbon monoxide at idle is present in the comparison of average data presented in the statisticians report attached as Appendix II. This report contains a full analysis of the emissions performance of the five fuels over the entire testing period.

In addition, the Department of Environmental Quality processed a subset of the ADOT test vehicles through their newly acquired emissions laboratory. Their report is attached as Appendix III and supports reductions in carbon monoxide based on average data. The data in their report also exhibits high variation in some cases and makes the application of statistical methods rather difficult. Their conclusions are therefore based on averaged data.

The basic distinction between the ADOT and DEQ tests stems from a difference in the time and condition under which the emission samples were gathered. The ADOT procedure basically sampled exhaust emissions under steady state idle and steady state cruise conditions. This procedure was utilized because no testing facilities were available in the Phoenix area which had the capability of performing more elaborate tests at the time the study began in October of 1987.

With the completion of the DEQ lab in 1989, the capability existed to do a limited number of tests over a simulated driving cycle. Accordingly, these simulations covered the entire range of driving conditions including cold starts, acceleration, cruise, deceleration and idle.

COST

During the entire course of the Alternate Fuel Study, every repair relating to fuel systems of the test vehicles was identified in the Equipment Section's computer system. These items have been extracted and are attached to the report as Appendix IV.

The pilot study did not identify any increased maintenance cost directly related to the use of alternative fuels. The one-time conversion costs of the vehicles to compressed natural gas and propane were not considered maintenance and the costs associated with the use of the deteriorated methanol blend, as noted below, were omitted.

Replacement of fuel-related items such as fuel pumps and filters frequently occur as routine maintenance on high-mileage vehicles when a reduced fuel flow is noted in the shop testing procedure. Such a condition in a vehicle with 60,000 to 80,000 miles is not unusual; and in those instances where it did occur, department mechanics could not determine that the cause was related to the type of fuel used.

One problem did surface with regard to the storage characteristics of the methanol blend tested in the pilot project. This fuel, when stored underground in a partially filled tank for a four month period exhibited a loss of vapor pressure and an increased residual gum content. Subsequent use of this fuel in some ADOT vehicles caused operational problems and gummed fuel injectors as indicated in the Appendix IV mechanics reports. Therefore use of this fuel blend where long term storage is likely should not be recommended.

Because of ADOT's favorable experience with the five clean-burning fuels from both a driveability and maintenance perspective, ADOT converted the remainder of its fleet in the non attainment areas to oxygenated fuels early in 1989. No problems have been experienced as a result of this conversion.

Appendix I.

Summary of Problems for Controlled Test Vehicles

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 1 & VEHICLE CATEGORY 1)

ETHANOL 1983 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1			2		45	1	35	9	7		2					
2			1		38		34	8	6		1			5		
3			4		11		1	9								
4							7	9								
5					7		34	9	7	1			5			
6			6		14		13	2	2							
7			2		7		1	2								
8																
9																
TOTAL	0	0	15	0	122	1	125	48	22	1	3	0	5	5	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting....................	[ ]	[ ]
3) Stalls in traffic.........................	[ ]	[ ]
4) Vapor lock................................ (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness............................	[ ]	[ ]
6) Hesitation, bucking or coughing..........	[ ]	[ ]
7) Lack of power.............................	[ ]	[ ]
8) Pinging...................................	[ ]	[ ]
9) Dieseling.................................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 1 & VEHICLE CATEGORY 2)
Ethanol 1984 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	1	1														
2	1		2	1												
3	2	1		5												
4																
5	2	4		5												
6	1															
7	1	1														
8	1															
9																
TOTAL	9	7	2	11	0	0	0	0	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing.........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 1 & VEHICLE CATEGORY 3)

ETHANOL 1985 Celebrity

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1																
2												1	1			
3			4		4	1				1	3		1			
4																
5	1															
6										1						
7			1		2								1			
8																
9																
TOTAL	1	0	5	0	6	1	0	0	0	2	3	1	3	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 1 & VEHICLE CATEGORY 4)

ETHANOL 1985 Ranger

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1								4								
2					1			4								
3																
4	10													1		
5													1			
6																
7	2															
8																
9																
TOTAL	12	0	0	0	1	0	0	8	0	0	0	0	1	1	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 1 & VEHICLE CATEGORY 5)

ETHANOL 1980 C-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1																
2			3													
3																
4																
5			5													
6	2		1													
7																
8																
9																
TOTAL	2	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting....................	[ ]	[ ]
3) Stalls in traffic.........................	[ ]	[ ]
4) Vapor lock................................ (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness............................	[ ]	[ ]
6) Hesitation, bucking or coughing..........	[ ]	[ ]
7) Lack of power.............................	[ ]	[ ]
8) Pinging...................................	[ ]	[ ]
9) Dieseling.................................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 1 & VEHICLE CATEGORY 6)

ETHANOL 1986 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1			24	2	32		21									
2																
3																
4																
5																
6																
7																
8																
9																
TOTAL	0	0	24	2	32	0	21	0	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 2 & VEHICLE CATEGORY 1)

METHANOL 1983 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	11	11					5		1	1	1	2	1		15	
2		10	1									1			14	
3										11	1	1			14	
4															5	
5	12		2				43	1	11	1	7	2			5	
6	3						1		3		6		1			
7	6		1				7		4	1	7	2				
8																
9																
TOTAL	32	21	4	0	0	0	56	1	19	14	22	8	2	0	54	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting....................	[ ]	[ ]
3) Stalls in traffic.........................	[ ]	[ ]
4) Vapor lock................................ (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness............................	[ ]	[ ]
6) Hesitation, bucking or coughing..........	[ ]	[ ]
7) Lack of power.............................	[ ]	[ ]
8) Pinging...................................	[ ]	[ ]
9) Dieseling.................................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 2 & VEHICLE CATEGORY 2)

METHANOL 1984 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1											2					
2									1		3					
3											1					
4																
5									1		2	1	2			
6			8		44		55		25		23		5			
7							2									
8									2		2	1	2			
9									1							
TOTAL	0	0	8	0	44	0	57	0	30	0	33	2	9	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 2 & VEHICLE CATEGORY 3)

METHANOL 1985 CELEBRITY

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1					2		1		2		4	3		15		
2		1				2		1	30		3	4	1	21		
3	2	2			1			1						7		
4							1		1		1					
5																
6								1	9			3				
7									11			2				
8									1		4	1	1	14		
9														14		
TOTAL	2	3	0	0	3	2	2	3	54	0	12	13	2	71	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 2 & VEHICLE CATEGORY 4)
METHANOL 1985 RANGER

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	2															
2	2		1			1										
3	2		10		13	2	1			7						
4																
5	40	1	38		11		1		1	1						
6			38		10	2				2	1	1				
7						11										
8																
9																
TOTAL	46	1	87	0	34	16	2	0	1	10	1	1	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 2 & VEHICLE CATEGORY 5)
Methanol 1980 C-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1							3	3	1	4	1	1	5		13	8
2					2	1	5	1	6	2	15	15				
3					1	7	2	3	1	1	2		1			
4										1						
5					6		39	5	22	2	19	5				
6					16	4	42	7	3	1	9		1			
7	1		1		6	10	13	4	1							
8			1		4	7		6								
9																
TOTAL	1	0	2	0	35	29	104	29	34	11	46	21	7	0	13	8

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing.........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 2 & VEHICLE CATEGORY 6)

Methanol 1986 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	2		1		1			1	1		16		5			
2	2								1				1			
3													1			
4																
5																
6	1												1			
7																
8																
9																
TOTAL	5	0	1	0	1	0	0	1	2	0	16	0	8	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 3 & VEHICLE CATEGORY 1)

MTBE 1983 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1																
2																
3																
4																
5																
6																
7																
8																
9																
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 3 & VEHICLE CATEGORY 2)
MTBE 1984 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	4															
2	1						14	11			1					
3							3	1			1	1				
4	1						1									
5																
6			10								4					
7									1							
8																
9																
TOTAL	6	0	10	0	0	0	18	12	1	0	6	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 3 & VEHICLE CATEGORY 3)
MTBE 1985 Celebrity

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1																
2																
3																
4																
5																
6																
7																
8																
9																
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing..........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 3 & VEHICLE CATEGORY 4)

MTBE 1985 Ranger

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1																
2																
3																
4																
5					3		1									
6																
7					4											
8																
9																
TOTAL	0	0	0	0	7	0	1	0	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 3 & VEHICLE CATEGORY 5)

MTBE 1980 C-10

	4th QTR 87 M	4th QTR 87 S	1st QTR 88 M	1st QTR 88 S	2nd QTR 88 M	2nd QTR 88 S	3rd QTR 88 M	3rd QTR 88 S	4th QTR 88 M	4th QTR 88 S	1st QTR 89 M	1st QTR 89 S	2nd QTR 89 M	2nd QTR 89 S	3rd QTR 89 M	3rd QTR 89 S
1	6															
2																
3		1														
4																
5	1	6					32		9							
6		6	2	1			34		10	24		12				
7							1									
8			2				35		10	24		8				
9																
TOTAL	7	13	4	1	0	0	102	0	29	48	0	20	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 3 & VEHICLE CATEGORY 6)

MTBE 1986 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1		1							3		1					
2											1					
3																
4																
5	1								1		1					
6																
7									1		1					
8																
9																
TOTAL	1	1	0	0	0	0	0	0	5	0	4	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing.........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 4 & VEHICLE CATEGORY 1)

CNG 1983 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	21															
2	4							1								
3				1		2		2								
4	4															
5	1				4	1	1									
6	8			1												
7							1	1								
8																
9																
TOTAL	38	0	0	2	4	3	2	4	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing.........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 4 & VEHICLE CATEGORY 2)

CNG 1984 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	37															
2						1		1								
3						1		2								
4						2										
5								2								
6							1	2			1		3	2		
7					9	7		2			1		4	2		
8																
9																
TOTAL	37	0	0	0	9	11	1	9	0	0	2	0	7	4	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 4 & VEHICLE CATEGORY 3)

CNG 1985 Celebrity

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1															1	
2						1			1		7					
3										1						
4																
5																
6																
7									1						1	
8																
9																
TOTAL	0	0	0	0	0	1	0	0	2	1	7	0	0	0	2	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 4 & VEHICLE CATEGORY 4)

CNG 1985 Ranger

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1											1			3		
2			1		2											
3			1		2	2										
4			1													
5			1		8									8		
6			4		5									7		
7			4		6							1	1	9		
8																
9																
TOTAL	0	0	12	0	23	2	0	0	0	0	1	1	1	27	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 4 & VEHICLE CATEGORY 5)

CNG 1980 C-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	2		1	2												
2	5					1										
3	1			1						1						
4	5															
5								1								
6	2					1	1	1		1						
7	54		3	9		1	1	1	6	1						
8			3													
9																
TOTAL	69	0	7	12	0	3	2	3	6	3	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing.........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 4 & VEHICLE CATEGORY 6)

CNG 1986 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1			6	2									4			
2			11	1												
3			5	1												
4																
5			3	3												
6			2	2	1											
7			8	6	1											
8																
9																
TOTAL	0	0	35	15	2	0	0	0	0	0	0	0	4	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 5 & VEHICLE CATEGORY 1)

PROPANE 1983 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1			4		45		20									
2			4		46		20									
3					31		4	11								
4								1								
5			4		13	31	9		24							
6				4	14	39	2									
7							9		24							
8							2									
9																
TOTAL	0	0	12	4	149	70	66	12	48	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting....................	[ ]	[ ]
3) Stalls in traffic.........................	[ ]	[ ]
4) Vapor lock................................ (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness............................	[ ]	[ ]
6) Hesitation, bucking or coughing..........	[ ]	[ ]
7) Lack of power.............................	[ ]	[ ]
8) Pinging..................................	[ ]	[ ]
9) Dieseling................................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 5 & VEHICLE CATEGORY 2)

PROPANE 1984 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	4															
2			1													
3																
4	5															
5	1		10			1										
6	25		4													
7	3		4			1										
8			3			1										
9																
TOTAL	38	0	22	0	0	3	0	0	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 5 & VEHICLE CATEGORY 3)

PROPANE 1985 Celebrity

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1									6		16		2			
2			2	2	1											
3	2		5	2				3			2		1			
4											1			1		
5							3	15			1		1	1		3
6	1				1		2	15			8		1	7		3
7			3				7	17	3	2			3	4		3
8								12								
9																
TOTAL	3	0	10	4	2	0	12	62	9	2	28	0	8	13	0	9

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting....................	[ ]	[ ]
3) Stalls in traffic.........................	[ ]	[ ]
4) Vapor lock................................ (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness............................	[ ]	[ ]
6) Hesitation, bucking or coughing..........	[ ]	[ ]
7) Lack of power.............................	[ ]	[ ]
8) Pinging..................................	[ ]	[ ]
9) Dieseling................................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 5 & VEHICLE CATEGORY 4)

PROPANE 1985 Ranger

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1			3		1											
2																
3			2													
4																
5			1		4											
6																
7					1											
8																
9																
TOTAL	0	0	6	0	6	0	0	0	0	0	0	0	0	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine	[ ]	[ ]
2) Stalled after starting	[ ]	[ ]
3) Stalls in traffic	[ ]	[ ]
4) Vapor lock (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness	[ ]	[ ]
6) Hesitation, bucking or coughing	[ ]	[ ]
7) Lack of power	[ ]	[ ]
8) Pinging	[ ]	[ ]
9) Dieseling	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 5 & VEHICLE CATEGORY 5)

PROPANE 1980 C-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1			45			3										
2			49			4										
3			46			4							2			
4	2															
5			52			4										
6													2			
7																
8																
9																
TOTAL	2	0	192	0	0	15	0	0	0	0	0	0	4	0	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing..........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

(FUEL TYPE 5 & VEHICLE CATEGORY 6)

PROPANE 1986 S-10

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1																
2							5	1								1
3																1
4																
5	1															1
6	15				3											1
7		15			3											
8																
9																
TOTAL	16	15	0	0	6	0	5	1	0	0	0	0	0	0	0	4

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing.........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

TUCSON

SUMMARY OF PROBLEMS FOR CONTROLLED TEST VEHICLES

MTBE & 98 MIXED TYPE VEHICLES

	4th QTR 87		1st QTR 88		2nd QTR 88		3rd QTR 88		4th QTR 88		1st QTR 89		2nd QTR 89		3rd QTR 89	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
1	39	2	61	2	13	1	8	6	1		2	2				
2	7	1	12		2	2	3	4	1		1		1			
3	2	3	4	1	1		2				2			1		
4	16	1	1	1	44		13	1								
5	14	7	84	7	27	1	11	6	2		4		2	1		
6	25	15	73	14	63	16	43	26	26	1	4	3	10	2		
7	7		36	9	36	6	60	18	1	1	2	2	3	3		
8	3	1	1	4		1	1				1					
9			5	3		1					2		1			
TOTAL	113	30	272	41	186	28	141	61	31	2	18	7	17	7	0	0

Key:

	M Mildly Annoying	S Very Troublesome
1) Cranking required to start engine........	[ ]	[ ]
2) Stalled after starting..................	[ ]	[ ]
3) Stalls in traffic.......................	[ ]	[ ]
4) Vapor lock.............................. (stalls with difficult restart)	[ ]	[ ]
5) Idle roughness..........................	[ ]	[ ]
6) Hesitation, bucking or coughing.........	[ ]	[ ]
7) Lack of power...........................	[ ]	[ ]
8) Pinging.................................	[ ]	[ ]
9) Dieseling...............................	[ ]	[ ]

Appendix II.

Analysis of ADOT Emissions Study

STATISTICAL ANALYSIS OF ALTERNATE ENERGY FUELS

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November 1989

The initial database consisted of emissions test results for 90 vehicles. Data from two vehicles were eliminated due to identifiable mechanical defects. Vehicles were also eliminated from analysis if pretest measurements were absent. Mean emissions readings by individual vehicle identification number are presented in Appendix A.

Carbon Monoxide (CO)

Data from 79 vehicles were used in the carbon monoxide analysis. Analysis tables for CO are presented in Appendix B. Vehicles averaged 2.28 emissions tests using gasoline and 12.33 tests using alternate fuels. Due to a few missing data points, vehicles averaged 2.09 measurements of CO at load using gasoline and only 9.62 measurements using alternate fuels. It was discovered that the five fuel groups differed significantly on CO in the gasoline phase of the study (idle: $F(4,169) = 2.70$; load: $F(4,169) = 2.73$, both $p < .05$). This can partially be explained by different performance by the six vehicle types ($F(5,168) = 4.25$, $p = .001$ at idle; no significant effect for load), but is thought to be primarily due to the substantial variation individual vehicles are known to display in emissions testing. On the average, CO at idle increased from .17 to .20 and CO at load increased from .19 to .29. Neither of these measures was statistically significant, although the effects were marginal ($F(4,1116) = 2.26$, $p = .061$ for idle; $F(4,980) = 2.05$, $p = .085$ for load).

Each fuel type was then analyzed individually. The CO means for each fuel group are displayed in Table 1. As can be seen, only compressed natural gas showed a statistically significant change in CO. The decrease is apparent under both idle and load conditions. This effect, however, is probably due to the fact that the pretest averages for the CNG group are unusually high.

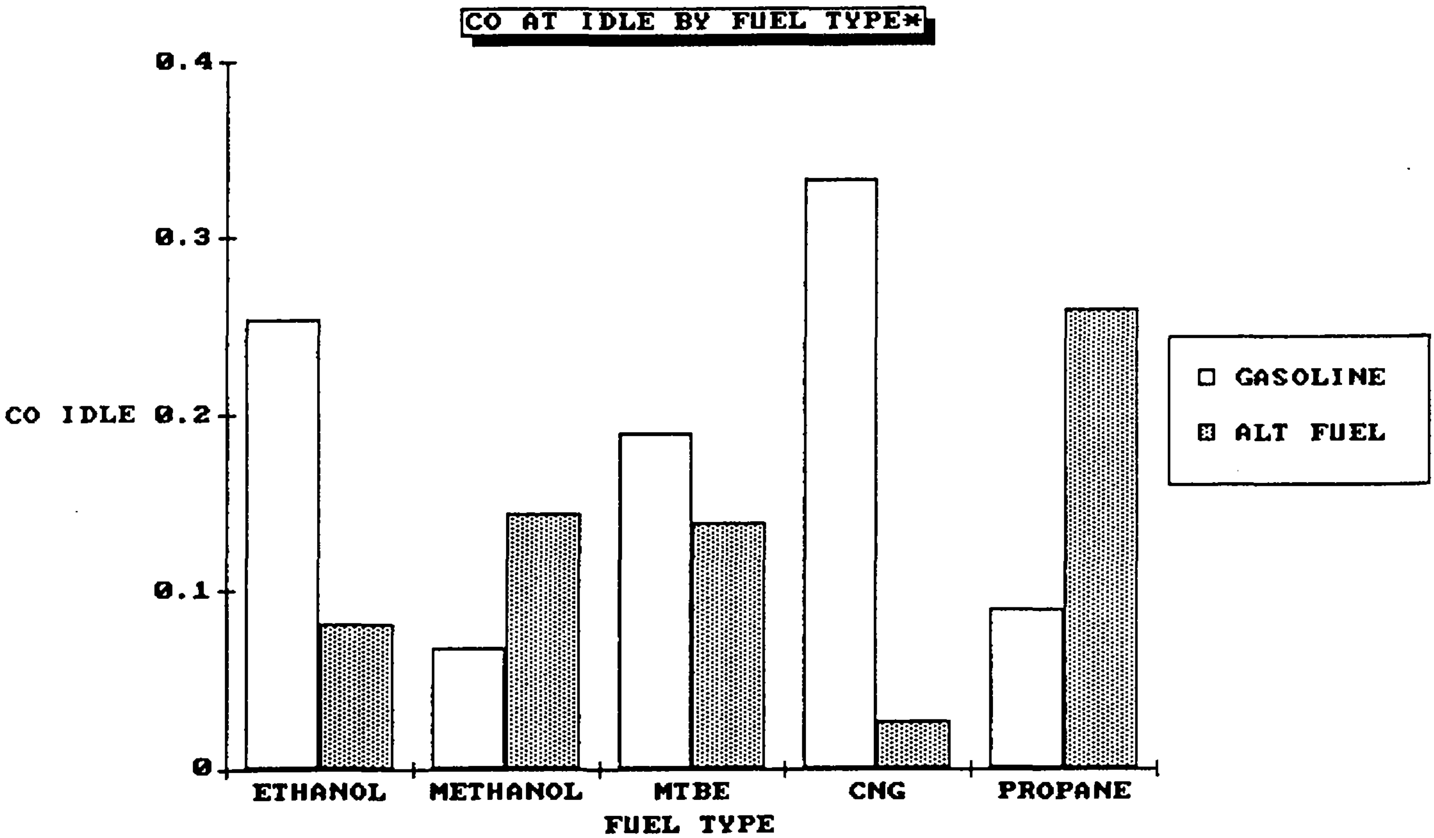
In order to minimize seasonal variation, an analysis was performed on data for the months of October through December only. Average CO emissions at idle and at load for each fuel type are depicted in Figures 1 and 2. Overall, a significant decrease in CO at idle was found, from .1668 to .1344 ($F(4,309) = 3.19$, $p < .05$). This effect is thought to be due to the significant variation in pretest measurements for the five fuel groups ($F(4,69) = 2.70$, $p < .05$). Results for CO at load reveal an average increase from .19 to .28, although this change is not statistically significant ($F(4,304) = 2.06$, $p = .09$).

Table 1. Mean carbon monoxide levels by fuel type.

Fuel Type	CO at Idle		CO at Load	
	Gasoline	Alt Fuel	Gasoline	Alt Fuel
Ethanol	.254	.140	.174	.419
Methanol	.068	.255	.095	.253
MTBE	.189	.181	.196	.442
CNG	.332	.125*	.579	.148**
Propane	.090	.281	.088	.123

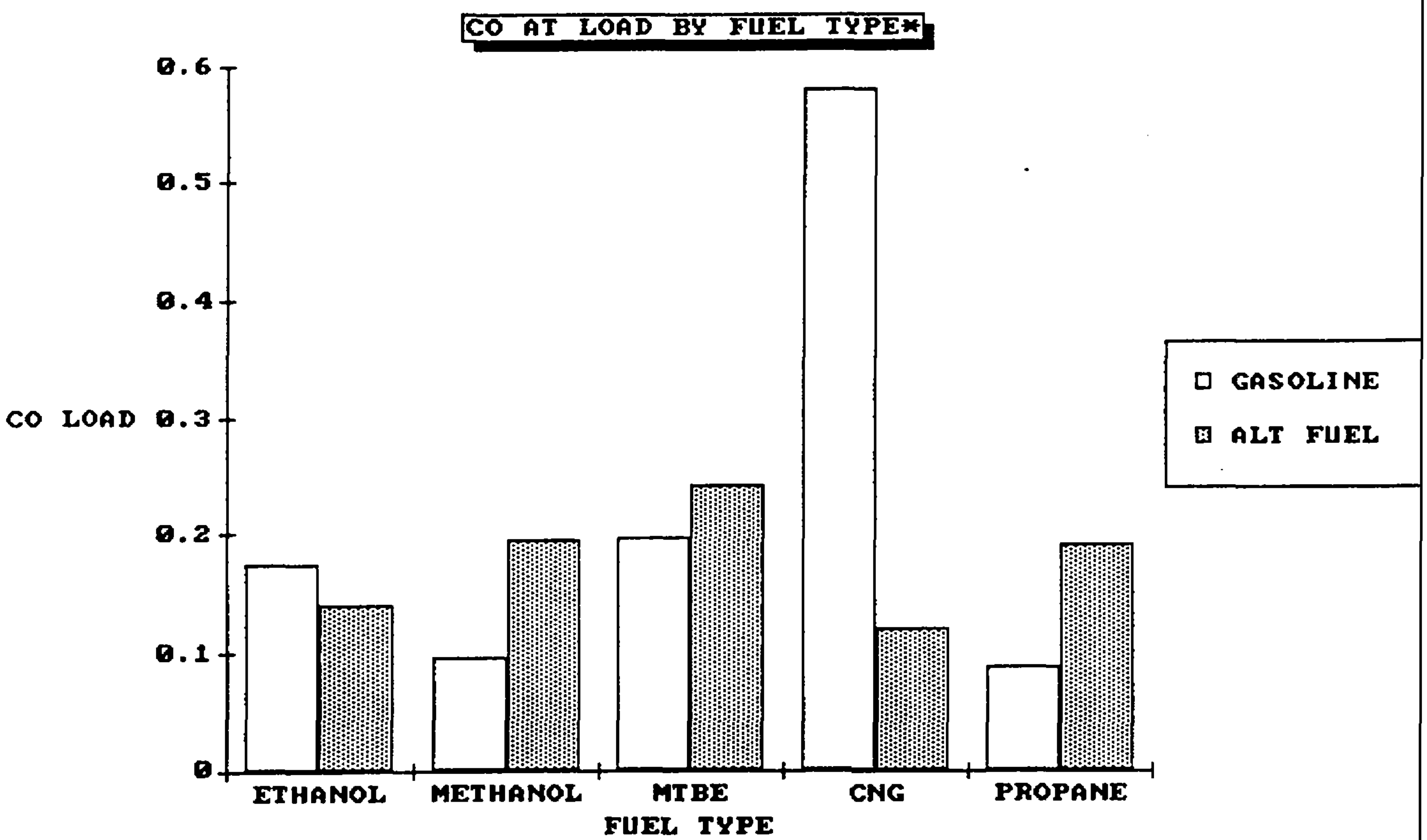
*$p < .05$ **$p < .01$

Figure 1



*October through December only

Figure 2



*October through December only

Hydrocarbons (HC)

Data from 79 vehicles were used in the hydrocarbon at idle analysis; these vehicles averaged 2.16 measurements using gasoline and 12.33 measurements using alternate fuels. Due to a substantial amount of missing data for hydrocarbons at load, only 11 vehicles were used in this analysis, averaging 1.36 tests on gasoline and 6 tests using alternate fuels. Statistical analysis tables for HC are presented in Appendix C. The five fuel groups did not differ significantly on either HC at idle ($F(4,169) < 1$, n.s.) or at load ($F(4,10) = 2.50$, n.s.) in the gasoline phase of the study.

With the use of alternate fuels, hydrocarbons at idle increased from an average of 45.69 to a mean of 65.01. This change is statistically significant, $F(4,1116) = 3.95$, $p < .01$. Hydrocarbons at load, however, decreased from an average of 141.53 to 73.23. This change is also significant ($F(4,71) = 5.71$, $p < .001$.

The HC means for each fuel group are displayed in Table 2. As can be seen, only propane showed a statistically significant increase in HC at idle. Compressed natural gas was the only fuel to show a significant reduction in HC under load conditions; this effect, however, is probably due to the large pretest average for the CNG group.

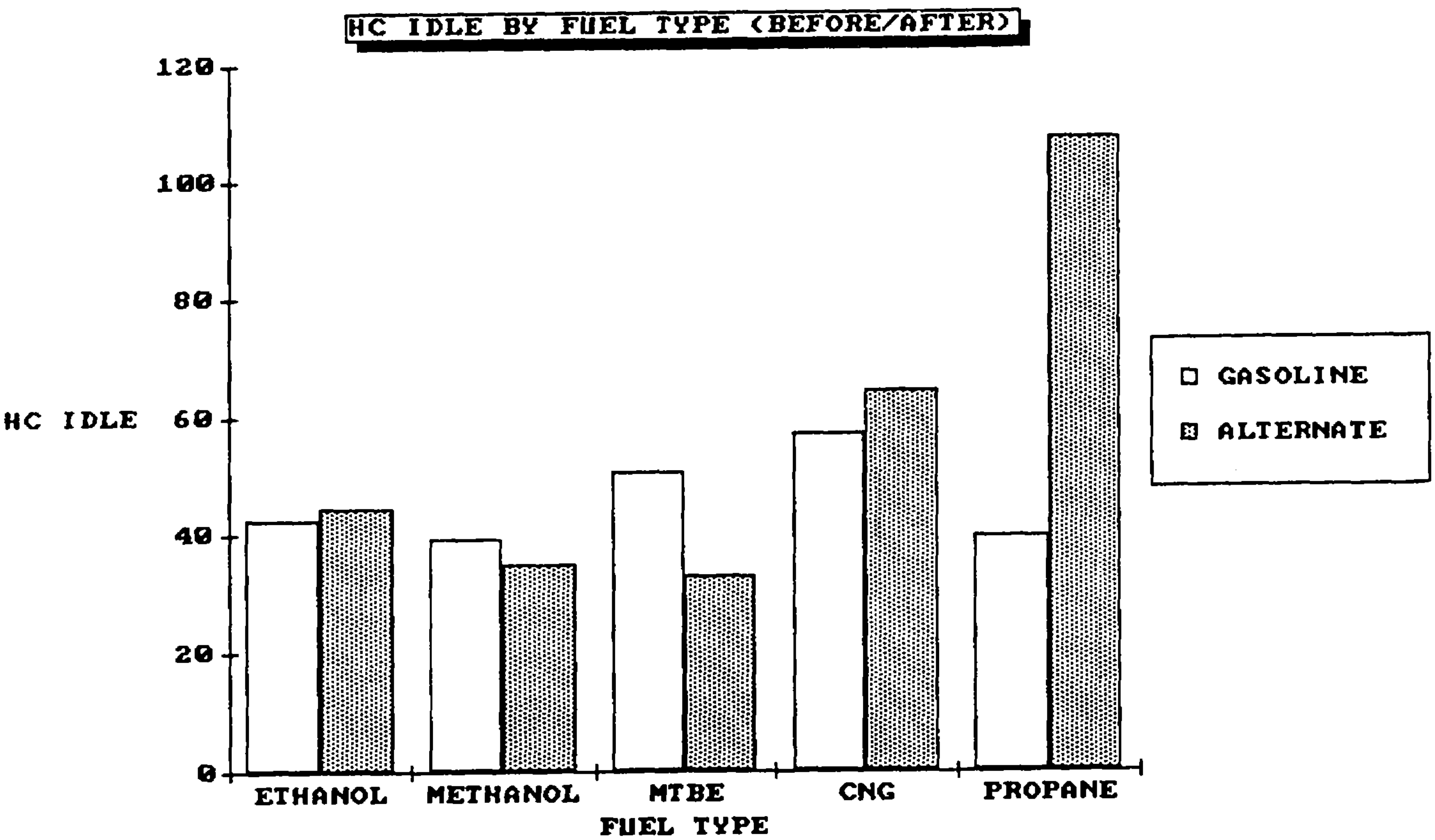
Analysis for the months of October through December revealed a significant difference for hydrocarbons at idle, $F(4,309) = 6.25$, $p < .001$. This difference represents an increase from 45.69 to 56.71. Results for hydrocarbons at idle by fuel type are depicted in Figure 3. A comparable analysis for HC at load could not be performed: due to an inadequate number of data points on this measure, the data matrix was incomplete.

Table 2. Mean hydrocarbon levels by fuel type.

Fuel Type	HC at Idle		HC at Load	
	Gasoline	Alt Fuel	Gasoline	Alt Fuel
Ethanol	42.448	40.359	98.333	60.471
Methanol	39.348	50.692	83.500	76.917
MTBE	50.485	40.427	100.500	79.571
CNG	57.074	69.589	266.250	73.083**
Propane	39.872	124.706*	97.000	81.000

*$p < .025$ **$p < .01$

Figure 3



*October through December only

Nitrogen Oxides (NOx)

Data from 78 vehicles were used in the nitrogen oxides analysis; these vehicles averaged 2.18 emissions tests using gasoline and 9.53 tests using alternate fuels. Statistical analysis tables for NOx are presented in Appendix D. The five fuel groups did not differ significantly from each other in the gasoline phase of the study ($\underline{F}(4,160) = 1.57$, n.s.).

With the use of alternate fuels, nitrogen oxides increased from an average of 328.40 to 419.45. This change is not statistically significant, $\underline{F}(4,879) = 1.59$, n.s.

The NOx means for each fuel group are displayed in Table 3. Only methanol showed a statistically significant increase in NOx ($\underline{F}(1,232) = 5.08$, $\underline{p} = .025$); however, a marginally significant increase was found for MTBE ($\underline{F}(1,153) = 3.31$, $\underline{p} = .071$).

Analysis on the months of October through December revealed a significant difference for nitrogen oxides, $\underline{F}(4,283) = 3.24$, $\underline{p} < .025$. The change represents an overall increase on this measure from 328.40 to 490.36. Results for nitrogen oxides by fuel type are depicted in Figure 4.

Summary

Some significant effects for fuel type were found in analysis. Specifically, a significant decrease in hydrocarbons at load and carbon monoxide under both idle and load conditions was observed for vehicles using compressed natural gas. This effect, however, is most likely due to the inflated emissions readings obtained from these vehicles during the gasoline phase of the study. In fact, vehicles operating on CNG did not differ significantly from vehicles using other fuels in emissions of CO at idle or HC at load (see results of Duncan's Multiple Range Tests in the appendices). Further results indicated that vehicles using ethanol and MTBE emitted significantly more CO at load than vehicles using compressed natural gas; however, vehicles using CNG did not differ on this measure from vehicles using propane or methanol. The reduction in emissions obtained using compressed natural gas thus is not very meaningful.

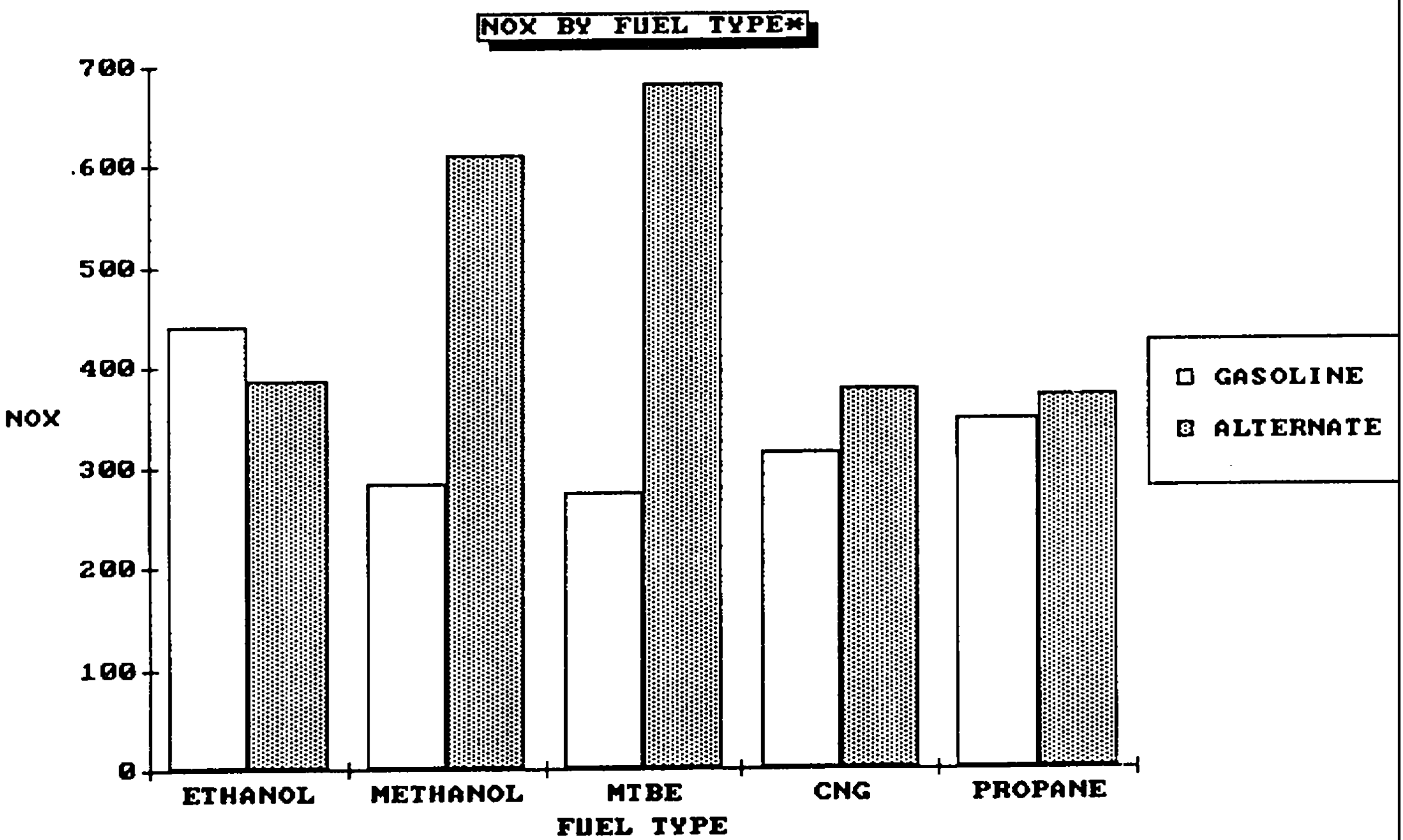
The remainder of significant effects discovered during the course of this investigation represent increases in emissions with use of alternate fuels. Vehicles using propane significantly increased their emission of hydrocarbons at idle. Methanol-powered vehicles significantly increased their emission of nitrogen oxides; vehicles using MTBE showed a marginal increase on this measure. Whether these effects are real, are due to uncontrolled sources of variation (e.g., vehicle type and individual vehicle variation), or are due simply to chance given the large number of statistical tests performed, cannot be determined.

Table 3. Mean nitrogen oxide levels by fuel type.

Fuel Type	Gasoline	Alternate Fuel
Ethanol	439.577	462.966
Methanol	283.326	458.079*
MTBE	273.710	435.419**
CNG	313.148	441.389
Propane	345.474	293.743

*p = .025 **p = .071

Figure 4



*October through December only

APPENDIX A

Average Emissions Readings by Vehicle

MEANS TABLES
Carbon Monoxide at Idle

Variable	Value	Label	Mean	Std Dev	Cases
VEHICLE TYPE 1					
IDNO	B719		.7009	.9056	11
YEAR	1		.0150	.0071	2
YEAR	2		.8533	.9388	9
IDNO	B721		.0468	.0784	19
YEAR	1		.0400	.0436	3
YEAR	2		.0481	.0843	16
IDNO	B726		.0238	.0062	16
YEAR	1		.0200	7.0917E-11	2
YEAR	2		.0243	.0065	14
IDNO	B727		.4188	1.5958	17
YEAR	1		.0200	7.0917E-11	2
YEAR	2		.4720	1.6985	15
IDNO	B729		.0183	.0058	12
YEAR	1		.0150	.0071	2
YEAR	2		.0190	.0057	10
IDNO	B735		.0236	.0114	22
YEAR	1		.0167	.0058	3
YEAR	2		.0247	.0117	19
IDNO	B738		.0175	.0050	4
YEAR	1		.0100	.0000	1
YEAR	2		.0200	2.5611E-10	3
IDNO	B741		.7544	1.1149	18
YEAR	1		1.2733	.5311	3
YEAR	2		.6507	1.1831	15
IDNO	B745		.0800	.2407	20
YEAR	1		.0167	.0058	3
YEAR	2		.0912	.2606	17
IDNO	B746		.3587	.8396	15
YEAR	1		2.4200	.1980	2
YEAR	2		.0415	.0447	13
IDNO	B749		.3879	.6937	14
YEAR	1		.3400	.3253	2
YEAR	2		.3958	.7474	12
IDNO	B750		.0183	.0041	6
YEAR	1		.0150	.0071	2
YEAR	2		.0200	5.7904E-11	4

IDNO	B759		.3990	.6562	10
YEAR		1	1.4700	.7637	2
YEAR		2	.1313	.2463	8

VEHICLE TYPE 2

IDNO	B767		.0233	.0086	21
YEAR		1	.0133	.0058	3
YEAR		2	.0250	.0079	18
IDNO	B768		.5541	1.3923	22
YEAR		1	.0150	.0058	4
YEAR		2	.6739	1.5202	18
IDNO	B773		.0250	.0055	6
YEAR		1	.0200	.0000	1
YEAR		2	.0260	.0055	5
IDNO	B792		.0416	.0446	19
YEAR		1	.0167	.0058	3
YEAR		2	.0463	.0473	16
IDNO	B793		.0209	.0043	22
YEAR		1	.0167	.0058	3
YEAR		2	.0216	.0037	19
IDNO	B794		.0200	.0082	4
YEAR		1	.0200	.0100	3
YEAR		2	.0200	.0000	1
IDNO	B808		.0256	.0142	18
YEAR		1	.0200	7.0917E-11	2
YEAR		2	.0263	.0150	16
IDNO	B815		.0211	.0058	18
YEAR		1	.0133	.0058	3
YEAR		2	.0227	.0046	15
IDNO	B817		.0208	.0067	12
YEAR		1	.0100	3.5459E-11	2
YEAR		2	.0230	.0048	10
IDNO	B823		.0242	.0067	12
YEAR		1	.0300	.0000	1
YEAR		2	.0236	.0067	11
IDNO	B827		.0200	.0033	19
YEAR		1	.0167	.0058	3
YEAR		2	.0206	.0025	16
IDNO	B831		.0206	.0024	17
YEAR		1	.0200	.0000	1
YEAR		2	.0206	.0025	16

IDNO	B833		.0208	.0028	13
YEAR		1	.0200	7.0917E-11	2
YEAR		2	.0209	.0030	11
IDNO	B835		.0220	.0108	15
YEAR		1	.0150	.0071	2
YEAR		2	.0231	.0111	13

VEHICLE TYPE 3

IDNO	A362		.0267	.0103	6
YEAR		1	.0233	.0153	3
YEAR		2	.0300	4.1403E-10	3
IDNO	A364		.4164	.6992	11
YEAR		1	.4200	.0000	1
YEAR		2	.4160	.7371	10
IDNO	A427		.1558	.1715	19
YEAR		1	.3833	.2654	3
YEAR		2	.1131	.1167	16
IDNO	A431		.0919	.0791	16
YEAR		1	.0300	.0283	2
YEAR		2	.1007	.0805	14
IDNO	A432		.6756	1.9217	9
YEAR		1	.0300	.0000	1
YEAR		2	.7563	2.0381	8
IDNO	A439		.0595	.0648	20
YEAR		1	.0533	.0351	3
YEAR		2	.0606	.0694	17
IDNO	A442		.0850	.1124	10
YEAR		1	.4000	.0000	1
YEAR		2	.0500	.0206	9
IDNO	A445		.0721	.0783	19
YEAR		1	.0150	.0071	2
YEAR		2	.0788	.0802	17
IDNO	A446		.2540	.4196	20
YEAR		1	.1600	.1838	2
YEAR		2	.2644	.4400	18
IDNO	A450		.0883	.0919	12
YEAR		1	.3200	.0000	1
YEAR		2	.0673	.0587	11
IDNO	A470		.1180	.1702	15
YEAR		1	.0300	.0000	1
YEAR		2	.1243	.1748	14

IDNO	A482		.0665	.0594	17
YEAR		1	.0200	.0000	1
YEAR		2	.0694	.0601	16

VEHICLE TYPE 4

IDNO	B887		.2843	.5190	14
YEAR		1	.5450	.7566	2
YEAR		2	.2408	.5019	12
IDNO	B888		.0180	.0045	5
YEAR		1	.0167	.0058	3
YEAR		2	.0200	7.0917E-11	2
IDNO	B906		.0175	.0050	4
YEAR		1	.0200	7.0917E-11	2
YEAR		2	.0150	.0071	2
IDNO	B934		.0700	.0954	5
YEAR		1	.0967	.1242	3
YEAR		2	.0300	.0141	2
IDNO	B938		.5725	1.3067	12
YEAR		1	.1600	.1980	2
YEAR		2	.6550	1.4273	10
IDNO	B943		.4611	.8472	9
YEAR		1	.0200	.0000	1
YEAR		2	.5163	.8883	8
IDNO	BB70		.4714	1.0027	21
YEAR		1	.0300	2.8976E-10	2
YEAR		2	.5179	1.0455	19
IDNO	BB73		.0500	.0370	7
YEAR		1	.0500	.0436	3
YEAR		2	.0500	.0383	4
IDNO	BB85		.0633	.0840	9
YEAR		1	.0333	.0321	3
YEAR		2	.0783	.1003	6
IDNO	BC32		.6890	1.1961	20
YEAR		1	.1567	.0153	3
YEAR		2	.7829	1.2792	17
IDNO	BC51		.3345	.3844	11
YEAR		1	.8050	.2333	2
YEAR		2	.2300	.3320	9
IDNO	BC56		.2411	.3406	19
YEAR		1	.6300	7.0659E-09	2
YEAR		2	.1953	.3307	17

IDNO	BC65		1.7550	2.6387	6
YEAR		1	.0900	.0990	2
YEAR		2	2.5875	2.9714	4

VEHICLE TYPE 5

IDNO	B432		.1218	.2687	11
YEAR		1	.5500	.5233	2
YEAR		2	.0267	.0050	9
IDNO	B443		.0333	.0265	9
YEAR		1	.0100	.0000	1
YEAR		2	.0363	.0267	8
IDNO	B476		.0390	.0247	10
YEAR		1	.0500	.0424	2
YEAR		2	.0363	.0220	8
IDNO	B498		.0633	.0393	6
YEAR		1	.0633	.0379	3
YEAR		2	.0633	.0493	3
IDNO	B504		.8467	1.2289	3
YEAR		1	.2500	.0000	1
YEAR		2	1.1450	1.5768	2
IDNO	B516		1.0540	1.4213	5
YEAR		1	.0600	.0000	1
YEAR		2	1.3025	1.5106	4
IDNO	B530		.6682	.7538	11
YEAR		1	.0200	.0000	1
YEAR		2	.7330	.7615	10
IDNO	B533		.0305	.0216	21
YEAR		1	.0467	.0551	3
YEAR		2	.0278	.0117	18
IDNO	B549		.9733	.8682	18
YEAR		1	.0267	.0208	3
YEAR		2	1.1627	.8276	15
IDNO	B551		.5195	.8682	22
YEAR		1	.0300	.0200	3
YEAR		2	.5968	.9128	19
IDNO	B625		.2244	.3463	9
YEAR		1	.6033	.3953	3
YEAR		2	.0350	.0138	6
IDNO	B641		.1861	.4410	18
YEAR		1	.0250	.0071	2
YEAR		2	.2063	.4653	16

VEHICLE TYPE 6

IDNO	BD06		.0254	.0088	13
YEAR		1	.0350	.0212	2
YEAR		2	.0236	.0050	11
IDNO	BD08		.0652	.1959	21
YEAR		1	.0200	7.0917E-11	2
YEAR		2	.0700	.2059	19
IDNO	BD09		.0231	.0070	16
YEAR		1	.0150	.0071	2
YEAR		2	.0243	.0065	14
IDNO	BD12		.0233	.0049	15
YEAR		1	.0200	7.0917E-11	2
YEAR		2	.0238	.0051	13
IDNO	BD39		.0229	.0056	21
YEAR		1	.0150	.0071	2
YEAR		2	.0237	.0050	19
IDNO	BD42		.0853	.2512	17
YEAR		1	.5400	.7354	2
YEAR		2	.0247	.0052	15
IDNO	BD51		.0490	.0868	21
YEAR		1	.0167	.0058	3
YEAR		2	.0544	.0930	18
IDNO	BD52		.1864	.4259	14
YEAR		1	.5400	.7354	2
YEAR		2	.1275	.3724	12
IDNO	BD55		.4362	1.4855	13
YEAR		1	.0167	.0058	3
YEAR		2	.5620	1.6929	10
IDNO	BD57		.0253	.0062	17
YEAR		1	.0167	.0058	3
YEAR		2	.0271	.0047	14
IDNO	BD61		.0714	.2380	21
YEAR		1	.0167	.0058	3
YEAR		2	.0806	.2569	18
IDNO	BD64		.0216	.0037	19
YEAR		1	.0233	.0058	3
YEAR		2	.0212	.0034	16
IDNO	BD66		.0231	.0048	16
YEAR		1	.0233	.0058	3
YEAR		2	.0231	.0048	13

IDNO	BD70		.1755	.6743	20
YEAR		1	.0200	.0141	2
YEAR		2	.1928	.7106	18
IDNO	BD74		.0786	.1609	21
YEAR		1	.3500	.4667	2
YEAR		2	.0500	.0872	19

MEANS TABLES
Carbon Monoxide at Load

Variable	Value	Label	Mean	Std Dev	Cases
VEHICLE TYPE 1					
IDNO	B719		.7060	1.0330	10
YEAR	1		.4550	.6293	2
YEAR	2		.7688	1.1370	8
IDNO	B721		.1524	.4524	17
YEAR	1		.6333	1.0710	3
YEAR	2		.0493	.1028	14
IDNO	B726		.2900	.4336	15
YEAR	1		.0100	3.5459E-11	2
YEAR	2		.3331	.4520	13
IDNO	B727		.2167	.4970	15
YEAR	1		.0550	.0636	2
YEAR	2		.2415	.5318	13
IDNO	B729		.4960	.5901	10
YEAR	1		.0100	.0141	2
YEAR	2		.6175	.6028	8
IDNO	B735		.0740	.1686	20
YEAR	1		.0167	.0115	3
YEAR	2		.0841	.1817	17
IDNO	B738		.0133	.0058	3
YEAR	1		.0100	.0000	1
YEAR	2		.0150	.0071	2
IDNO	B741		1.0244	1.5752	18
YEAR	1		.9500	.2433	3
YEAR	2		1.0393	1.7329	15
IDNO	B745		.0258	.0304	19
YEAR	1		.0533	.0351	3
YEAR	2		.0206	.0277	16
IDNO	B746		1.3962	2.1310	13
YEAR	1		5.9850	.3182	2
YEAR	2		.5618	.6796	11
IDNO	B749		.0738	.0743	13
YEAR	1		.2100	.1273	2
YEAR	2		.0491	.0251	11
IDNO	B750		.0120	.0130	5
YEAR	1		.0250	.0071	2
YEAR	2		.0033	.0058	3

IDNO	B759		.2110	.2698	10
YEAR		1	.4100	.4525	2
YEAR		2	.1613	.2240	8

VEHICLE TYPE 2

IDNO	B767		.2847	.4782	19
YEAR		1	.0167	.0115	3
YEAR		2	.3350	.5073	16
IDNO	B768		.0214	.0180	21
YEAR		1	.0325	.0263	4
YEAR		2	.0188	.0154	17
IDNO	B773		.0460	.0472	5
YEAR		1	.0000	.0000	1
YEAR		2	.0575	.0457	4
IDNO	B792		.0847	.1752	17
YEAR		1	.0333	.0321	3
YEAR		2	.0957	.1921	14
IDNO	B793		.1540	.3630	20
YEAR		1	.0367	.0379	3
YEAR		2	.1747	.3915	17
IDNO	B794		.0375	.0310	4
YEAR		1	.0467	.0306	3
YEAR		2	.0100	.0000	1
IDNO	B808		.2056	.3833	16
YEAR		1	.0200	.0141	2
YEAR		2	.2321	.4043	14
IDNO	B815		.0241	.0224	17
YEAR		1	.0233	.0153	3
YEAR		2	.0243	.0241	14
IDNO	B817		1.6740	5.1743	10
YEAR		1	.0000	.0000	2
YEAR		2	2.0925	5.7812	8
IDNO	B823		.0445	.0450	11
YEAR		1	.0200	.0000	1
YEAR		2	.0470	.0467	10
IDNO	B827		.0224	.0208	17
YEAR		1	.0500	.0361	3
YEAR		2	.0164	.0108	14
IDNO	B831		.0488	.0400	16
YEAR		1	.1000	.0000	1
YEAR		2	.0453	.0389	15

IDNO	B833		.0145	.0104	11
YEAR		1	.0100	3.5459E-11	2
YEAR		2	.0156	.0113	9
IDNO	B835		.0229	.0264	14
YEAR		1	.0100	3.5459E-11	2
YEAR		2	.0250	.0281	12

VEHICLE TYPE 3

IDNO	A362		.0540	.0518	5
YEAR		1	.0400	.0200	3
YEAR		2	.0750	.0919	2
IDNO	A364		.0500	.0989	10
YEAR		1	.3300	.0000	1
YEAR		2	.0189	.0105	9
IDNO	A427		.4978	.9734	18
YEAR		1	.6200	.4900	3
YEAR		2	.4733	1.0547	15
IDNO	A431		.3175	.2061	16
YEAR		1	.3000	.3677	2
YEAR		2	.3200	.1964	14
IDNO	A432		.7163	1.9532	8
YEAR		1	.0700	.0000	1
YEAR		2	.8086	2.0908	7
IDNO	A439		.3817	.6334	18
YEAR		1	.2133	.1582	3
YEAR		2	.4153	.6902	15
IDNO	A442		.2322	.1840	9
YEAR		1	.3400	.0000	1
YEAR		2	.2188	.1919	8
IDNO	A445		.2582	.4314	17
YEAR		1	.0250	.0212	2
YEAR		2	.2893	.4515	15
IDNO	A446		.2495	.2541	20
YEAR		1	.6450	.3323	2
YEAR		2	.2056	.2127	18
IDNO	A450		.3018	.2553	11
YEAR		1	.0100	.0000	1
YEAR		2	.3310	.2491	10
IDNO	A470		.3564	.2469	14
YEAR		1	.1500	.0000	1
YEAR		2	.3723	.2495	13

IDNO	A482		.1033	.1519	15
YEAR		1	.0100	.0000	1
YEAR		2	.1100	.1553	14

VEHICLE TYPE 4

IDNO	B887		.4138	.4658	13
YEAR		1	.3000	.3960	2
YEAR		2	.4345	.4916	11
IDNO	B888		.0440	.0297	5
YEAR		1	.0400	.0361	3
YEAR		2	.0500	.0283	2
IDNO	B906		.0500	.0141	4
YEAR		1	.0450	.0071	2
YEAR		2	.0550	.0212	2
IDNO	B934		.1180	.1529	5
YEAR		1	.0767	.1069	3
YEAR		2	.1800	.2404	2
IDNO	B938		.8533	1.6735	9
YEAR		1	.2300	.3111	2
YEAR		2	1.0314	1.8845	7
IDNO	B943		.4113	.3962	8
YEAR		1	.0000	.0000	1
YEAR		2	.4700	.3885	7
IDNO	BB70		.4911	1.1737	19
YEAR		1	.1950	.2616	2
YEAR		2	.5259	1.2383	17
IDNO	BB73		.0186	.0107	7
YEAR		1	.0167	.0115	3
YEAR		2	.0200	.0115	4
IDNO	BB85		.0411	.0556	9
YEAR		1	.0700	.0889	3
YEAR		2	.0267	.0320	6
IDNO	BC32		.4989	1.6238	18
YEAR		1	.0600	.0781	3
YEAR		2	.5867	1.7752	15
IDNO	BC51		.1030	.2560	10
YEAR		1	.0200	.0141	2
YEAR		2	.1238	.2859	8
IDNO	BC56		.5456	.5590	16
YEAR		1	.9250	.0071	2
YEAR		2	.4914	.5790	14

IDNO	BC65		.6700	1.0647	6
YEAR		1	.0850	.0071	2
YEAR		2	.9625	1.2437	4

VEHICLE TYPE 5

IDNO	B432		.0857	.0665	7
YEAR		1	.0300	2.8976E-10	2
YEAR		2	.1080	.0669	5
IDNO	B443		.2000	.2546	2
YEAR		1	.0200	.0000	1
YEAR		2	.3800	.0000	1
IDNO	B476		.7233	1.2558	9
YEAR		1	.4350	.5162	2
YEAR		2	.8057	1.4222	7
IDNO	B498		2.4017	5.3959	6
YEAR		1	.0433	.0231	3
YEAR		2	4.7600	7.4902	3
IDNO	B504		.0650	.0495	2
YEAR		1	.1000	.0000	1
YEAR		2	.0300	.0000	1
IDNO	B516		.8950	1.2759	4
YEAR		1	.8300	.0000	1
YEAR		2	.9167	1.5618	3
IDNO	B530		.0167	.0153	3
YEAR		1	.0000	.0000	1
YEAR		2	.0250	.0071	2
IDNO	B533		.0209	.0247	11
YEAR		1	.0300	.0346	3
YEAR		2	.0175	.0219	8
IDNO	B549		.0238	.0120	16
YEAR		1	.0167	.0208	3
YEAR		2	.0254	.0097	13
IDNO	B551		.1547	.3150	15
YEAR		1	.0933	.0945	3
YEAR		2	.1700	.3512	12
IDNO	B625		.3856	.5991	9
YEAR		1	.2633	.1762	3
YEAR		2	.4467	.7406	6
IDNO	B641		.9045	2.3669	11
YEAR		1	.0200	7.0917E-11	2
YEAR		2	1.1011	2.6007	9

VEHICLE TYPE 6

IDNO	BD06		.0317	.0354	12
YEAR		1	.0450	.0495	2
YEAR		2	.0290	.0348	10
IDNO	BD08		.0211	.0200	19
YEAR		1	.0100	3.5459E-11	2
YEAR		2	.0224	.0208	17
IDNO	BD09		.0357	.0367	14
YEAR		1	.0050	.0071	2
YEAR		2	.0408	.0373	12
IDNO	BD12		.0169	.0149	13
YEAR		1	.0050	.0071	2
YEAR		2	.0191	.0151	11
IDNO	BD39		.0667	.1842	18
YEAR		1	.0100	3.5459E-11	2
YEAR		2	.0738	.1949	16
IDNO	BD42		.0575	.1044	16
YEAR		1	.1050	.1485	2
YEAR		2	.0507	.1024	14
IDNO	BD51		.0284	.0257	19
YEAR		1	.0067	.0058	3
YEAR		2	.0325	.0259	16
IDNO	BD52		.0482	.0711	11
YEAR		1	.0050	.0071	2
YEAR		2	.0578	.0758	9
IDNO	BD55		.5125	1.5935	12
YEAR		1	.1167	.0764	3
YEAR		2	.6444	1.8471	9
IDNO	BD57		.0563	.1215	16
YEAR		1	.1800	.2773	3
YEAR		2	.0277	.0306	13
IDNO	BD61		.1184	.2707	19
YEAR		1	.0067	.0058	3
YEAR		2	.1394	.2915	16
IDNO	BD64		.0267	.0252	18
YEAR		1	.0533	.0404	3
YEAR		2	.0213	.0188	15
IDNO	BD66		.1400	.2953	15
YEAR		1	.0100	1.2805E-10	3
YEAR		2	.1725	.3243	12

IDNO	BD70		.0194	.0186	18
YEAR		1	.0450	.0495	2
YEAR		2	.0163	.0115	16
IDNO	BD74		.1458	.3057	19
YEAR		1	.0050	.0071	2
YEAR		2	.1624	.3200	17

MEANS TABLES
Hydrocarbons at Idle

Variable	Value	Label	Mean	Std Dev	Cases
VEHICLE TYPE 1					
IDNO	B719		152.7273	194.6849	11
YEAR	1		27.5000	6.3640	2
YEAR	2		180.5556	206.3517	9
IDNO	B721		70.6842	34.7500	19
YEAR	1		50.0000	46.1194	3
YEAR	2		74.5625	32.6169	16
IDNO	B726		10.0000	4.5314	16
YEAR	1		12.5000	4.9497	2
YEAR	2		9.6429	4.5507	14
IDNO	B727		80.1176	160.6358	17
YEAR	1		12.5000	4.9497	2
YEAR	2		89.1333	169.5527	15
IDNO	B729		47.2500	31.7580	12
YEAR	1		18.5000	14.8492	2
YEAR	2		53.0000	31.4289	10
IDNO	B735		18.7727	18.0315	22
YEAR	1		14.0000	1.7321	3
YEAR	2		19.5263	19.3545	19
IDNO	B738		48.5000	58.1521	4
YEAR	1		22.0000	.0000	1
YEAR	2		57.3333	67.8552	3
IDNO	B741		65.4444	39.8589	18
YEAR	1		97.6667	35.2326	3
YEAR	2		59.0000	38.5338	15
IDNO	B745		35.5500	26.5141	20
YEAR	1		15.0000	4.3589	3
YEAR	2		39.1765	27.1897	17
IDNO	B746		86.8000	27.2769	15
YEAR	1		121.5000	27.5772	2
YEAR	2		81.4615	23.9396	13
IDNO	B749		149.4286	29.5002	14
YEAR	1		127.0000	36.7696	2
YEAR	2		153.1667	28.2644	12
IDNO	B750		47.6667	24.3447	6
YEAR	1		21.5000	7.7782	2
YEAR	2		60.7500	16.8201	4

IDNO	B759		67.9000	48.5236	10
YEAR		1	131.0000	14.1421	2
YEAR		2	52.1250	39.7076	8

VEHICLE TYPE 2

IDNO	B767		34.5238	30.5133	21
YEAR		1	15.6667	7.5056	3
YEAR		2	37.6667	31.8674	18
IDNO	B768		59.3636	69.9595	22
YEAR		1	17.5000	7.1880	4
YEAR		2	68.6667	74.3830	18
IDNO	B773		22.3333	4.8028	6
YEAR		1	18.0000	.0000	1
YEAR		2	23.2000	4.8166	5
IDNO	B792		26.0526	20.1342	19
YEAR		1	22.3333	4.9329	3
YEAR		2	26.7500	21.9074	16
IDNO	B793		13.3182	7.4730	22
YEAR		1	17.3333	11.1505	3
YEAR		2	12.6842	6.9446	19
IDNO	B794		16.7500	7.1822	4
YEAR		1	19.6667	5.1316	3
YEAR		2	8.0000	.0000	1
IDNO	B808		15.6667	12.3717	18
YEAR		1	10.0000	4.2426	2
YEAR		2	16.3750	12.9402	16
IDNO	B815		19.1111	29.3877	18
YEAR		1	55.0000	69.3974	3
YEAR		2	11.9333	5.4310	15
IDNO	B817		31.4167	20.1109	12
YEAR		1	37.0000	12.7279	2
YEAR		2	30.3000	21.6336	10
IDNO	B823		33.6667	30.1612	12
YEAR		1	15.0000	.0000	1
YEAR		2	35.3636	31.0267	11
IDNO	B827		70.2105	51.8476	19
YEAR		1	16.3333	5.5076	3
YEAR		2	80.3125	50.3226	16
IDNO	B831		47.4118	20.7818	17
YEAR		1	22.0000	.0000	1
YEAR		2	49.0000	20.3699	16

IDNO	B833		17.0769	6.6891	13
YEAR		1	20.0000	.0000	2
YEAR		2	16.5455	7.1884	11
IDNO	B835		78.7333	41.0791	15
YEAR		1	20.0000	5.6569	2
YEAR		2	87.7692	36.0928	13

VEHICLE TYPE 3

IDNO	A362		13.1667	9.9883	6
YEAR		1	15.3333	13.8684	3
YEAR		2	11.0000	6.5574	3
IDNO	A364		119.2727	100.3355	11
YEAR		1	142.0000	.0000	1
YEAR		2	117.0000	105.4641	10
IDNO	A427		73.2105	49.7333	19
YEAR		1	116.6667	74.0698	3
YEAR		2	65.0625	42.2855	16
IDNO	A431		53.6875	48.2642	16
YEAR		1	42.0000	38.1838	2
YEAR		2	55.3571	50.5137	14
IDNO	A432		52.3333	98.0663	9
YEAR		1	52.0000	.0000	1
YEAR		2	52.3750	104.8372	8
IDNO	A439		29.7500	34.6028	20
YEAR		1	29.3333	17.3877	3
YEAR		2	29.8235	37.2025	17
IDNO	A442		41.5000	37.0143	10
YEAR		1	110.0000	.0000	1
YEAR		2	33.8889	29.8263	9
IDNO	A445		34.5789	39.7273	19
YEAR		1	12.0000	16.9706	2
YEAR		2	37.2353	41.0648	17
IDNO	A446		62.2000	45.3032	20
YEAR		1	47.0000	50.9117	2
YEAR		2	63.8889	45.9474	18
IDNO	A450		57.2500	42.9484	12
YEAR		1	115.0000	.0000	1
YEAR		2	52.0000	40.8069	11
IDNO	A470		49.5333	50.6696	15
YEAR		1	24.0000	.0000	1
YEAR		2	51.3571	52.0689	14

IDNO	A482		64.2941	107.6283	17
YEAR		1	20.0000	.0000	1
YEAR		2	67.0625	110.5311	16

VEHICLE TYPE 4

IDNO	B887		51.2143	49.8570	14
YEAR		1	80.0000	67.8823	2
YEAR		2	46.4167	48.4045	12
IDNO	B888		18.6000	10.1390	5
YEAR		1	21.0000	13.2288	3
YEAR		2	15.0000	4.2426	2
IDNO	B906		117.7500	159.6963	4
YEAR		1	16.0000	22.6274	2
YEAR		2	219.5000	185.9691	2
IDNO	B934		41.8000	8.7579	5
YEAR		1	38.3333	8.5049	3
YEAR		2	47.0000	8.4853	2
IDNO	B938		74.0833	103.4561	12
YEAR		1	29.0000	19.7990	2
YEAR		2	83.1000	111.7860	10
IDNO	B943		53.4444	43.1686	9
YEAR		1	24.0000	.0000	1
YEAR		2	57.1250	44.6140	8
IDNO	BB70		55.8571	56.4166	21
YEAR		1	36.5000	12.0208	2
YEAR		2	57.8947	59.0121	19
IDNO	BB73		142.2857	188.8789	7
YEAR		1	28.6667	24.9065	3
YEAR		2	227.5000	219.8765	4
IDNO	BB85		87.7778	54.5912	9
YEAR		1	28.0000	9.6437	3
YEAR		2	117.6667	38.9239	6
IDNO	BC32		67.0000	87.2950	20
YEAR		1	28.0000	17.3494	3
YEAR		2	73.8824	93.1456	17
IDNO	BC51		155.5455	154.1845	11
YEAR		1	185.0000	224.8600	2
YEAR		2	149.0000	152.0880	9
IDNO	BC56		37.5263	29.5379	19
YEAR		1	43.5000	61.5183	2
YEAR		2	36.8235	27.2035	17

IDNO	BC65		51.0000	54.0666	6
YEAR		1	21.5000	30.4056	2
YEAR		2	65.7500	60.7749	4

VEHICLE TYPE 5

IDNO	B432		48.5455	39.4522	11
YEAR		1	113.0000	67.8823	2
YEAR		2	34.2222	10.0097	9
IDNO	B443		111.3333	39.9875	9
YEAR		1	50.0000	.0000	1
YEAR		2	119.0000	34.9694	8
IDNO	B476		97.4000	82.7999	10
YEAR		1	118.5000	58.6899	2
YEAR		2	92.1250	90.3524	8
IDNO	B498		123.5000	55.6660	6
YEAR		1	124.3333	36.6652	3
YEAR		2	122.6667	80.0021	3
IDNO	B504		199.0000	64.1327	3
YEAR		1	178.0000	.0000	1
YEAR		2	209.5000	86.9741	2
IDNO	B516		109.8000	29.2524	5
YEAR		1	127.0000	.0000	1
YEAR		2	105.5000	31.9009	4
IDNO	B530		155.0909	51.4790	11
YEAR		1	39.0000	.0000	1
YEAR		2	166.7000	36.0187	10
IDNO	B533		76.5238	55.5730	21
YEAR		1	65.6667	67.0025	3
YEAR		2	78.3333	55.5062	18
IDNO	B549		196.1667	78.6408	18
YEAR		1	58.6667	65.8584	3
YEAR		2	223.6667	45.0376	15
IDNO	B551		113.2273	76.7556	22
YEAR		1	61.6667	34.9905	3
YEAR		2	121.3684	78.8939	19
IDNO	B625		92.3333	75.3691	9
YEAR		1	182.3333	23.7557	3
YEAR		2	47.3333	39.6619	6
IDNO	B641		90.7778	64.7607	18
YEAR		1	66.0000	16.9706	2
YEAR		2	93.8750	68.1311	16

VEHICLE TYPE 6

IDNO	BD06		14.6154	10.5951	13
YEAR		1	13.5000	9.1924	2
YEAR		2	14.8182	11.2234	11
IDNO	BD08		14.7619	15.8553	21
YEAR		1	19.5000	12.0208	2
YEAR		2	14.2632	16.3871	19
IDNO	BD09		12.1875	5.6829	16
YEAR		1	16.5000	3.5355	2
YEAR		2	11.5714	5.7474	14
IDNO	BD12		16.0000	6.7082	15
YEAR		1	17.0000	2.8284	2
YEAR		2	15.8462	7.1862	13
IDNO	BD39		10.0476	6.1113	21
YEAR		1	17.0000	2.8284	2
YEAR		2	9.3158	5.9260	19
IDNO	BD42		16.4118	18.1248	17
YEAR		1	45.0000	46.6690	2
YEAR		2	12.6000	9.3564	15
IDNO	BD51		34.7143	23.9795	21
YEAR		1	20.0000	4.0000	3
YEAR		2	37.1667	25.1004	18
IDNO	BD52		46.8571	38.1452	14
YEAR		1	24.0000	24.0416	2
YEAR		2	50.6667	39.4492	12
IDNO	BD55		41.0000	83.1234	13
YEAR		1	15.3333	13.8684	3
YEAR		2	48.7000	94.2574	10
IDNO	BD57		14.5882	7.1069	17
YEAR		1	22.0000	12.1244	3
YEAR		2	13.0000	4.9147	14
IDNO	BD61		58.8571	95.6092	21
YEAR		1	19.6667	3.5119	3
YEAR		2	65.3889	102.1597	18
IDNO	BD64		94.5263	50.9143	19
YEAR		1	4.6667	4.5092	3
YEAR		2	111.3750	34.5000	16
IDNO	BD66		297.6875	673.3727	16
YEAR		1	24.3333	21.8251	3
YEAR		2	360.7692	737.3720	13
IDNO	BD70		14.7500	14.6283	20

YEAR		1	24.0000	.0000	2
YEAR		2	13.7222	15.0989	18
IDNO	BD74		144.9048	131.7911	21
YEAR		1	1.5000	2.1213	2
YEAR		2	160.0000	129.5106	19

MEANS TABLES
Hydrocarbons at Load

Variable	Value	Label	Mean	Std Dev	Cases
VEHICLE TYPE 1					
IDNO	B741		71.0833	42.7327	12
YEAR	1		101.0000	11.3137	2
YEAR	2		65.1000	44.4858	10
IDNO	B746		132.1667	69.8496	6
YEAR	1		220.5000	27.5772	2
YEAR	2		88.0000	8.6795	4
IDNO	B759		125.2500	30.0153	4
YEAR	1		126.0000	.0000	1
YEAR	2		125.0000	36.7560	3
VEHICLE TYPE 3					
IDNO	A427		83.4615	45.4507	13
YEAR	1		97.0000	2.8284	2
YEAR	2		81.0000	49.3437	11
IDNO	A446		51.3750	28.9364	16
YEAR	1		84.5000	2.1213	2
YEAR	2		46.6429	27.8004	14
VEHICLE TYPE 4					
IDNO	B887		121.0000	4.3589	3
YEAR	1		119.0000	.0000	1
YEAR	2		122.0000	5.6569	2
IDNO	BB70		83.2000	50.0329	10
YEAR	1		106.0000	.0000	1
YEAR	2		80.6667	52.3832	9
IDNO	BC51		133.1429	166.6228	7
YEAR	1		503.0000	.0000	1
YEAR	2		71.5000	37.3778	6
VEHICLE TYPE 5					
IDNO	B476		100.0000	57.8878	3
YEAR	1		81.0000	.0000	1
YEAR	2		109.5000	78.4889	2
IDNO	B516		72.3333	49.0034	3
YEAR	1		121.0000	.0000	1
YEAR	2		48.0000	35.3553	2

IDNO	B551		64.5000	47.8086	4
YEAR		1	61.0000	.0000	1
YEAR		2	65.6667	58.4836	3

MEANS TABLES
Nitrogen Oxides

Variable	Value	Label	Mean	Std Dev	Cases
VEHICLE TYPE 1					
IDNO	B719		195.2500	110.5825	8
YEAR	1		171.5000	33.2340	2
YEAR	2		203.1667	128.8339	6
IDNO	B721		337.0833	348.2991	12
YEAR	1		230.3333	99.8866	3
YEAR	2		372.6667	398.2615	9
IDNO	B726		267.4286	400.4485	14
YEAR	1		182.5000	3.5355	2
YEAR	2		281.5833	433.5713	12
IDNO	B727		970.0000	692.4872	5
YEAR	1		454.0000	.0000	1
YEAR	2		1099.0000	726.9420	4
IDNO	B729		518.4286	521.4898	7
YEAR	1		1645.0000	.0000	1
YEAR	2		330.6667	173.7926	6
IDNO	B735		266.7222	333.5768	18
YEAR	1		192.6667	39.0171	3
YEAR	2		281.5333	365.3630	15
IDNO	B738		355.6667	276.5110	3
YEAR	1		64.0000	.0000	1
YEAR	2		501.5000	159.0990	2
IDNO	B741		401.7143	758.0004	14
YEAR	1		303.6667	183.8813	3
YEAR	2		428.4545	858.1964	11
IDNO	B745		334.3125	417.3118	16
YEAR	1		593.3333	413.8627	3
YEAR	2		274.5385	410.4824	13
IDNO	B746		745.2500	700.8619	8
YEAR	1		79.5000	21.9203	2
YEAR	2		967.1667	671.7206	6
IDNO	B749		351.9000	319.4208	10
YEAR	1		872.0000	38.1838	2
YEAR	2		221.8750	185.3756	8
IDNO	B750		604.7500	547.0365	4
YEAR	1		136.5000	17.6777	2
YEAR	2		1073.0000	142.8356	2

IDNO	B759		683.5000	356.5850	8
YEAR		1	781.0000	41.0122	2
YEAR		2	651.0000	415.4607	6

VEHICLE TYPE 2

IDNO	B767		535.6111	319.6594	18
YEAR		1	199.3333	127.5827	3
YEAR		2	602.8667	304.4250	15
IDNO	B768		134.8947	66.5481	19
YEAR		1	169.5000	95.3607	4
YEAR		2	125.6667	57.5496	15
IDNO	B773		732.0000	266.1090	5
YEAR		1	935.0000	.0000	1
YEAR		2	681.2500	277.9357	4
IDNO	B792		239.1250	353.4893	16
YEAR		1	135.0000	82.8191	3
YEAR		2	263.1538	389.5050	13
IDNO	B793		351.7778	339.4994	18
YEAR		1	361.0000	237.3120	3
YEAR		2	349.9333	363.1683	15
IDNO	B794		156.5000	23.1589	4
YEAR		1	155.3333	28.2194	3
YEAR		2	160.0000	.0000	1
IDNO	B808		266.1429	362.0238	14
YEAR		1	245.0000	69.2965	2
YEAR		2	269.6667	392.8857	12
IDNO	B815		1137.8000	338.0879	15
YEAR		1	775.0000	.0000	1
YEAR		2	1163.7143	335.0342	14
IDNO	B817		319.7000	234.1291	10
YEAR		1	283.5000	78.4889	2
YEAR		2	328.7500	262.9263	8
IDNO	B823		261.3333	238.1874	9
YEAR		1	727.0000	.0000	1
YEAR		2	203.1250	173.1700	8
IDNO	B827		170.8125	228.7660	16
YEAR		1	212.3333	111.6348	3
YEAR		2	161.2308	250.6190	13
IDNO	B831		224.0909	206.4526	11
YEAR		1	68.0000	.0000	1
YEAR		2	239.7000	210.6672	10

IDNO	B833		294.1818	191.5337	11
YEAR		1	159.0000	28.2843	2
YEAR		2	324.2222	200.4313	9
IDNO	B835		249.0000	297.5976	13
YEAR		1	180.0000	176.7767	2
YEAR		2	261.5455	319.4165	11

VEHICLE TYPE 3

IDNO	A362		391.6000	256.6482	5
YEAR		1	290.6667	299.2730	3
YEAR		2	543.0000	89.0955	2
IDNO	A364		453.6250	221.2367	8
YEAR		1	808.0000	.0000	1
YEAR		2	403.0000	182.1620	7
IDNO	A427		262.9412	197.4672	17
YEAR		1	231.0000	94.7523	2
YEAR		2	267.2000	209.1825	15
IDNO	A431		641.1333	566.4174	15
YEAR		1	183.0000	115.9655	2
YEAR		2	711.6154	576.9027	13
IDNO	A432		424.2857	321.0886	7
YEAR		1	296.0000	.0000	1
YEAR		2	445.6667	346.2333	6
IDNO	A439		348.1333	233.4514	15
YEAR		1	373.3333	294.0686	3
YEAR		2	341.8333	231.1355	12
IDNO	A442		455.7143	170.7715	7
YEAR		1	526.0000	.0000	1
YEAR		2	444.0000	183.9641	6
IDNO	A445		213.8667	142.1121	15
YEAR		1	86.5000	14.8492	2
YEAR		2	233.4615	142.9118	13
IDNO	A446		626.8824	564.1813	17
YEAR		1	288.5000	358.5031	2
YEAR		2	672.0000	579.7009	15
IDNO	A450		541.6000	480.5837	10
YEAR		1	360.0000	.0000	1
YEAR		2	561.7778	505.2232	9
IDNO	A482		255.1429	198.4210	14
YEAR		1	196.0000	.0000	1
YEAR		2	259.6923	205.7617	13

IDNO	B432		1071.6250	719.1384	8
YEAR		1	885.0000	.0000	1
YEAR		2	1098.2857	772.4760	7

VEHICLE TYPE 4

IDNO	B887		907.2727	412.2946	11
YEAR		1	525.0000	.0000	1
YEAR		2	945.5000	413.5379	10
IDNO	B888		305.2000	119.5521	5
YEAR		1	280.0000	148.2532	3
YEAR		2	343.0000	91.9239	2
IDNO	B906		659.2500	403.7453	4
YEAR		1	334.0000	197.9899	2
YEAR		2	984.5000	163.3417	2
IDNO	B934		470.0000	258.3718	4
YEAR		1	555.0000	238.2939	3
YEAR		2	215.0000	.0000	1
IDNO	B938		405.1000	227.8813	10
YEAR		1	445.0000	57.9828	2
YEAR		2	395.1250	256.3555	8
IDNO	B943		657.6250	454.9201	8
YEAR		1	287.0000	.0000	1
YEAR		2	710.5714	463.9827	7
IDNO	BB70		616.9412	669.6556	17
YEAR		1	378.0000	217.7889	2
YEAR		2	648.8000	707.0146	15
IDNO	BB73		410.3333	238.9909	6
YEAR		1	247.6667	83.9901	3
YEAR		2	573.0000	237.3942	3
IDNO	BB85		344.1429	191.9344	7
YEAR		1	320.3333	108.1912	3
YEAR		2	362.0000	254.7195	4
IDNO	BC32		250.1250	218.8546	16
YEAR		1	215.0000	132.8646	3
YEAR		2	258.2308	237.8021	13
IDNO	BC51		580.6667	531.3744	9
YEAR		1	267.5000	16.2635	2
YEAR		2	670.1429	578.2757	7
IDNO	BC56		923.3125	256.5808	16
YEAR		1	785.0000	569.9281	2
YEAR		2	943.0714	218.2026	14

IDNO	BC65		534.0000	388.9409	3
YEAR		1	311.5000	74.2462	2
YEAR		2	979.0000	.0000	1

VEHICLE TYPE 5

IDNO	B443		698.8333	539.5136	6
YEAR		1	1238.0000	.0000	1
YEAR		2	591.0000	525.9596	5
IDNO	B476		564.4444	851.0786	9
YEAR		1	195.0000	.0000	1
YEAR		2	610.6250	897.7056	8
IDNO	B498		299.6667	124.0301	6
YEAR		1	202.3333	15.8219	3
YEAR		2	397.0000	98.9293	3
IDNO	B504		208.6667	54.2433	3
YEAR		1	249.0000	.0000	1
YEAR		2	188.5000	58.6899	2
IDNO	B516		339.3333	303.6928	3
YEAR		1	690.0000	.0000	1
YEAR		2	164.0000	2.8284	2
IDNO	B530		956.5556	620.4086	9
YEAR		1	1853.0000	.0000	1
YEAR		2	844.5000	557.4419	8
IDNO	B533		421.1765	518.3590	17
YEAR		1	676.6667	481.6890	3
YEAR		2	366.4286	526.0374	14
IDNO	B549		169.6000	59.4220	15
YEAR		1	197.0000	120.1541	3
YEAR		2	162.7500	40.1636	12
IDNO	B551		484.8889	516.8002	18
YEAR		1	218.6667	85.5414	3
YEAR		2	538.1333	552.3081	15
IDNO	B625		405.4444	226.3952	9
YEAR		1	367.0000	66.1589	3
YEAR		2	424.6667	280.9389	6
IDNO	B641		201.9375	100.7263	16
YEAR		1	260.0000	43.8406	2
YEAR		2	193.6429	104.7191	14

VEHICLE TYPE 6

IDNO	BD06		249.1667	234.5963	12
YEAR		1	222.0000	8.4853	2
YEAR		2	254.6000	258.9608	10
IDNO	BD08		206.0000	239.0263	19
YEAR		1	135.0000	164.0488	2
YEAR		2	214.3529	248.7750	17
IDNO	BD09		293.7857	420.2897	14
YEAR		1	132.0000	9.8995	2
YEAR		2	320.7500	450.7763	12
IDNO	BD12		170.9167	50.1570	12
YEAR		1	206.5000	86.9741	2
YEAR		2	163.8000	43.5502	10
IDNO	BD39		298.1176	424.8875	17
YEAR		1	192.0000	74.9533	2
YEAR		2	312.2667	451.7685	15
IDNO	BD42		172.2857	62.6301	14
YEAR		1	214.0000	83.4386	2
YEAR		2	165.3333	60.2802	12
IDNO	BD51		334.5625	331.1187	16
YEAR		1	264.3333	106.8285	3
YEAR		2	350.7692	365.5542	13
IDNO	BD52		351.3750	419.3910	8
YEAR		1	166.5000	71.4178	2
YEAR		2	413.0000	476.4406	6
IDNO	BD55		344.5556	618.1311	9
YEAR		1	124.6667	39.6274	3
YEAR		2	454.5000	753.1225	6
IDNO	BD57		382.0000	386.6166	15
YEAR		1	196.0000	164.7756	3
YEAR		2	428.5000	416.5417	12
IDNO	BD61		323.3750	302.9019	16
YEAR		1	228.3333	51.7333	3
YEAR		2	345.3077	333.8586	13
IDNO	BD64		372.4118	480.1845	17
YEAR		1	419.6667	352.6618	3
YEAR		2	362.2857	513.8362	14
IDNO	BD66		329.6667	377.2994	15
YEAR		1	190.6667	118.6859	3
YEAR		2	364.4167	414.7662	12

IDNO	BD70		207.6875	65.3450	16
YEAR		1	217.5000	81.3173	2
YEAR		2	206.2857	66.3423	14
IDNO	BD74		265.3889	388.5919	18
YEAR		1	341.5000	458.9123	2
YEAR		2	255.8750	395.2575	16

APPENDIX B

Statistical Analysis Tables
Carbon Monoxide

STATISTICAL ANALYSIS OVER TIME (BEFORE/AFTER)
Carbon Monoxide at Idle

GASOLINE (1987)

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Cell Means and Standard Deviations
Variable .. COIDLE

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	.254	.463	29
FUELTYPE	METHANOL	.068	.170	46
FUELTYPE	MTBE	.189	.420	33
FUELTYPE	CNG	.332	.668	27
FUELTYPE	PROPANE	.090	.174	39
For entire sample		.168	.398	174

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	25.71	169	.15		
CONSTANT	5.84	1	5.84	38.39	.000
FUELTYPE	1.65	4	.41	2.70	.032

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ALTERNATE FUEL (1988-89)

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Cell Means and Standard Deviations
Variable .. COIDLE

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	.140	.446	195
FUELTYPE	METHANOL	.255	.809	250
FUELTYPE	MTBE	.181	.710	157
FUELTYPE	CNG	.125	.396	146
FUELTYPE	PROPANE	.281	.771	204
For entire sample		.205	.670	952

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	423.55	947	.45		
CONSTANT	35.48	1	35.48	79.32	.000
FUELTYPE	3.67	4	.92	2.05	.085

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STATISTICAL ANALYSIS OVER TIME (BEFORE/AFTER)
Carbon Monoxide at Load

GASOLINE (1987)

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Cell Means and Standard Deviations
Variable .. COLOAD

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	.174	.304	29
FUELTYPE	METHANOL	.095	.170	46
FUELTYPE	MTBE	.196	.313	33
FUELTYPE	CNG	.579	1.606	27
FUELTYPE	PROPANE	.088	.200	39
For entire sample		.201	.682	174

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	75.59	169	.45		
CONSTANT	8.59	1	8.59	19.21	.000
FUELTYPE	4.89	4	1.22	2.73	.031

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ALTERNATE FUEL (1988-89)

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Cell Means and Standard Deviations
Variable .. COLOAD

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	.419	1.489	164
FUELTYPE	METHANOL	.253	.789	210
FUELTYPE	MTBE	.442	1.382	136
FUELTYPE	CNG	.148	.367	128
FUELTYPE	PROPANE	.123	.538	178
For entire sample		.273	1.010	816

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	817.67	811	1.01		
CONSTANT	60.61	1	60.61	60.11	.000
FUELTYPE	13.47	4	3.37	3.34	.010

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STATISTICAL ANALYSIS BY FUEL TYPE
Carbon Monoxide at Idle

ETHANOL

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Cell Means and Standard Deviations
Variable .. COIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.254	.463	29
YEAR	ALT FUEL	.140	.446	195
For entire sample		.155	.449	224

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	44.57	222	.20		
CONSTANT	3.93	1	3.93	19.57	.000
YEAR	.33	1	.33	1.63	.203

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METHANOL

Cell Means and Standard Deviations
Variable .. COIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.068	.170	46
YEAR	ALT FUEL	.255	.809	250
For entire sample		.226	.749	296

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	164.18	294	.56		
CONSTANT	4.07	1	4.07	7.29	.007
YEAR	1.36	1	1.36	2.43	.120

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MTBE

Cell Means and Standard Deviations
Variable .. COIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.189	.420	33
YEAR	ALT FUEL	.181	.710	157
For entire sample		.183	.668	190

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	84.33	188	.45		
CONSTANT	3.74	1	3.74	8.33	.004
YEAR	.00	1	.00	.00	.954

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CNG

Cell Means and Standard Deviations
Variable .. COIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.332	.668	27
YEAR	ALT FUEL	.125	.396	146
For entire sample		.157	.454	173

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	34.40	171	.20		
CONSTANT	4.75	1	4.75	23.61	.000
YEAR	.98	1	.98	4.86	.029

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PROPANE

Cell Means and Standard Deviations
Variable .. COIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.090	.174	39
YEAR	ALT FUEL	.281	.771	204
For entire sample		.251	.713	243

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	121.79	241	.51		
CONSTANT	4.52	1	4.52	8.95	.003
YEAR	1.20	1	1.20	2.37	.125

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STATISTICAL ANALYSIS BY FUEL TYPE
Carbon Monoxide at Load

ETHANOL

Cell Means and Standard Deviations
Variable .. COLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.174	.304	29
YEAR	ALT FUEL	.419	1.489	164
For entire sample		.382	1.380	193

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	364.14	191	1.91		
CONSTANT	8.67	1	8.67	4.55	.034
YEAR	1.47	1	1.47	.77	.381

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METHANOL

Cell Means and Standard Deviations
Variable .. COLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.095	.170	46
YEAR	ALT FUEL	.253	.789	210
For entire sample		.224	.720	256

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	131.37	254	.52		
CONSTANT	4.55	1	4.55	8.80	.003
YEAR	.94	1	.94	1.83	.178

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MTBE

Cell Means and Standard Deviations
Variable .. COLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.196	.313	33
YEAR	ALT FUEL	.442	1.382	136
For entire sample		.394	1.250	169

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Tests of Significance for COLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	260.81	167	1.56		
CONSTANT	10.83	1	10.83	6.94	.009
YEAR	1.61	1	1.61	1.03	.312

CNG

Cell Means and Standard Deviations
Variable .. COLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.579	1.606	27
YEAR	ALT FUEL	.148	.367	128
For entire sample		.223	.757	155

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	84.17	153	.55		
CONSTANT	11.78	1	11.78	21.42	.000
YEAR	4.13	1	4.13	7.50	.007

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PROPANE

Cell Means and Standard Deviations
Variable .. COLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	.088	.200	39
YEAR	ALT FUEL	.123	.538	178
For entire sample		.117	.494	217

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	52.78	215	.25		
CONSTANT	1.42	1	1.42	5.80	.017
YEAR	.04	1	.04	.16	.694

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STATISTICAL ANALYSIS FOR MONTHS OF OCTOBER THROUGH DECEMBER
Carbon Monoxide at Idle

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Cell Means and Standard Deviations
Variable .. COIDLE

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL			
YEAR	GASOLINE	.254	.463	29
YEAR	ALT FUEL	.082	.241	32
FUELTYPE	METHANOL			
YEAR	GASOLINE	.068	.170	46
YEAR	ALT FUEL	.143	.418	40
FUELTYPE	MTBE			
YEAR	GASOLINE	.189	.420	33
YEAR	ALT FUEL	.138	.368	20
FUELTYPE	CNG			
YEAR	GASOLINE	.332	.668	27
YEAR	ALT FUEL	.026	.021	22
FUELTYPE	PROPANE			
YEAR	GASOLINE	.090	.174	39
YEAR	ALT FUEL	.259	.712	31
For entire sample		.153	.415	319

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	52.15	309	.17		
CONSTANT	7.51	1	7.51	44.50	.000
FUELTYPE	.27	4	.07	.40	.805
YEAR	.24	1	.24	1.45	.230
FUELTYPE BY YEAR	2.15	4	.54	3.19	.014

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STATISTICAL ANALYSIS FOR MONTHS OF OCTOBER THROUGH DECEMBER
Carbon Monoxide at Load

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Cell Means and Standard Deviations
Variable .. COLOAD

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL			
YEAR	GASOLINE	.174	.304	29
YEAR	ALT FUEL	.419	1.489	164
FUELTYPE	METHANOL			
YEAR	GASOLINE	.095	.170	46
YEAR	ALT FUEL	.253	.789	210
FUELTYPE	MTBE			
YEAR	GASOLINE	.196	.313	33
YEAR	ALT FUEL	.442	1.382	136
FUELTYPE	CNG			
YEAR	GASOLINE	.579	1.606	27
YEAR	ALT FUEL	.148	.367	128
FUELTYPE	PROPANE			
YEAR	GASOLINE	.088	.200	39
YEAR	ALT FUEL	.123	.538	178
For entire sample		.260	.960	990

* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for COLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	893.26	980	.91		
CONSTANT	35.03	1	35.03	38.43	.000
FUELTYPE	5.31	4	1.33	1.46	.213
YEAR	.35	1	.35	.39	.534
FUELTYPE BY YEAR	7.48	4	1.87	2.05	.085

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DUNCAN'S MULTIPLE RANGE TEST
Carbon Monoxide by Fuel Type

CARBON MONOXIDE AT IDLE

Multiple Range Test

Duncan Procedure
Ranges for the .050 level -

2.78 2.93 3.01 3.09

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
.4729 * Range * Sqrt(1/N(I) + 1/N(J))

No two groups are significantly different at the .050 level

CARBON MONOXIDE AT LOAD

Multiple Range Test

Duncan Procedure
Ranges for the .050 level -

2.78 2.93 3.01 3.09

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
.7100 * Range * Sqrt(1/N(I) + 1/N(J))

(*) Denotes pairs of groups significantly different at the .050 level

Mean	Group	Grp 5	Grp 4	Grp 2	Grp 1	Grp 3
.1228	Grp 5					
.1484	Grp 4					
.2528	Grp 2					
.4186	Grp 1	*	*			
.4424	Grp 3	*	*			

APPENDIX C

Statistical Analysis Tables
Hydrocarbons

STATISTICAL ANALYSIS OVER TIME (BEFORE/AFTER)
Hydrocarbons at Idle

GASOLINE (1987)

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Cell Means and Standard Deviations
Variable .. HCIDLE

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	42.448	42.736	29
FUELTYPE	METHANOL	39.348	48.414	46
FUELTYPE	MTBE	50.485	47.260	33
FUELTYPE	CNG	57.074	71.800	27
FUELTYPE	PROPANE	39.872	49.226	39
For entire sample		44.845	51.666	174

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	454202.06	169	2687.59		
CONSTANT	352170.81	1	352170.81	131.04	.000
FUELTYPE	7608.75	4	1902.19	.71	.588

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ALTERNATE FUEL (1988-89)

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Cell Means and Standard Deviations
Variable .. HCIDLE

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	40.359	47.959	195
FUELTYPE	METHANOL	50.692	82.920	250
FUELTYPE	MTBE	40.427	46.184	157
FUELTYPE	CNG	69.589	72.578	146
FUELTYPE	PROPANE	124.706	209.233	204
For entire sample		65.641	117.528	952

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	12141816.26	947	12821.35		
CONSTANT	3894754.98	1	3894755.0	303.77	.000
FUELTYPE	994284.88	4	248571.22	19.39	.000

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STATISTICAL ANALYSIS OVER TIME (BEFORE/AFTER)
Hydrocarbons at Load

GASOLINE (1987)

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Cell Means and Standard Deviations
Variable .. HCLOAD

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	98.333	24.007	3
FUELTYPE	METHANOL	83.500	31.820	2
FUELTYPE	MTBE	100.500	16.842	4
FUELTYPE	CNG	266.250	165.423	4
FUELTYPE	PROPANE	97.000	2.828	2
For entire sample		141.533	110.315	15

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	85118.92	10	8511.89		
CONSTANT	227333.37	1	227333.37	26.71	.000
FUELTYPE	85252.82	4	21313.20	2.50	.109

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ALTERNATE FUEL (1988-89)

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Cell Means and Standard Deviations
Variable .. HCLOAD

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	60.471	41.772	17
FUELTYPE	METHANOL	76.917	51.609	12
FUELTYPE	MTBE	79.571	49.216	14
FUELTYPE	CNG	73.083	31.079	12
FUELTYPE	PROPANE	81.000	49.344	11
For entire sample		73.227	44.348	66

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	123679.50	61	2027.53		
CONSTANT	354982.69	1	354982.69	175.08	.000
FUELTYPE	4158.09	4	1039.52	.51	.727

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STATISTICAL ANALYSIS BY FUEL TYPE
Hydrocarbons at Idle

ETHANOL

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Cell Means and Standard Deviations
Variable .. HCIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	42.448	42.736	29
YEAR	ALT FUEL	40.359	47.959	195
For entire sample		40.629	47.231	224

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	497356.04	222	2240.34		
CONSTANT	173109.67	1	173109.67	77.27	.000
YEAR	110.20	1	110.20	.05	.825

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METHANOL

Cell Means and Standard Deviations
Variable .. HCIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	39.348	48.414	46
YEAR	ALT FUEL	50.692	82.920	250
For entire sample		48.929	78.601	296

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	1817531.72	294	6182.08		
CONSTANT	314974.52	1	314974.52	50.95	.000
YEAR	4999.79	1	4999.79	.81	.369

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MTBE

Cell Means and Standard Deviations
Variable .. HCIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	50.485	47.260	33
YEAR	ALT FUEL	40.427	46.184	157
For entire sample		42.174	46.404	190

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	404212.65	188	2150.07		
CONSTANT	225371.29	1	225371.29	104.82	.000
YEAR	2758.62	1	2758.62	1.28	.259

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CNG

Cell Means and Standard Deviations
Variable .. HCIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	57.074	71.800	27
YEAR	ALT FUEL	69.589	72.578	146
For entire sample		67.636	72.393	173

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	897839.19	171	5250.52		
CONSTANT	365570.25	1	365570.25	69.63	.000
YEAR	3568.86	1	3568.86	.68	.411

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PROPANE

Cell Means and Standard Deviations
Variable .. HCIDLE

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	39.872	49.226	39
YEAR	ALT FUEL	124.706	209.233	204
For entire sample		111.091	195.134	243

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	8979078.71	241	37257.59		
CONSTANT	886809.54	1	886809.54	23.80	.000
YEAR	235629.30	1	235629.30	6.32	.013

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STATISTICAL ANALYSIS BY FUEL TYPE
Hydrocarbons at Load

ETHANOL

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Cell Means and Standard Deviations
Variable .. HCLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	98.333	24.007	3
YEAR	ALT FUEL	60.471	41.772	17
For entire sample		66.150	41.502	20

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	29070.90	18	1615.05		
CONSTANT	64307.65	1	64307.65	39.82	.000
YEAR	3655.65	1	3655.65	2.26	.150

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METHANOL

Cell Means and Standard Deviations
Variable .. HCLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	83.500	31.820	2
YEAR	ALT FUEL	76.917	51.609	12
For entire sample		77.857	48.346	14

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	30311.42	12	2525.95		
CONSTANT	44114.58	1	44114.58	17.46	.001
YEAR	74.30	1	74.30	.03	.867

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MTBE

Cell Means and Standard Deviations
Variable .. HCLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	100.500	16.842	4
YEAR	ALT FUEL	79.571	49.216	14
For entire sample		84.222	44.526	18

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	32340.43	16	2021.28		
CONSTANT	100880.02	1	100880.02	49.91	.000
YEAR	1362.68	1	1362.68	.67	.424

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CNG

Cell Means and Standard Deviations
Variable .. HCLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	266.250	165.423	4
YEAR	ALT FUEL	73.083	31.079	12
For entire sample		121.375	116.807	16

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	92719.67	14	6622.83		
CONSTANT	345441.33	1	345441.33	52.16	.000
YEAR	111940.08	1	111940.08	16.90	.001

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PROPANE

Cell Means and Standard Deviations
Variable .. HCLOAD

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	97.000	2.828	2
YEAR	ALT FUEL	81.000	49.344	11
For entire sample		83.462	45.451	13

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCLOAD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	24356.00	11	2214.18		
CONSTANT	53619.08	1	53619.08	24.22	.000
YEAR	433.23	1	433.23	.20	.667

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STATISTICAL ANALYSIS FOR MONTHS OF OCTOBER THROUGH DECEMBER
Hydrocarbons at Idle

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Cell Means and Standard Deviations
Variable .. HCIDLE

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL			
YEAR	GASOLINE	42.448	42.736	29
YEAR	ALT FUEL	44.656	64.011	32
FUELTYPE	METHANOL			
YEAR	GASOLINE	39.348	48.414	46
YEAR	ALT FUEL	35.100	41.840	40
FUELTYPE	MTBE			
YEAR	GASOLINE	50.485	47.260	33
YEAR	ALT FUEL	33.000	43.516	20
FUELTYPE	CNG			
YEAR	GASOLINE	57.074	71.800	27
YEAR	ALT FUEL	64.182	42.556	22
FUELTYPE	PROPANE			
YEAR	GASOLINE	39.872	49.226	39
YEAR	ALT FUEL	107.452	73.225	31
For entire sample		50.279	56.604	319

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for HCIDLE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	884361.83	309	2862.01		
CONSTANT	791804.18	1	791804.18	276.66	.000
FUELTYPE	63848.30	4	15962.07	5.58	.000
YEAR	9133.42	1	9133.42	3.19	.075
FUELTYPE BY YEAR	71559.10	4	17889.77	6.25	.000

DUNCAN'S MULTIPLE RANGE TEST
Hydrocarbons at Load by Fuel Type

Multiple Range Test

Duncan Procedure
Ranges for the .050 level -

2.83 2.98 3.07 3.14

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
31.8397 * Range * Sqrt(1/N(I) + 1/N(J))

No two groups are significantly different at the .050 level

APPENDIX D

Statistical Analysis Tables
Nitrogen Oxides

STATISTICAL ANALYSIS OVER TIME (BEFORE/AFTER)
Nitrogen Oxides

GASOLINE (1987)

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Cell Means and Standard Deviations
Variable .. NOX

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	439.577	380.675	26
FUELTYPE	METHANOL	283.326	220.267	43
FUELTYPE	MTBE	273.710	236.550	31
FUELTYPE	CNG	313.148	221.181	27
FUELTYPE	PROPANE	345.474	350.994	38
For entire sample		325.333	288.887	165

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for NOX using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	13169467.06	160	82309.17		
CONSTANT	17414544.15	1	17414544	211.57	.000
FUELTYPE	517259.61	4	129314.90	1.57	.185

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ALTERNATE FUEL (1988-89)

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Cell Means and Standard Deviations
Variable .. NOX

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL	462.966	457.785	147
FUELTYPE	METHANOL	458.079	497.053	191
FUELTYPE	MTBE	435.419	479.565	124
FUELTYPE	CNG	441.389	430.223	95
FUELTYPE	PROPANE	293.743	347.244	167
For entire sample		415.094	450.153	724

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for NOX using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	143241123.4	719	199222.70		
CONSTANT	119473246.5	1	119473246	599.70	.000
FUELTYPE	3265976.25	4	816494.06	4.10	.003

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STATISTICAL ANALYSIS BY FUEL TYPE
Nitrogen Oxides

ETHANOL

Cell Means and Standard Deviations
Variable .. NOX

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	439.577	380.675	26
YEAR	ALT FUEL	462.966	457.785	147
For entire sample		459.451	446.118	173

* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for NOX using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	34219577.18	171	200114.49		
CONSTANT	17996178.70	1	17996179	89.93	.000
YEAR	12085.66	1	12085.66	.06	.806

METHANOL

Cell Means and Standard Deviations
Variable .. NOX

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	283.326	220.267	43
YEAR	ALT FUEL	458.079	497.053	191
For entire sample		425.966	463.479	234

* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for NOX using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	48979527.26	232	211118.65		
CONSTANT	19292830.57	1	19292831	91.38	.000
YEAR	1071852.46	1	1071852.5	5.08	.025

MTBE

Cell Means and Standard Deviations
Variable .. NOX

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	273.710	236.550	31
YEAR	ALT FUEL	435.419	479.565	124
For entire sample		403.077	445.869	155

* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for NOX using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	29966568.58	153	195859.93		
CONSTANT	12471026.81	1	12471027	63.67	.000
YEAR	648520.49	1	648520.49	3.31	.071

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CNG

Cell Means and Standard Deviations
Variable .. NOX

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	313.148	221.181	27
YEAR	ALT FUEL	441.389	430.223	95
For entire sample		413.008	396.434	122

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for NOX using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	18670610.00	120	155588.42		
CONSTANT	11969867.32	1	11969867	76.93	.000
YEAR	345766.99	1	345766.99	2.22	.139

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PROPANE

Cell Means and Standard Deviations
Variable .. NOX

FACTOR	CODE	Mean	Std. Dev.	N
YEAR	GASOLINE	345.474	350.994	38
YEAR	ALT FUEL	293.743	347.244	167
For entire sample		303.332	347.661	205

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for NOX using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	24574307.40	203	121055.70		
CONSTANT	12648579.41	1	12648579	104.49	.000
YEAR	82842.04	1	82842.04	.68	.409

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STATISTICAL ANALYSIS FOR MONTHS OF OCTOBER THROUGH DECEMBER
Nitrogen Oxides

- - - - - - - - - -

Cell Means and Standard Deviations
Variable .. NOX

FACTOR	CODE	Mean	Std. Dev.	N
FUELTYPE	ETHANOL			
YEAR	GASOLINE	439.577	380.675	26
YEAR	ALT FUEL	387.107	342.886	28
FUELTYPE	METHANOL			
YEAR	GASOLINE	283.326	220.267	43
YEAR	ALT FUEL	610.182	657.066	33
FUELTYPE	MTBE			
YEAR	GASOLINE	273.710	236.550	31
YEAR	ALT FUEL	681.556	747.954	18
FUELTYPE	CNG			
YEAR	GASOLINE	313.148	221.181	27
YEAR	ALT FUEL	377.278	322.927	18
FUELTYPE	PROPANE			
YEAR	GASOLINE	345.474	350.994	38
YEAR	ALT FUEL	371.032	494.484	31
For entire sample		393.229	426.544	293

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for NOX using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	48778053.67	283	172360.61		
CONSTANT	45446486.91	1	45446487	263.67	.000
FUELTYPE	673662.23	4	168415.56	.98	.420
YEAR	1624863.31	1	1624863.3	9.43	.002
FUELTYPE BY YEAR	2234856.67	4	558714.17	3.24	.013

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Appendix III.

Emissions Analysis
Department of Environmental Quality

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

ROSE MOFFORD, GOVERNOR
RANDOLPH WOOD, DIRECTOR

RECEIVED

ADOT ALTERNATIVE FUELS FLEET -- EMISSION TEST PROGRAM

By Frank W. Cox

Introduction

An increasing population (both human and vehicle) and corresponding increases in various environmental pollutants has prompted the State of Arizona to enact legislation establishing controls and mandating research aimed at abatement. HB 2115 and SB 1360 mandated an alternative-fuels fleet study to be performed by the Arizona Department of Transportation (ADOT), and HB 2206 mandated a vehicle emissions study of a representative portion of the ADOT fleet to be performed by the Arizona Department of Environmental Quality (ADEQ).

The ADOT vehicle fleet was put into service in October of 1987 using unleaded gasoline to gather baseline performance and I&M emission data. In January of 1988 the use of the baseline gasoline was discontinued and operation on the various alternative fuels began. In February of 1989, after thirteen months of operation on the alternative fuels, the ADEQ Emissions Research Laboratory (ERL) began testing selected ADOT fleet vehicles to determine the effect, if any, of the alternative fuels on evaporative and exhaust emissions as compared to these emissions generated by the use of unleaded gasoline.

This report contains the summarized data obtained from the ERL testing and discussions of this data and the test methods.

Vehicles

The test vehicle fleet is listed in Table 1. The only vehicle type included in the ADOT fleet which was not tested was the 1984 Chevrolet S10 pickup. This vehicle type was omitted from the test fleet because of its similarity to the 1983 Chevrolet S10 pickup. In order to directly compare fuel effects, vehicles 1 thru 5 were tested with unleaded gasoline and two discreet oxygenated fuels, one containing methyl tertiarybutyl ether (MTBE) and the other containing ethanol (EtOH). Vehicle 6 was a gasoline/CNG (compressed natural gas) dual-fueled vehicle and was tested only with these two fuels (no oxygenated fuel substituted for the gasoline). Vehicle 7 had been converted to liquid petroleum gas (LPG), was fuel dedicated, and could not be tested with other fuels. The remaining vehicle (8) was tested with unleaded gasoline and with a third oxygenated fuel containing methanol (MeOH). Vehicles 6,7, and 8 were, with respect to emission control system and to engine size and configuration, similar to vehicles 5,4, and 3, respectively.

600 North 40th Street Phoenix, Arizona 85008

Fuels

The oxygenate compositions and Reid vapor pressures (RVP) of the liquid test fuels were:

Composition (nominal)	RVP, psi Original Fuel Samples	RVP, psi Actual Test Fuels
1. Unleaded Gasoline (neat)	12.1	10.3[1]
2. Gasoline/11% MTBE	11.7	11.8
3. Gasoline/10% EtOH	11.6	11.5
4. Gasoline/5% MeOH/5% TBA[2]	7.3[3]	11.9

1. This apparently low RVP is discussed later in this report.
2. Actually equivalent to "Oxinol" (ARCO trade name) with 4.75% MeOH/4.75% TBA.
3. This fuel was not used for testing.

Fuel samples were taken from the storage tanks at the ADOT fueling depots. The criterion for acceptance for testing was that the RVPs of the liquid fuels be similar. Fuels, 1,2, and 3 were judged to be acceptable, but the vapor pressure of the "Oxinol" blend was too low. The entire supplies of fuels 1,2, and 3 were taken as single batches of the individual fuels directly from the ADOT storage tanks into 55-gallon drums and immediately sealed. The storage tanks from which the test fuels were taken were the same as those from which the original samples were obtained. The "Oxinol" test fuel was acquired after the ADOT took delivery of a new batch. The vapor pressure of this fuel was within the desired range.

Test Procedures

Upon delivery, each vehicle fuel tank was removed and a drain line and thermocouple were installed. The drain line was extended to the lowest point of the tank and the thermocouple to the midpoint between the tank bottom and the fuel surface at the 40% nominal fuel tank volume level. Each tank was then pressurized to 3 psi air to ensure vapor tightness and reinstalled on the vehicle.

Each vehicle was checked for engine vacuum leaks and faulty spark plugs and spark plug wires. These were the only maintenance items replaced when found to be faulty. Engine operating parameters were also checked and, excepting the LPG and CNG vehicles, set to factory specifications. Vehicle preparation was completed with checks of the exhaust system and installed fuel tank for leaks. This was accomplished with the instrument bench hydrocarbon analyzer by attaching a 3-port valve and sniff line between the sample inlet and the analyzer.

At the end of testing, the thermocouple was removed from the fuel tank and the fittings installed for the thermocouple and drain line were capped.

With three exceptions, to be discussed below, the Federal Test Procedure (FTP) was used for all tests. The details of the procedure are given in the Code of Federal Regulations (CFR) Title 40, Part 86, Subpart B. This reference also gives the details of the required equipment, calibrations, and conditions.

One departure from the FTP concerned the ambient test temperature limits. The FTP requires that the temperature to which the vehicle and test equipment are exposed be maintained within the limits, 68°F to 86°F. Since the available test fuels were winter grade (vapor pressures at the lower end of volatility class D), the decision was made to test at lower than the specified ambient temperature range. An ambient temperature range of 51°F to 69°F was chosen (a -17°F offset from the FTP) because 1. it was believed to be the lowest feasible range at which the facility could be maintained, 2. this range more nearly simulates winter temperatures in Maricopa county, and 3. the FTP specified temperatures would result in unrealistic canister loading during the pretest soak period.

The diurnal (or heat build) evaporative (SHED) test is intended to measure evaporative losses during a simulated diurnal (daily) temperature rise. Testing at lower ambient temperatures required that the temperature range for the fuel heat build also be lowered. Accordingly, this range was lowered 17°F from the FTP to 43°F-67°F. The FTP heat build ramp was maintained.

Preceding the 12-36 hour soak period prior to testing, the FTP stipulates that the fuel tank be drained, the vehicle refueled to the required volume, and then driven on the dynomometer according to the Urban Dynomometer Driving Schedule (UDDS) and at the vehicle test weight and horsepower. The UDDS is required within one hour of refueling. The FTP allows up to three additional preconditioning driving cycles, each preceded by a one hour soak period.

Since each ADOT test fuel was significantly different from the others, and to minimize memory effects, a three-driving-cycle schedule was adopted for preconditioning when the test fuel was different from the preceding test. For back-to-back tests with the same fuel, the single preconditioning driving cycle was used. The three-driving-cycle schedule was:

1. drain and refuel
2. UDDS driving cycle within one hour of refueling
3. ten minute soak
4. UDDS driving cycle
5. one hour soak
6. drain and refuel
7. UDDS driving cycle.

The soak period between the first and second driving cycles was reduced to ten minutes to conserve time and the extra refueling was included as an added measure to minimize memory effects of the previous fuel.

The fuel sequence was random beginning or ending the test series with no particular fuel. For the first test, however, each vehicle was preconditioned using the three-driving-cycle schedule.

At least two tests were performed with each vehicle/fuel couple. A third test was performed when agreement between the duplicate tests was judged to be inadequate or when FTP limits were exceeded to a point considered to be capable of producing significant effects on test data.

Results and Discussions

The results of the emissions test program are presented in Table 2. Excepting the SHED emissions for vehicle B545 in the CNG mode, each emission value is the arithmetic average of at least duplicate tests, and in some cases, triplicate tests. The number of vehicles was small and little effort was exerted to verify mechanical condition or emission control functionality. Therefore, no statistical evaluation has been performed to determine the significance of data magnitude or relativity. This discussion is based upon a general interpretation of the data and the resulting conclusions reflect the opinion of the author.

Evaporative emissions are primarily effected by 1. test temperature (and temperature ramp), 2. fuel composition and volatility, 3. the type and condition of the fuel handling system, and 4. the configuration and condition of the evaporative emission controls. Since both ambient and heat build temperatures were lowered by 17°F from the FTP, the SHED data can only be internally compared. The magnitude of the evaporative emissions is significant only for comparison of the various fuels with a single vehicle. Relative data can, however, be compared across the vehicle/fuel matrix. The fuel vapor pressures given previously in this report would lead to a tentative conclusion that the evaporative emissions from the gasoline should be lower than from the alternative liquid fuels. The data, however, do not support this conclusion. At face value, the data indicate that essentially equivalent vapors are emitted from the MTBE fuel as compared to gasoline and lower levels are emitted from the EtOH fuel.

A number of parameters which influence evaporative emissions must be considered. First, RVP is a measure of volatility at 100°F and the rate of vapor pressure change as a function of temperature is not known for the test fuels. In addition, the history and condition of the control canisters is not known, and the average replicate variation of all vehicle/fuel couples was about 20%, a variability consistent with literature values. These uncertainties leave little doubt that no conclusion can be drawn with respect to the effect of fuel composition upon evaporative emissions.

The repeatability of the exhaust measurements was much better than that for evaporative emissions. The average replicate variations for all vehicle/fuel couples were about 8.5% for hydrocarbons, 7.0% for nitrogen oxides, and 12.5% for carbon monoxide. Actual fuel vapor pressure and vapor control canister condition cannot be ignored as exhaust emission variables, but their effects should be less prominent with respect to exhaust emissions as compared to evaporative emissions.

For the group of five vehicles tested with gasoline, MTBE, and EtOH fuels; the emission trends for the oxygenated fuels relative to gasoline are:

1. hydrocarbons - decreases for both MTBE and EtOH,
2. nitrogen oxides - no apparent effect for either oxygenated fuel, and
3. carbon monoxide - decreases for both MTBE and EtOH.

These general trends are also consistent with the gasoline/"Oxinol" test results. The oxygenated fuels produced no positive deviations for hydrocarbon emissions and the two deviations shown for NO_x emissions are very close to the average variation for replicate tests.

One emission anomaly shown in Table 2 requires discussion. Vehicle B729 with MTBE shows a 29.4% increase for CO as compared to gasoline. This vehicle was exceptionally hard to start and required triplicate tests with MTBE. The CO levels produced by the independent tests were 5.1, 3.0, and 5.2 grams/mile. Long cold starts for the first and third tests produced high phase 1 emissions, but this did not account for the difference between 3 and 5 grams/mile. Further analysis of the raw data revealed consistently high CO emissions in phase 3 (the hot start) of the tests with MTBE as compared to either gasoline or the EtOH fuel. The only conclusion supported by the data is that this vehicle, under the test conditions and in its operating condition at the time, did produce higher CO emissions with MTBE fuel than with gasoline. The author cannot offer a reasonable explanation for this anomaly.

Excepting the vehicle/fuel anomaly discussed in the preceding paragraph, the CO emissions with the oxygenated fuels are substantially lower than those produced with gasoline. The average decreases (percent change with respect to gasoline) for both MTBE and EtOH fuels are larger than the corresponding average duplication variations.

Very little can be said about the single vehicle (BC32) tested with gasoline and an "Oxinol" type oxygenated blend other than the exhaust emission changes for the oxygenated fuel relative to gasoline agree with the changes shown for the 5-vehicle X 3-fuel matrix discussed above.

Extreme caution must be practiced when comparing test results from two vehicles. The exhaust emissions from the propane fueled vehicle (B745), however, are impressively low when compared to the emissions from a similar vehicle (B729) operating on the liquid fuels.

The dual-fueled gasoline/CNG vehicle (B545) emissions are not representative. Test results prompted an "after-the-fact" more detailed inspection of the vehicle. Apparently, a faulty PCV valve had caused engine oil to be drawn into the intake system. Both the intake air filter and the evaporative control canister were saturated with engine oil. Comparing emissions from this vehicle, again with reservations, to those from a similar vehicle (B511) leads to the conclusion that the dual-fueled vehicle was operating fuel rich with gasoline and exceptionally fuel rich with CNG. The significance of the vehicle B545 data lies in their value for demonstrating the high evaporative emissions associated with an inoperative control canister and the change in exhaust emissions associated with fuel rich operation (exhaust NO_x is lowered, but HC and CO emissions increase; at some point, to intolerable levels).

It is well known that the composition of exhaust hydrocarbon emissions is similar to the fuel hydrocarbon composition. The methane fractions of vehicle B545 exhaust hydrocarbon emissions were calculated and found to average 7.9% with gasoline and 71.3% when the vehicle was fueled by CNG. The large increase in the methane portion of the hydrocarbon emissions is indicative of a decrease in reactivity with respect to atmospheric smog formation.

Table 2 also contains volumetric fuel economy (FE) values. Since the UDDS involves very little steady state operation at cruise speeds, the FE magnitude is not directly relatable to user service. The values in the table should, however, approximate the fuel economy of the vehicles when operated in populated areas. The volumetric FE gains shown for MTBE (B938) and for MTBE and EtOH (B511) resulted from two (of twelve) anomalous exhaust CO_2 levels. CO_2 was low for one of the duplicate tests of B938 with MTBE fuel and high for one of the duplicate tests of B511 with gasoline. The volumetric energy content of the oxygenated fuels is slightly less than that of gasoline and a small corresponding decrease in volumetric fuel economy should be expected. The 2.2% average loss for the oxygenated fuels (disregarding the values discussed above) is reasonable.

The volumetric fuel economies for the vehicles operating on gaseous fuels (CNG and LPG) are given in gasoline equivalents based upon the energy consumed. The energy charge density within the engine cannot be maintained with carbureted gaseous fuels as compared to liquid fuels (there is a volumetric efficiency loss); therefore, a fuel economy loss is inevitable.

The fuel economy based upon energy content is given in Table 3 in terms of BTU consumption per mile traveled. These data show that there is little, if any, difference in operating efficiency associated with the use of any of the liquid fuels. Disregarding the three values discussed earlier in conjunction with volumetric fuel economy, the average change in fuel-energy economy was +0.4% when the oxygenated fuels were used.

Summary

The Emissions Research Laboratory of the ADEQ tested eight (8) selected vehicles from the ADOT alternative fuels fleet to determine the effect of the alternative fuels upon evaporative and exhaust emissions. Duplicate tests were performed for all vehicle/fuel couples. Five (5) vehicles were tested with three (3) fuels (unleaded gasoline, gasoline/11% MTBE, and gasoline/10% ethanol); one (1) vehicle was tested with gasoline and gasoline/5% methanol/5% TBA; one (1) vehicle (dual-fueled) was tested with gasoline and CNG; and one (1) vehicle (dedicated) was tested with LPG.

For the 5-vehicle/3-fuel test matrix (and tentatively the single vehicle with gasoline/"Oxinol") the oxygenated fuel effects were: 1. no apparent effect on evaporative emissions, exhaust NO_x, or fuel-energy economy; and 2. decreases in exhaust HC, exhaust CO, and volumetric fuel economy. A mechanical problem (a faulty PCV valve) severely limited the value of the data obtained from the gasoline/CNG dual-fueled vehicle, but emissions from the dedicated LPG vehicle were impressively low.

FEC:mc

Attachments:
Table 1
Table 2
Table 3

TABLE 1
TEST VEHICLE MATRIX

	MAKE	ENGINE FAMILY	EMISSION CONTROL	ADOT No.
1.	1986 Chevrolet S10	G1G2-8T5HTR5	EGR/PMP/OXD/CLS	BD12
2.	1985 Chevrolet Celebrity	F1G2-8V8HGG9	EGR/3CL	A446
3.	1985 Ford Ranger	FFM2-8T2HKG0	EGR/PMP/OXD/3CL	B938
4.	1983 Chevrolet S10	D1G2-8T2H5C2	EGR/PMP/OXD	B729
5.	1980 Chevrolet C10	08Y2A	EGR/OXD	B511
	Optional*			
6.	1980 Chevrolet C10	08Y2A	EGR/OXD (CNG)	B545
7.	1983 Chevrolet S10	D1G2-8T2H5C2	EGR/PMP/OXD (LPG)	B745
8.	1985 Ford Ranger	FFM2-8T2HKG0	EGR/PMP/OXD/3CL	BC32

* Vehicles in the optional category to be tested only on base gasoline and one alternative fuel: CNG for 6, LPG for 7 and methanol blend for 8.

Table 2 ---- ADOT FLEET EVAPORATIVE AND EXHAUST EMISSIONS[1]

FUEL TYPE	EMISSIONS: EVAPORATIVE		EXHAUST						Miles/Gal	
	Shed gms.	% Chg.	HC gms.	% Chg.	NOx gms.	% Chg.	CO gms.	% Chg.	FE	%Chg.
1985 CHEVROLET CELEBRITY (4446)										
Gasoline	0.3		0.4		0.5		8.0		17.8	
MTBE 11%	0.3	0.0	0.3	-25.0	0.5	0.0	6.7	-16.3	17.2	-3.4
Ethanol 10%	0.2	-33.3	0.3	-25.0	0.5	0.0	7.8	-2.5	17.0	-4.4
1986 CHEVROLET S10 (2012)										
Gasoline	0.3		0.4		1.2		5.3		17.8	
MTBE 11%	0.3	0.0	0.4	0.0	1.1	-8.3	4.1	-22.6	17.6	-1.1
Ethanol 10%	0.2	-33.3	0.3	-25.0	1.1	-8.3	3.6	-32.1	17.5	-1.7
1985 FORD RANGER (8973)										
Gasoline	1.6		1.8		1.0		33.3		15.8	
MTBE 11%	1.3	-18.9	1.5	-16.7	1.0	0.0	28.5	-14.4	16.2	+2.5
Ethanol 10%	1.2	-25.0	1.5	-16.7	1.0	0.0	25.6	-23.1	15.7	-0.6
1983 CHEVROLET S10 (87[illegible])										
Gasoline	1.6		0.6		1.8		3.4		19.6	
MTBE 11%	1.7	+6.3	0.6	0.0	1.9	+5.6	4.4[2]	+29.4	19.2	-2.0
Ethanol 10%	1.6	0.0	0.6	0.0	2.0	+11.1	2.2	-35.3	19.5	-0.5

[1] All values are arithmetic averages of at least two tests.
[2] The author sees no plausible explanation for this anomaly.

Table 2 cont. --- ADOT FLEET EVAPORATIVE AND EXHAUST EMISSIONS[1]

FUEL TYPE	EMISSIONS: EVAPORATIVE: Shed gms.	% Chg.	EXHAUST: HC gms.	% Chg.	NOx gms.	% Chg.	CO gms.	% Chg.	Miles/Gal: FE	%Chg.
1990 CHEVROLET C10 (8511)										
Gasoline	3.4		1.0		7.4		14.7		12.4	
MTBE 11%	3.3	-2.9	0.9	-10.0	7.4	0.0	13.4	-8.8	12.7	+2.4
Ethanol 10%	4.1	+20.6	0.8	-20.0	7.4	0.0	11.3	-23.1	12.6	+1.6
1985 FORD RANGER ([illegible])										
Gasoline	4.1		1.6		8.8		31.0		17.5	
Methanol 5% TBA 5%	1.9	-53.7	1.5	-6.3	9.9	+12.5	25.3	-18.4	16.8	-4.0
1983 CHEVROLET S10 (8745)										
Propane	----[2]		0.4		0.9		0.6		15.7[3]	
1980 CHEVROLET C10 (8545)										
Gasoline	23.0		2.2		6.0		41.7		12.9	
CNG	26.1[4]		4.1	+86.4	2.6	-56.7	105.2	+152.3	10.4[5]	-19.4[6]

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[1]All values are arithmetic averages of at least two tests.

[2]Evaporative emissions are meaningless for a closed system. System integrity was checked with one hot soak (0.5 grams emitted).

[3]Fuel economy in terms of a volume of gasoline containing energy equivalent to the propane consumed.

[4]Equivalent evaporative emissions while in the CNG mode, shows that the two fuel systems are independent.

[5]See footnote 3 (energy equivalent to the CNG consumed).

[6]The 19.4 fuel economy loss is the sum of the effects: (1) fuel - rich mixture, (2) volumetric efficiency loss, and (3) decreased combustion speed.

Table 3 - ADOT FLEET FUEL-ENERGY ECONOMY

FUELS

1. Gasoline (unleaded)
2. Gasoline/11% MTBE
3. Gasoline/10% Ethanol
4. Gasoline/ 5% Methanol/5% TBA
5. Compressed Natural Gas (CNG)
6. Propane

VEHICLE	BTU/mi. With Corresponding Fuel					
	1	2	3	4	5	6
A446	6347	6424	6428			
BD12	6341	6297	6252			
B938	7122	6830	6956			
B729	5761	5770	5611			
B511	9102	8725	8644			
BC32	6450			6514		
B545	8725				10878	
B745						6746

Appendix IV.
Mechanics Report

ARIZONA DEPARTMENT OF TRANSPORTATION

OFFICE MEMO

October 4, 1989

TO: ROBERT E. PIKE
Research Planner
AZ Tr Research Center (075-R)

FROM: LARRY L. KINDRED
Automotive Shop Supervisor (D-1)
Equipment Services (071-R)

SUBJECT: ALTERNATE FUEL PROGRAM

XL-1 - Type I - Ethanol

During our test period this liquid fuel had minimal problems.

XL-2 - Type II- Methanol

During our test this fuel was the worst of them all. We had problems with injectors, fuel pump and carburetor problems, plus stalling out problems.

XL-3 - Type III - MTBE

During our test period we experienced very minimal problems with this fuel. It mixed well with regular and unleaded.

XNG - Type IV - Natural Gas

The inconveniency of the refill station(s) proved to be a problem plus the fact that drivers found it easier to fill up with regular gas and use it rather than to take the time to refill with CNG.

XPG - Type V - Liquid Propane

During the test period we experienced problems with the 0-90 gauges not working properly with each other (tank and dash). The cost of replacement parts were expensive. Where our people were required to refill their vehicles proved very inconvenient. There was considerable downtime.

Larry Kindred

LLK:cg

cc: J. West
B. Brown
D. Halachoff

8-9590 2/75
FORMERLY 8-9547

NOT A ATF Vehicle Equip. # A539

ORC 4199
methal

XL2

Sample
Mechanics Log
Vehicle Plate # ST-1410

Date	Mechanic	Odometer	Description of Problem	Hrs to Repair	Cost of Parts
10-21 88	17 57	43658	Bad Tank of fuel		

Equip. # A362

XL2

Sample
Mechanics Log
Vehicle Plate # ST1016

Date	Mechanic	Odometer	Description of Problem	Hrs to Repair	Cost of Parts
10-26-88	63		Pops thru intake	10.6	

clogged fuel injectors
Replaced All (6) injectors

Equip. #BC32

XL2

Sample
Mechanics Log
Vehicle Plate # ST1276

Date	Mechanic	Odometer	Description of Problem	Hrs to Repair	Cost of Parts
6-15-80	Ralph	23179	CARB. high CO Replaced CARB.	4	

Equip. # A445

XL2

Sample
Mechanics Log
Vehicle Plate # ST1008

Date	Mechanic	Odometer	Description of Problem	Hrs to Repair	Cost of Parts
11-7-88	Ralph	35638	Back Firing clogged up Nozzle Back Firing when cold		

Equip. # BB70X

XL2

Sample
Mechanics Log
Vehicle Plate # ST1118

Date	Mechanic	Odometer	Description of Problem	Hrs to Repair	Cost of Parts
12-29-88	34	36084	HESITATES+STALLS	2	$24.00
			R+R FUEL FILTER		
			CHECK ON ACE DYNAMOS		
			TIE, MACHINE PLUGS,		
			WIRES, ELECTRICAL OK		
			TEST FUEL PUMP		
			PRESSURE 6 LB,		
			VACUUM 17 IN.		
			HAD CARB REBUILT →	2.7	22.00
			TEST VEHICLE EACH		
			TIME		
			FINAL DRAIN ALL		
			FUEL PUT UNLEADED		
			IN TANK TEST DROVE		
			NO HESITATION OR		
			STALLING DURING TEST		

Equip. # B551

XL2

Sample
Mechanics Log
Vehicle Plate # ________

Date	Mechanic	Odometer	Description of Problem	Hrs to Repair	Cost of Parts
12-5-88	64	52936	CARB R&R ① Large Amt dirt ② Accel pump stuck in down pos. ③ Throttle shaft bore wore ④ CARB body warped. Pull fuel Sample for Test Field Test Indicates Approx 8% ECOH Dilute remaining fuel in Ⓡ Tank (3-4 GAL) c̄ NON-ECOH Unlead - veh. Runs normal	2.7	25.00

Equip. # A362

XL2

Sample
Mechanics Log
Vehicle Plate # ______

Date	Mechanic	Odometer	Description of Problem	Hrs to Repair	Cost of Parts
12-29-89	17	40792	Stall No power Backfire, Bad fuel Methanol Went Back to unleaded OK	2	32.00

Equip. #3533

XL2

Sample
Mechanics Log
Vehicle Plate # ______

Date	Mechanic	Odometer	Description of Problem	Hrs to Repair	Cost of Parts
10/7/88	64	58816	Fuel pump	.8	[redacted]
10/7/88	64	58816	CARB R&R [redacted]	1.8	$11.13
10/13/88	64	58816	ADJ CARB scope check	1.9	

ARIZONA DEPARTMENT OF TRANSPORTATION

OFFICE MEMO

October 5, 1989

TO: Larry Kindred
ADOT Equipment Services

FROM: Tom McCowan
T.E.S.
ORG 4141

The following A.D.O.T. personnel assigned this ORG (4141) have verified the time spent on alternate fuels due to availability and location. This is downtime.

BB75X	Steve Becsei	2 hrs. weekly
BB73X	Jack Norvell	2 hrs. weekly
BB73X	Joe Rodriguez	2 hrs. weekly
BB75X	Ron Laulo	1 hr. weekly
BB85X	Kerry Huston	2 hrs. weekly
BB75X	Dave Schepper	1 hr. weekly
BD13X	Bill Byerly	2 hrs. weekly
A362X	Diane Schotka	2 hrs. weekly
		14 hrs. weekly

Thomas E. McCowan

cc: File

6-9590 2/75
(FORMERLY 8-954)

Appendix V.

Vehicle and Fuel Type

VEHICLE TYPE

TYPE A	83 Chev S-10
TYPE B	84 Chev S-10
TYPE C	85 Chev Celebrity
TYPE D	85 Ford Ranger
TYPE E	80 Chev C-10
TYPE F	86 Chev S-10
TYPE G	79 Chev C-10

FUEL TYPE

TYPE I	Ethanol Blend
TYPE II	Methanol Blend
TYPE III	MTBE Blend
TYPE IV	Compressed Natural Gas
TYPE V	Propane