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Determination of Alternative Fuels Combustion Products: Phase I Report

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FOREWORD

This project was conducted for the National Renewable Energy Laboratory (NREL) by the Department of Emissions Research of Southwest Research Institute (SwRI). This program was authorized by NREL Subcontract No. YAW-3-13253-01. Operation and management of NREL is conducted by Midwest Research Institute for the United States Department of Energy under Prime Contract No. DE-AC36-83CH10093. This program was initiated on October 1, 1993, and testing was completed in October, 1994. This project was based on SwRI Proposal 08-14326 to NREL and was identified within SwRI as Project 08-6068. The NREL Technical Monitors for this program were Mr. Brent Bailey and Mr. Chris Colucci of NREL Alternative Fuels Division, Golden, Colorado. The SwRI Project Manager was Dr. Lawrence R. Smith, and the Project Leader was Mr. Kevin A. Whitney. Mr. Jimmie Chessher, Laboratory Supervisor, was responsible for emission testing.

ABSTRACT

This report describes the laboratory effort to identify and quantify organic exhaust species generated from alternative-fueled light-duty vehicles operating over the Federal Test Procedure on compressed natural gas, liquefied petroleum gas, methanol, ethanol, and reformulated gasoline. The exhaust species from these vehicles were identified and quantified for fuel/air equivalence ratios of 0.8, 1.0, and 1.2, nominally, and were analyzed with and without a vehicle catalyst in place to determine the influence of a catalytic converter on species formation.

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ACRONYMS AND ABBREVIATIONS

CARB	California Air Resources Board
CDM	Calibration/Display Module
cfm	cubic foot per minute
CFR	Code of Federal Regulations
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CVS	Constant Volume Sampler
DNPH	2,4-dinitrophenylhydrazine
E85	85% denatured ethanol and 15% gasoline
E100	100% ethanol
ECM	Engine Control Module
EGO	Exhaust Gas Oxygen
EPA	Environmental Protection Agency
EtOH	Ethanol
FID	Flame Ionization Detector
FTP	Federal Test Procedure
GC	Gas Chromatograph
GC/FID	Gas Chromatograph/Flame Ionization Detector
GC/MS	Gas Chromatograph/Mass Spectrometry
hp	horsepower
HC	Hydrocarbons
IAC	Idle Air Control
lb	pound
L/min	liters per minute
LPG	Liquefied Petroleum Gas
M85	85% methanol and 15% gasoline
MEOH	methanol
mg	milligram
MIR	Maximum Incremental Reactivity
mph	miles per hour
MS	Mass Spectrometer
MTBE	methyl tertiary-butyl ether
NDIR	nondispersive infrared
NMOG	Non-Methane Organic Gas
NO_x	Oxides of Nitrogen
OD	Overdrive
OEM	Original Equipment Manufacturer
ppb	parts per billion
RAF	Reactivity Adjustment Factor
RFG	Reformulated Gasoline
RVP	Reid Vapor Pressure
SAE	Society of Automotive Engineers
scfm	standard cubic feet per minute
SwRI	Southwest Research Institute
THC	Total Hydrocarbons

THC/FID	Total Hydrocarbons as determined by a Flame Ionization Detector
THC/GC	Total Hydrocarbons as determined by a Gas Chromatograph
TLEV	Transitional Low Emission Vehicle
UDDS	Urban Dynamometer Driving Schedule
UEGO	Universal Exhaust Gas Oxygen
uv	ultraviolet
VIN	Vehicle Identification Number

I. INTRODUCTION

In recent years, both government and industry have increased their efforts to develop and advance technology that allows an effective use of alternative transportation fuels, including LPG, CNG, ethanol, and methanol. However, concerns continue over the potential impact of these fuels on air pollution, and on the actual air quality benefits of alternative fuels. For alternative fuels to be viable candidates to replace conventional fuels, it must be demonstrated that their impact on air quality will be no worse than that of existing fuels, and preferably should show characteristics that will improve air quality. To make this determination, it is necessary to identify the engine exhaust species that may be generated from alternative fuels and compare them to those from conventional fuels.

A. Objective

The objective of this program was to identify volatile organic exhaust species generated from alternative-fueled light-duty vehicles operating over the FTP on CNG, LPG, methanol, ethanol, and RFG. The exhaust species from these vehicles were identified and quantified for fuel/air equivalence ratios of 0.8, 1.0, and 1.2, nominally, and were analyzed with and without a catalyst in place to determine the influence of a catalytic converter on species formation.

B. Scope

A total of five fuels were evaluated under this program (LPG, CNG, methanol, ethanol, and RFG). Each fuel was evaluated on one of two vehicles at nominal fuel/air equivalence ratios of 0.8, 1.0, and 1.2. Duplicate FTP tests were conducted at each equivalence ratio, with and without the catalyst in place, for a total of 12 FTPs per fuel (3 equivalence ratios × 2 sampling configurations [with and without catalyst] × duplicate tests) — a total of 60 FTP tests for the 5 fuels.

THC, CO, NO_x, and CO_2 emissions were quantified, using proportional exhaust gas samples collected in Tedlar bags, in a manner consistent with EPA protocols for light-duty emissions testing.[1] Analytical procedures for conducting hydrocarbon speciation (C_1 to C_{12} hydrocarbons, aldehydes and ketones) were similar to the CRC Auto/Oil Phase II methods. Using the results of speciation, a limited comparison of the ozone-forming potential of each vehicle/fuel combination was undertaken based on the MIR scale as used by CARB for individual exhaust species. Mass spectral analyses were also conducted on exhaust samples to determine exhaust hydrocarbons not identified by other speciation methods.

C. Test Vehicles

Two test vehicles were used in this program. A 1993 Chevrolet Lumina equipped with a 3.1-liter V-6 engine was used for the evaluation of LPG, CNG, and RFG combustion products. This vehicle was obtained from a local leasing company and was equipped with appropriate aftermarket conversion kits for operation on CNG and LPG. A 1988 Chevrolet Corsica, obtained from the University of Tennessee, was employed for testing with ethanol and methanol. This vehicle was originally provided to the University by General Motors for participation in the SAE Methanol Marathon. This vehicle was equipped with a CDM which allowed for modification of fuel control system calibrations. Separate calibrations were provided by the University of Tennessee for operation on ethanol and methanol. A more detailed description of the test vehicles is given in Section II.A.

D. Test Fuels

This program used five different test fuels in the FTP evaluations: commercially available LPG, CNG blended by SwRI to reflect average gas composition available in the United States,[2] a fuel blended by Phillips Petroleum to represent California Phase 2 RFG, chemical grade ethanol (>99% pure), and chemical grade methanol (>99%pure). A more detailed description of the test fuels is given in Section II.B.

E. Test Procedures

Exhaust emissions were evaluated using the chassis dynamometer portion of the light-duty Federal Test Procedure as described in the CFR, Title 40, Part 86, Subpart B. A more detailed description of the test procedures is given in Section II.C.

F. Emissions Measurement Procedures

Analyses of exhaust samples included determination of regulated exhaust emissions by CFR methods, hydrocarbon speciation and analyses of aldehyde and ketone according to Auto/Oil Phase II methods, and the determination of trace exhaust species by mass spectral analysis methods. A more detailed description of the emissions measurement procedures is given in Section II.D.

II. GENERAL EQUIPMENT, INSTRUMENTS, PREPARATIONS, AND PROCEDURES

This section describes the test vehicles, test fuels, testing and analytical procedures, and general instrumentation used throughout this project.

A. Description of Test Vehicles

A 1993 Chevrolet Lumina was used to evaluate the LPG, CNG, and RFG fuels while a 1988 Chevrolet Corsica was used to evaluate the ethanol and methanol fuels. Using two different vehicles for these evaluations provided adequate qualitative information concerning exhaust emissions; however, quantitative comparisons of exhaust emissions between the two vehicles has limited value.

The 1993 Chevrolet Lumina used to evaluate LPG, CNG, and RFG was equipped with an appropriate conversion kit for each of the gaseous fuels. Both kits were Mogas ECOLO-Feedback carbureted systems. These kits used feedback from the OEM EGO sensor to regulate a fuel control valve to maintain fuel/air stoichiometry. The kits were installed and tuned by SwRI according to the manufacturer's instructions.

The 1988 Chevrolet Corsica, used to evaluate the ethanol and methanol, originally operated on gasoline and was converted to M85 operation by the University of Tennessee as part of the SAE Methanol Marathon. The vehicle came equipped with a CDM which allows the user to modify the vehicle's fuel injection and ignition timing calibrations. The University has maintained the vehicle as a research tool and leased the vehicle to SwRI for this program. As provided, the vehicle was calibrated to operate on ethanol. A separate calibration for operation on methanol was also provided. Descriptions of both test vehicles are provided in Table 1.

TABLE 1. TEST VEHICLE DESCRIPTIONS

Item	Description	
Vehicle	Lumina	Corsica
Vehicle Body Style	2-door Euro sedan	4-door sedan
VIN	2G1WN14TXP9261375	1G1LT51W8JY667124
Vehicle Odometer	5,685 miles (as received)	14,705 miles (as received)
Engine Family	P1G3.4V8XGZ5/PBO-1K	NA (special waiver)
Engine Type	3.1-liter V-6	2.8-liter V-6
Transmissions	4-speed automatic OD	5-speed manual
Fuel System	multi-point fuel injection	multi-point fuel injection
Tires	P205/70R15	195/70-R14

To force the vehicles to operate at fuel/air equivalence ratios other than stoichiometry, each vehicle's switching EGO sensor was replaced with a UEGO sensor. The UEGO sensor was capable of operating throughout the range of fuel/air equivalence ratios required by this program. The UEGO signal was passed through a comparator circuit to generate a switching output similar to that of an EGO sensor. The comparator output was connected to the EGO sensor input of each vehicle's fuel control system. By using a comparator switchpoint that was tunable by the operator, the closed loop system was adjusted to control to equivalence ratios other than stoichiometry.

During tests conducted on LPG, CNG, ethanol, and methanol, each vehicle was fitted with a 3-way catalyst designed for application on alcohol-fueled Luminas. According to engineers at GM, this catalyst was more suited for use with CNG and LPG than the OEM gasoline catalyst on the Lumina. In addition, this catalyst was also installed on the Corsica to replace a damaged catalyst that was provided with the vehicle. The performance of the new catalyst was stabilized, using a 24-hour break-in period on an engine dynamometer, before the catalyst was installed on the first test vehicle. Although the break-in period was not meant to simulate any specific vehicle driving schedule, the break-in can generally be considered equivalent to 4,000 miles of in-use driving. The OEM gasoline catalyst, as received on the Lumina, was used during all testing with reformulated gasoline.

B. Description of Fuel

This program used five different test fuels in emissions evaluations: commercially available LPG, CNG blended by SwRI to reflect average gas composition available in the United States,[2] a fuel blended by Phillips Petroleum to be representative of California Phase 2 RFG, ethanol of >99% purity, and methanol with >99% purity. Compositions of the gaseous fuels are given in Table 2. Note that the LPG used in this program did not meet the HD-5 specification for propylene content, which is 5% maximum. However, this fuel was represented by the supplier as a motor grade fuel. With the approval of the NREL Technical Monitor, this fuel was used as a representative sample of commercially available LPG. Selected properties for reformulated gasoline and the alcohol fuels are given in Table 3.

TABLE 2. GASEOUS FUELS COMPOSITION

Fuel Component	Fuel Composition (volume percent)	
	LPG[a]	CNG[b]
Methane	0.1	92.7
Ethane	2.0	3.4
Propylene	6.1	0.0
Propane	91.4	1.3
Butane and higher	0.4	0.0
Nitrogen	0.0	2.6

[a] Average of duplicate analyses from each of two LPG cylinders (4 samples total) using ASTM Method D2163
[b] Average of duplicate analyses from each of two CNG batches (4 samples total) using ASTM Method D1945

TABLE 3. PROPERTIES OF THE LIQUID FUELS

Fuel Properties	Phase 2 RFG	Ethanol	Methanol
RVP, psi	6.9	2.6	5.0
Sulfur, ppm	33	<0.01	<0.01
Benzene, vol %	0.84	0.0	0.0
Aromatics	27.1	0.0	0.0
Olefins, vol %	4.6	0.0	0.0
Distillation, °F			
50%	210	169	146
90%	294	169	146
Oxygenate, vol %	11.2% MTBE	100% Ethanol	99% Methanol
Carbon, wt %	84.1	52.3	37.5
Hydrogen, wt %	13.9	13.1	12.3
Oxygen, wt%	2.0	34.6	50.2

C. Dynamometer and Constant Volume Sampling System

A Clayton, Model ECE-50 passenger car chassis dynamometer with a direct-drive variable inertia flywheel system was used for all testing. The inertia weight simulates equivalent weights of vehicles from 1,000 lb to 8,875 lb in 125-lb increments. Dynamometer settings used for this test program are given in Table 4. A positive displacement-type constant volume sampling system with a nominal flow capacity of 565 scfm was used to dilute the vehicle's exhaust. A cooling fan of 5,000 cfm capacity was used in front of the test vehicle

during all emissions test driving cycles. In addition, the hood of each test vehicle was fully open during all driving cycles. The cooling fan was off and the hood was closed during soak periods.

TABLE 4. CHASSIS DYNAMOMETER SETTINGS

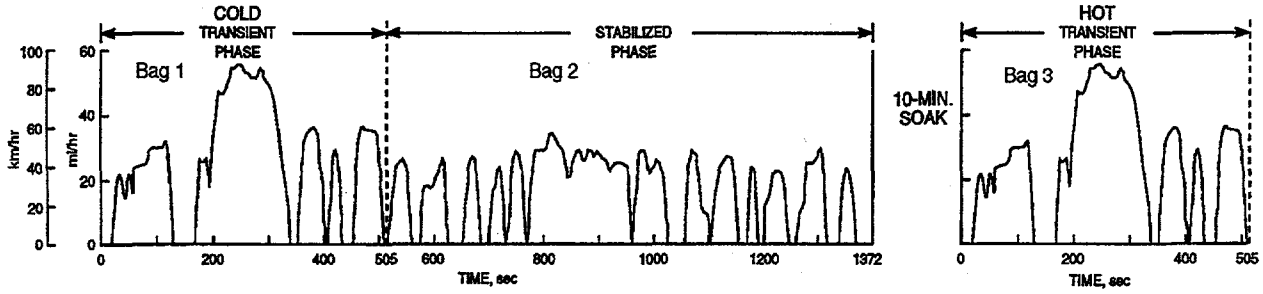

FIGURE 1. FTP DRIVING SCHEDULE SHOWING TEST SEGMENTS

Item	Lumina	Corsica
Inertial Weight	4,000 lb	3,500 lb
Actual Road Load @ 50 mph	6.5 hp	4.5 hp

D. Emissions Test and Sampling Procedures

Exhaust emissions were evaluated using the light-duty FTP .[1] This procedure uses the UDDS, which is 1,372 seconds in duration. The UDDS is divided into two segments: the first consists of 505 seconds and the second consists of 867 seconds. An FTP is composed of a cold-transient 505 and a cold-stabilized 867 portion, followed by a 10-minute soak, and then a hot-transient 505. The FTP driving schedule with its cold- and hot-transient test segments is shown in Figure 1.

A repeat pair of valid FTPs were conducted at each test point, for a total of 12 FTPs per fuel (3 equivalence ratios × 2 sampling configurations [with and without catalyst] × duplicate tests). Test-to-test repeatability criteria, as developed under the Auto/Oil Air Quality Improvement Research Program,[3] were used for this program and are given in Table 5. Using this method, repeatability ratios were calculated for each repeat pair of valid tests. The repeatability ratio for each exhaust constituent is the ratio of the high and low values obtained from the duplicate tests. If one of the calculated ratios was greater than the criteria given in Table 5, a third FTP test was conducted and averaged with the results of the first two tests.

TABLE 5. TEST REPEATABILITY CRITERIA

Exhaust Constituent	Repeatability Ratio
THC	1.33
CO	1.70
NO_x	1.29

E. Exhaust Emissions Analyses Procedures

A summary of exhaust emissions sampling and analytical techniques used in this program is given in Table 6. A more detailed description of these techniques is listed below.

TABLE 6. EXHAUST SPECIES COLLECTION AND ANALYSIS METHODS

Compounds	Method of Collection	Method of Analysis
Total Hydrocarbons	Bag	FID
Carbon Monoxide	Bag	NDIR
Oxides of Nitrogen	Bag	Chemiluminescent analysis
Carbon Dioxide	Bag	NDIR
Hydrocarbon Speciation, C_1 - C_{12}	Bag	GC-FID
Aldehydes and Ketones	Impingers containing DNPH	HPLC-UV
Methanol and Ethanol	Impingers containing water	GC-FID
Unidentified compounds	Sorbant cartridge	Mass spectral analysis

1. Regulated Gaseous Emissions

THC or OMHCE, CO, NO_x, and CO_2 emissions were quantified in a manner consistent with EPA protocols for light-duty emissions testing as given in the *Code of Federal Regulations, Title 40, Part 86, Subpart B*. HC, CO, NO_x, and CO_2 were sampled using proportional exhaust gas samples collected in Tedlar bags. HC were measured using an FID. CO and CO_2 were determined using NDIR instruments. NO_x was measured using a chemiluminescent instrument. Wet absorption techniques were employed to collect methanol, ethanol, and aldehydes for the determination of OMHCE. These techniques are discussed in more detail below.

Methane levels were determined using proportional exhaust gas samples collected in Tedlar bags. A GC equipped with an FID was utilized in accordance with the SAE J1151 procedure to analyze the samples. The GC system was equipped with a packed column

to resolve methane from other hydrocarbons in the sample. Samples were introduced into a 5-mL sample loop via a diaphragm pump. For analysis, the valve was switched to the inject position and the helium carrier gas swept the sample from the loop toward the detector through a 61 cm × 0.3 cm Porapak N column in series with a 122 cm × 0.3 cm molecular sieve 13X column. As soon as the methane peak passed into the molecular sieve column, the helium flow was reversed through the Porapak N column to vent. Peak areas were compared to an external calibration standard.

2. Hydrocarbon Speciation Procedures

NMOG emissions were determined by hydrocarbon speciation. Analytical procedures for conducting the hydrocarbon speciation (C_1 to C_{12} hydrocarbons, aldehydes and ketones, and alcohols) were similar to the CRC Auto/Oil Phase II methods. With these methods, exhaust samples are analyzed for the presence of more than 190 different exhaust species. The sum of the masses of non-methane species is equivalent to the NMOG emissions rate. Three GC procedures and one HPLC procedure were used to identify and quantify specific compounds. A brief description of these procedures is given below.

a. C_1-C_4 Species

The first GC procedure allowed the separation and determination of exhaust concentrations of C_1-C_4 individual hydrocarbon species, including methane; ethane; ethylene; acetylene; propane; propylene; propadiene; butane; trans-2-butene; 1-butene; 2-methylpropene; 2,2-dimethylpropane; propyne; 1,3-butadiene; 2-methylpropane; 1-butyne; and cis-2-butene. Bag samples were analyzed using a gas chromatograph equipped with an FID. The gas chromatograph system utilized a Hewlett-Packard Model 5890 Series II GC with an FID, two pneumatically operated and electrically controlled valves, and two analytical columns. The carrier gas was helium. An external multiple component standard in zero air was used to quantify the results. Detection limits for the procedure were on the order of 5 ppbC in dilute exhaust for all compounds.

b. C_5-C_{12} Species

The second GC procedure provided separation and exhaust concentrations for more than 100 C_5-C_{12} individual HC compounds. Bag samples were analyzed using a gas chromatograph equipped with an FID. The GC system utilized a Hewlett-Packard Model 5890 Series II GC with an FID, a pneumatically operated and electrically controlled valve, and an analytical column. The carrier gas was helium. An external multiple component standard in zero air was used to quantify the results. Detection limits for the procedure were on the order of 10 ppbC in dilute exhaust for all compounds.

c. Benzene and Toluene

The third GC procedure used a separate system configured similarly to those mentioned above to determine individual concentrations of benzene and toluene according to the CRC Auto/Oil Phase II Protocol.

d. Aldehydes and Ketones

An HPLC procedure was utilized for the analysis of aldehydes and ketones. Samples were collected by bubbling dilute exhaust at a nominal flowrate of 4 L/min through chilled glass impingers containing an acetonitrile solution of 2,4-DNPH and perchloric acid. For analysis, a portion of the acetonitrile solution was injected into a liquid chromatograph equipped with a UV detector. External standards of the aldehyde and ketone DNPH derivatives were used to quantify the results. The aldehydes and ketones measured were: formaldehyde, acetaldehyde, acrolein, acetone, propionaldehyde, crotonaldehyde, isobutyraldehyde/methylethylketone (not resolved from each other during normal operating conditions, and so reported together), benzaldehyde, and hexanaldehyde. Detection limits for this procedure were on the order of 0.005 ppm aldehyde or ketone in dilute exhaust.

3. Alcohols

The collection of methanol and ethanol in exhaust was accomplished by bubbling exhaust through glass impingers. Each impinger contained 25 mL of deionized water maintained at ice-bath temperature. Exhaust samples were collected continuously during test cycles at a nominal flow rate of 4 L/min through a Teflon sample line held at 102°C (215°F). For analysis, a 1-µL portion of the sample was injected into the GC equipped with an FID and an analytical column. The analytical column was a 0.53-mm × 30-m capillary column with a 1-µm film of DB-WAX as the stationary phase. The GC carrier gas was helium at a column head pressure of approximately 4 psi. The column oven temperature was maintained at 70°C for 1 min, then ramped to 110°C at 10°/min, and held at 110°C for 5 min. External standards in deionized water were used to quantify the results. Detection limits for this procedure were on the order of 0.06 ppm in dilute exhaust.

4. Mass Spectral Analyses

Mass spectral analyses were also conducted on exhaust samples in an effort to determine exhaust hydrocarbons not identified by the previously described speciation methods. Sample collection was accomplished by drawing CVS-diluted exhaust through two tubes in series, each packed with a solid sorbent material. Figure 2 is a schematic drawing of the sampling system.

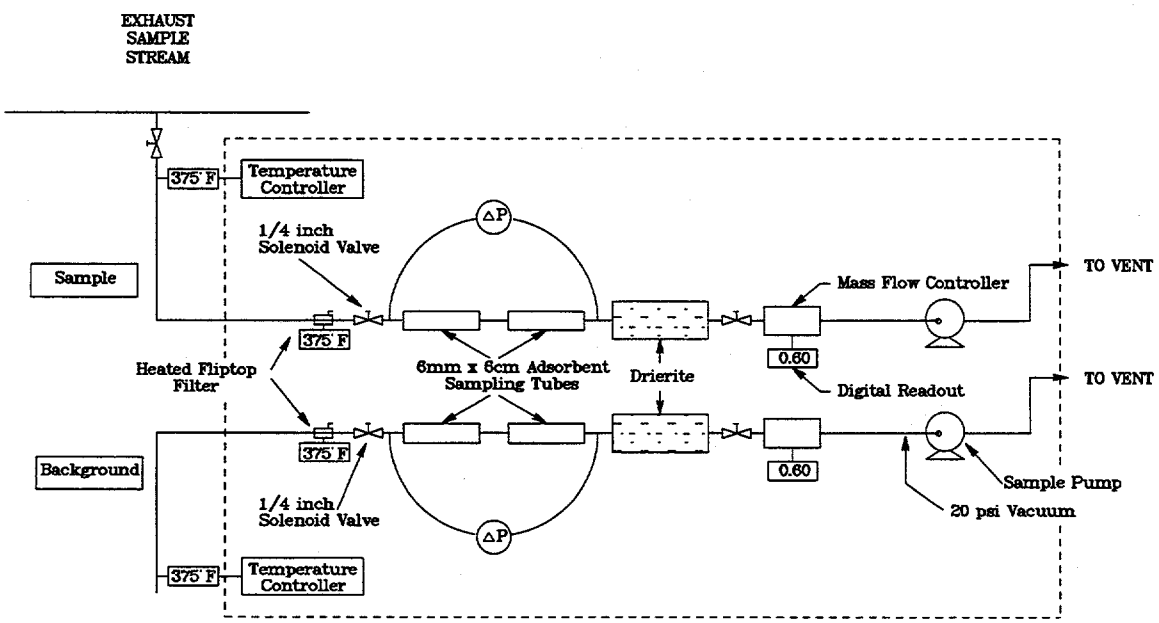

FIGURE 2. SCHEMATIC OF MASS SPECTRAL ANALYSES SAMPLING SYSTEM

Exhaust samples were collected continuously during the test cycle. The temperature of the sampling system up to the sorbent tubes is maintained at 375°F. Before reaching the sorbent tubes, the sample passes through heated, flip-top filter holders fitted with glass fiber particulate filters. The sorbent tubes are borosilicate glass tubes packed with a proprietary sorbent material, which is held in place with small end plugs of silanized glass wool.

For analysis, the samples were thermally desorbed onto a GC column coupled to a quadruple MS and a FID. A thermal desorption autosampler is used to heat the sorbent tube to 300°C while helium, the inert carrier gas, purges the sample from the tube. The sample is subsequently caught on a cryogenically cooled trap maintained at -100°C. The tube is purged for 300 seconds. At this point the cryogenic trap is ballistically heated to 300°C, introducing the sample onto the GC column. A splitless period of 30 seconds is used. To help in resolving the lighter compounds, the GC is cryogenically cooled at the start of the analysis, then ramped to the final set point. During the sample analysis period, the autosampler switches modes to further clean and condition the sorbent tube for future sampling by continuing to heat and purge the tube.

Hydrocarbons smaller than C_6 are not collected by the solid sorbent material. However, the C_1 to C_5 compounds are readily identified by the three GC speciation methods described in Section II.E.2.

III. VEHICLE TESTING

A. Baseline Testing with Gasoline

To establish a baseline on the Chevrolet Lumina, an initial "check-out" FTP was conducted using the unleaded gasoline present in the vehicle when it was delivered. The results of this test are given in Table 7. A detailed computer printout of the emissions data is presented in Appendix A. The results of this test showed the vehicle emitted an unexpectedly high amount of CO. Because of these results, the vehicle underwent a thorough diagnostic check. Although the "CHECK ENGINE" light was not illuminated, an error code was resident in the ECM memory. This code indicated an error in the operation of the IAC valve. The valve was inspected, appeared to be in proper working order, and was reinstalled.

The vehicle was refueled with RFG, the error code was cleared, and the vehicle was driven in urban traffic to ensure that the error code would not repeat. The vehicle was then driven over the UDDS three times as preconditioning for FTP testing. Throughout 15 miles of urban driving and 22.5 miles of operation on the chassis dynamometer, the IAC error code never reoccurred.

Duplicate FTPs were conducted on RFG to confirm proper vehicle operation and to establish baseline emissions levels for this program. Results of these tests are presented in Table 7. The repeatability of the two tests met the Auto/Oil program's test repeatability criteria. Detailed computer printouts of the emissions data are presented in Appendix B. For comparison purposes, FTP results from two other Luminas tested at SwRI (from NREL Report No. TP-421-5462) are also provided. Although the average CO emissions from these duplicate baseline tests were slightly above EPA standards, overall emissions seem to be representative

of this model vehicle. These baseline results were approved by the NREL Technical Monitor before the program proceeded.

TABLE 7. INITIAL LUMINA TEST RESULTS WITH GASOLINE (U.S. FTP CYCLE)

Test Vehicle	Test No.	Test Fuel	HC g/mile	CO g/mile	NO_x g/mile
'93 Lumina Checkout[a]	CHECK-OUT	unleaded gasoline (as received)	0.31	6.02	0.59
'93 Lumina Baseline[a]	L-PH2-REF-R1	Phase 2 RFG	0.21	3.34	0.36
'93 Lumina Baseline[a]	L-PH2-REF-R2	Phase 2 RFG	0.25	4.64	0.32
'91 Lumina Baseline[b]	average of 2 tests	Howell EEE	0.37	4.56	0.49
'92 Lumina Baseline[b]	average of 3 tests	Howell EEE	0.32	4.25	0.40

[a] This project
[b] From NREL Report No. TP-421-5462

B. Testing with LPG

The LPG conversion kit was installed on the vehicle without difficulty. At the recommendation of GM, the catalytic converter was replaced with one designed for use in an alcohol-fueled Lumina. Prior to installation, this catalyst was stabilized in a test cell as described in Section II.A. In addition, the UEGO sensor and comparator circuit needed to control fuel/air equivalence ratio were installed. The vehicle operated satisfactorily over the FTP at stoichiometry. However, lean operation of the vehicle was limited by poor driveability. In addition, rich operation of the vehicle was limited to a 1.15 equivalence ratio. Settings richer than this led to uncontrolled operation of the conversion kit. The fuel control system was able to maintain fuel/air equivalence ratios around desired set points throughout most portions of the FTP. However, the system would not maintain adequate fuel control during heavy accelerations and decelerations. In addition, the conversion kit operated extremely rich during FTP idles (1.18~1.20 air-fuel equivalence ratio) in all states of adjustment. SwRI contacted the kit manufacturer concerning this situation; however, attempts to change the idle performance of the conversion kit were unsuccessful. Testing on LPG proceeded smoothly, and repeatability criteria were met at all test conditions. Detailed computer printouts of the emissions results for these tests are provided in Appendix C.

C. Testing with CNG

The CNG conversion kit for this program shared many of its parts with the LPG kit. To configure the vehicle to operate on CNG, the pressure regulator, feedback fuel control valve, and air/gas mixer from the LPG kit were replaced with components appropriate to operation on CNG. The vehicle operated satisfactorily over the FTP at stoichiometry and lean conditions. Rich operation of the vehicle was limited by poor driveability. The fuel control system was able to maintain fuel/air equivalence ratios around desired set points throughout most portions of the FTP. However, as was the case with LPG operation, the system would not maintain adequate fuel control during heavy accelerations and decelerations, and operated extremely rich at idle (1.18~1.20 air-fuel equivalence ratio) during FTP tests, even at stoichiometric and

lean calibrations. SwRI also contacted the kit manufacturer concerning this situation; however, as was the case with LPG, attempts to change the idle performance of the conversion kit were unsuccessful.

Testing with CNG was temporarily delayed after only three tests were conducted. The cause of the delay was to ensure worker safety during CNG testing. A safety concern arose as a result of fuel tank failures in California and Minnesota involving CNG-fueled pickup trucks equipped with aluminum/fiberglass composite fuel cylinders. SwRI was fueling the CNG test vehicle from aluminum/fiberglass composite cylinders and felt it was prudent to remove these cylinders from service. Steel cylinders were obtained for CNG storage, and testing proceeded after a 2-week delay.

The CNG that remained in the aluminum/fiberglass composite cylinders was transferred to the steel cylinders. The test matrix had been interrupted between duplicate test runs with the vehicle operating at a 1.0 fuel/air equivalence ratio without a catalyst. When the testing resumed, HC emissions results from the duplicate tests conducted before and after the delay differed significantly. A third test was conducted, and the results of the two tests conducted after the delay were within repeatability requirements for this program. There were no further test-to-test repeatability problems while operating the vehicle on CNG. Detailed computer printouts of the emissions results for these tests are provided in Appendix D.

D. Testing with Reformulated Gasoline

After the Lumina was restored to its original configuration, the UEGO sensor and comparator circuit used during testing on LPG and CNG were re-installed. Test L-PH2-1.0-CK2 was conducted for comparison to baseline results to ensure proper operation of the vehicle and fuel control system. Emissions results of Test L-PH2-1.0-CK2 are compared to average baseline emissions in Table 8 and represent tests conducted 5 months apart. Emissions results were similar enough to meet the test-to-test repeatability criteria for this program and they confirmed proper vehicle operation. The test vehicle operated satisfactorily over all operating conditions and maintained desired fuel/air equivalence ratios over most operating conditions; however, when testing at lean conditions, the vehicle would operate near stoichiometry during accelerations due to fuel enrichment compensation. Testing with reformulated gasoline proceeded smoothly, and repeatability criteria were met at all test conditions. Detailed computer printouts of the emissions results are provided in Appendix E.

TABLE 8. LUMINA FTP RESULTS COMPARED TO BASELINE

Test	Average of 2 baseline tests	L-PH2-1.0-CK2
FID HC[a] (g/mi)	0.23	0.25
CO (g/mi)	3.99	4.64
NO_x (g/mi)	0.34	0.32

[a] Hydrocarbon as measured with flame ionization detector calibrated on propane

E. Testing with Ethanol

As received, the Chevrolet Corsica was calibrated to operate on ethanol. To prepare the vehicle for testing, an OEM 3-way catalyst designed for use in an alcohol-fueled Lumina was installed. This catalyst was the same one used in previous testing of LPG and CNG. In addition, a wide range oxygen sensor and the custom closed-loop fuel control system used in previous testing were installed on the vehicle. These systems appeared to operate properly when the test vehicle was driven over the UDDS. However, the vehicle did not start or idle well when the engine was at ambient temperature. An FTP test (C-ETH-1.0-CK1) was conducted to determine the extent of the driveability problems. Emissions results for this test are given in Table 9. Engine cranking was necessary for approximately 8 seconds before engine firing occurred. Cold-start idle was rough, and the engine stumbled and backfired during the first acceleration of the FTP. However, once the vehicle warmed up and entered closed-loop operation, driveability was satisfactory. This vehicle was originally calibrated to operate on M85, and E100 has a much lower volatility; therefore, it was necessary to modify the cold-start calibration to provide additional fuel during starting and warmup. Using the CDM on the vehicle, open-loop acceleration fuel enrichment was increased until the vehicle operated smoothly over the complete FTP cycle. The CDM is a dash-top computer that contains all the vehicle calibrations for ethanol and methanol operation. FTP emissions results with the final calibration (C-ETH-1.0-CK8) are also given in Table 9. Although the calibration modifications resulted in increased mass emissions from the vehicle, they were necessary to maintain satisfactory driveability over the FTP.

TABLE 9. INITIAL CORSICA TEST RESULTS WITH ETHANOL (U.S. FTP CYCLE)

Test Number	C-ETH-1.0-CK1	C-ETH-1.0-CK8
FID HC[a] (g/mi)	0.577	0.895
CO (g/mi)	1.761	4.288
NO_x (g/mi)	0.494	0.571
Fuel Economy (mpg)	11.38	11.36

[a] Hydrocarbon as measured with flame ionization detector calibrated on propane; not corrected for differing response to alcohols.

Testing with ethanol was initiated; however, after the first test (C-ETH-1.0-C1), the fuel pump failed and had to be replaced. When the testing resumed, HC emissions results from the duplicate tests (C-ETH-1.0-C1 and C-ETH-1.0-C2) differed significantly. A third test (C-ETH-1.0-C3) was conducted and the results of that test and test C-ETH-1.0-C2 were within repeatability requirements for this program. These data are presented in Table 10. No further repeatability problems were encountered during testing with ethanol.

TABLE 10. FTP RESULTS BEFORE AND AFTER FUEL PUMP REPLACEMENT

	TEST			REPEATABILITY RATIO[b]		
	C-ETH-1.0-C1	C-ETH-1.0-C2	C-ETH-1.0-C3	E1 to E2	E2 to E3	LIMIT
TEST DATE	06/21/94	06/24/94	06/27/94			
ODOMETER (miles)	14,871	14,903	14,921			
FID HC[a] (g/mi)	1.009	0.702	0.861	1.44	1.23	1.33
CO (g/mi)	4.134	3.284	3.719	1.26	1.13	1.70
NO_x (g/mi)	0.479	0.557	0.542	1.16	1.03	1.29

[a] Total hydrocarbons as measured with flame ionization detector calibrated on propane; not corrected for differing response to alcohols.

[b] Repeatability ratio is ratio of the larger to the smaller value of the repeat pair. Repeatability ratio criteria per SAE Paper 920319.

After conducting tests at stoichiometry with and without the catalyst, the vehicle was tested at lean conditions. With the exception of poor vehicle driveability, no problems were encountered during the lean-operation tests. Following testing at lean conditions, preparations were made to test the vehicle under fuel-rich conditions. However, the CDM on this vehicle is apparently equipped with a fail-safe device that prohibits extremely rich operation. The SwRI custom fuel control system was not able to adjust the control system to force the vehicle to operate rich. In an effort to get the vehicle to operate at rich conditions, SwRI consulted with General Motors; however, no obvious solutions were found. In an effort to force the vehicle to operate fuel-rich, the coolant temperature sensor was bypassed with the signal from an identical sensor placed in ice water. This condition forced the vehicle to use a cold-temperature calibration that provided additional enrichment and to remain in open-loop operation longer. However, the resulting operation was only slightly richer than stoichiometry. In addition, vehicle driveability during open-loop operation was less than satisfactory. Idle was rough, and the engine would stumble and backfire during accelerations. However, the vehicle was able to meet repeatability criteria for all test conditions. Detailed computer printouts of the emissions results for individual tests are provided in Appendix F.

F. Testing with Methanol

After testing on ethanol, the fuel system was drained and flushed with methanol, and the vehicle's calibration was changed to the one specified by the University of Tennessee for operation on methanol. However, the vehicle did not start or idle well when the engine was at ambient temperatures, and the vehicle could not be driven satisfactorily over the FTP. Cold-start idle was rough, the engine stumbled and backfired, and the vehicle could not follow the FTP trace during heavy acceleration in the open-loop fuel-control mode. While attempting to correct the open-loop performance of the vehicle, the CDM malfunctioned, and the vehicle would not operate properly. After repairs were made, the open-loop calibration of the vehicle was adjusted. The vehicle operated smoothly over the FTP cycle, except during the first 60 seconds of Bag 1. In this case, the vehicle was in open-loop fuel control and would stumble and

sometimes backfire slightly during accelerations. Attempts to improve the open-loop fuel calibration of the vehicle were unsuccessful. After consulting with the NREL Project Officer, it was determined that further calibration of the vehicle was beyond the scope of this program.

As with operation on ethanol, the vehicle could not be adjusted to operate rich as planned. As was done during testing on ethanol, the coolant temperature sensor was bypassed with the signal from an identical sensor placed in ice water in an effort to make the vehicle operate fuel-rich. This condition forced the vehicle to use a cold-temperature calibration, which provided additional enrichment, and to remain in open-loop operation longer. However, as was the case with ethanol, the resulting operation was only slightly richer than stoichiometry and vehicle driveability during open-loop operation was less than satisfactory. Idle was rough, and the engine would stumble and backfire during accelerations. The vehicle was able to meet repeatability criteria for all test conditions. Detailed computer printouts of the emissions results for individual tests are included in Appendix G.

G. Fuel/Air Equivalence Ratios Achieved During Testing

For each fuel, the fuel control system was tuned to the desired fuel/air equivalence ratio set point by operating the vehicle on the chassis dynamometer at a steady-state condition of 50 mph. Actual road load was set at 6.5 hp for the Lumina and 4.5 hp for the Corsica. These road loads correspond to the dynamometer setting during FTP testing. The fuel/air equivalence ratio set points used during testing with each fuel are shown in Table 11. As previously noted, target equivalence ratios were not achieved for all test conditions. Lean operation on LPG, ethanol, and methanol was limited by poor driveability, as was rich operation on CNG. Rich operation on LPG, ethanol, and methanol was limited by the capabilities of the vehicles' fuel-control systems.

TABLE 11 - TEST FUEL/AIR EQUIVALENCE RATIOS

Fuel/Air Equivalence Ratio					
Desired	**LPG**	**CNG**	**RFG**	**EtOH**	**MtOH**
0.8	0.83	0.80	0.81	0.86	0.90
1.0	1.01	0.99	0.99	1.01	1.00
1.2	1.15	1.10	1.20	1.05	1.05

IV. TEST RESULTS AND DISCUSSION

This section includes the presentation and discussion of results of testing with all the fuels. Regulated exhaust emissions, toxic exhaust emissions, speciated exhaust emissions, potential ozone formation, and mass spectral analyses results are provided.

A. Regulated Exhaust Emissions

Tables 12 and 13 show NMOG, CO, and NO_x exhaust emissions for each of the five fuels as a function of operating conditions without and with the vehicle catalyst in place, respectively. Also contained in Tables 12 and 13 are values for both the average THC mass emissions determined by hydrocarbon speciation (THC/GC) and by a flame ionization detector (THC/FID). The THC values were based on fuel density and fuel weight fractions of carbon, hydrogen, and oxygen, but did not take into consideration the FID response factors for MtOH or EtOH. Agreement between THC mass determined by the two methods was found to be good, with a maximum difference of 11.5% observed for a single test. Most tests showed differences of less than 5%. Although the Lumina did not meet CO tailpipe emissions standards with any fuel, emissions measured from the stock vehicle operating on reformulated gasoline are consistent with previously published emissions data for this model vehicle.[4] The Corsica was an experimental vehicle operating on neat alcohols and was not required to meet certification standards. Although CO and NO_x emissions levels from the alcohol fuels were similar to those from other fuels, NMOG emissions were 3 to 5 times higher at stoichiometric conditions. In addition, none of the alternative fuel configurations were optimized to provide the lowest possible tailpipe emissions; therefore, fuel-to-fuel comparisons of absolute FTP results are inconclusive. However, trends between rich, stoichiometric, and lean operation are observable for all fuels.

At stoichiometric operation, catalyst efficiencies for THC, CO, and NO_x were greater than 75% for all fuels except for the alcohols, where NO_x efficiencies were less than 40%. While operating on LPG and reformulated gasoline at rich conditions without a catalyst, HC emissions were about twice as high and CO emissions were approximately 5 to 7 times as high as at stoichiometric operation without a catalyst. THC emissions during rich operation on CNG without a catalyst were about 4 times higher and CO emissions about 11 times higher than during stoichiometric operation. The high HC emissions indicate that severe engine misfiring occurred with CNG at rich conditions. While operating on ethanol and methanol, fuel-rich conditions were only slightly richer than at stoichiometric conditions. In addition, the method of obtaining rich operation used a calibration that was completely different from the stoichiometric conditions. As a result, THC emissions without a catalyst increased less than 10% from stoichiometric conditions while operating on ethanol and decreased by about 10% while operating on methanol. The slight decrease in THC emissions on methanol can be attributed to less stumbling and backfiring during rich operation than at the stoichiometric condition. CO emissions without a catalyst were about 40% and 20% higher during rich operation than at stoichiometric conditions with ethanol and methanol, respectively.

TABLE 12. SUMMARY OF AVERAGE FTP EMISSIONS WITHOUT CATALYST

OPERATING CONDITION	FUEL-LEAN				
VEHICLE	LUMINA			CORSICA	
FUEL	LPG	CNG	RFG	EtOH	MtOH
TEST EQUIVALENCE RATIO	0.83	0.80	0.81	0.86	0.90
NMOG (grams/mile)	4.89	0.46	11.31	10.84	8.64
CO (grams/mile)	11.17	9.63	9.27	9.03	9.28
NO_x (grams/mile)	1.28	1.50	1.34	0.60	0.55
THC/FID (grams/mile)	5.52	2.47	11.17	10.95	8.96
THC/GC (grams/mile)	4.98	2.59	11.40	10.99	8.66
OPERATING CONDITION	STOICHIOMETRIC				
VEHICLE	LUMINA			CORSICA	
FUEL	LPG	CNG	RFG	EtOH	MtOH
TEST EQUIVALENCE RATIO	1.01	0.99	0.99	1.01	1.00
NMOG (grams/mile)	1.84	0.55	2.41	5.20	5.42
CO (grams/mile)	20.96	14.53	17.30	15.67	14.30
NO_x (grams/mile)	2.27	1.17	2.29	0.75	0.57
THC/FID (grams/mile)	1.95	3.19	2.51	5.25	5.52
THC/GC (grams/mile)	1.94	3.23	2.48	5.36	5.45
OPERATING CONDITION	FUEL-RICH				
VEHICLE	LUMINA			CORSICA	
FUEL	LPG	CNG	RFG	EtOH	MtOH
TEST EQUIVALENCE RATIO	1.15	1.10	1.20	1.05	1.05
NMOG (grams/mile)	2.50	1.82	3.64	5.74	4.78
CO (grams/mile)	100.1	103.2	124.4	21.50	17.49
NO_x (grams/mile)	0.65	0.39	0.78	0.99	1.41
THC/FID (grams/mile)	2.92	12.25	4.14	5.86	4.78
THC/GC (grams/mile)	2.87	12.36	4.01	5.91	4.81

TABLE 13. SUMMARY OF AVERAGE FTP EMISSIONS WITH CATALYST

OPERATING CONDITION	FUEL-LEAN				
VEHICLE	LUMINA			CORSICA	
FUEL	LPG	CNG	RFG	EtOH	MtOH
TEST EQUIVALENCE RATIO	0.83	0.80	0.81	0.86	0.90
NMOG (grams/mile)	0.49	0.07	0.19	0.98	0.65
CO (grams/mile)	2.41	1.16	4.24	2.67	1.86
NO_x (grams/mile)	1.36	1.11	1.03	0.57	0.38
THC/FID (grams/mile)	0.56	1.01	0.24	1.00	0.65
THC/GC (grams/mile)	0.56	1.03	0.25	1.03	0.66
OPERATING CONDITION	STOICHIOMETRIC				
VEHICLE	LUMINA			CORSICA	
FUEL	LPG	CNG	RFG	EtOH	MtOH
TEST EQUIVALENCE RATIO	1.01	0.99	0.99	1.01	1.00
NMOG (grams/mile)	0.17	0.05	0.19	0.93	0.63
CO (grams/mile)	4.48	3.59	4.20	3.50	2.35
NO_x (grams/mile)	0.60	0.20	0.34	0.55	0.36
THC/FID (grams/mile)	0.29	0.84	0.25	0.96	0.65
THC/GC (grams/mile)	0.29	0.86	0.22	1.00	0.65
OPERATING CONDITION	FUEL-RICH				
VEHICLE	LUMINA			CORSICA	
FUEL	LPG	CNG	RFG	EtOH	MtOH
TEST EQUIVALENCE RATIO	1.15	1.10	1.20	1.05	1.05
NMOG (grams/mile)	1.78	0.45	3.59	1.16	0.79
CO (grams/mile)	94.75	39.12	124.57	4.75	3.35
NO_x (grams/mile)	0.03	0.02	0.36	0.40	0.83
THC/FID (grams/mile)	2.33	9.15	4.04	1.30	0.80
THC/GC (grams/mile)	2.33	9.27	3.59	1.28	0.81

For fuel-rich conditions operating on the gaseous fuels and on reformulated gasoline, NO_x emissions without a catalyst were reduced by more than half from stoichiometric levels. The high levels of CO in the exhaust (greater than 100 g/mi for all fuels) during rich operation allowed for nearly all the NO_x to be reduced across the catalyst; however, the lack of excess oxygen in the exhaust resulted in generally poor catalyst efficiencies for THC and CO with LPG and RFG. Because the achievable fuel-rich equivalence ratio was limited to 1.10 while operating on CNG, THC and CO catalyst efficiencies were slightly better than LPG and RFG. Given the unusual calibration of the Corsica while operating at rich conditions on the alcohol fuels, engine-out NO_x emissions were 1.3 times higher while operating on ethanol and were nearly 2.5 times higher while operating on methanol than at stoichiometric conditions. Catalyst efficiencies during rich operation of the Corsica were better than at stoichiometric operation, with greater than 80% efficiency for THC and CO and about 50% reduction of NO_x on both alcohol fuels.

At lean conditions without a catalyst, CO emissions from LPG, RFG, ethanol, and methanol fuels were approximately half of those produced during stoichiometric operation. However, due to lean misfire on these fuels, THC emissions were about 2 to 4 times higher at lean conditions than at stoichiometric conditions. Lean NO_x emissions were nearly half of stoichiometric levels during operation on LPG and RFG and were almost 20% lower than at stoichiometric conditions while operating on the alcohol fuels. While operating on CNG, combustion appeared stable at lean conditions. This resulted in lower THC and CO emissions without a catalyst compared to stoichiometric operation, and in slightly elevated NO_x levels. The abundance of excess oxygen in the exhaust stream at lean conditions allowed for good conversion of THC and CO in the catalyst while operating on all fuels. However, excess oxygen also resulted in poor catalytic control of NO_x. Lean operation on LPG gave a slight increase in average NO_x emissions across the catalyst.

B. Toxic Exhaust Emissions

Emissions of air toxics are presented in Table 14 for all three fuel/air equivalence ratios investigated. There was speculation that the high level of toxic emissions from the alcohol fuels might have been due to the poor operation of the Corsica during open-loop operation in Bags 1 and 3 of the FTP. Since the Corsica operated satisfactorily during hot stabilized operation, toxic emissions measured in Bag 2 are also presented in Table 14 for comparison.

In general, formaldehyde accounted for 65% to 80% of toxic mass emissions while operating on LPG and CNG at stoichiometric and fuel-lean conditions. Under the same conditions, acetaldehyde accounted for about 25% of toxic emissions from LPG. However, at fuel-rich conditions a large portion of tailpipe toxic emissions from the gaseous fuels unexpectedly consisted of benzene, which accounted for 54% and 36% of toxic emissions from LPG and CNG, respectively. The origin of the benzene emissions is currently unknown. Toxic emissions from reformulated gasoline consisted primarily of benzene (~65%), formaldehyde (~20%), and 1,3-butadiene (~10%). About 90% of after-catalyst toxic emissions from ethanol were acetaldehyde and 10% were formaldehyde. Nearly all of the toxic emissions from operation on methanol were from formaldehyde.

TABLE 14 - AVERAGE FTP TOXIC EMISSIONS RATES

FTP											
Operating Condition	Compound	Without Catalyst					With Catalyst				
		LPG	CNG	RFG	EtOH	MtOH	LPG	CNG	RFG	EtOH	MtOH
Lean	Formaldehyde	199.8	92.3	485.0	318.2	736.1	2.4	1.2	2.7	6.1	23.9
	Acetaldehyde	38.9	4.2	82.4	1131.2	6.3	0.7	0.1	0.9	52.5	0.1
	Benzene	0.7	0.5	168.5	1.8	1.4	0.0	0.1	7.2	0.6	0.1
	1,3-Butadiene	3.1	0.8	61.7	1.0	0.6	0.1	<0.1	1.2	0.2	<0.1
	Total Toxics	242.5	97.8	797.6	1452.2	744.4	3.2	1.5	11.9	59.3	24.2
Stoich.	Formaldehyde	53.1	70.4	97.3	166.1	409.3	1.0	0.9	2.7	5.3	24.4
	Acetaldehyde	17.7	3.7	18.3	478.1	8.7	0.4	0.1	0.8	66.2	0.9
	Benzene	0.6	0.5	63.4	1.6	1.4	0.1	0.2	7.9	0.7	0.1
	1,3-Butadiene	1.8	0.6	21.3	0.7	0.1	0.1	0.1	1.1	0.1	<0.1
	Total Toxics	73.2	75.2	200.3	646.5	419.5	1.5	1.3	12.4	72.4	25.3
Rich	Formaldehyde	52.7	137.0	53.8	172.4	343.8	1.6	1.5	20.5	7.2	29.7
	Acetaldehyde	10.3	7.9	9.3	458.4	1.9	1.2	0.3	20.4	63.4	0.1
	Benzene	0.7	0.8	120.0	1.6	1.6	3.5	1.0	126.3	1.0	0.2
	1,3-Butadiene	1.6	0.4	18.2	0.6	0.4	0.3	<0.1	18.7	0.3	<0.1
	Total Toxics	65.2	146.1	201.3	633.1	347.7	6.5	2.8	185.9	71.8	30.1
Bag 2											
Operating Condition	Compound	Without Catalyst					With Catalyst				
		LPG	CNG	RFG	EtOH	MtOH	LPG	CNG	RFG	EtOH	MtOH
Lean	Formaldehyde	226.0	110.9	641.3	383.1	887.6	0.2	0.4	0.4	0.5	1.8
	Acetaldehyde	42.7	4.9	97.7	1465.2	7.7	<0.1	0.1	0.3	0.7	0.1
	Benzene	0.9	0.3	210.7	1.6	1.4	<0.1	0.2	1.2	<0.1	<0.1
	1,3-Butadiene	3.6	0.7	73.9	0.8	0.5	<0.1	<0.1	<0.1	<0.1	<0.1
	Total Toxics	273.1	116.9	1023.7	1850.7	897.2	0.2	0.7	1.9	1.2	1.8
Stoich.	Formaldehyde	41.7	88.1	110.5	175.3	393.8	0.2	0.2	<0.1	0.5	1.8
	Acetaldehyde	20.5	4.6	20.3	510.5	9.0	0.1	<0.1	0.1	0.7	<0.1
	Benzene	0.6	0.5	67.3	1.4	1.4	0.1	0.2	<0.1	0.4	<0.1
	1,3-Butadiene	2.0	0.5	22.5	0.5	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
	Total Toxics	64.8	93.7	220.6	687.7	404.1	0.4	0.5	0.1	1.5	1.9
Rich	Formaldehyde	56.4	161.4	58.5	162.3	326.4	0.1	0.1	17.6	0.2	1.7
	Acetaldehyde	11.1	9.1	9.8	441.6	1.7	0.3	0.1	24.3	0.6	<0.1
	Benzene	0.5	0.9	136.1	1.3	1.7	3.9	1.1	144.1	0.3	0.1
	1,3-Butadiene	1.7	0.4	20.0	0.4	0.3	0.3	<0.1	21.0	<0.1	<0.1
	Total Toxics	69.7	171.7	224.4	605.6	330.1	4.5	1.3	207.0	1.1	1.8

During rich operation on reformulated gasoline and the gaseous fuels, more benzene emissions were observed with the catalyst than without it. Although the origin of the additional benzene is unknown, it is speculated that thermal cracking and recombination of hydrocarbons within the catalyst is responsible for the increase. However, additional research is needed in this matter. When operating on RFG at rich conditions, an increase in acetaldehyde emissions across the catalyst was also observed, while at the same time formaldehyde emissions were lower. This situation could possibly be the result of partial oxidation in the oxygen-lean exhaust; however, the formation mechanism responsible for a net increase in acetaldehyde and a net decrease in formaldehyde across the catalyst is unknown.

C. Potential Ozone Formation

In order to allow for a comparison of emissions on the basis of ozone-forming potential, CARB has published a list of MIRs for a number of VOCs, defined as grams of ozone per gram of specific VOC emitted. These MIRs are given in Appendix H[5], and were either estimated by CARB or derived from smog chamber experiments based on a Los Angeles atmospheric mix at VOC-limited ozone conditions. Following CARB methodology, a comparison of the ozone-forming potential on a gram per mile basis for each fuel is achieved by multiplying the MIR for each VOC by the emission rate of that VOC. The summation of these products yields the ozone-forming potential for a specific fuel [i.e., $g\ O_3/mi = \sum (VOC_i \times MIR_i)$] .[5]

Presented in Table 15 is the potential mass of ozone formed by hydrocarbon emissions from each fuel for the entire FTP and for the Bag 2 segment of the FTP. During stoichiometric operation with a catalyst, the mass of potential ozone formed from CNG was 90% less, from LPG 68% less, and from methanol 23% less than from reformulated gasoline. FTP ozone forming potential of ethanol during stoichiometric operation with a catalyst was 150% more than with RFG, primarily because of unburned ethanol and ethylene in the exhaust during Bag 1 open-loop operation. Although the catalyst-out potential ozone formation of the alcohol fuels was higher than the gaseous fuels and RFG, the data are not directly comparable due to the cold-start calibration difficulties encountered with the Corsica. However, during hot, stabilized running (Bag 2), where the Corsica operated properly, the data show that the four alternative fuels have similar levels of ozone-forming potential with the vehicle catalyst in place.

TABLE 15 - POTENTIAL OZONE FORMATION (MG/MILE)

	Operating Condition	Without Catalyst					With Catalyst				
		LPG	CNG	RFG	ETH	MTH	LPG	CNG	RFG	ETH	MTH
FTP	Lean	11,947	1,777	41,943	23,947	9,885	435	68	731	1,743	538
	Stoich.	5,326	1,614	9,855	11,780	5,904	223	71	695	1,739	532
	Rich	6,532	4,793	12,851	12,279	5,061	3,435	602	14,300	2,074	653
Bag 2	Lean	13,960	2,125	54,206	29,916	11,113	125	47	93	91	29
	Stoich.	5,942	1,894	10,710	10,969	5,385	30	32	11	24	24
	Rich	7,104	5,497	14,377	10,577	4,320	3,487	533	16,259	19	30

D. Reactivity Adjustment Factors

Average reactivity adjustment factors (RAFs) for each vehicle-fuel combination at all three operating conditions are presented in Table 16. RAFs were calculated as the ratio of the specific reactivities determined in these tests (g ozone/g NMOG) and the specific reactivity determined by CARB for a group of TLEV vehicles tested with RF-A fuel (3.42 g ozone/g NMOG). RAFs of post-catalyst exhaust during stoichiometric operation were 0.38, 0.37, 1.07, 0.54, and 0.25 for LPG, CNG, RFG, ethanol, and methanol, respectively. At lean conditions, the reactivity of post-catalyst emissions was similar to stoichiometry. At fuel-rich conditions, the high concentrations of unburned fuel in the post-catalyst exhaust caused the RAFs for LPG and RFG to increase, whereas an increase in less reactive unburned fuel caused the reactivities of CNG, ethanol, and methanol to drop. The increase in RAF for LPG is most likely because of unburned propylene from the fuel and exhaust-formed ethylene passing through the catalyst. RAFs from LPG and CNG with the catalyst in place were about half the value of RAFs without the catalyst. This was due primarily to large reductions in ethylene, propylene, and formaldehyde concentrations across the catalyst. The catalyst appeared to have little influence on RAFs while operating on RFG. RAFs from ethanol and methanol with the catalyst in place were about 20% less than without the catalyst.

TABLE 16. REACTIVITY ADJUSTMENT FACTORS

Operating Condition	Without Catalyst					With Catalyst				
	LPG	CNG	RFG	ETH	MTH	LPG	CNG	RFG	ETH	MTH
Lean	0.71	1.12	1.08	0.65	0.33	0.38	0.37	1.07	0.54	0.25
Stoich.	0.84	0.84	1.20	0.66	0.32	0.38	0.37	1.07	0.54	0.25
Rich	0.76	0.75	1.03	0.62	0.31	0.56	0.31	1.16	0.52	0.24

E. Speciated Exhaust Emissions/Prevalent Species

Prevalent exhaust species detected by GC-FID analysis are compiled in Appendices I through M. These species represent more than 95% of all measured NMOG mass detected by GC-FID at all operating conditions. The most prominent of these constituents observed for each fuel are listed in Table 17. These compounds account for more than 95% of all measured NMOG from the alternative fuels and more than 60% from reformulated gasoline. The predominant constituents of LPG and CNG exhaust were C_1-C_3 compounds. The most prevalent species in exhaust from reformulated gasoline were mostly C_4-C_8 compounds. Ethanol and methanol exhaust constituents were mostly C_1 and C_2 compounds.

TABLE 17 - PROMINENT NON-METHANE EXHAUST SPECIES IDENTIFIED BY HYDROCARBON SPECIATION

Fuel	LPG	CNG	RFG	Ethanol	Methanol
Prominent Species	ethane ethylene propane propylene acetylene formaldehyde acetaldehyde	ethane ethylene propane propylene acetylene formaldehyde acetaldehyde	ethylene propylene acetylene isobutylene isopentane MTBE benzene 2,3-dimethylpentane 2,2,4-trimethylpentane toluene ethylbenzene m- & p-xylene o-xylene formaldehyde	ethane ethylene acetylene ethanol formaldehyde acetaldehyde	ethylene acetylene methanol toluene formaldehyde
NMOG wt%	>95%	>95%	>60%	>97%	>98%

F. Mass Spectral Analyses

In addition to the GC-FID analyses, GC/MS analyses were conducted on all exhaust samples. A number of compounds identified by GC-FID speciation were confirmed by GC/MS analysis. These compounds are listed in Table 18. Normally, hydrocarbons smaller than C_6 were not adsorbed in the sorbent traps used in this study, and their identification by GC-FID speciation methods could not be confirmed by GC/MS analysis. Compounds that were not present at levels that could be detected by Auto/Oil speciation methods, but were identified by GC/MS analysis, are also listed in Table 18. Additional compounds identified by GC/MS analysis that were not identified by other analytical methods are listed in Table 19. Virtually all of the compounds identified were observed in exhaust sampled without a catalyst in place, or during fuel-rich operation on reformulated gasoline. Notable combustion products from all the fuels identified by GC/MS analysis included a number of nitrogen-containing compounds such as nitromethane, nitroethane, nitropropane, and nitropropane. In addition, a number of higher-molecular-weight compounds were observed in all exhaust samples. It is speculated that these compounds originated from the lubricating oil.

TABLE 18. SPECIATED COMPOUNDS CONFIRMED BY GC-MS ANALYSIS

Exhaust Configuration	Without Catalyst			With Catalyst		
Fuel\Air Equivalence Ratio	0.8	1.0	1.2	0.8	1.0	1.2
Methanol	LPG[b] CNG[b] RFG[b] MtOH[a]	LPG[b] CNG[b] RFG[b] MtOH[a]	LPG[b] CNG[b] RFG[b] EtOH[c] MtOH[a]	LPG[b] CNG[b] MtOH[b]	LPG[b] CNG[b] MtOH[a]	LPG[b] CNG[b] RFG[b] MtOH[b]
Ethanol	EtOH[a] MtOH[c]	EtOH[a] MtOH[c]	EtOH[a]	EtOH[a]	EtOH[a]	EtOH[b]
Methylpropylbenzene	CNG[b] RFG[a] EtOH[b]	CNG[b] RFG[a]	CNG[b] RFG[a] EtOH[b]	RFG[b]	CNG[b] RFG[b] EtOH[b]	RFG[a] EtOH[b]
Ethylbenzene	LPG[b] CNG[b] RFG[b] EtOH[a]	LPG[b] CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b]
Benzene	LPG[b] CNG[b] RFG[b] EtOH[a] MtOH[b]	LPG[a] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[a] RFG[b] EtOH[b] MtOH[b]	CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[a]	LPG[a] CNG[b] RFG[b] EtOH[b] MtOH[b]
Diethylbenzene	CNG[b] RFG[a] EtOH[c]	CNG[b] RFG[a]	LPG[b] RFG[a]	RFG[a] EtOH[c]	CNG[b] RFG[a] EtOH[c]	LPG[b] CNG[b] RFG[a]
Dimethybenzene	CNG[b] RFG[a]	CNG[b] RFG[a]	RFG[a]	RFG[b]	RFG[b]	RFG[a]
Methylethylbenzene	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[c]	LPG[a] CNG[b] RFG[a] EtOH[b]	CNG[b] RFG[a] EtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b]	CNG[b] RFG[b] EtOH[b]	CNG[b] RFG[a] EtOH[a] MtOH[a]
Naphthalene	RFG[a]	RFG[a]	RFG[a]	RFG[c]	RFG[c]	RFG[a] EtOH[c]
Propylbenzene	RFG[a]	RFG[a]	RFG[a] MtOH[c]	RFG[b]	CNG[b] RFG[b] MtOH[a]	RFG[a] EtOH[a] MtOH[c]
Tetramethylbenzene	CNG[b] RFG[a]	RFG[a]	CNG[b] RFG[a]	LPG[b] CNG[b] RFG[a]	RFG[a]	RFG[a]

TABLE 18 (Cont'd). SPECIATED COMPOUNDS CONFIRMED BY GC-MS ANALYSIS

Exhaust Configuration	Without Catalyst			With Catalyst		
Fuel\Air Equivalence Ratio	**0.8**	**1.0**	**1.2**	**0.8**	**1.0**	**1.2**
Trimethylbenzene	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[a] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[a]	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[a]
Methylpentane	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[a]	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[a]	LPG[b] CNG[a] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[a]
Dimethylpentane	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[a]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]
Dimethylbutene	RFG[b]	RFG[b] EtOH[c]	RFG[b] MtOH[b]			RFG[b]
Methylcyclopentane	LPG[b] RFG[b]	LPG[b] CNG[b] RFG[b]	LPG[b] RFG[b]	LPG[b] CNG[b] RFG[b]	RFG[b] EtOH[c]	RFG[b]
Propylcyclohexane						MtOH[c]
Dodecane	CNG[b] RFG[b]	LPG[b] CNG[a] RFG[b]	LPG[b] CNG[b] RFG[b]	CNG[b] RFG[b]	LPG[b] CNG[b] RFG[b]	CNG[b] RFG[b] EtOH[b]
Heptane	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[a] MtOH[a]
1-Heptene	EtOH[c] MtOH[c]					
Hexane	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[a]	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[a]	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]
Methylpropane	LPG[b] CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[a] CNG[b] RFG[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]

TABLE 18 (Cont'd). SPECIATED COMPOUNDS CONFIRMED BY GC-MS ANALYSIS

Exhaust Configuration	Without Catalyst			With Catalyst		
Fuel\Air Equivalence Ratio	**0.8**	**1.0**	**1.2**	**0.8**	**1.0**	**1.2**
Methylheptane	LPG[b] RFG[a]	LPG[b] CNG[b] RFG[a]	LPG[b] CNG[b] RFG[a] MtOH[b]	LPG[b] RFG[b] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[b]	LPG[b] CNG[b] RFG[b] EtOH[b]
Methylhexane	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[a] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[c]
Methylpentene	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[a] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[a]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[b]
Octane	RFG[b]	RFG[b] EtOH[a]	RFG[b] MtOH[b]	RFG[b]	LPG[b] CNG[b] RFG[b]	LPG[b] CNG[b] RFG[b] EtOH[b]
Methyloctane	RFG[b] EtOH[c]	CNG[b] RFG[b] EtOH[b]	RFG[b]	RFG[b]	LPG[b] RFG[b]	RFG[b] EtOH[b]
Dimethyloctane	LPG[b] CNG[b] RFG[b]	LPG[b] CNG[b] RFG[b]	LPG[b] CNG[b] RFG[b] MtOH[b]	CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[b] RFG[b]	LPG[b] CNG[b] RFG[b] EtOH[b] MtOH[c]
Undecane	CNG[b] RFG[b] MtOH[b]	LPG[b] CNG[a] RFG[b] MtOH[b]	LPG[b] CNG[b] RFG[b] MtOH[b]	CNG[b] RFG[b] EtOH[b]	LPG[b] CNG[a] RFG[b] MtOH[b]	LPG[b] CNG[b] RFG[b] EtOH[b]
Methhylethylketone	RFG[a]	RFG[a]	RFG[a] EtOH[b]	RFG[a] EtOH[b] MtOH[b]	RFG[a] EtOH[b] MtOH[b]	RFG[a] EtOH[b] MtOH[b]
Isobutyraldehyde	LPG[a] CNG[b] RFG[b]	RFG[b]	LPG[b] RFG[b] EtOH[b]	RFG[b] EtOH[b] MtOH[b]	LPG[b] RFG[b] EtOH[b] MtOH[b]	LPG[b] RFG[b] EtOH[b] MtOH[b]

[a] Compound was identified by both GC-FID and GC-MS under the specified operating conditions.
[b] Compound found by GC-FID/not found by GC-MS.
[c] Compound found by GC-MS/not found by GC-FID.

TABLE 19. OTHER COMPOUNDS IDENTIFIED BY GC-MS ANALYSIS

Exhaust Configuration	Without Catalyst			With Catalyst		
Fuel/Air Equivalence Ratio	0.8	1.0	1.2	0.8	1.0	1.2
AROMATICS						
1,1(1,2-ethanediyl)bis-4-methyl-benzene	RFG	RFG	RFG			RFG
1,2,3,4-tetrahydro-methyl-naphthalene	RFG	RFG	RFG			RFG
1-Ethyl-2,3-dihydro-1-methyl-1H-indene	RFG	RFG	RFG			RFG
acenaphthylene	RFG	RFG	RFG			RFG
azulene	EtOH			EtOH		
biphenylene		EtOH				
cis-decahydro-naphthalene		LPG				
cyclodecane						EtOH
cyclohexadiene						EtOH
Ethyl-dimethylethyl-benzene	RFG	RFG	RFG			RFG
Ethyl-naphthalene	RFG	RFG	RFG			RFG
isopropyl-cyclobutane		EtOH				
methyl-(1-methylethyl)-benzene	RFG	RFG	RFG			RFG
methyl-naphthalene	RFG	CNG RFG	CNG RFG EtOH		RFG	RFG
methylethyl-naphthalene	RFG	RFG	RFG			RFG
phenanthrene	RFG	RFG	RFG			RFG
1,1'-(1,2-dimethyl-1,2-ethanediyl)bis-benzene	RFG	RFG	RFG			RFG
AROMATIC - UNSATURATED						
1,1'-(1,2-ethanediyl)bis-benzene	RFG	RFG	RFG			RFG
1,1'-(1-methyl-1,2-ethanediyl)bis-benzene	RFG	RFG	RFG			RFG
ethynyl-benzene	LPG	LPG	LPG			
ethynyl-ethyl-benzene	RFG	RFG	RFG	RFG	RFG	RFG
AROMATIC - OXYGEN-CONTAINING						
1-(4-ethylphenyl)-ehtanone						EtOH
1-methyl-4-methylene-cyclohexane						EtOH
1-napthalene-carboxaldehyde						RFG
1-phenyl-ethanone			MtOH		CNG	
2-naphthyl-aldehyde	RFG	RFG				RFG
2,5-biphenyl-phenol		CNG				
3-ethyl-phenol						EtOH
benzene-acetaldehyde	RFG	RFG				RFG
benzoic acid	LPG EtOH MtOH	MtOH	MtOH	LPG		

TABLE 19 (Cont'd). OTHER COMPOUNDS IDENTIFIED BY GC-MS ANALYSIS

Exhaust Configuration	Without Catalyst			With Catalyst		
Fuel/Air Equivalence Ratio	**0.8**	**1.0**	**1.2**	**0.8**	**1.0**	**1.2**
diethyl-benzyl-ethanol	RFG	RFG	RFG			RFG
dimethyl-benzaldehyde	RFG	RFG	RFG			RFG
ethyl-benzaldehyde	RFG	RFG	RFG			RFG
ethylmethyl-phenol						EtOH
methyl-benzaldehyde	RFG	RFG	RFG			RFG MtOH
methyl-phenol	RFG	RFG	RFG			RFG MtOH
methyl-pentanone				EtOH		EtOH
p-(2-methylallyl)-phenol	RFG	RFG	RFG			RFG
phenyl-maleic anhydride	EtOH MtOH	CNG	CNG			
toluene-methanol	RFG	RFG	RFG			RFG
trimethyl-2-cyclopentane-1-one						EtOH
OXYGEN-CONTAINING						
1-butanol, 3-methyl, formate	MtOH					
1-methylethylester					LPG	
1-hydroxy-4,5-diethyl-2(1H0-pyridinethione)	EtOH MtOH			EtOH MtOH		
2,5-dihydrofuran	RFG	RFG	RFG			RFG EtOH
2-butanone	RFG	RFG	RFG			RFG
2-ethyl-1-butanol	RFG	RFG	RFG			RFG
2-butanoic acid						EtOH
2-methoxy-2-methyl-propane	RFG	RFG	RFG EtOH			RFG
2-methyl-2-propanol	MtOH					
6 carbon ketone	RFG	RFG	RFG			
acetic acid ethyl ester	EtOH	EtOH	EtOH			
.alpha.-methyl-benzene-methanol	EtOH	EtOH	EtOH			EtOH
1-(1-propenyl)-bicyclo[3.2.1]octane-2-one	RFG	RFG	RFG			
butanediol	RFG	RFG	RFG			RFG
butenol				EtOH	EtOH	EtOH
diethoxy-ethane				EtOH	EtOH	
ethyl-oxirane		MtOH				
formic acid ethyl ester	MtOH		EtOH			
hexanoic acid	EtOH		EtOH			

TABLE 19 (Cont'd). OTHER COMPOUNDS IDENTIFIED BY GC-MS ANALYSIS

Exhaust Configuration	Without Catalyst			With Catalyst		
Fuel/Air Equivalence Ratio	**0.8**	**1.0**	**1.2**	**0.8**	**1.0**	**1.2**
isopropyl-myristate	EtOH MtOH	EtOH MtOH	MtOH		EtOH	
methyl-butanol						EtOH
methyl-pentadiene						EtOH
phenyl-methanol	RFG	RFG	RFG			RFG
propanol	MtOH		EtOH		EtOH	MtOH
tetradecanoic acid		CNG			LPG	
OXYGEN-CONTAINING - UNSATURATED						
2-phenyl-2-butenal		RFG	RFG			
3-heptene-2-ol						EtOH
3-pentene-2-one						EtOH
4-hexene-1-ol						EtOH
diethyl-ketene	RFG	RFG	RFG			
UNSATURATED						
1,3,7-octatrien-5-yne	RFG	RFG	RFG			
3,4-nonadiene				EtOH		
3-methyl-decane			CNG			
cycloheptatriene	EtOH					
dimethyl-decene	MtOH					
dimehtyl-heptene	EtOH					
hexadiyne	RFG EtOH MtOH	RFG EtOH	RFG EtOH			
SATURATED						
2-methyl-butane			MtOH			
C_{15} branched alkane						EtOH
C_{17} branched alkane	RFG MtOH	RFG MtOH	RFG EtOH MtOH	MtOH	MtOH	RFG EtOH MtOH
C_{18} branched alkane	MtOH					EtOH
C_{19} branched alkane	MtOH	MtOH	EtOH MtOH	MtOH		EtOH MtOH
C_{20} branched alkane	MtOH	MtOH	EtOH MtOH	MtOH		EtOH MtOH
dimethyloxy-dimethyl-cyclohexane					MtOH	
eicosane		MtOH			MtOH	EtOH

TABLE 19 (Cont'd). OTHER COMPOUNDS IDENTIFIED BY GC-MS ANALYSIS

Exhaust Configuration	Without Catalyst			With Catalyst		
Fuel/Air Equivalence Ratio	**0.8**	**1.0**	**1.2**	**0.8**	**1.0**	**1.2**
hexadecane	MtOH	MtOH	EtOH MtOH	MtOH	MtOH	EtOH
methyl-tetradecane	RFG	RFG	RFG			RFG
nonadecane	MtOH	MtOH	EtOH MtOH	MtOH	MtOH	EtOH MtOH
octadecane	MtOH	MtOH	EtOH MtOH	MtOH	MtOH	EtOH MtOH
pentadecane	MtOH	CNG MtOH	EtOH MtOH	MtOH	MtOH	EtOH MtOH
tetradecane	MtOH	CNG	EtOH		MtOH	
tetramethyl-cyclopropane	EtOH	EtOH				
tetramethyl-hexadecane					MtOH	
trimethyl-dodecane	RFG	RFG	RFG			RFG
NITROGEN-CONTAINING						
1-cyclopropyl-4-nitro-benzene	RFG	RFG				
1-nitropropane	LPG	LPG				
1-nitro-2-propanol		LPG				
2,4-dimethyl-2-nitro-pentane	RFG	RFG	RFG			
2-nitropropane	LPG	LPG	LPG			
nitroethane	LPG	LPG EtOH	LPG CNG EtOH			
nitromethane	LPG EtOH MtOH	EtOH MtOH	CNG EtOH			
SULFUR-CONTAINING						
sulfonylbis-methane		MtOH		EtOH	EtOH MtOH	MtOH
sulfur dioxide		EtOH				

V. SUMMARY AND CONCLUSIONS

Regulated and volatile organic exhaust species were characterized from a 1993 Chevrolet Lumina operating on compressed natural gas (CNG), liquefied petroleum gas (LPG), and reformulated gasoline (RFG), and from a 1988 Chevrolet Corsica operating on ethanol (EtOH) and methanol (MtOH). For the evaluation of gaseous fuels, aftermarket conversion kits were installed on the Lumina. The Corsica was a dedicated alcohol vehicle owned by the University of Tennessee. For all fuels, the vehicles were operated over the chassis dynamometer portion of the Federal Test Procedure (FTP) for light-duty vehicles at fuel/air equivalence ratios of 0.8, 1.0, and 1.2; exhaust emissions were sampled both with and without the catalytic converter in place. The objective of the program was to qualitatively identify organic emissions from alternative-fueled vehicles during normal operation and simulated failure modes. To provide additional information for the program, these vehicle exhaust emissions were also quantified. Vehicles were tuned on each fuel to provide adequate driveability over the FTP; optimization of the vehicles to provide the lowest emissions levels was outside the scope of this program.

Analyses of exhaust samples included determination of regulated exhaust emissions by *Code of Federal Regulations* methods, hydrocarbon speciation, analyses of aldehydes and ketones according to Auto/Oil Phase II methods, and the determination of trace exhaust species by mass spectral analysis methods. In addition, a limited comparison of the ozone-forming potential of each vehicle/fuel combination was conducted based on the Maximum Incremental Reactivity scale as used by the California Air Resources Board for determining reactivity of individual exhaust species. Some of the findings in the study are listed below.

- Speciation data showed greater than 95% of all LPG and CNG organic exhaust constituents to be C_1-C_3 compounds.

- Prevalent species in exhaust from reformulated gasoline were mostly C_4-C_8 compounds.

- For the alcohol fuels, more than 96% of organic exhaust species were C_1 and C_2 compounds.

- More than 99% of measured NMOG mass could be attributed to 34 species in CNG exhaust, 54 species in LPG exhaust, more than 200 species in reformulated gasoline exhaust, 7 species in ethanol exhaust, and 5 species in methanol exhaust.

- Because of poor vehicle driveability on neat alcohols, unburned fuel accounted for virtually all NMOG emissions during operation on ethanol and methanol.

- Acetaldehyde accounted for virtually all toxic emissions while operating on ethanol, while formaldehyde composed practically all toxic emissions while operating on methanol.

- On average, Reactivity Adjustment Factors (RAFs) of CNG and LPG exhaust were about 65% less than those of reformulated gasoline, whereas RAFs from ethanol and methanol were 50% and 75% less, respectively, than those of reformulated gasoline.

- Potential ozone produced by post-catalyst CNG and LPG emissions was less than half of that produced by RFG during stoichiometric operation. The alcohol fuels had RAFs of a level similar to the gaseous fuels at those operating conditions; however, high NMOG mass emissions rates resulted in ozone forming potentials for ethanol and methanol exhaust that were similar to reformulated gasoline.

- GC/MS analysis identified a number of nitrogen-containing compounds in exhaust samples from all fuels, including nitromethane, nitroethane, and nitropropane. A number of heavier compounds, likely from the lubricating oil, were also identified in exhaust from all fuels.

VI. RECOMMENDATIONS

The primary objective of this program was to identify organic compounds qualitatively in the exhaust of vehicles operating at various conditions on alternative fuels. Identification efforts were successful and the basic project goal was met. In addition, exhaust emissions were quantified in an attempt to provide fuel-to-fuel comparisons of exhaust emissions. However, these comparisons were difficult due to the variability of the vehicles used to generate exhaust. None of the vehicle-fuel combinations evaluated in this program were optimized to provide the lowest exhaust emissions. Both gaseous conversion kits operated rich at idle under certain conditions. In addition, the alcohol-fueled vehicle ran rough and drove poorly when it was not fully warmed up. For all alternative fuels tested, especially the alcohol fuels, insufficient fuel system calibrations affected the level of exhaust emissions. This was particularly apparent in the cold-start portion of the FTP. A possible means of lessening the influence of the poor vehicle calibrations would be to examine and compare the Bag 2 exhaust emissions generated in this program. Some Bag 2 observations are noted in this report; however, additional effort in this area may be warranted.

In future studies examining exhaust emissions levels, OEM alternative-fueled vehicles or the latest generation of electronically-controlled fuel-injected gaseous conversion kits should be used when possible. This would preclude examining M100 and E100, as OEM alcohol vehicles are currently limited to a maximum of M85 and E85. However, a current TLEV-certified flexible-fueled vehicle fitted with the appropriate electronically-controlled gaseous fuel conversion kit should provide a more direct comparison of exhaust emissions levels from alternative fuels.

The extreme fuel/air equivalence ratios examined during this program were representative of severe fuel-control failure modes; however, in almost all instances vehicle driveability was severely degraded. It is likely that such vehicle failures would be quickly repaired. Of more concern are vehicles operating slightly rich or slightly lean. These conditions may not be noticeable to the driver, but may severely effect the performance of a

catalytic converter. It is suggested that these types of in-use situations are more likely to occur and go unnoticed for long periods of time, and it may require additional work to quantify their effects.

The technique used to sample trace species for mass spectral analysis worked well for C_6 and higher species; however, a quantification of a number of these species was not possible. Additional refinements to the method are needed to provide emission rates for these compounds. The presence of a number of nitrogen-containing organic compounds (e.g., nitromethane, nitroethane, nitropropane) in the exhaust from all four alternative fuels is noteworthy, and additional analytical efforts are needed to investigate the presence of these compounds.

VII. REFERENCES

1. Code of Federal Regulations, Title 40, Part 86, Subpart B.

2. King, S., "Natural Gas as a Stationary Engine and Vehicular Fuel," SAE Paper 912364, 1991.

3. Painter, L. and Rutherford, J., "Statistical Design and Analysis Methods for the Auto/Oil Quality Research Program, SAE Paper 920319, 1992.

4. Bass, E.A., *Evaluation of Aftermarket LPG Conversion Kits in Light-Duty Vehicle Applications*, NREL TP-421-5462, Golden, CO: National Renewable Energy Laboratory, June 1993.

5. California Code of Regulations, Title 13, Section 1960.1, "California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," amended June 24, 1996.

APPENDIX A

COMPUTER PRINTOUT OF EMISSIONS DATA FROM "CHECK-OUT" FTP OF CHEVROLET LUMINA

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG EPA FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M
VEHICLE MODEL 93 CHEVY LUMINA
ENGINE 3.1 L (189 CID)-V-6
TRANSMISSION L4
ODOMETER 5693 MILES (9160 KM)

TEST CHECK-OUT
DATE 11/ 9/93 RUN
DYNO 2 BAG CART 2
ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
TEST WEIGHT 4000 LBS (1814 KG)

GASOLINE AS RECD
FUEL DENSITY 6.160 LB/GAL
H .134 C .866 O .000 X .000

BAROMETER 29.42 IN HG (747.3 MM HG) DRY BULB TEMPERATURE 75.0°F (23.9°C) NOX HUMIDITY C.F. 1.012
RELATIVE HUMIDITY 58.6 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.7	867.8	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.976/.982	.978/.982	.976/.982
MEASURED DISTANCE MILES (KM)	3.65 (5.87)	3.91 (6.29)	3.65 (5.88)
BLOWER FLOW RATE SCFM (SCMM)	561.8 (15.91)	563.0 (15.95)	563.5 (15.96)
GAS METER FLOW RATE SCFM (SCMM)	.00 (.00)	.00 (.00)	.00 (.00)
TOTAL FLOW SCF (SCM)	4735. (134.1)	8143. (230.6)	4745. (134.4)
HC SAMPLE METER/RANGE/PPM (BAG)	49.8/ 2/ 49.77	90.2/ 1/ 9.05	16.2/ 2/ 16.19
HC BCKGRD METER/RANGE/PPM	6.1/ 2/ 6.10	59.6/ 1/ 5.98	5.8/ 2/ 5.80
CO SAMPLE METER/RANGE/PPM	56.2/ 14/ 254.13	43.2/ 12/ 42.04	88.1/ 13/ 215.15
CO BCKGRD METER/RANGE/PPM	.2/ 14/ .81	1.5/ 12/ 1.43	.5/ 13/ 1.09
CO2 SAMPLE METER/RANGE/PCT	83.8/ 14/ .7311	70.3/ 14/ .5037	79.4/ 14/ .6481
CO2 BCKGRD METER/RANGE/PCT	13.8/ 14/ .0470	13.8/ 14/ .0470	13.9/ 14/ .0474
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	72.9/ 1/ 18.23	13.4/ 1/ 3.35	30.5/ 1/ 7.63
NOX BCKGRD METER/RANGE/PPM	1.0/ 1/ .25	1.0/ 1/ .25	1.1/ 1/ .28
DILUTION FACTOR	17.73	26.51	20.11
HC CONCENTRATION PPM	44.02	3.30	10.68
CO CONCENTRATION PPM	245.00	39.49	207.39
CO2 CONCENTRATION PCT	.6868	.4585	.6031
NOX CONCENTRATION PPM	18.00	3.11	7.37
HC MASS GRAMS	3.403	.438	.827
CO MASS GRAMS	38.251	10.603	32.443
CO2 MASS GRAMS	1686.17	1935.92	1483.77
NOX MASS GRAMS	4.670	1.388	1.916
FUEL MASS KG	.554	.616	.485
FUEL ECONOMY MPG (L/100KM)	18.42 (12.77)	17.74 (13.26)	21.06 (11.17)

3-BAG COMPOSITE RESULTS

HC	G/MI	.314
CO	G/MI	6.021
NOX	G/MI	.593
FUEL ECONOMY MPG (L/100KM)		18.71 (12.57)

APPENDIX B

COMPUTER PRINTOUTS OF EMISSIONS DATA FROM REFORMULATED GASOLINE BASELINE FTPs OF CHEVROLET LUMINA

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG EPA FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M TEST L-PH2-REF-R1 GASOLINE EM-1611-F
VEHICLE MODEL 93 CHEVY LUMINA DATE 11/11/93 RUN FUEL DENSITY 6.157 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 DYNO 2 BAG CART 2 H .137 C .847 O .016 X .000
TRANSMISSION L4 ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 5732 MILES (9222 KM) TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.21 IN HG (741.9 MM HG) DRY BULB TEMPERATURE 77.0°F (25.0°C) NOX HUMIDITY C.F. 1.024
RELATIVE HUMIDITY 56.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	504.9	867.6	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.975/.982	.977/.982	.975/.982
MEASURED DISTANCE MILES (KM)	3.64 (5.86)	3.86 (6.22)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	564.4 (15.98)	563.9 (15.97)	563.4 (15.96)
GAS METER FLOW RATE SCFM (SCMM)	.00 (.00)	.00 (.00)	.00 (.00)
TOTAL FLOW SCF (SCM)	4750. (134.5)	8154. (230.9)	4744. (134.4)
HC SAMPLE METER/RANGE/PPM (BAG)	42.1/ 2/ 42.08	10.8/ 2/ 10.79	14.5/ 2/ 14.49
HC BCKGRD METER/RANGE/PPM	8.9/ 2/ 8.89	9.8/ 2/ 9.79	8.9/ 2/ 8.89
CO SAMPLE METER/RANGE/PPM	80.2/ 13/ 193.48	19.3/ 12/ 18.61	42.0/ 13/ 95.82
CO BCKGRD METER/RANGE/PPM	.9/ 13/ 1.96	2.0/ 12/ 1.90	.5/ 13/ 1.09
CO2 SAMPLE METER/RANGE/PCT	84.4/ 14/ .7432	70.4/ 14/ .5051	80.6/ 14/ .6698
CO2 BCKGRD METER/RANGE/PCT	13.5/ 14/ .0458	13.4/ 14/ .0454	13.0/ 14/ .0438
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	49.4/ 1/ 12.36	5.6/ 1/ 1.40	23.3/ 1/ 5.83
NOX BCKGRD METER/RANGE/PPM	2.7/ 1/ .68	.7/ 1/ .18	.7/ 1/ .18
DILUTION FACTOR	17.38	26.22	19.57
HC CONCENTRATION PPM	33.69	1.37	6.05
CO CONCENTRATION PPM	185.34	16.29	91.82
CO2 CONCENTRATION PCT	.7001	.4615	.6282
NOX CONCENTRATION PPM	11.72	1.23	5.66
HC MASS GRAMS	2.671	.187	.479
CO MASS GRAMS	29.022	4.380	14.361
CO2 MASS GRAMS	1723.97	1951.07	1545.29
NOX MASS GRAMS	3.086	.557	1.489
FUEL MASS KG	.573	.631	.506
FUEL ECONOMY MPG (L/100KM)	17.75 (13.26)	17.09 (13.76)	19.97 (11.78)

3-BAG COMPOSITE RESULTS

HC	G/MI	.214
CO	G/MI	3.342
NOX	G/MI	.365
FUEL ECONOMY MPG (L/100KM)		17.95 (13.10)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG EPA FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M TEST L-PH2-REF-R2 GASOLINE EM-1611-F
VEHICLE MODEL 93 CHEVY LUMINA DATE 11/12/93 RUN FUEL DENSITY 6.157 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 DYNO 2 BAG CART 2 H .137 C .847 O .016 X .000
TRANSMISSION L4 ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 5743 MILES (9240 KM) TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 28.98 IN HG (736.1 MM HG) DRY BULB TEMPERATURE 79.0°F (26.1°C) NOX HUMIDITY C.F. 1.065
RELATIVE HUMIDITY 57.2 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.2	867.2	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.973/.980	.975/.980	.974/.980
MEASURED DISTANCE MILES (KM)	3.61 (5.80)	3.86 (6.20)	3.62 (5.83)
BLOWER FLOW RATE SCFM (SCMM)	555.0 (15.72)	557.4 (15.79)	557.0 (15.77)
GAS METER FLOW RATE SCFM (SCMM)	.00 (.00)	.00 (.00)	.00 (.00)
TOTAL FLOW SCF (SCM)	4673. (132.3)	8056. (228.2)	4690. (132.8)
HC SAMPLE METER/RANGE/PPM (BAG)	44.2/ 2/ 44.17	76.5/ 1/ 7.68	16.9/ 2/ 16.89
HC BCKGRD METER/RANGE/PPM	6.9/ 2/ 6.90	65.3/ 1/ 6.55	7.4/ 2/ 7.40
CO SAMPLE METER/RANGE/PPM	53.9/ 14/ 242.10	18.3/ 12/ 17.63	73.7/ 13/ 176.03
CO BCKGRD METER/RANGE/PPM	.2/ 14/ .81	1.2/ 12/ 1.14	.6/ 13/ 1.31
CO2 SAMPLE METER/RANGE/PCT	84.7/ 14/ .7493	71.2/ 14/ .5166	80.6/ 14/ .6698
CO2 BCKGRD METER/RANGE/PCT	14.8/ 14/ .0510	14.6/ 14/ .0502	14.7/ 14/ .0506
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	47.9/ 1/ 11.98	5.4/ 1/ 1.35	12.7/ 1/ 3.18
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .18	.5/ 1/ .13	.5/ 1/ .13
DILUTION FACTOR	17.14	25.66	19.34
HC CONCENTRATION PPM	37.68	1.38	9.88
CO CONCENTRATION PPM	233.32	16.05	169.25
CO2 CONCENTRATION PCT	.7013	.4683	.6218
NOX CONCENTRATION PPM	11.82	1.23	3.06
HC MASS GRAMS	2.939	.185	.773
CO MASS GRAMS	35.948	4.264	26.171
CO2 MASS GRAMS	1699.10	1956.30	1512.03
NOX MASS GRAMS	3.183	.571	.827
FUEL MASS KG	.569	.633	.501
FUEL ECONOMY MPG (L/100KM)	17.71 (13.28)	17.02 (13.82)	20.17 (11.66)

3-BAG COMPOSITE RESULTS

HC	G/MI	.253
CO	G/MI	4.637
NOX	G/MI	.323
FUEL ECONOMY MPG (L/100KM)		17.95 (13.10)

APPENDIX C

COMPUTER PRINTOUTS OF EMISSIONS DATA FROM FTPs WITH LPG

Page C-	Test Number	Operating Condition	Catalyst Installation
1	L-LPG-0.8-E1	Lean	Without Catalyst
2	L-LPG-0.8-E2	Lean	Without Catalyst
3	L-LPG-0.8-C1	Lean	With Catalyst
4	L-LPG-0.8-C2	Lean	With Catalyst
5	L-LPG-1.0-E1	Stoich	Without Catalyst
6	L-LPG-1.0-E2	Stoich	Without Catalyst
7	L-LPG-1.0-C1	Stoich	With Catalyst
8	L-LPG-1.0-C2	Stoich	With Catalyst
9	L-LPG-1.2-E1	Rich	Without Catalyst
10	L-LPG-1.2-E2	Rich	Without Catalyst
11	L-LPG-1.2-C1	Rich	With Catalyst
12	L-LPG-1.2-C2	Rich	With Catalyst

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-LPG-0.8-E1 | LPG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 2/ 1/94 RUN 1 | FUEL DENSITY 5.733 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .181 C .819 O .000 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6120 MILES (9847 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.64 IN HG (752.9 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .811
RELATIVE HUMIDITY 21.6 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.0	867.6	505.0
DRY/WET CORRECTION FACTOR, SAMP/BACK	.986/.994	.989/.994	.987/.994
MEASURED DISTANCE MILES (KM)	3.64 (5.86)	3.88 (6.25)	3.65 (5.88)
BLOWER FLOW RATE SCFM (SCMM)	569.3 (16.12)	572.3 (16.21)	571.9 (16.20)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.29 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4794. (135.8)	8280. (234.5)	4815. (136.4)
HC SAMPLE METER/RANGE/PPM (BAG)	19.2/ 3/ 191.57	19.1/ 3/ 190.58	18.9/ 3/ 188.58
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	.9/ 3/ 8.98	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	54.1/ 13/ 125.52	98.0/ 13/ 243.05	79.4/ 13/ 191.31
CO BCKGRD METER/RANGE/PPM	.2/ 13/ .44	.3/ 13/ .65	.5/ 13/ 1.09
CO2 SAMPLE METER/RANGE/PCT	79.7/ 14/ .6535	64.5/ 14/ .4268	74.7/ 14/ .5695
CO2 BCKGRD METER/RANGE/PCT	14.1/ 14/ .0482	13.9/ 14/ .0474	13.4/ 14/ .0454
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	30.5/ 2/ 30.51	34.8/ 1/ 8.77	31.0/ 2/ 31.01
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ .50	1.5/ 1/ .39	.2/ 2/ .20
CH4 SAMPLE PPM (1.110)	4.76	5.95	5.53
CH4 BCKGRD PPM	2.54	2.53	2.54
DILUTION FACTOR	17.07	24.89	19.26
HC CONCENTRATION PPM	184.06	181.96	181.01
CO CONCENTRATION PPM	122.34	238.33	186.43
CO2 CONCENTRATION PCT	.6081	.3813	.5265
NOX CONCENTRATION PPM	30.04	8.39	30.82
CH4 CONCENTRATION PPM	2.36	3.52	3.12
NMHC CONCENTRATION PPM	181.43	178.05	177.55
THC MASS GRAMS	15.555	26.016	15.244
CO MASS GRAMS	19.336	65.062	29.598
CO2 MASS GRAMS	1511.60	1636.97	1314.47
NOX MASS GRAMS	6.325	3.052	6.518
CH4 MASS GRAMS	.214	.551	.284
NMHC MASS GRAMS (FID)	14.204	24.074	13.962
FUEL MASS KG	.530	.606	.469
FUEL ECONOMY MPG (L/100KM)	17.90 (13.14)	16.67 (14.11)	20.26 (11.61)

3-BAG COMPOSITE RESULTS

THC	G/MI	5.495	CH4	G/MI	.107
CO	G/MI	11.980	NMHC	G/MI	5.063
NOX	G/MI	1.259	CARBONYL	G/MI	.272
			ALCOHOL	G/MI	.053

FUEL ECONOMY MPG (L/100KM) 17.81 (13.21)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-LPG-0.8-E2 | LPG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 2/ 2/94 RUN 1 | FUEL DENSITY 5.733 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .181 C .819 O .000 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6131 MILES (9864 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.62 IN HG (752.3 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .811
RELATIVE HUMIDITY 21.6 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	504.8	867.8	505.6
DRY/WET CORRECTION FACTOR, SAMP/BACK	.986/.994	.989/.994	.987/.994
MEASURED DISTANCE MILES (KM)	3.66 (5.88)	3.90 (6.27)	3.65 (5.88)
BLOWER FLOW RATE SCFM (SCMM)	569.9 (16.14)	571.9 (16.20)	570.5 (16.16)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4797. (135.9)	8276. (234.4)	4810. (136.2)
HC SAMPLE METER/RANGE/PPM (BAG)	18.3/ 3/ 182.59	19.0/ 3/ 189.58	21.9/ 3/ 218.51
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	.8/ 3/ 7.98	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	47.0/ 13/ 107.96	84.5/ 13/ 205.21	78.2/ 13/ 188.07
CO BCKGRD METER/RANGE/PPM	.7/ 13/ 1.52	.8/ 13/ 1.74	.7/ 13/ 1.52
CO2 SAMPLE METER/RANGE/PCT	79.2/ 14/ .6446	64.4/ 14/ .4255	74.7/ 14/ .5695
CO2 BCKGRD METER/RANGE/PCT	14.8/ 14/ .0510	14.4/ 14/ .0494	14.5/ 14/ .0498
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	32.9/ 2/ 32.91	33.8/ 1/ 8.52	32.1/ 2/ 32.11
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ .50	1.2/ 1/ .31	.4/ 2/ .40
CH4 SAMPLE PPM (1.110)	4.69	5.85	5.76
CH4 BCKGRD PPM	2.69	2.73	2.80
DILUTION FACTOR	17.36	25.16	19.18
HC CONCENTRATION PPM	175.07	181.91	210.95
CO CONCENTRATION PPM	104.17	200.09	182.84
CO2 CONCENTRATION PCT	.5965	.3781	.5223
NOX CONCENTRATION PPM	32.44	8.22	31.74
CH4 CONCENTRATION PPM	2.16	3.23	3.11
NMHC CONCENTRATION PPM	172.67	178.33	207.50
THC MASS GRAMS	14.877	25.972	17.539
CO MASS GRAMS	16.477	54.597	28.996
CO2 MASS GRAMS	1483.71	1622.41	1302.55
NOX MASS GRAMS	6.836	2.988	6.705
CH4 MASS GRAMS	.196	.504	.282
NMHC MASS GRAMS (FID)	13.527	24.101	16.299
FUEL MASS KG	.518	.595	.467
FUEL ECONOMY MPG (L/100KM)	18.35 (12.82)	17.02 (13.82)	20.36 (11.56)

3-BAG COMPOSITE RESULTS

THC	G/MI	5.610	CH4	G/MI	.099
CO	G/MI	10.355	NMHC	G/MI	5.191
NOX	G/MI	1.291	CARBONYL	G/MI	.271
			ALCOHOL	G/MI	.048

FUEL ECONOMY MPG (L/100KM) 18.12 (12.98)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M
VEHICLE MODEL 93 CHEVY LUMINA
ENGINE 3.1 L (189 CID)-V-6
TRANSMISSION L4
ODOMETER 6083 MILES (9787 KM)

TEST L-LPG-0.8-C1
DATE 1/28/94 RUN 1
DYNO 2 BAG CART 2
ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
TEST WEIGHT 4000 LBS (1814 KG)

LPG
FUEL DENSITY 5.733 LB/GAL
H .181 C .819 O .000 X .000

BAROMETER 29.40 IN HG (746.8 MM HG) DRY BULB TEMPERATURE 73.0°F (22.8°C) NOX HUMIDITY C.F. .807
RELATIVE HUMIDITY 19.8 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.2	867.7	505.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.986/.994	.989/.994	.987/.994
MEASURED DISTANCE MILES (KM)	3.61 (5.80)	3.79 (6.09)	3.60 (5.79)
BLOWER FLOW RATE SCFM (SCMM)	568.2 (16.09)	572.1 (16.20)	571.7 (16.19)
GAS METER FLOW RATE SCFM (SCMM)	.14 (.00)	.14 (.00)	.14 (.00)
TOTAL FLOW SCF (SCM)	4785. (135.5)	8275. (234.4)	4816. (136.4)
HC SAMPLE METER/RANGE/PPM (BAG)	53.6/ 2/ 53.57	11.6/ 2/ 11.59	38.3/ 2/ 38.28
HC BCKGRD METER/RANGE/PPM	5.1/ 2/ 5.10	5.7/ 2/ 5.70	5.7/ 2/ 5.70
CO SAMPLE METER/RANGE/PPM	15.6/ 12/ 15.01	45.2/ 12/ 44.01	57.4/ 12/ 56.11
CO BCKGRD METER/RANGE/PPM	.9/ 12/ .85	2.3/ 12/ 2.19	.5/ 12/ .47
CO2 SAMPLE METER/RANGE/PCT	80.1/ 14/ .6607	66.5/ 14/ .4522	75.7/ 14/ .5855
CO2 BCKGRD METER/RANGE/PCT	13.3/ 14/ .0450	13.1/ 14/ .0442	12.9/ 14/ .0434
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	39.2/ 2/ 39.22	35.8/ 1/ 9.01	31.7/ 2/ 31.71
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ .40	.8/ 1/ .21	.3/ 2/ .30
CH4 SAMPLE PPM (1.110)	3.86	5.11	4.68
CH4 BCKGRD PPM	2.43	2.38	2.34
DILUTION FACTOR	17.52	25.55	19.66
HC CONCENTRATION PPM	48.76	6.12	32.87
CO CONCENTRATION PPM	13.88	41.18	54.55
CO2 CONCENTRATION PCT	.6183	.4097	.5443
NOX CONCENTRATION PPM	38.84	8.82	31.43
CH4 CONCENTRATION PPM	1.57	2.82	2.46
NMHC CONCENTRATION PPM	47.02	2.99	30.14
THC MASS GRAMS	3.877	.846	2.595
CO MASS GRAMS	2.190	11.236	8.662
CO2 MASS GRAMS	1533.99	1757.91	1359.16
NOX MASS GRAMS	8.126	3.190	6.619
CH4 MASS GRAMS	.142	.440	.224
NMHC MASS GRAMS (FID)	3.675	.405	2.370
FUEL MASS KG	.516	.593	.460
FUEL ECONOMY MPG (L/100KM)	18.16 (12.95)	16.62 (14.16)	20.34 (11.56)

3-BAG COMPOSITE RESULTS

THC	G/MI	.540	CH4	G/MI	.085
CO	G/MI	2.316	NMHC	G/MI	.451
NOX	G/MI	1.415	CARBONYL	G/MI	.004

FUEL ECONOMY MPG (L/100KM) 17.85 (13.18)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-LPG-0.8-C2 | LPG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 1/31/94 RUN 1 | FUEL DENSITY 5.733 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .181 C .819 O .000 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6101 MILES (9816 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.65 IN HG (753.1 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .816
RELATIVE HUMIDITY 23.8 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	504.7	868.0	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.985/.994	.988/.994	.986/.994
MEASURED DISTANCE MILES (KM)	3.65 (5.88)	3.88 (6.24)	3.65 (5.87)
BLOWER FLOW RATE SCFM (SCMM)	572.5 (16.21)	574.4 (16.27)	574.0 (16.26)
GAS METER FLOW RATE SCFM (SCMM)	.14 (.00)	.14 (.00)	.14 (.00)
TOTAL FLOW SCF (SCM)	4817. (136.4)	8312. (235.4)	4835. (136.9)
HC SAMPLE METER/RANGE/PPM (BAG)	57.9/ 2/ 57.87	10.8/ 2/ 10.79	38.8/ 2/ 38.78
HC BCKGRD METER/RANGE/PPM	5.6/ 2/ 5.60	6.4/ 2/ 6.40	6.0/ 2/ 6.00
CO SAMPLE METER/RANGE/PPM	13.7/ 12/ 13.16	50.2/ 12/ 48.95	59.4/ 12/ 58.12
CO BCKGRD METER/RANGE/PPM	.7/ 12/ .66	.9/ 12/ .85	.4/ 12/ .38
CO2 SAMPLE METER/RANGE/PCT	81.1/ 14/ .6790	67.4/ 14/ .4640	76.4/ 14/ .5969
CO2 BCKGRD METER/RANGE/PCT	13.7/ 14/ .0466	13.7/ 14/ .0466	13.4/ 14/ .0454
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	32.4/ 2/ 32.41	33.5/ 1/ 8.44	32.9/ 2/ 32.91
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ .40	1.5/ 1/ .39	.3/ 2/ .30
CH4 SAMPLE PPM (1.110)	3.49	4.55	4.40
CH4 BCKGRD PPM	2.32	2.35	2.33
DILUTION FACTOR	17.04	24.89	19.28
HC CONCENTRATION PPM	52.60	4.65	33.09
CO CONCENTRATION PPM	12.23	47.24	56.51
CO2 CONCENTRATION PCT	.6352	.4192	.5538
NOX CONCENTRATION PPM	32.04	8.07	32.63
CH4 CONCENTRATION PPM	1.30	2.29	2.19
NMHC CONCENTRATION PPM	51.15	2.11	30.66
THC MASS GRAMS	4.206	.648	2.622
CO MASS GRAMS	1.943	12.946	9.007
CO2 MASS GRAMS	1586.34	1806.92	1388.32
NOX MASS GRAMS	6.819	2.964	6.971
CH4 MASS GRAMS	.119	.360	.200
NMHC MASS GRAMS (FID)	4.023	.286	2.420
FUEL MASS KG	.534	.610	.470
FUEL ECONOMY MPG (L/100KM)	17.79 (13.22)	16.54 (14.22)	20.17 (11.66)

3-BAG COMPOSITE RESULTS

THC	G/MI	.525	CH4	G/MI	.070
CO	G/MI	2.513	NMHC	G/MI	.451
NOX	G/MI	1.311	CARBONYL	G/MI	.004
FUEL ECONOMY MPG (L/100KM)		17.69 (13.30)			

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M TEST L-LPG-1.0-E1 LPG
VEHICLE MODEL 93 CHEVY LUMINA DATE 1/18/94 RUN 1 FUEL DENSITY 5.733 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 DYNO 2 BAG CART 2 H .181 C .819 O .000 X .000
TRANSMISSION L4 ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 5945 MILES (9565 KM) TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.56 IN HG (750.8 MM HG) DRY BULB TEMPERATURE 69.0°F (20.6°C) NOX HUMIDITY C.F. .793
RELATIVE HUMIDITY 18.3 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.2	868.2	505.0
DRY/WET CORRECTION FACTOR, SAMP/BACK	.987/.996	.990/.996	.988/.996
MEASURED DISTANCE MILES (KM)	3.64 (5.85)	3.86 (6.22)	3.63 (5.84)
BLOWER FLOW RATE SCFM (SCMM)	552.8 (15.66)	568.1 (16.09)	572.7 (16.22)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4666. (132.2)	8224. (232.9)	4823. (136.6)
HC SAMPLE METER/RANGE/PPM (BAG)	78.0/ 2/ 77.95	64.9/ 2/ 64.86	78.5/ 2/ 78.45
HC BCKGRD METER/RANGE/PPM	5.5/ 2/ 5.50	6.1/ 2/ 6.10	5.8/ 2/ 5.80
CO SAMPLE METER/RANGE/PPM	62.7/ 1/ 564.79	66.5/ 14/ 309.87	85.8/ 14/ 420.70
CO BCKGRD METER/RANGE/PPM	.0/ 1/ .00	.1/ 14/ .40	.5/ 14/ 2.02
CO2 SAMPLE METER/RANGE/PCT	78.1/ 14/ .6254	63.8/ 14/ .4182	73.7/ 14/ .5539
CO2 BCKGRD METER/RANGE/PCT	13.5/ 14/ .0458	13.5/ 14/ .0458	13.7/ 14/ .0466
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	46.1/ 2/ 46.12	82.5/ 1/ 20.62	44.7/ 2/ 44.72
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ .30	1.0/ 1/ .26	.4/ 2/ .40
CH4 SAMPLE PPM (1.110)	6.40	5.87	6.04
CH4 BCKGRD PPM	2.90	2.84	2.85
DILUTION FACTOR	16.98	25.69	19.39
HC CONCENTRATION PPM	72.78	59.00	72.96
CO CONCENTRATION PPM	553.27	304.65	410.91
CO2 CONCENTRATION PCT	.5823	.3742	.5097
NOX CONCENTRATION PPM	45.84	20.37	44.34
CH4 CONCENTRATION PPM	3.67	3.14	3.34
NMHC CONCENTRATION PPM	68.71	55.52	69.25
THC MASS GRAMS	5.940	8.535	6.133
CO MASS GRAMS	85.121	82.604	65.334
CO2 MASS GRAMS	1409.01	1595.47	1274.61
NOX MASS GRAMS	9.186	7.195	9.183
CH4 MASS GRAMS	.323	.488	.304
NMHC MASS GRAMS (FID)	5.236	7.456	5.454
FUEL MASS KG	.520	.584	.465
FUEL ECONOMY MPG (L/100KM)	18.18 (12.94)	17.22 (13.66)	20.29 (11.60)

3-BAG COMPOSITE RESULTS

THC	G/MI	1.946	CH4	G/MI	.107
CO	G/MI	20.869	NMHC	G/MI	1.710
NOX	G/MI	2.185	CARBONYL	G/MI	.112
			ALCOHOL	G/MI	.017

FUEL ECONOMY MPG (L/100KM) 18.19 (12.93)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-LPG-1.0-E2 | LPG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 1/19/94 RUN 1 | FUEL DENSITY 5.733 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .181 C .819 O .000 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 5957 MILES (9584 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.59 IN HG (751.6 MM HG) DRY BULB TEMPERATURE 68.0°F (20.0°C) NOX HUMIDITY C.F. .832
RELATIVE HUMIDITY 31.2 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.0	867.9	505.8
DRY/WET CORRECTION FACTOR, SAMP/BACK	.984/.993	.987/.993	.985/.993
MEASURED DISTANCE MILES (KM)	3.64 (5.86)	3.90 (6.28)	3.65 (5.87)
BLOWER FLOW RATE SCFM (SCMM)	566.4 (16.04)	572.8 (16.22)	568.1 (16.09)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4769. (135.1)	8290. (234.8)	4791. (135.7)
HC SAMPLE METER/RANGE/PPM (BAG)	80.3/ 2/ 80.25	68.2/ 2/ 68.16	80.4/ 2/ 80.35
HC BCKGRD METER/RANGE/PPM	5.9/ 2/ 5.90	6.7/ 2/ 6.70	6.6/ 2/ 6.60
CO SAMPLE METER/RANGE/PPM	66.3/ 1/ 607.52	65.8/ 14/ 305.99	87.1/ 14/ 428.32
CO BCKGRD METER/RANGE/PPM	.1/ 1/ .69	.5/ 14/ 2.02	.6/ 14/ 2.43
CO2 SAMPLE METER/RANGE/PCT	78.8/ 14/ .6376	64.7/ 14/ .4293	73.9/ 14/ .5570
CO2 BCKGRD METER/RANGE/PCT	14.4/ 14/ .0494	14.5/ 14/ .0498	14.9/ 14/ .0515
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	47.9/ 2/ 47.92	84.4/ 1/ 21.09	45.8/ 2/ 45.82
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ .40	1.5/ 1/ .39	.5/ 2/ .50
CH4 SAMPLE PPM (1.110)	6.16	5.60	5.73
CH4 BCKGRD PPM	2.51	2.50	2.50
DILUTION FACTOR	16.59	25.09	19.27
HC CONCENTRATION PPM	74.71	61.73	74.10
CO CONCENTRATION PPM	591.79	297.94	416.20
CO2 CONCENTRATION PCT	.5911	.3814	.5082
NOX CONCENTRATION PPM	47.55	20.72	45.35
CH4 CONCENTRATION PPM	3.80	3.20	3.36
NMHC CONCENTRATION PPM	70.49	58.18	70.37
THC MASS GRAMS	6.253	9.013	6.340
CO MASS GRAMS	93.055	81.437	65.748
CO2 MASS GRAMS	1461.80	1639.56	1262.58
NOX MASS GRAMS	10.217	7.738	9.790
CH4 MASS GRAMS	.342	.500	.304
NMHC MASS GRAMS (FID)	5.490	7.877	5.506
FUEL MASS KG	.542	.598	.462
FUEL ECONOMY MPG (L/100KM)	17.47 (13.46)	16.96 (13.87)	20.55 (11.44)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.029	CH4	G/MI	.109
CO	G/MI	21.057	NMHC	G/MI	1.772
NOX	G/MI	2.347	CARBONYL	G/MI	.121
			ALCOHOL	G/MI	.027

FUEL ECONOMY MPG (L/100KM) 17.96 (13.10)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-LPG-1.0-C1		LPG
VEHICLE MODEL 93 CHEVY LUMINA	DATE 1/13/94	RUN 1	FUEL DENSITY 5.733 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2	BAG CART 2	H .181 C .819 O .000 X .000
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)		
ODOMETER 5902 MILES (9496 KM)	TEST WEIGHT 4000 LBS (1814 KG)		

BAROMETER 29.31 IN HG (744.5 MM HG) DRY BULB TEMPERATURE 64.0°F (17.8°C) NOX HUMIDITY C.F. .914

RELATIVE HUMIDITY 60.7 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.3	868.4	504.5
DRY/WET CORRECTION FACTOR, SAMP/BACK	.979/.987	.982/.987	.980/.987
MEASURED DISTANCE MILES (KM)	3.64 (5.85)	3.87 (6.23)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	566.7 (16.05)	567.1 (16.06)	565.9 (16.03)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4775. (135.2)	8212. (232.6)	4760. (134.8)
HC SAMPLE METER/RANGE/PPM (BAG)	28.8/ 2/ 28.78	14.0/ 2/ 13.99	18.9/ 2/ 18.89
HC BCKGRD METER/RANGE/PPM	6.7/ 2/ 6.70	8.9/ 2/ 8.89	7.1/ 2/ 7.10
CO SAMPLE METER/RANGE/PPM	46.6/ 14/ 205.00	43.0/ 12/ 41.84	57.1/ 13/ 133.05
CO BCKGRD METER/RANGE/PPM	.7/ 14/ 2.83	2.2/ 12/ 2.09	.9/ 13/ 1.96
CO2 SAMPLE METER/RANGE/PCT	80.4/ 14/ .6661	66.4/ 14/ .4509	75.7/ 14/ .5855
CO2 BCKGRD METER/RANGE/PCT	14.5/ 14/ .0498	14.0/ 14/ .0478	13.9/ 14/ .0474
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	32.3/ 1/ 8.14	17.6/ 1/ 4.47	41.5/ 1/ 10.43
NOX BCKGRD METER/RANGE/PPM	.9/ 1/ .23	.5/ 1/ .13	.7/ 1/ .18
CH4 SAMPLE PPM (1.110)	7.61	7.73	6.08
CH4 BCKGRD PPM	2.96	2.82	2.78
DILUTION FACTOR	16.98	25.63	19.48
HC CONCENTRATION PPM	22.48	5.44	12.16
CO CONCENTRATION PPM	195.21	38.61	126.81
CO2 CONCENTRATION PCT	.6193	.4049	.5405
NOX CONCENTRATION PPM	7.92	4.35	10.26
CH4 CONCENTRATION PPM	4.82	5.02	3.44
NMHC CONCENTRATION PPM	17.13	-.12	8.34
THC MASS GRAMS	1.779	.783	.960
CO MASS GRAMS	30.731	10.454	19.903
CO2 MASS GRAMS	1533.13	1724.15	1334.05
NOX MASS GRAMS	1.874	1.768	2.419
CH4 MASS GRAMS	.435	.778	.309
NMHC MASS GRAMS (FID)	1.336	.000	.648
FUEL MASS KG	.529	.581	.456
FUEL ECONOMY MPG (L/100KM)	17.89 (13.15)	17.34 (13.57)	20.62 (11.41)

3-BAG COMPOSITE RESULTS

THC	G/MI	.279	CH4	G/MI	.152
CO	G/MI	4.668	NMHC	G/MI	.126
NOX	G/MI	.527	CARBONYL	G/MI	.000
			ALCOHOL	G/MI	.001

FUEL ECONOMY MPG (L/100KM) 18.27 (12.87)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-LPG-1.0-C2	LPG
VEHICLE MODEL 93 CHEVY LUMINA	DATE 1/17/94 RUN 1	FUEL DENSITY 5.733 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2	H .181 C .819 O .000 X .000
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)	
ODOMETER 5924 MILES (9531 KM)	TEST WEIGHT 4000 LBS (1814 KG)	

BAROMETER 29.38 IN HG (746.3 MM HG) DRY BULB TEMPERATURE 62.0°F (16.7°C) NOX HUMIDITY C.F. .841

RELATIVE HUMIDITY 41.5 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	504.9	868.5	504.9
DRY/WET CORRECTION FACTOR, SAMP/BACK	.983/.992	.986/.992	.984/.992
MEASURED DISTANCE MILES (KM)	3.64 (5.85)	3.86 (6.21)	3.63 (5.84)
BLOWER FLOW RATE SCFM (SCMM)	568.7 (16.11)	572.6 (16.22)	571.9 (16.20)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4788. (135.6)	8293. (234.9)	4815. (136.4)
HC SAMPLE METER/RANGE/PPM (BAG)	28.2/ 2/ 28.18	11.0/ 2/ 10.99	17.0/ 2/ 16.99
HC BCKGRD METER/RANGE/PPM	5.3/ 2/ 5.30	5.6/ 2/ 5.60	5.5/ 2/ 5.50
CO SAMPLE METER/RANGE/PPM	86.9/ 13/ 211.83	37.9/ 12/ 36.82	43.3/ 13/ 98.96
CO BCKGRD METER/RANGE/PPM	.8/ 13/ 1.74	.7/ 12/ .66	.3/ 13/ .65
CO2 SAMPLE METER/RANGE/PCT	79.5/ 14/ .6499	66.1/ 14/ .4470	75.0/ 14/ .5742
CO2 BCKGRD METER/RANGE/PCT	13.1/ 14/ .0442	12.9/ 14/ .0434	12.9/ 14/ .0434
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	31.1/ 1/ 7.84	29.3/ 1/ 7.40	50.2/ 1/ 12.60
NOX BCKGRD METER/RANGE/PPM	.8/ 1/ .21	.6/ 1/ .15	.5/ 1/ .13
CH4 SAMPLE PPM (1.110)	5.68	6.24	4.97
CH4 BCKGRD PPM	2.23	2.26	2.24
DILUTION FACTOR	17.37	25.89	19.97
HC CONCENTRATION PPM	23.19	5.61	11.77
CO CONCENTRATION PPM	204.18	35.32	95.71
CO2 CONCENTRATION PCT	.6083	.4053	.5330
NOX CONCENTRATION PPM	7.65	7.25	12.48
CH4 CONCENTRATION PPM	3.58	4.07	2.84
NMHC CONCENTRATION PPM	19.22	1.10	8.62
THC MASS GRAMS	1.867	.798	.949
CO MASS GRAMS	32.233	9.656	15.195
CO2 MASS GRAMS	1510.10	1742.49	1330.75
NOX MASS GRAMS	1.669	2.738	2.737
CH4 MASS GRAMS	.323	.637	.258
NMHC MASS GRAMS (FID)	1.503	.149	.678
FUEL MASS KG	.522	.587	.452
FUEL ECONOMY MPG (L/100KM)	18.11 (12.99)	17.11 (13.75)	20.85 (11.28)

3-BAG COMPOSITE RESULTS

THC	G/MI	.286	CH4	G/MI	.123
CO	G/MI	4.295	NMHC	G/MI	.158
NOX	G/MI	.670	CARBONYL	G/MI	.003
			ALCOHOL	G/MI	.001

FUEL ECONOMY MPG (L/100KM) 18.24 (12.90)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-LPG-1.2-E1 | LPG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 1/21/94 RUN 1 | FUEL DENSITY 5.733 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .181 C .819 O .000 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 5997 MILES (9649 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.66 IN HG (753.4 MM HG) DRY BULB TEMPERATURE 66.0°F (18.9°C) NOX HUMIDITY C.F. .883
RELATIVE HUMIDITY 48.9 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.2	867.5	504.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.983/.989	.985/.989	.983/.989
MEASURED DISTANCE MILES (KM)	3.60 (5.79)	3.82 (6.15)	3.60 (5.80)
BLOWER FLOW RATE SCFM (SCMM)	572.4 (16.21)	575.3 (16.29)	578.6 (16.39)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4822. (136.6)	8322. (235.7)	4867. (137.8)
HC SAMPLE METER/RANGE/PPM (BAG)	14.1/ 3/ 140.69	88.8/ 2/ 88.75	10.5/ 3/ 104.77
HC BCKGRD METER/RANGE/PPM	.7/ 3/ 6.98	7.2/ 2/ 7.20	.7/ 3/ 6.98
CO SAMPLE METER/RANGE/PPM	66.6/ 3/3163.23	64.8/ 2/1471.87	51.4/ 2/1040.79
CO BCKGRD METER/RANGE/PPM	.1/ 3/ 2.05	.2/ 2/ 2.68	.0/ 2/ .00
CO2 SAMPLE METER/RANGE/PCT	70.4/ 14/ .5051	58.9/ 14/ .3615	68.3/ 14/ .4760
CO2 BCKGRD METER/RANGE/PCT	13.7/ 14/ .0466	13.4/ 14/ .0454	13.6/ 14/ .0462
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	33.6/ 1/ 8.47	25.3/ 1/ 6.40	52.3/ 1/ 13.12
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .18	.6/ 1/ .15	.6/ 1/ .15
CH4 SAMPLE PPM (1.110)	20.57	11.92	13.22
CH4 BCKGRD PPM	2.46	2.45	2.52
DILUTION FACTOR	14.15	22.76	19.90
HC CONCENTRATION PPM	134.20	81.87	98.13
CO CONCENTRATION PPM	3074.42	1433.79	1012.89
CO2 CONCENTRATION PCT	.4618	.3181	.4322
NOX CONCENTRATION PPM	8.30	6.25	12.98
CH4 CONCENTRATION PPM	18.28	9.58	10.83
NMHC CONCENTRATION PPM	113.91	71.23	86.12
THC MASS GRAMS	10.940	11.507	8.111
CO MASS GRAMS	488.774	393.390	162.525
CO2 MASS GRAMS	1154.70	1372.47	1090.50
NOX MASS GRAMS	1.914	2.488	3.021
CH4 MASS GRAMS	1.664	1.506	.995
NMHC MASS GRAMS (FID)	8.969	9.680	6.844
FUEL MASS KG	.652	.675	.457
FUEL ECONOMY MPG (L/100KM)	14.36 (16.38)	14.73 (15.97)	20.52 (11.46)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.805	CH4	G/MI	.375
CO	G/MI	93.746	NMHC	G/MI	2.348
NOX	G/MI	.678	CARBONYL	G/MI	.068
			ALCOHOL	G/MI	.014

FUEL ECONOMY MPG (L/100KM) 15.99 (14.72)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M
VEHICLE MODEL 93 CHEVY LUMINA
ENGINE 3.1 L (189 CID)-V-6
TRANSMISSION L4
ODOMETER 6016 MILES (9679 KM)

TEST L-LPG-1.2-E2
DATE 1/24/94 RUN 1
DYNO 2 BAG CART 2
ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
TEST WEIGHT 4000 LBS (1814 KG)

LPG
FUEL DENSITY 5.733 LB/GAL
H .181 C .819 O .000 X .000

BAROMETER 29.33 IN HG (745.0 MM HG) DRY BULB TEMPERATURE 78.0°F (25.6°C) NOX HUMIDITY C.F. 1.067
RELATIVE HUMIDITY 60.1 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.1	867.7	505.3
DRY/WET CORRECTION FACTOR, SAMP/BACK	.973/.980	.975/.980	.974/.980
MEASURED DISTANCE MILES (KM)	3.64 (5.86)	3.88 (6.24)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	560.9 (15.88)	563.7 (15.96)	560.0 (15.86)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.27 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4724. (133.8)	8156. (231.0)	4718. (133.6)
HC SAMPLE METER/RANGE/PPM (BAG)	15.4/ 3/ 153.66	96.2/ 2/ 96.14	11.6/ 3/ 115.74
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	9.6/ 2/ 9.59	.9/ 3/ 8.98
CO SAMPLE METER/RANGE/PPM	65.6/ 3/3164.95	66.4/ 2/1570.89	81.3/ 2/2152.84
CO BCKGRD METER/RANGE/PPM	.1/ 3/ 2.33	.4/ 2/ 6.26	.4/ 2/ 6.26
CO2 SAMPLE METER/RANGE/PCT	70.9/ 14/ .5123	85.2/ 13/ .3577	68.5/ 14/ .4787
CO2 BCKGRD METER/RANGE/PCT	13.5/ 14/ .0458	18.7/ 13/ .0436	12.9/ 14/ .0434
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	28.1/ 1/ 7.10	19.6/ 1/ 4.97	40.4/ 1/ 10.16
NOX BCKGRD METER/RANGE/PPM	.2/ 1/ .05	.3/ 1/ .08	.2/ 1/ .05
CH4 SAMPLE PPM (1.110)	22.24	13.12	14.76
CH4 BCKGRD PPM	2.37	2.37	2.36
DILUTION FACTOR	14.02	22.49	16.73
HC CONCENTRATION PPM	145.32	86.98	107.30
CO CONCENTRATION PPM	3063.86	1521.52	2081.43
CO2 CONCENTRATION PCT	.4698	.3161	.4379
NOX CONCENTRATION PPM	7.05	4.90	10.11
CH4 CONCENTRATION PPM	20.04	10.85	12.54
NMHC CONCENTRATION PPM	123.08	74.93	93.38
THC MASS GRAMS	11.645	12.063	8.571
CO MASS GRAMS	477.198	409.121	323.776
CO2 MASS GRAMS	1150.63	1336.62	1071.27
NOX MASS GRAMS	1.924	2.308	2.756
CH4 MASS GRAMS	1.787	1.671	1.117
NMHC MASS GRAMS (FID)	9.494	9.979	7.194
FUEL MASS KG	.645	.672	.535
FUEL ECONOMY MPG (L/100KM)	14.68 (16.03)	15.02 (15.66)	17.58 (13.38)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.924	CH4	G/MI	.410
CO	G/MI	106.381	NMHC	G/MI	2.419
NOX	G/MI	.627	CARBONYL	G/MI	.070
			ALCOHOL	G/MI	.025

FUEL ECONOMY MPG (L/100KM) 15.59 (15.09)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 408-6068-00

VEHICLE NUMBER 53M
VEHICLE MODEL 93 CHEVY LUMINA
ENGINE 3.1 L (189 CID)-V-6
TRANSMISSION L4
ODOMETER 6034 MILES (9708 KM)

TEST L-LPG-1.2-C1
DATE 1/26/94 RUN 2
DYNO 2 BAG CART 2
ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
TEST WEIGHT 4000 LBS (1814 KG)

LPG
FUEL DENSITY 5.733 LB/GAL
H .181 C .819 O .000 X .000

BAROMETER 29.09 IN HG (738.9 MM HG) DRY BULB TEMPERATURE 77.0°F (25.0°C) NOX HUMIDITY C.F. 1.052
RELATIVE HUMIDITY 59.7 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.0	867.9	505.6
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.981	.975/.981	.974/.981
MEASURED DISTANCE MILES (KM)	3.63 (5.84)	3.89 (6.25)	3.63 (5.83)
BLOWER FLOW RATE SCFM (SCMM)	559.8 (15.85)	559.4 (15.84)	559.8 (15.85)
GAS METER FLOW RATE SCFM (SCMM)	.14 (.00)	.14 (.00)	.14 (.00)
TOTAL FLOW SCF (SCM)	4713. (133.5)	8094. (229.2)	4718. (133.6)
HC SAMPLE METER/RANGE/PPM (BAG)	13.9/ 3/ 138.69	71.9/ 2/ 71.86	82.1/ 2/ 82.05
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	8.9/ 2/ 8.89	8.6/ 2/ 8.60
CO SAMPLE METER/RANGE/PPM	64.5/ 3/3073.85	58.7/ 2/1310.51	74.4/ 2/1870.45
CO BCKGRD METER/RANGE/PPM	.2/ 3/ 4.66	.4/ 2/ 6.26	.6/ 2/ 9.40
CO2 SAMPLE METER/RANGE/PCT	72.1/ 14/ .5298	62.5/ 14/ .4025	71.0/ 14/ .5137
CO2 BCKGRD METER/RANGE/PCT	14.7/ 14/ .0506	14.5/ 14/ .0498	14.2/ 14/ .0486
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	4.5/ 1/ 1.16	1.3/ 1/ .34	1.0/ 1/ .26
NOX BCKGRD METER/RANGE/PPM	1.0/ 1/ .26	.8/ 1/ .21	.6/ 1/ .15
CH4 SAMPLE PPM (1.110)	23.55	16.75	18.04
CH4 BCKGRD PPM	2.70	2.77	2.87
DILUTION FACTOR	13.90	21.78	16.63
HC CONCENTRATION PPM	130.36	63.37	73.97
CO CONCENTRATION PPM	2972.63	1267.17	1803.46
CO2 CONCENTRATION PCT	.4828	.3550	.4680
NOX CONCENTRATION PPM	.92	.14	.11
CH4 CONCENTRATION PPM	21.04	14.11	15.35
NMHC CONCENTRATION PPM	107.00	47.71	56.94
THC MASS GRAMS	10.156	8.468	5.761
CO MASS GRAMS	461.894	338.159	280.547
CO2 MASS GRAMS	1179.74	1489.78	1145.02
NOX MASS GRAMS	.246	.064	.030
CH4 MASS GRAMS	1.872	2.156	1.367
NMHC MASS GRAMS (FID)	8.235	6.306	4.387
FUEL MASS KG	.645	.682	.534
FUEL ECONOMY MPG (L/100KM)	14.63 (16.08)	14.82 (15.88)	17.64 (13.33)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.145	CH4	G/MI	.498
CO	G/MI	92.709	NMHC	G/MI	1.643
NOX	G/MI	.025	CARBONYL	G/MI	.004
FUEL ECONOMY MPG (L/100KM)		15.48 (15.19)			

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M
VEHICLE MODEL 93 CHEVY LUMINA
ENGINE 3.1 L (189 CID)-V-6
TRANSMISSION L4
ODOMETER 6046 MILES (9728 KM)

TEST L-LPG-1.2-C2
DATE 1/27/94 RUN 1
DYNO 2 BAG CART 2
ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
TEST WEIGHT 4000 LBS (1814 KG)

LPG
FUEL DENSITY 5.733 LB/GAL
H .181 C .819 O .000 X .000

BAROMETER 28.95 IN HG (735.3 MM HG) DRY BULB TEMPERATURE 75.0°F (23.9°C) NOX HUMIDITY C.F. 1.073
RELATIVE HUMIDITY 66.3 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.0	868.1	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.973/.980	.975/.980	.973/.980
MEASURED DISTANCE MILES (KM)	3.64 (5.86)	3.89 (6.26)	3.64 (5.85)
BLOWER FLOW RATE SCFM (SCMM)	555.8 (15.74)	557.1 (15.78)	555.0 (15.72)
GAS METER FLOW RATE SCFM (SCMM)	.14 (.00)	.14 (.00)	.14 (.00)
TOTAL FLOW SCF (SCM)	4679. (132.5)	8063. (228.3)	4674. (132.4)
HC SAMPLE METER/RANGE/PPM (BAG)	14.5/ 3/ 144.68	77.7/ 2/ 77.65	89.4/ 2/ 89.35
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	8.7/ 2/ 8.69	8.4/ 2/ 8.40
CO SAMPLE METER/RANGE/PPM	65.4/ 3/3148.26	61.7/ 2/1408.77	76.7/ 2/1962.13
CO BCKGRD METER/RANGE/PPM	.3/ 3/ 7.00	.5/ 2/ 7.83	.6/ 2/ 9.40
CO2 SAMPLE METER/RANGE/PCT	71.4/ 14/ .5195	61.1/ 14/ .3862	70.4/ 14/ .5051
CO2 BCKGRD METER/RANGE/PCT	13.5/ 14/ .0458	13.3/ 14/ .0450	13.8/ 14/ .0470
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	4.0/ 1/ 1.03	.8/ 1/ .21	.9/ 1/ .23
NOX BCKGRD METER/RANGE/PPM	.2/ 1/ .05	.0/ 1/ .00	.3/ 1/ .08
CH4 SAMPLE PPM (1.110)	23.84	15.97	17.75
CH4 BCKGRD PPM	3.06	2.87	2.72
DILUTION FACTOR	13.95	22.05	16.62
HC CONCENTRATION PPM	136.34	69.35	81.46
CO CONCENTRATION PPM	3036.58	1358.68	1888.49
CO2 CONCENTRATION PCT	.4770	.3432	.4610
NOX CONCENTRATION PPM	.98	.21	.16
CH4 CONCENTRATION PPM	21.01	13.22	15.20
NMHC CONCENTRATION PPM	113.02	54.68	64.59
THC MASS GRAMS	10.550	9.217	6.275
CO MASS GRAMS	468.431	361.179	291.042
CO2 MASS GRAMS	1157.23	1434.84	1117.24
NOX MASS GRAMS	.266	.097	.043
CH4 MASS GRAMS	1.856	2.013	1.341
NMHC MASS GRAMS (FID)	8.636	7.199	4.930
FUEL MASS KG	.642	.677	.531
FUEL ECONOMY MPG (L/100KM)	14.75 (15.94)	14.94 (15.74)	17.81 (13.21)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.303	CH4	G/MI	.475
CO	G/MI	96.791	NMHC	G/MI	1.823
NOX	G/MI	.031	CARBONYL	G/MI	.004
FUEL ECONOMY MPG (L/100KM)		15.62 (15.06)			

APPENDIX D

COMPUTER PRINTOUTS OF EMISSIONS DATA FROM FTPs WITH CNG

Page D-	Test Number	Operating Condition	Catalyst Installation
1	L-CNG-0.8-E1	Lean	Without Catalyst
2	L-CNG-0.8-E2	Lean	Without Catalyst
3	L-CNG-0.8-C1	Lean	With Catalyst
4	L-CNG-0.8-C2	Lean	With Catalyst
5	L-CNG-1.0-E2	Stoich	Without Catalyst
6	L-CNG-1.0-E3	Stoich	Without Catalyst
7	L-CNG-1.0-C1	Stoich	With Catalyst
8	L-CNG-1.0-C2	Stoich	With Catalyst
9	L-CNG-1.2-E1	Rich	Without Catalyst
10	L-CNG-1.2-E2	Rich	Without Catalyst
11	L-CNG-1.2-C1	Rich	With Catalyst
12	L-CNG-1.2-C2	Rich	With Catalyst

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M TEST L-CNG-0.8-E1 CNG
VEHICLE MODEL 93 CHEVY LUMINA DATE 3/23/94 RUN 1 FUEL DENSITY 5.601 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 DYNO 2 BAG CART 2 H .235 C .720 O .000 X .045
TRANSMISSION L4 ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6530 MILES (10506 KM) TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 28.98 IN HG (736.1 MM HG) DRY BULB TEMPERATURE 74.0°F (23.3°C) NOX HUMIDITY C.F. 1.145
RELATIVE HUMIDITY 78.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.1	867.0	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.965/.977	.969/.977	.967/.977
MEASURED DISTANCE MILES (KM)	3.62 (5.83)	3.86 (6.21)	3.64 (5.86)
BLOWER FLOW RATE SCFM (SCMM)	558.7 (15.82)	558.7 (15.82)	558.3 (15.81)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.27 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4706. (133.3)	8078. (228.8)	4703. (133.2)
HC SAMPLE METER/RANGE/PPM (BAG)	95.3/ 2/ 95.24	10.0/ 3/ 99.78	81.3/ 2/ 81.25
HC BCKGRD METER/RANGE/PPM	9.3/ 2/ 9.29	1.0/ 3/ 9.98	9.3/ 2/ 9.29
CO SAMPLE METER/RANGE/PPM	85.8/ 13/ 208.79	81.8/ 13/ 197.82	45.7/ 13/ 104.79
CO BCKGRD METER/RANGE/PPM	.4/ 13/ .87	.4/ 13/ .87	.4/ 13/ .87
CO2 SAMPLE METER/RANGE/PCT	76.2/ 14/ .5936	62.1/ 14/ .3978	72.3/ 14/ .5328
CO2 BCKGRD METER/RANGE/PCT	13.3/ 14/ .0450	13.2/ 14/ .0446	13.1/ 14/ .0442
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	28.6/ 2/ 28.61	28.1/ 1/ 7.10	24.2/ 2/ 24.21
NOX BCKGRD METER/RANGE/PPM	.2/ 2/ .20	.8/ 1/ .21	.3/ 2/ .30
CH4 SAMPLE PPM (1.100)	69.15	73.18	57.66
CH4 BCKGRD PPM	3.47	3.40	3.05
DILUTION FACTOR	15.51	22.65	17.54
HC CONCENTRATION PPM	86.55	90.24	72.49
CO CONCENTRATION PPM	199.08	189.71	99.71
CO2 CONCENTRATION PCT	.5515	.3552	.4911
NOX CONCENTRATION PPM	28.43	6.90	23.93
CH4 CONCENTRATION PPM	65.90	69.93	54.78
NMHC CONCENTRATION PPM	14.06	13.32	12.23
THC MASS GRAMS	7.216	12.870	6.140
CO MASS GRAMS	30.888	50.524	15.461
CO2 MASS GRAMS	1345.63	1487.53	1197.58
NOX MASS GRAMS	8.294	3.455	6.978
CH4 MASS GRAMS	5.855	10.665	4.865
NMHC MASS GRAMS (FID)	1.080	1.756	.939
FUEL MASS KG	.512	.580	.448
FUEL ECONOMY MPG (L/100KM)	17.98 (13.09)	16.91 (13.91)	20.63 (11.40)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.600	CH4	G/MI	2.130
CO	G/MI	9.697	NMHC	G/MI	.368
NOX	G/MI	1.469	CARBONYL	G/MI	.097
			ALCOHOL	G/MI	.004

FUEL ECONOMY MPG (L/100KM) 18.05 (13.03)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-CNG-0.8-E2 | CNG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 3/24/94 RUN 1 | FUEL DENSITY 5.601 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .235 C .720 O .000 X .045
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6542 MILES (10526 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.07 IN HG (738.4 MM HG) DRY BULB TEMPERATURE 78.0°F (25.6°C) NOX HUMIDITY C.F. 1.210
RELATIVE HUMIDITY 75.1 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.0	867.2	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.963/.975	.967/.975	.964/.975
MEASURED DISTANCE MILES (KM)	3.61 (5.81)	3.86 (6.21)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	560.7 (15.88)	561.4 (15.90)	560.7 (15.88)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4722. (133.7)	8119. (229.9)	4724. (133.8)
HC SAMPLE METER/RANGE/PPM (BAG)	10.2/ 3/ 101.77	96.0/ 2/ 95.94	83.4/ 2/ 83.35
HC BCKGRD METER/RANGE/PPM	1.2/ 3/ 11.97	11.9/ 2/ 11.89	9.6/ 2/ 9.59
CO SAMPLE METER/RANGE/PPM	87.4/ 13/ 213.21	75.1/ 13/ 179.76	59.0/ 13/ 137.86
CO BCKGRD METER/RANGE/PPM	.2/ 13/ .44	.6/ 13/ 1.31	.2/ 13/ .44
CO2 SAMPLE METER/RANGE/PCT	75.8/ 14/ .5871	61.9/ 14/ .3954	72.3/ 14/ .5328
CO2 BCKGRD METER/RANGE/PCT	13.0/ 14/ .0438	13.0/ 14/ .0438	12.8/ 14/ .0430
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	26.6/ 2/ 26.61	27.6/ 1/ 6.97	24.6/ 2/ 24.61
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ .30	.9/ 1/ .23	.2/ 2/ .20
CH4 SAMPLE PPM (1.100)	73.87	70.02	62.05
CH4 BCKGRD PPM	3.69	3.75	3.14
DILUTION FACTOR	15.65	22.89	17.43
HC CONCENTRATION PPM	90.57	84.57	74.31
CO CONCENTRATION PPM	203.96	172.09	131.95
CO2 CONCENTRATION PCT	.5461	.3536	.4922
NOX CONCENTRATION PPM	26.33	6.75	24.42
CH4 CONCENTRATION PPM	70.41	66.43	59.09
NMHC CONCENTRATION PPM	13.11	11.50	9.30
THC MASS GRAMS	7.573	12.169	6.272
CO MASS GRAMS	31.752	46.064	20.550
CO2 MASS GRAMS	1336.94	1488.33	1205.50
NOX MASS GRAMS	8.150	3.592	7.562
CH4 MASS GRAMS	6.277	10.183	5.270
NMHC MASS GRAMS (FID)	1.011	1.524	.718
FUEL MASS KG	.509	.577	.454
FUEL ECONOMY MPG (L/100KM)	18.01 (13.06)	17.01 (13.83)	20.18 (11.65)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.543	CH4	G/MI	2.126
CO	G/MI	9.560	NMHC	G/MI	.317
NOX	G/MI	1.527	CARBONYL	G/MI	.100
			ALCOHOL	G/MI	.000

FUEL ECONOMY MPG (L/100KM) 18.01 (13.06)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M TEST L-CNG-0.8-C1 CNG
VEHICLE MODEL 93 CHEVY LUMINA DATE 3/21/94 RUN 2 FUEL DENSITY 5.601 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 DYNO 2 BAG CART 2 H .235 C .720 O .000 X .045
TRANSMISSION L4 ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6498 MILES (10455 KM) TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.18 IN HG (741.2 MM HG) DRY BULB TEMPERATURE 78.0°F (25.6°C) NOX HUMIDITY C.F. .992
RELATIVE HUMIDITY 49.7 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.2	867.3	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.972/.983	.975/.983	.973/.983
MEASURED DISTANCE MILES (KM)	3.60 (5.80)	3.83 (6.16)	3.62 (5.83)
BLOWER FLOW RATE SCFM (SCMM)	563.6 (15.96)	565.9 (16.03)	563.1 (15.95)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4748. (134.5)	8185. (231.8)	4743. (134.3)
HC SAMPLE METER/RANGE/PPM (BAG)	49.3/ 2/ 49.27	35.9/ 2/ 35.88	45.6/ 2/ 45.57
HC BCKGRD METER/RANGE/PPM	8.9/ 2/ 8.89	8.3/ 2/ 8.30	7.4/ 2/ 7.40
CO SAMPLE METER/RANGE/PPM	36.9/ 12/ 35.84	13.1/ 12/ 12.58	29.3/ 12/ 28.38
CO BCKGRD METER/RANGE/PPM	.4/ 12/ .38	.0/ 12/ .00	.1/ 12/ .09
CO2 SAMPLE METER/RANGE/PCT	77.0/ 14/ .6068	63.5/ 14/ .4145	72.5/ 14/ .5357
CO2 BCKGRD METER/RANGE/PCT	13.2/ 14/ .0446	13.1/ 14/ .0442	12.9/ 14/ .0434
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	84.2/ 1/ 21.04	22.6/ 1/ 5.72	79.9/ 1/ 19.98
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .18	.7/ 1/ .18	.7/ 1/ .18
CH4 SAMPLE PPM (1.100)	36.98	27.67	34.81
CH4 BCKGRD PPM	2.76	2.72	2.51
DILUTION FACTOR	15.70	23.03	17.79
HC CONCENTRATION PPM	40.94	27.94	38.59
CO CONCENTRATION PPM	34.27	12.22	27.39
CO2 CONCENTRATION PCT	.5651	.3722	.4948
NOX CONCENTRATION PPM	20.87	5.55	19.81
CH4 CONCENTRATION PPM	34.39	25.07	32.44
NMHC CONCENTRATION PPM	3.11	.37	2.91
THC MASS GRAMS	3.343	3.927	3.140
CO MASS GRAMS	5.365	3.299	4.284
CO2 MASS GRAMS	1391.06	1579.67	1216.83
NOX MASS GRAMS	5.322	2.440	5.046
CH4 MASS GRAMS	3.083	3.874	2.905
NMHC MASS GRAMS (FID)	.241	.049	.225
FUEL MASS KG	.510	.578	.446
FUEL ECONOMY MPG (L/100KM)	17.96 (13.10)	16.85 (13.96)	20.63 (11.40)

3-BAG COMPOSITE RESULTS

THC	G/MI	.961	CH4	G/MI	.921
CO	G/MI	1.081	NMHC	G/MI	.038
NOX	G/MI	1.021	CARBONYL	G/MI	.002
			ALCOHOL	G/MI	.000

FUEL ECONOMY MPG (L/100KM) 18.01 (13.06)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-CNG-0.8-C2 | CNG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 3/22/94 RUN 1 | FUEL DENSITY 5.601 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .235 C .720 O .000 X .045
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6509 MILES (10472 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.22 IN HG (742.2 MM HG) DRY BULB TEMPERATURE 75.0°F (23.9°C) NOX HUMIDITY C.F. .835
RELATIVE HUMIDITY 25.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.0	867.3	505.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.981/.992	.985/.992	.982/.992
MEASURED DISTANCE MILES (KM)	3.61 (5.80)	3.86 (6.22)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	564.6 (15.99)	566.8 (16.05)	563.8 (15.97)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4755. (134.7)	8197. (232.1)	4751. (134.6)
HC SAMPLE METER/RANGE/PPM (BAG)	51.0/ 2/ 50.97	39.6/ 2/ 39.58	50.7/ 2/ 50.67
HC BCKGRD METER/RANGE/PPM	7.6/ 2/ 7.60	8.2/ 2/ 8.20	8.1/ 2/ 8.10
CO SAMPLE METER/RANGE/PPM	36.1/ 12/ 35.05	12.3/ 12/ 11.80	46.9/ 12/ 45.69
CO BCKGRD METER/RANGE/PPM	.3/ 12/ .28	.3/ 12/ .28	.5/ 12/ .47
CO2 SAMPLE METER/RANGE/PCT	76.1/ 14/ .5919	62.7/ 14/ .4049	71.9/ 14/ .5268
CO2 BCKGRD METER/RANGE/PCT	12.8/ 14/ .0430	13.2/ 14/ .0446	13.5/ 14/ .0458
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	31.5/ 2/ 31.51	32.9/ 1/ 8.29	24.9/ 2/ 24.91
NOX BCKGRD METER/RANGE/PPM	.2/ 2/ .20	1.2/ 1/ .31	.2/ 2/ .20
CH4 SAMPLE PPM (1.100)	38.51	30.26	38.51
CH4 BCKGRD PPM	2.51	2.61	2.74
DILUTION FACTOR	16.08	23.56	18.01
HC CONCENTRATION PPM	43.85	31.73	43.02
CO CONCENTRATION PPM	33.90	11.30	44.17
CO2 CONCENTRATION PCT	.5516	.3622	.4836
NOX CONCENTRATION PPM	31.33	8.00	24.72
CH4 CONCENTRATION PPM	36.16	27.76	35.92
NMHC CONCENTRATION PPM	4.07	1.19	3.51
THC MASS GRAMS	3.607	4.504	3.526
CO MASS GRAMS	5.313	3.053	6.919
CO2 MASS GRAMS	1359.84	1539.35	1191.36
NOX MASS GRAMS	6.738	2.965	5.314
CH4 MASS GRAMS	3.246	4.297	3.222
NMHC MASS GRAMS (FID)	.316	.159	.273
FUEL MASS KG	.499	.563	.439
FUEL ECONOMY MPG (L/100KM)	18.37 (12.81)	17.42 (13.51)	20.91 (11.25)

3-BAG COMPOSITE RESULTS

THC	G/MI	1.079	CH4	G/MI	1.008
CO	G/MI	1.242	NMHC	G/MI	.060
NOX	G/MI	1.190	CARBONYL	G/MI	.003
			ALCOHOL	G/MI	.009

FUEL ECONOMY MPG (L/100KM) 18.48 (12.73)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-CNG-1.0-E2 | CNG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 3/ 7/94 RUN 1 | FUEL DENSITY 5.573 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .236 C .725 O .000 X .040
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6327 MILES (10180 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.22 IN HG (742.2 MM HG) DRY BULB TEMPERATURE 76.0°F (24.4°C) NOX HUMIDITY C.F. 1.087
RELATIVE HUMIDITY 66.6 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.2	867.5	505.0
DRY/WET CORRECTION FACTOR, SAMP/BACK	.968/.979	.971/.979	.969/.979
MEASURED DISTANCE MILES (KM)	3.63 (5.84)	3.85 (6.20)	3.62 (5.83)
BLOWER FLOW RATE SCFM (SCMM)	564.5 (15.99)	564.2 (15.98)	564.5 (15.99)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.27 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4755. (134.7)	8161. (231.1)	4753. (134.6)
HC SAMPLE METER/RANGE/PPM (BAG)	90.2/ 2/ 90.15	11.5/ 3/ 114.74	13.6/ 3/ 135.70
HC BCKGRD METER/RANGE/PPM	10.0/ 2/ 9.99	1.2/ 3/ 11.97	1.1/ 3/ 10.98
CO SAMPLE METER/RANGE/PPM	55.0/ 1/ 504.72	74.6/ 13/ 178.42	42.7/ 1/ 378.16
CO BCKGRD METER/RANGE/PPM	.2/ 1/ 1.68	.7/ 13/ 1.52	.3/ 1/ 2.52
CO2 SAMPLE METER/RANGE/PCT	75.6/ 14/ .5838	62.4/ 14/ .4013	71.3/ 14/ .5181
CO2 BCKGRD METER/RANGE/PCT	13.9/ 14/ .0474	13.7/ 14/ .0466	13.8/ 14/ .0470
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	90.1/ 1/ 22.48	29.1/ 1/ 7.35	75.3/ 1/ 18.84
NOX BCKGRD METER/RANGE/PPM	1.3/ 1/ .34	1.7/ 1/ .44	1.0/ 1/ .26
CH4 SAMPLE PPM (1.110)	62.45	83.08	99.70
CH4 BCKGRD PPM	2.73	2.94	2.93
DILUTION FACTOR	15.09	22.52	17.05
HC CONCENTRATION PPM	80.82	103.30	125.37
CO CONCENTRATION PPM	483.66	171.05	361.95
CO2 CONCENTRATION PCT	.5396	.3568	.4738
NOX CONCENTRATION PPM	22.17	6.93	18.60
CH4 CONCENTRATION PPM	59.90	80.27	96.94
NMHC CONCENTRATION PPM	14.33	14.21	17.76
THC MASS GRAMS	6.682	14.603	10.311
CO MASS GRAMS	75.825	46.026	56.723
CO2 MASS GRAMS	1330.36	1509.87	1167.81
NOX MASS GRAMS	6.208	3.329	5.207
CH4 MASS GRAMS	5.377	12.368	8.700
NMHC MASS GRAMS (FID)	1.113	1.893	1.378
FUEL MASS KG	.531	.587	.465
FUEL ECONOMY MPG (L/100KM)	17.29 (13.61)	16.60 (14.17)	19.71 (11.94)

3-BAG COMPOSITE RESULTS

THC	G/MI	3.123	CH4	G/MI	2.626
CO	G/MI	14.839	NMHC	G/MI	.422
NOX	G/MI	1.199	CARBONYL	G/MI	.075
			ALCOHOL	G/MI	.000

FUEL ECONOMY MPG (L/100KM) 17.52 (13.43)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-CNG-1.0-E3	CNG
VEHICLE MODEL 93 CHEVY LUMINA	DATE 3/ 8/94 RUN 1	FUEL DENSITY 5.573 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2	H .236 C .725 O .000 X .040
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)	
ODOMETER 6338 MILES (10197 KM)	TEST WEIGHT 4000 LBS (1814 KG)	

BAROMETER 29.06 IN HG (738.1 MM HG) DRY BULB TEMPERATURE 77.0°F (25.0°C) NOX HUMIDITY C.F. 1.081

RELATIVE HUMIDITY 63.3 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.4	867.8	505.8
DRY/WET CORRECTION FACTOR, SAMP/BACK	.968/.979	.972/.979	.969/.979
MEASURED DISTANCE MILES (KM)	3.65 (5.87)	3.87 (6.23)	3.65 (5.88)
BLOWER FLOW RATE SCFM (SCMM)	555.0 (15.72)	559.0 (15.83)	555.1 (15.72)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.27 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4677. (132.5)	8089. (229.1)	4682. (132.6)
HC SAMPLE METER/RANGE/PPM (BAG)	91.3/ 2/ 91.25	13.7/ 3/ 136.70	11.9/ 3/ 118.74
HC BCKGRD METER/RANGE/PPM	9.4/ 2/ 9.39	1.1/ 3/ 10.98	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	53.3/ 1/ 486.56	70.3/ 13/ 167.04	81.4/ 14/ 394.97
CO BCKGRD METER/RANGE/PPM	.2/ 1/ 1.68	.9/ 13/ 1.96	.3/ 14/ 1.21
CO2 SAMPLE METER/RANGE/PCT	75.6/ 14/ .5838	62.0/ 14/ .3966	70.9/ 14/ .5123
CO2 BCKGRD METER/RANGE/PCT	13.4/ 14/ .0454	13.8/ 14/ .0470	12.3/ 14/ .0411
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	90.3/ 1/ 22.53	27.7/ 1/ 7.00	69.9/ 1/ 17.50
NOX BCKGRD METER/RANGE/PPM	1.0/ 1/ .26	.9/ 1/ .23	.6/ 1/ .15
CH4 SAMPLE PPM (1.110)	63.22	101.63	87.00
CH4 BCKGRD PPM	2.87	3.10	2.26
DILUTION FACTOR	15.12	22.73	17.22
HC CONCENTRATION PPM	82.47	126.20	111.22
CO CONCENTRATION PPM	466.72	159.84	379.82
CO2 CONCENTRATION PCT	.5415	.3517	.4736
NOX CONCENTRATION PPM	22.29	6.77	17.36
CH4 CONCENTRATION PPM	60.54	98.66	84.87
NMHC CONCENTRATION PPM	15.27	16.69	17.01
THC MASS GRAMS	6.711	17.667	9.035
CO MASS GRAMS	71.971	42.627	58.632
CO2 MASS GRAMS	1313.10	1475.00	1149.72
NOX MASS GRAMS	6.105	3.209	4.759
CH4 MASS GRAMS	5.346	15.066	7.502
NMHC MASS GRAMS (FID)	1.167	2.205	1.300
FUEL MASS KG	.523	.575	.458
FUEL ECONOMY MPG (L/100KM)	17.65 (13.33)	17.02 (13.82)	20.16 (11.67)

3-BAG COMPOSITE RESULTS

THC	G/MI	3.416	CH4	G/MI	2.877
CO	G/MI	14.223	NMHC	G/MI	.458
NOX	G/MI	1.136	CARBONYL	G/MI	.079
			ALCOHOL	G/MI	.003

FUEL ECONOMY MPG (L/100KM) 17.94 (13.11)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-CNG-1.0-C1	CNG	
VEHICLE MODEL 93 CHEVY LUMINA	DATE 2/22/94 RUN 2	FUEL DENSITY 5.573 LB/GAL	
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2	H .236 C .725 O .000 X .040	
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)		
ODOMETER 6275 MILES (10096 KM)	TEST WEIGHT 4000 LBS (1814 KG)		

BAROMETER 28.95 IN HG (735.3 MM HG) DRY BULB TEMPERATURE 77.0°F (25.0°C) NOX HUMIDITY C.F. 1.055

RELATIVE HUMIDITY 59.7 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	504.6	868.1	505.8
DRY/WET CORRECTION FACTOR, SAMP/BACK	.969/.980	.973/.980	.970/.980
MEASURED DISTANCE MILES (KM)	3.64 (5.86)	3.88 (6.24)	3.64 (5.86)
BLOWER FLOW RATE SCFM (SCMM)	561.7 (15.91)	561.4 (15.90)	552.6 (15.65)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.27 (.01)	.26 (.01)
TOTAL FLOW SCF (SCM)	4726. (133.8)	8126. (230.1)	4661. (132.0)
HC SAMPLE METER/RANGE/PPM (BAG)	59.1/ 2/ 59.07	27.3/ 2/ 27.28	61.2/ 2/ 61.16
HC BCKGRD METER/RANGE/PPM	9.7/ 2/ 9.69	9.7/ 2/ 9.69	9.6/ 2/ 9.59
CO SAMPLE METER/RANGE/PPM	84.4/ 13/ 204.94	17.7/ 12/ 17.05	53.8/ 13/ 124.77
CO BCKGRD METER/RANGE/PPM	.5/ 13/ 1.09	1.1/ 12/ 1.04	.7/ 13/ 1.52
CO2 SAMPLE METER/RANGE/PCT	76.1/ 14/ .5919	63.0/ 14/ .4085	73.0/ 14/ .5432
CO2 BCKGRD METER/RANGE/PCT	13.4/ 14/ .0454	13.5/ 14/ .0458	14.1/ 14/ .0482
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	15.2/ 1/ 3.87	6.2/ 1/ 1.59	9.5/ 1/ 2.43
NOX BCKGRD METER/RANGE/PPM	.3/ 1/ .08	.3/ 1/ .08	.1/ 1/ .03
CH4 SAMPLE PPM (1.110)	45.77	19.62	47.71
CH4 BCKGRD PPM	3.99	3.62	3.73
DILUTION FACTOR	15.66	23.42	17.23
HC CONCENTRATION PPM	49.99	18.00	52.13
CO CONCENTRATION PPM	196.42	15.53	118.96
CO2 CONCENTRATION PCT	.5495	.3646	.4978
NOX CONCENTRATION PPM	3.79	1.52	2.40
CH4 CONCENTRATION PPM	42.04	16.16	44.20
NMHC CONCENTRATION PPM	3.33	.07	3.06
THC MASS GRAMS	4.033	2.521	4.170
CO MASS GRAMS	30.604	4.162	18.280
CO2 MASS GRAMS	1346.38	1536.36	1203.07
NOX MASS GRAMS	1.024	.703	.640
CH4 MASS GRAMS	3.751	2.479	3.889
NMHC MASS GRAMS (FID)	.257	.009	.233
FUEL MASS KG	.508	.561	.450
FUEL ECONOMY MPG (L/100KM)	18.09 (13.00)	17.49 (13.45)	20.46 (11.50)

3-BAG COMPOSITE RESULTS

THC	G/MI	.882	CH4	G/MI	.839
CO	G/MI	3.690	NMHC	G/MI	.034
NOX	G/MI	.201	CARBONYL	G/MI	.003
			ALCOHOL	G/MI	.007

FUEL ECONOMY MPG (L/100KM) 18.36 (12.81)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M
VEHICLE MODEL 93 CHEVY LUMINA
ENGINE 3.1 L (189 CID)-V-6
TRANSMISSION L4
ODOMETER 6287 MILES (10115 KM)

TEST L-CNG-1.0-C2
DATE 2/23/94 RUN 1
DYNO 2 BAG CART 2
ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
TEST WEIGHT 4000 LBS (1814 KG)

CNG
FUEL DENSITY 5.573 LB/GAL
H .236 C .725 O .000 X .040

BAROMETER 29.23 IN HG (742.4 MM HG) DRY BULB TEMPERATURE 70.0°F (21.1°C) NOX HUMIDITY C.F. .849
RELATIVE HUMIDITY 33.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.0	867.9	505.6
DRY/WET CORRECTION FACTOR, SAMP/BACK	.980/.991	.984/.991	.981/.991
MEASURED DISTANCE MILES (KM)	3.63 (5.84)	3.86 (6.21)	3.64 (5.85)
BLOWER FLOW RATE SCFM (SCMM)	560.8 (15.88)	566.2 (16.04)	561.5 (15.90)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4732. (134.0)	8195. (232.1)	4734. (134.1)
HC SAMPLE METER/RANGE/PPM (BAG)	52.3/ 2/ 52.27	23.3/ 2/ 23.29	51.1/ 2/ 51.07
HC BCKGRD METER/RANGE/PPM	6.0/ 2/ 6.00	5.9/ 2/ 5.90	6.8/ 2/ 6.80
CO SAMPLE METER/RANGE/PPM	48.5/ 14/ 214.50	14.3/ 12/ 13.74	45.9/ 13/ 105.28
CO BCKGRD METER/RANGE/PPM	.5/ 14/ 2.02	1.4/ 12/ 1.33	.5/ 13/ 1.09
CO2 SAMPLE METER/RANGE/PCT	76.0/ 14/ .5903	62.4/ 14/ .4013	71.4/ 14/ .5195
CO2 BCKGRD METER/RANGE/PCT	13.1/ 14/ .0442	13.0/ 14/ .0438	13.0/ 14/ .0438
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	18.1/ 1/ 4.60	7.6/ 1/ 1.95	12.0/ 1/ 3.06
NOX BCKGRD METER/RANGE/PPM	.2/ 1/ .05	.1/ 1/ .03	.3/ 1/ .08
CH4 SAMPLE PPM (1.110)	41.23	17.84	40.47
CH4 BCKGRD PPM	2.36	2.37	2.47
DILUTION FACTOR	15.69	23.88	18.09
HC CONCENTRATION PPM	46.66	17.64	44.65
CO CONCENTRATION PPM	206.60	12.17	101.52
CO2 CONCENTRATION PCT	.5489	.3594	.4781
NOX CONCENTRATION PPM	4.55	1.92	2.99
CH4 CONCENTRATION PPM	39.02	15.57	38.14
NMHC CONCENTRATION PPM	3.34	.35	2.31
THC MASS GRAMS	3.763	2.463	3.594
CO MASS GRAMS	32.229	3.289	15.844
CO2 MASS GRAMS	1346.74	1526.89	1173.57
NOX MASS GRAMS	.990	.724	.650
CH4 MASS GRAMS	3.486	2.409	3.409
NMHC MASS GRAMS (FID)	.258	.047	.179
FUEL MASS KG	.509	.557	.437
FUEL ECONOMY MPG (L/100KM)	18.01 (13.06)	17.51 (13.43)	21.04 (11.18)

3-BAG COMPOSITE RESULTS

THC	G/MI	.818	CH4	G/MI	.781
CO	G/MI	3.495	NMHC	G/MI	.035
NOX	G/MI	.203	CARBONYL	G/MI	.002
			ALCOHOL	G/MI	.000

FUEL ECONOMY MPG (L/100KM) 18.50 (12.72)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-CNG-1.2-E1	CNG
VEHICLE MODEL 93 CHEVY LUMINA	DATE 3/10/94 RUN 1	FUEL DENSITY 5.573 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2	H .236 C .725 O .000 X .040
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)	
ODOMETER 6390 MILES (10281 KM)	TEST WEIGHT 4000 LBS (1814 KG)	

BAROMETER 29.60 IN HG (751.8 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .816

RELATIVE HUMIDITY 23.8 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.7	866.8	505.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.984/.994	.987/.994	.985/.994
MEASURED DISTANCE MILES (KM)	3.62 (5.83)	3.87 (6.23)	3.63 (5.83)
BLOWER FLOW RATE SCFM (SCMM)	573.7 (16.25)	577.3 (16.35)	571.6 (16.19)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4837. (137.0)	8344. (236.3)	4817. (136.4)
HC SAMPLE METER/RANGE/PPM (BAG)	64.3/ 3/ 641.57	41.6/ 3/ 415.07	29.8/ 3/ 297.34
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	.8/ 3/ 7.98	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	62.5/ 3/2912.38	65.3/ 2/1532.04	77.8/ 2/2006.86
CO BCKGRD METER/RANGE/PPM	.2/ 3/ 4.66	.4/ 2/ 6.26	.5/ 2/ 7.83
CO2 SAMPLE METER/RANGE/PCT	71.2/ 14/ .5166	57.5/ 14/ .3464	67.2/ 14/ .4613
CO2 BCKGRD METER/RANGE/PCT	13.3/ 14/ .0450	13.1/ 14/ .0442	12.9/ 14/ .0434
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	30.6/ 1/ 7.72	14.9/ 1/ 3.79	31.0/ 1/ 7.82
NOX BCKGRD METER/RANGE/PPM	1.5/ 1/ .39	1.6/ 1/ .41	1.2/ 1/ .31
CH4 SAMPLE PPM (1.110)	495.81	317.97	225.07
CH4 BCKGRD PPM	3.46	3.35	3.64
DILUTION FACTOR	11.24	18.07	14.11
HC CONCENTRATION PPM	634.30	407.53	289.92
CO CONCENTRATION PPM	2841.53	1498.78	1956.98
CO2 CONCENTRATION PCT	.4756	.3046	.4210
NOX CONCENTRATION PPM	7.37	3.40	7.53
CH4 CONCENTRATION PPM	492.66	314.80	221.69
NMHC CONCENTRATION PPM	87.44	58.10	43.84
THC MASS GRAMS	52.543	58.203	23.921
CO MASS GRAMS	453.180	412.317	310.825
CO2 MASS GRAMS	1192.92	1317.87	1051.54
NOX MASS GRAMS	1.575	1.255	1.604
CH4 MASS GRAMS	44.993	49.593	20.163
NMHC MASS GRAMS (FID)	6.907	7.917	3.449
FUEL MASS KG	.740	.767	.580
FUEL ECONOMY MPG (L/100KM)	12.37 (19.02)	12.76 (18.43)	15.80 (14.89)

3-BAG COMPOSITE RESULTS

THC	G/MI	12.596	CH4	G/MI	10.728
CO	G/MI	104.618	NMHC	G/MI	1.714
NOX	G/MI	.380	CARBONYL	G/MI	.151
			ALCOHOL	G/MI	.001

FUEL ECONOMY MPG (L/100KM) 13.42 (17.52)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-CNG-1.2-E2 | CNG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 3/11/94 RUN 1 | FUEL DENSITY 5.573 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .236 C .725 O .000 X .040
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6401 MILES (10299 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.53 IN HG (750.1 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .842
RELATIVE HUMIDITY 30.6 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.4	867.9	505.3
DRY/WET CORRECTION FACTOR, SAMP/BACK	.982/.992	.985/.992	.983/.992
MEASURED DISTANCE MILES (KM)	3.62 (5.83)	3.88 (6.25)	3.59 (5.77)
BLOWER FLOW RATE SCFM (SCMM)	571.9 (16.20)	573.9 (16.25)	570.8 (16.17)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4829. (136.8)	8306. (235.2)	4810. (136.2)
HC SAMPLE METER/RANGE/PPM (BAG)	65.1/ 3/ 649.55	40.5/ 3/ 404.10	28.0/ 3/ 279.38
HC BCKGRD METER/RANGE/PPM	1.0/ 3/ 9.98	1.1/ 3/ 10.98	1.0/ 3/ 9.98
CO SAMPLE METER/RANGE/PPM	60.9/ 3/2787.04	64.6/ 2/1507.60	77.6/ 2/1998.68
CO BCKGRD METER/RANGE/PPM	.5/ 3/ 11.69	.7/ 2/ 10.97	.8/ 2/ 12.55
CO2 SAMPLE METER/RANGE/PCT	70.9/ 14/ .5123	59.3/ 14/ .3659	67.2/ 14/ .4613
CO2 BCKGRD METER/RANGE/PCT	14.1/ 14/ .0482	14.3/ 14/ .0490	14.4/ 14/ .0494
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	27.9/ 1/ 7.05	15.8/ 1/ 4.02	32.3/ 1/ 8.14
NOX BCKGRD METER/RANGE/PPM	1.2/ 1/ .31	1.2/ 1/ .31	1.4/ 1/ .36
CH4 SAMPLE PPM (1.110)	499.52	307.16	208.32
CH4 BCKGRD PPM	4.33	4.59	4.13
DILUTION FACTOR	11.46	17.56	14.17
HC CONCENTRATION PPM	640.45	393.75	270.10
CO CONCENTRATION PPM	2706.96	1466.24	1940.27
CO2 CONCENTRATION PCT	.4683	.3197	.4154
NOX CONCENTRATION PPM	6.76	3.73	7.81
CH4 CONCENTRATION PPM	495.57	302.83	204.48
NMHC CONCENTRATION PPM	90.37	57.61	43.13
THC MASS GRAMS	52.905	56.311	22.292
CO MASS GRAMS	430.986	401.532	307.669
CO2 MASS GRAMS	1172.54	1376.67	1035.88
NOX MASS GRAMS	1.489	1.411	1.711
CH4 MASS GRAMS	45.182	47.490	18.568
NMHC MASS GRAMS (FID)	7.126	7.814	3.387
FUEL MASS KG	.720	.781	.571
FUEL ECONOMY MPG (L/100KM)	12.71 (18.51)	12.57 (18.71)	15.87 (14.82)

3-BAG COMPOSITE RESULTS

THC	G/MI	12.256	CH4	G/MI	10.350
CO	G/MI	101.816	NMHC	G/MI	1.711
NOX	G/MI	.404	CARBONYL	G/MI	.184
			ALCOHOL	G/MI	.010

FUEL ECONOMY MPG (L/100KM) 13.40 (17.56)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-CNG-1.2-C1	CNG
VEHICLE MODEL 93 CHEVY LUMINA	DATE 3/15/94 RUN 1	FUEL DENSITY 5.573 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2	H .236 C .725 O .000 X .040
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)	
ODOMETER 6421 MILES (10331 KM)	TEST WEIGHT 4000 LBS (1814 KG)	

BAROMETER 29.19 IN HG (741.4 MM HG) DRY BULB TEMPERATURE 74.0°F (23.3°C) NOX HUMIDITY C.F. 1.050

RELATIVE HUMIDITY 65.8 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.8	867.5	506.0
DRY/WET CORRECTION FACTOR, SAMP/BACK	.967/.981	.971/.981	.969/.981
MEASURED DISTANCE MILES (KM)	3.63 (5.84)	3.90 (6.28)	3.65 (5.88)
BLOWER FLOW RATE SCFM (SCMM)	556.5 (15.76)	560.5 (15.87)	559.1 (15.83)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4694. (132.9)	8107. (229.6)	4717. (133.6)
HC SAMPLE METER/RANGE/PPM (BAG)	64.7/ 3/ 645.56	28.6/ 3/ 285.36	19.9/ 3/ 198.56
HC BCKGRD METER/RANGE/PPM	1.1/ 3/ 10.98	1.1/ 3/ 10.98	1.1/ 3/ 10.98
CO SAMPLE METER/RANGE/PPM	73.4/ 2/1831.36	50.6/ 1/ 458.17	73.9/ 1/ 722.19
CO BCKGRD METER/RANGE/PPM	.4/ 2/ 6.26	.5/ 1/ 4.19	.5/ 1/ 4.19
CO2 SAMPLE METER/RANGE/PCT	37.5/ 1/ .6890	69.1/ 14/ .4869	78.3/ 14/ .6289
CO2 BCKGRD METER/RANGE/PCT	2.7/ 1/ .0470	13.6/ 14/ .0462	14.2/ 14/ .0486
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	2.2/ 1/ .57	1.5/ 1/ .39	1.7/ 1/ .44
NOX BCKGRD METER/RANGE/PPM	.9/ 1/ .23	1.1/ 1/ .28	1.1/ 1/ .28
CH4 SAMPLE PPM (1.100)	544.70	247.89	173.64
CH4 BCKGRD PPM	4.62	4.20	4.13
DILUTION FACTOR	10.47	17.35	13.49
HC CONCENTRATION PPM	635.63	275.02	188.40
CO CONCENTRATION PPM	1749.79	438.00	689.69
CO2 CONCENTRATION PCT	.6465	.4434	.5839
NOX CONCENTRATION PPM	.36	.12	.18
CH4 CONCENTRATION PPM	540.53	243.93	169.81
NMHC CONCENTRATION PPM	41.06	6.70	1.61
THC MASS GRAMS	51.073	38.227	15.249
CO MASS GRAMS	270.781	117.077	107.263
CO2 MASS GRAMS	1573.28	1863.96	1428.07
NOX MASS GRAMS	.095	.055	.047
CH4 MASS GRAMS	47.899	37.337	15.123
NMHC MASS GRAMS (FID)	3.147	.887	.124
FUEL MASS KG	.772	.778	.592
FUEL ECONOMY MPG (L/100KM)	11.88 (19.80)	12.69 (18.54)	15.59 (15.09)

3-BAG COMPOSITE RESULTS

THC	G/MI	9.129	CH4	G/MI	8.821
CO	G/MI	39.053	NMHC	G/MI	.306
NOX	G/MI	.016	CARBONYL	G/MI	.002
			ALCOHOL	G/MI	.000

FUEL ECONOMY MPG (L/100KM) 13.23 (17.78)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-CNG-1.2-C2 | CNG
VEHICLE MODEL 93 CHEVY LUMINA | DATE 3/16/94 RUN 1 | FUEL DENSITY 5.573 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .236 C .725 O .000 X .040
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6432 MILES (10349 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.22 IN HG (742.2 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. 1.049
RELATIVE HUMIDITY 72.8 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.1	867.2	505.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.967/.981	.971/.981	.968/.981
MEASURED DISTANCE MILES (KM)	3.63 (5.84)	3.90 (6.28)	3.63 (5.84)
BLOWER FLOW RATE SCFM (SCMM)	564.8 (16.00)	564.7 (15.99)	564.1 (15.97)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4766. (135.0)	8166. (231.3)	4754. (134.6)
HC SAMPLE METER/RANGE/PPM (BAG)	58.6/ 3/ 584.70	30.5/ 3/ 304.32	18.2/ 3/ 181.60
HC BCKGRD METER/RANGE/PPM	1.1/ 3/ 10.98	1.3/ 3/ 12.97	1.1/ 3/ 10.98
CO SAMPLE METER/RANGE/PPM	70.1/ 2/1705.70	54.4/ 1/ 498.28	69.7/ 1/ 671.37
CO BCKGRD METER/RANGE/PPM	.3/ 2/ 4.70	.4/ 1/ 3.35	.5/ 1/ 4.19
CO2 SAMPLE METER/RANGE/PCT	81.9/ 14/ .6941	69.4/ 14/ .4911	78.4/ 14/ .6306
CO2 BCKGRD METER/RANGE/PCT	13.0/ 14/ .0438	13.0/ 14/ .0438	13.2/ 14/ .0446
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	1.9/ 1/ .49	1.1/ 1/ .28	1.7/ 1/ .44
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .18	.7/ 1/ .18	1.2/ 1/ .31
CH4 SAMPLE PPM (1.100)	496.65	259.92	156.71
CH4 BCKGRD PPM	3.64	3.73	3.38
DILUTION FACTOR	10.61	17.05	13.59
HC CONCENTRATION PPM	574.76	292.11	171.43
CO CONCENTRATION PPM	1626.64	476.29	639.35
CO2 CONCENTRATION PCT	.6544	.4499	.5893
NOX CONCENTRATION PPM	.33	.11	.15
CH4 CONCENTRATION PPM	493.35	256.41	153.58
NMHC CONCENTRATION PPM	32.07	10.06	2.49
THC MASS GRAMS	46.937	40.878	13.984
CO MASS GRAMS	255.622	128.233	100.203
CO2 MASS GRAMS	1617.21	1904.70	1452.47
NOX MASS GRAMS	.088	.053	.041
CH4 MASS GRAMS	44.396	39.532	13.784
NMHC MASS GRAMS (FID)	2.497	1.341	.193
FUEL MASS KG	.776	.801	.596
FUEL ECONOMY MPG (L/100KM)	11.83 (19.89)	12.30 (19.12)	15.38 (15.29)

3-BAG COMPOSITE RESULTS

THC	G/MI	9.169	CH4	G/MI	8.829
CO	G/MI	39.216	NMHC	G/MI	.335
NOX	G/MI	.015	CARBONYL	G/MI	.004
			ALCOHOL	G/MI	.000

FUEL ECONOMY MPG (L/100KM) 12.95 (18.16)

APPENDIX E

COMPUTER PRINTOUTS OF EMISSIONS DATA WITH REFORMULATED GASOLINE

Page E-	Test Number	Operating Condition	Catalyst Installation
1	L-PH2-0.8-E1	Lean	Without Catalyst
2	L-PH2-0.8-E2	Lean	Without Catalyst
3	L-PH2-0.8-C1	Lean	With Catalyst
4	L-PH2-0.8-C2	Lean	With Catalyst
5	L-PH2-1.0-E1	Stoich	Without Catalyst
6	L-PH2-1.0-E2	Stoich	Without Catalyst
7	L-PH2-1.0-C1	Stoich	With Catalyst
8	L-PH2-1.0-C2	Stoich	With Catalyst
9	L-PH2-1.2-E1	Rich	Without Catalyst
10	L-PH2-1.2-E2	Rich	Without Catalyst
11	L-PH2-1.2-C1	Rich	With Catalyst
12	L-PH2-1.2-C2	Rich	With Catalyst

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-PH2-0.8-E1 | GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA | DATE 4/22/94 RUN 1 | FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .139 C .841 O .020 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6805 MILES (10949 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.18 IN HG (741.2 MM HG) DRY BULB TEMPERATURE 76.0°F (24.4°C) NOX HUMIDITY C.F. 1.032
RELATIVE HUMIDITY 59.2 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.0	866.9	505.5
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.981	.976/.981	.975/.981
MEASURED DISTANCE MILES (KM)	3.60 (5.80)	3.85 (6.20)	3.59 (5.78)
BLOWER FLOW RATE SCFM (SCMM)	559.3 (15.84)	558.8 (15.82)	558.2 (15.81)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4719. (133.6)	8077. (228.8)	4705. (133.3)
HC SAMPLE METER/RANGE/PPM (BAG)	38.7/ 3/ 386.14	45.2/ 3/ 450.99	31.4/ 3/ 313.30
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	1.5/ 3/ 14.97	1.0/ 3/ 9.98
CO SAMPLE METER/RANGE/PPM	61.1/ 14/ 280.27	69.9/ 12/ 68.76	78.2/ 14/ 376.37
CO BCKGRD METER/RANGE/PPM	.5/ 14/ 2.02	1.8/ 12/ 1.71	.8/ 14/ 3.23
CO2 SAMPLE METER/RANGE/PCT	86.1/ 14/ .7787	72.3/ 14/ .5328	80.9/ 14/ .6753
CO2 BCKGRD METER/RANGE/PCT	13.8/ 14/ .0470	13.8/ 14/ .0470	14.2/ 14/ .0486
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	26.6/ 2/ 26.61	28.9/ 1/ 7.30	75.4/ 1/ 18.87
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ .30	1.9/ 1/ .49	2.1/ 1/ .54
CH4 SAMPLE PPM (1.120)	6.60	5.25	6.06
CH4 BCKGRD PPM	2.71	2.61	2.72
DILUTION FACTOR	15.66	22.62	17.79
HC CONCENTRATION PPM	378.67	436.69	303.88
CO CONCENTRATION PPM	268.73	65.12	361.14
CO2 CONCENTRATION PCT	.7347	.4878	.6295
NOX CONCENTRATION PPM	26.33	6.83	18.36
CH4 CONCENTRATION PPM	4.06	2.76	3.49
NMHC CONCENTRATION PPM	374.11	433.60	299.97
THC MASS GRAMS	31.715	61.993	25.493
CO MASS GRAMS	41.809	17.342	56.026
CO2 MASS GRAMS	1797.56	2043.17	1535.69
NOX MASS GRAMS	6.948	3.084	4.830
CH4 MASS GRAMS	.362	.421	.310
NMHC MASS GRAMS (FID)	28.829	57.194	23.049
FUEL MASS KG	.637	.734	.553
FUEL ECONOMY MPG (L/100KM)	15.89 (14.81)	14.72 (15.98)	18.24 (12.90)

3-BAG COMPOSITE RESULTS

THC	G/MI	12.104	CH4	G/MI	.101
CO	G/MI	9.030	NMHC	G/MI	11.106
NOX	G/MI	1.185	CARBONYL	G/MI	.760
			ALCOHOL	G/MI	.136

FUEL ECONOMY MPG (L/100KM) 15.82 (14.87)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-PH2-0.8-E2 | GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA | DATE 4/25/94 RUN 1 | FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .139 C .841 O .020 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6824 MILES (10979 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 28.98 IN HG (736.1 MM HG) DRY BULB TEMPERATURE 78.0°F (25.6°C) NOX HUMIDITY C.F. 1.137
RELATIVE HUMIDITY 67.5 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.0	866.9	505.3
DRY/WET CORRECTION FACTOR, SAMP/BACK	.969/.977	.972/.977	.970/.977
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.90 (6.27)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	554.6 (15.71)	554.4 (15.70)	553.8 (15.68)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.27 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4670. (132.3)	8013. (226.9)	4666. (132.1)
HC SAMPLE METER/RANGE/PPM (BAG)	39.3/ 3/ 392.13	41.1/ 3/ 410.09	32.8/ 3/ 327.27
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	.9/ 3/ 8.98	1.1/ 3/ 10.98
CO SAMPLE METER/RANGE/PPM	68.2/ 14/ 319.35	74.5/ 12/ 73.52	79.8/ 14/ 385.65
CO BCKGRD METER/RANGE/PPM	.2/ 14/ .81	.7/ 12/ .66	.4/ 14/ 1.62
CO2 SAMPLE METER/RANGE/PCT	86.8/ 14/ .7938	72.2/ 14/ .5313	81.2/ 14/ .6809
CO2 BCKGRD METER/RANGE/PCT	13.2/ 14/ .0446	13.2/ 14/ .0446	13.5/ 14/ .0458
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	30.4/ 2/ 30.41	36.5/ 1/ 9.19	75.8/ 1/ 18.97
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ .30	.9/ 1/ .23	1.3/ 1/ .34
CH4 SAMPLE PPM (1.120)	6.73	4.81	5.91
CH4 BCKGRD PPM	2.39	2.34	2.35
DILUTION FACTOR	15.31	22.82	17.61
HC CONCENTRATION PPM	384.67	401.50	316.92
CO CONCENTRATION PPM	306.61	70.52	370.54
CO2 CONCENTRATION PCT	.7521	.4886	.6377
NOX CONCENTRATION PPM	30.13	8.97	18.65
CH4 CONCENTRATION PPM	4.50	2.57	3.70
NMHC CONCENTRATION PPM	379.63	398.62	312.78
THC MASS GRAMS	31.924	57.184	26.388
CO MASS GRAMS	47.209	18.633	57.003
CO2 MASS GRAMS	1821.13	2030.23	1542.78
NOX MASS GRAMS	8.669	4.426	5.360
CH4 MASS GRAMS	.397	.390	.326
NMHC MASS GRAMS (FID)	28.951	52.162	23.832
FUEL MASS KG	.647	.726	.556
FUEL ECONOMY MPG (L/100KM)	15.68 (15.00)	15.07 (15.61)	18.22 (12.91)

3-BAG COMPOSITE RESULTS

THC	G/MI	11.443	CH4	G/MI	.099
CO	G/MI	9.510	NMHC	G/MI	10.411
NOX	G/MI	1.492	CARBONYL	G/MI	.804
			ALCOHOL	G/MI	.129

FUEL ECONOMY MPG (L/100KM) 15.97 (14.73)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-PH2-0.8-C1		GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA	DATE 4/20/94 RUN 1		FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2		H .139 C .841 O .020 X .000
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)		
ODOMETER 6776 MILES (10902 KM)	TEST WEIGHT 4000 LBS (1814 KG)		

BAROMETER 29.31 IN HG (744.5 MM HG) DRY BULB TEMPERATURE 73.0°F (22.8°C) NOX HUMIDITY C.F. 1.030

RELATIVE HUMIDITY 65.3 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.3	867.4	505.0
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.982	.976/.982	.974/.982
MEASURED DISTANCE MILES (KM)	3.61 (5.81)	3.86 (6.22)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	559.8 (15.85)	559.7 (15.85)	559.8 (15.86)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4717. (133.6)	8096. (229.3)	4714. (133.5)
HC SAMPLE METER/RANGE/PPM (BAG)	47.1/ 2/ 47.07	8.4/ 2/ 8.40	11.5/ 2/ 11.49
HC BCKGRD METER/RANGE/PPM	7.3/ 2/ 7.30	7.0/ 2/ 7.00	6.3/ 2/ 6.30
CO SAMPLE METER/RANGE/PPM	69.2/ 14/ 324.95	5.7/ 12/ 5.44	65.5/ 13/ 154.52
CO BCKGRD METER/RANGE/PPM	.3/ 14/ 1.21	.5/ 12/ .47	.6/ 13/ 1.31
CO2 SAMPLE METER/RANGE/PCT	86.7/ 14/ .7916	75.8/ 14/ .5871	83.7/ 14/ .7291
CO2 BCKGRD METER/RANGE/PCT	13.4/ 14/ .0454	13.8/ 14/ .0470	14.0/ 14/ .0478
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	25.0/ 2/ 25.01	28.2/ 1/ 7.12	55.7/ 1/ 13.97
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ .30	.8/ 1/ .21	1.1/ 1/ .28
CH4 SAMPLE PPM (1.120)	6.84	4.58	5.30
CH4 BCKGRD PPM	3.37	3.27	3.09
DILUTION FACTOR	15.98	22.47	17.75
HC CONCENTRATION PPM	40.23	1.71	5.55
CO CONCENTRATION PPM	311.88	4.82	147.82
CO2 CONCENTRATION PCT	.7491	.5422	.6840
NOX CONCENTRATION PPM	24.73	6.92	13.70
CH4 CONCENTRATION PPM	3.68	1.46	2.38
NMHC CONCENTRATION PPM	36.12	.07	2.88
THC MASS GRAMS	3.175	.236	.439
CO MASS GRAMS	48.501	1.286	22.975
CO2 MASS GRAMS	1831.92	2275.95	1671.95
NOX MASS GRAMS	6.508	3.128	3.604
CH4 MASS GRAMS	.327	.223	.212
NMHC MASS GRAMS (FID)	2.782	.010	.222
FUEL MASS KG	.623	.740	.555
FUEL ECONOMY MPG (L/100KM)	16.26 (14.46)	14.66 (16.05)	18.30 (12.85)

3-BAG COMPOSITE RESULTS

THC	G/MI	.248	CH4	G/MI	.065
CO	G/MI	4.713	NMHC	G/MI	.178
NOX	G/MI	1.067	CARBONYL	G/MI	.005
			ALCOHOL	G/MI	.000

FUEL ECONOMY MPG (L/100KM) 15.86 (14.83)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-PH2-0.8-C2 | GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA | DATE 4/21/94 RUN 1 | FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .139 C .841 O .020 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6787 MILES (10920 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.23 IN HG (742.4 MM HG) DRY BULB TEMPERATURE 76.0°F (24.4°C) NOX HUMIDITY C.F. .984
RELATIVE HUMIDITY 51.9 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.0	867.4	505.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.975/.984	.978/.984	.977/.984
MEASURED DISTANCE MILES (KM)	3.60 (5.79)	3.85 (6.20)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	556.8 (15.77)	558.4 (15.81)	557.7 (15.80)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4698. (133.0)	8076. (228.7)	4700. (133.1)
HC SAMPLE METER/RANGE/PPM (BAG)	41.9/ 2/ 41.88	81.9/ 1/ 8.22	12.9/ 2/ 12.89
HC BCKGRD METER/RANGE/PPM	6.6/ 2/ 6.60	67.3/ 1/ 6.75	6.2/ 2/ 6.20
CO SAMPLE METER/RANGE/PPM	56.7/ 13/ 132.04	4.6/ 12/ 4.38	90.2/ 13/ 221.00
CO BCKGRD METER/RANGE/PPM	.4/ 13/ .87	1.1/ 12/ 1.04	.5/ 13/ 1.09
CO2 SAMPLE METER/RANGE/PCT	89.3/ 14/ .8504	75.7/ 14/ .5855	83.0/ 14/ .7153
CO2 BCKGRD METER/RANGE/PCT	13.5/ 14/ .0458	13.3/ 14/ .0450	13.5/ 14/ .0458
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	96.7/ 1/ 24.08	27.1/ 1/ 6.85	56.8/ 1/ 14.24
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .18	.9/ 1/ .23	.8/ 1/ .21
CH4 SAMPLE PPM (1.120)	5.59	4.27	5.06
CH4 BCKGRD PPM	2.78	2.65	2.58
DILUTION FACTOR	15.25	22.54	17.92
HC CONCENTRATION PPM	35.71	1.76	7.04
CO CONCENTRATION PPM	126.80	3.28	213.15
CO2 CONCENTRATION PCT	.8076	.5425	.6720
NOX CONCENTRATION PPM	23.91	6.62	14.05
CH4 CONCENTRATION PPM	2.99	1.74	2.62
NMHC CONCENTRATION PPM	32.36	-.19	4.10
THC MASS GRAMS	2.865	.280	.555
CO MASS GRAMS	19.639	.873	33.032
CO2 MASS GRAMS	1967.22	2271.64	1637.84
NOX MASS GRAMS	5.983	2.850	3.518
CH4 MASS GRAMS	.265	.266	.233
NMHC MASS GRAMS (FID)	2.482	.000	.315
FUEL MASS KG	.651	.738	.549
FUEL ECONOMY MPG (L/100KM)	15.51 (15.17)	14.64 (16.07)	18.46 (12.74)

3-BAG COMPOSITE RESULTS

THC	G/MI	.245	CH4	G/MI	.069
CO	G/MI	3.773	NMHC	G/MI	.167
NOX	G/MI	.996	CARBONYL	G/MI	.006
			ALCOHOL	G/MI	.003

FUEL ECONOMY MPG (L/100KM) 15.74 (14.94)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-PH2-1.0-E1 | GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA | DATE 4/ 8/94 RUN 1 | FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .139 C .841 O .020 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6630 MILES (10667 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.27 IN HG (743.5 MM HG) DRY BULB TEMPERATURE 77.0°F (25.0°C) NOX HUMIDITY C.F. .954
RELATIVE HUMIDITY 45.7 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.0	867.3	504.9
DRY/WET CORRECTION FACTOR, SAMP/BACK	.978/.985	.981/.985	.979/.985
MEASURED DISTANCE MILES (KM)	3.62 (5.83)	3.86 (6.21)	3.62 (5.83)
BLOWER FLOW RATE SCFM (SCMM)	557.9 (15.80)	559.2 (15.84)	562.6 (15.93)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4707. (133.3)	8087. (229.0)	4736. (134.1)
HC SAMPLE METER/RANGE/PPM (BAG)	12.4/ 3/ 123.72	81.5/ 2/ 81.45	9.7/ 3/ 96.78
HC BCKGRD METER/RANGE/PPM	.7/ 3/ 6.98	6.8/ 2/ 6.80	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	53.3/ 1/ 486.56	54.2/ 14/ 243.66	82.0/ 14/ 398.47
CO BCKGRD METER/RANGE/PPM	.0/ 1/ .00	.5/ 14/ 2.02	.7/ 14/ 2.83
CO2 SAMPLE METER/RANGE/PCT	81.9/ 14/ .6941	68.6/ 14/ .4801	78.3/ 14/ .6289
CO2 BCKGRD METER/RANGE/PCT	12.9/ 14/ .0434	13.4/ 14/ .0454	14.0/ 14/ .0478
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	43.2/ 2/ 43.22	75.5/ 1/ 18.89	36.7/ 2/ 36.72
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ .30	.8/ 1/ .21	.3/ 2/ .30
CH4 SAMPLE PPM (1.100)	7.10	5.37	5.90
CH4 BCKGRD PPM	3.13	3.20	3.25
DILUTION FACTOR	17.54	25.83	19.52
HC CONCENTRATION PPM	117.14	74.92	89.21
CO CONCENTRATION PPM	472.67	235.83	384.97
CO2 CONCENTRATION PCT	.6531	.4365	.5835
NOX CONCENTRATION PPM	42.94	18.69	36.43
CH4 CONCENTRATION PPM	4.15	2.30	2.82
NMHC CONCENTRATION PPM	112.57	72.40	86.11
THC MASS GRAMS	9.727	10.754	7.471
CO MASS GRAMS	73.359	62.877	60.117
CO2 MASS GRAMS	1594.11	1830.04	1433.06
NOX MASS GRAMS	10.445	7.812	8.918
CH4 MASS GRAMS	.369	.350	.252
NMHC MASS GRAMS (FID)	8.653	9.560	6.660
FUEL MASS KG	.565	.637	.503
FUEL ECONOMY MPG (L/100KM)	18.01 (13.06)	16.99 (13.84)	20.19 (11.65)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.566	CH4	G/MI	.087
CO	G/MI	17.205	NMHC	G/MI	2.283
NOX	G/MI	2.325	CARBONYL	G/MI	.161
			ALCOHOL	G/MI	.035

FUEL ECONOMY MPG (L/100KM) 18.00 (13.07)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-PH2-1.0-E2 | GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA | DATE 4/11/94 RUN 1 | FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .139 C .841 O .020 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6649 MILES (10698 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.03 IN HG (737.4 MM HG) DRY BULB TEMPERATURE 74.0°F (23.3°C) NOX HUMIDITY C.F. 1.052
RELATIVE HUMIDITY 65.9 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.0	867.3	505.8
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.981	.976/.981	.974/.981
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.86 (6.21)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	552.6 (15.65)	555.7 (15.74)	555.6 (15.74)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4662. (132.0)	8036. (227.6)	4686. (132.7)
HC SAMPLE METER/RANGE/PPM (BAG)	13.7/ 3/ 136.70	88.3/ 2/ 88.25	10.1/ 3/ 100.78
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	8.6/ 2/ 8.60	1.0/ 3/ 9.98
CO SAMPLE METER/RANGE/PPM	56.1/ 1/ 516.59	55.5/ 14/ 250.45	81.0/ 14/ 392.64
CO BCKGRD METER/RANGE/PPM	.2/ 1/ 1.68	.4/ 14/ 1.62	.5/ 14/ 2.02
CO2 SAMPLE METER/RANGE/PCT	82.7/ 14/ .7094	68.8/ 14/ .4828	78.6/ 14/ .6341
CO2 BCKGRD METER/RANGE/PCT	13.1/ 14/ .0442	13.4/ 14/ .0454	13.9/ 14/ .0474
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	39.9/ 2/ 39.92	62.5/ 1/ 15.66	34.9/ 2/ 34.92
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ .30	.9/ 1/ .23	.2/ 2/ .20
CH4 SAMPLE PPM (1.100)	7.49	5.36	5.93
CH4 BCKGRD PPM	3.23	3.12	2.99
DILUTION FACTOR	17.11	25.63	19.39
HC CONCENTRATION PPM	129.18	79.99	91.31
CO CONCENTRATION PPM	496.78	241.20	377.47
CO2 CONCENTRATION PCT	.6678	.4392	.5891
NOX CONCENTRATION PPM	39.64	15.44	34.73
CH4 CONCENTRATION PPM	4.44	2.36	3.10
NMHC CONCENTRATION PPM	124.29	77.39	87.91
THC MASS GRAMS	10.520	11.349	7.571
CO MASS GRAMS	76.361	63.909	58.322
CO2 MASS GRAMS	1614.30	1830.09	1431.51
NOX MASS GRAMS	10.533	7.072	9.276
CH4 MASS GRAMS	.391	.358	.274
NMHC MASS GRAMS (FID)	9.463	10.156	6.727
FUEL MASS KG	.573	.638	.502
FUEL ECONOMY MPG (L/100KM)	17.70 (13.29)	16.96 (13.87)	20.22 (11.63)

3-BAG COMPOSITE RESULTS

THC	G/MI	2.701	CH4	G/MI	.091
CO	G/MI	17.390	NMHC	G/MI	2.416
NOX	G/MI	2.259	CARBONYL	G/MI	.158
			ALCOHOL	G/MI	.035

FUEL ECONOMY MPG (L/100KM) 17.93 (13.12)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-PH2-1.0-C1 | GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA | DATE 4/ 6/94 RUN 1 | FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .139 C .841 O .020 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6601 MILES (10621 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.32 IN HG (744.7 MM HG) DRY BULB TEMPERATURE 70.0°F (21.1°C) NOX HUMIDITY C.F. .823
RELATIVE HUMIDITY 26.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.6	867.6	505.7
DRY/WET CORRECTION FACTOR, SAMP/BACK	.986/.993	.988/.993	.987/.993
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.90 (6.27)	3.64 (5.85)
BLOWER FLOW RATE SCFM (SCMM)	560.9 (15.88)	563.3 (15.95)	562.7 (15.93)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4729. (133.9)	8149. (230.8)	4745. (134.4)
HC SAMPLE METER/RANGE/PPM (BAG)	44.4/ 2/ 44.37	70.6/ 1/ 7.08	13.6/ 2/ 13.59
HC BCKGRD METER/RANGE/PPM	6.3/ 2/ 6.30	63.7/ 1/ 6.39	6.0/ 2/ 6.00
CO SAMPLE METER/RANGE/PPM	62.5/ 14/ 287.87	9.4/ 12/ 9.00	48.6/ 13/ 111.89
CO BCKGRD METER/RANGE/PPM	.2/ 14/ .81	.3/ 12/ .28	.2/ 13/ .44
CO2 SAMPLE METER/RANGE/PCT	83.6/ 14/ .7271	70.1/ 14/ .5009	79.4/ 14/ .6481
CO2 BCKGRD METER/RANGE/PCT	12.6/ 14/ .0422	12.9/ 14/ .0434	12.7/ 14/ .0426
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	57.5/ 1/ 14.42	10.8/ 1/ 2.76	15.4/ 1/ 3.92
NOX BCKGRD METER/RANGE/PPM	.6/ 1/ .15	.6/ 1/ .15	.2/ 1/ .05
CH4 SAMPLE PPM (1.100)	5.41	2.97	4.05
CH4 BCKGRD PPM	2.53	2.55	2.55
DILUTION FACTOR	17.41	26.32	20.02
HC CONCENTRATION PPM	38.44	.94	7.90
CO CONCENTRATION PPM	280.51	8.56	109.08
CO2 CONCENTRATION PCT	.6873	.4591	.6076
NOX CONCENTRATION PPM	14.27	2.61	3.87
CH4 CONCENTRATION PPM	3.03	.51	1.62
NMHC CONCENTRATION PPM	35.10	.37	6.11
THC MASS GRAMS	3.103	.130	.621
CO MASS GRAMS	43.734	2.300	17.064
CO2 MASS GRAMS	1685.18	1939.87	1494.85
NOX MASS GRAMS	3.009	.948	.818
CH4 MASS GRAMS	.271	.079	.145
NMHC MASS GRAMS (FID)	2.711	.050	.473
FUEL MASS KG	.572	.631	.495
FUEL ECONOMY MPG (L/100KM)	17.73 (13.27)	17.32 (13.58)	20.63 (11.40)

3-BAG COMPOSITE RESULTS

THC	G/MI	.242	CH4	G/MI	.037
CO	G/MI	4.100	NMHC	G/MI	.198
NOX	G/MI	.360	CARBONYL	G/MI	.005
			ALCOHOL	G/MI	.002

FUEL ECONOMY MPG (L/100KM) 18.24 (12.90)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-PH2-1.0-C2 | GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA | DATE 4/ 7/94 RUN 1 | FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .139 C .841 O .020 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6612 MILES (10638 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.44 IN HG (747.8 MM HG) DRY BULB TEMPERATURE 74.0°F (23.3°C) NOX HUMIDITY C.F. .839
RELATIVE HUMIDITY 27.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.4	867.3	505.6
DRY/WET CORRECTION FACTOR, SAMP/BACK	.985/.992	.987/.992	.986/.992
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.87 (6.22)	3.64 (5.85)
BLOWER FLOW RATE SCFM (SCMM)	561.5 (15.90)	562.9 (15.94)	564.1 (15.98)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4732. (134.0)	8142. (230.6)	4756. (134.7)
HC SAMPLE METER/RANGE/PPM (BAG)	42.6/ 2/ 42.58	63.9/ 1/ 6.41	14.9/ 2/ 14.89
HC BCKGRD METER/RANGE/PPM	5.6/ 2/ 5.60	54.2/ 1/ 5.44	5.6/ 2/ 5.60
CO SAMPLE METER/RANGE/PPM	91.3/ 13/ 224.08	14.8/ 12/ 14.23	70.2/ 13/ 166.78
CO BCKGRD METER/RANGE/PPM	.8/ 13/ 1.74	1.9/ 12/ 1.81	.8/ 13/ 1.74
CO2 SAMPLE METER/RANGE/PCT	84.1/ 14/ .7371	70.3/ 14/ .5037	80.0/ 14/ .6589
CO2 BCKGRD METER/RANGE/PCT	13.4/ 14/ .0454	13.5/ 14/ .0458	13.9/ 14/ .0474
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	66.3/ 1/ 16.61	6.1/ 1/ 1.56	12.4/ 1/ 3.16
NOX BCKGRD METER/RANGE/PPM	1.5/ 1/ .39	1.3/ 1/ .34	.8/ 1/ .21
CH4 SAMPLE PPM (1.100)	5.18	3.29	4.38
CH4 BCKGRD PPM	2.76	2.74	2.74
DILUTION FACTOR	17.33	26.15	19.54
HC CONCENTRATION PPM	37.30	1.18	9.58
CO CONCENTRATION PPM	217.22	12.24	161.51
CO2 CONCENTRATION PCT	.6944	.4597	.6139
NOX CONCENTRATION PPM	16.24	1.24	2.97
CH4 CONCENTRATION PPM	2.58	.65	1.78
NMHC CONCENTRATION PPM	34.47	.46	7.62
THC MASS GRAMS	3.037	.162	.754
CO MASS GRAMS	33.892	3.286	25.324
CO2 MASS GRAMS	1703.72	1940.48	1513.85
NOX MASS GRAMS	3.493	.459	.641
CH4 MASS GRAMS	.230	.100	.160
NMHC MASS GRAMS (FID)	2.663	.062	.592
FUEL MASS KG	.573	.632	.505
FUEL ECONOMY MPG (L/100KM)	17.70 (13.29)	17.18 (13.69)	20.21 (11.64)

3-BAG COMPOSITE RESULTS

THC	G/MI	.253	CH4	G/MI	.039
CO	G/MI	4.308	NMHC	G/MI	.206
NOX	G/MI	.311	CARBONYL	G/MI	.006
			ALCOHOL	G/MI	.003

FUEL ECONOMY MPG (L/100KM) 18.05 (13.03)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-PH2-1.2-E1		GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA	DATE 4/14/94 RUN 2		FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2		H .139 C .841 O .020 X .000
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)		
ODOMETER 6707 MILES (10791 KM)	TEST WEIGHT 4000 LBS (1814 KG)		

BAROMETER 29.08 IN HG (738.6 MM HG) DRY BULB TEMPERATURE 75.0°F (23.9°C) NOX HUMIDITY C.F. 1.043

RELATIVE HUMIDITY 62.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.0	867.2	505.6
DRY/WET CORRECTION FACTOR, SAMP/BACK	.975/.981	.977/.981	.976/.981
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.87 (6.22)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	553.1 (15.66)	556.0 (15.75)	554.9 (15.72)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.27 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4667. (132.2)	8039. (227.7)	4678. (132.5)
HC SAMPLE METER/RANGE/PPM (BAG)	17.1/ 3/ 170.62	13.7/ 3/ 136.70	15.8/ 3/ 157.65
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	1.0/ 3/ 9.98	.9/ 3/ 8.98
CO SAMPLE METER/RANGE/PPM	83.4/ 2/2243.07	78.4/ 2/2031.48	94.5/ 2/2749.38
CO BCKGRD METER/RANGE/PPM	.3/ 2/ 4.70	.6/ 2/ 9.40	.6/ 2/ 9.40
CO2 SAMPLE METER/RANGE/PCT	79.5/ 14/ .6499	63.1/ 14/ .4097	72.0/ 14/ .5283
CO2 BCKGRD METER/RANGE/PCT	15.8/ 14/ .0552	15.8/ 14/ .0552	15.6/ 14/ .0544
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	89.5/ 1/ 22.33	22.9/ 1/ 5.80	38.3/ 1/ 9.64
NOX BCKGRD METER/RANGE/PPM	1.1/ 1/ .28	1.5/ 1/ .39	1.8/ 1/ .46
CH4 SAMPLE PPM (1.120)	14.33	14.88	15.90
CH4 BCKGRD PPM	3.43	3.44	3.33
DILUTION FACTOR	14.96	21.31	16.32
HC CONCENTRATION PPM	162.24	127.19	149.22
CO CONCENTRATION PPM	2164.60	1965.21	2656.45
CO2 CONCENTRATION PCT	.5984	.3571	.4773
NOX CONCENTRATION PPM	22.07	5.43	9.20
CH4 CONCENTRATION PPM	11.13	11.60	12.78
NMHC CONCENTRATION PPM	149.77	114.19	134.91
THC MASS GRAMS	12.868	17.245	11.759
CO MASS GRAMS	333.068	520.898	409.753
CO2 MASS GRAMS	1448.01	1488.37	1157.74
NOX MASS GRAMS	5.817	2.465	2.431
CH4 MASS GRAMS	.981	1.761	1.129
NMHC MASS GRAMS (FID)	11.414	14.992	10.307
FUEL MASS KG	.653	.766	.597
FUEL ECONOMY MPG (L/100KM)	15.56 (15.12)	14.16 (16.61)	17.01 (13.83)

3-BAG COMPOSITE RESULTS

THC	G/MI	3.938	CH4	G/MI	.377
CO	G/MI	119.916	NMHC	G/MI	3.443
NOX	G/MI	.849	CARBONYL	G/MI	.089
			ALCOHOL	G/MI	.029

FUEL ECONOMY MPG (L/100KM) 15.15 (15.53)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M | TEST L-PH2-1.2-E2 | GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA | DATE 4/15/94 RUN 1 | FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6 | DYNO 2 BAG CART 2 | H .139 C .841 O .020 X .000
TRANSMISSION L4 | ACTUAL ROAD LOAD 6.50 HP (4.85 KW)
ODOMETER 6718 MILES (10809 KM) | TEST WEIGHT 4000 LBS (1814 KG)

BAROMETER 29.04 IN HG (737.6 MM HG) DRY BULB TEMPERATURE 75.0°F (23.9°C) NOX HUMIDITY C.F. 1.044
RELATIVE HUMIDITY 62.5 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.7	867.1	506.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.975/.981	.977/.981	.976/.981
MEASURED DISTANCE MILES (KM)	3.65 (5.87)	3.90 (6.27)	3.65 (5.88)
BLOWER FLOW RATE SCFM (SCMM)	560.1 (15.86)	560.3 (15.87)	559.3 (15.84)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4723. (133.7)	8101. (229.4)	4723. (133.8)
HC SAMPLE METER/RANGE/PPM (BAG)	20.0/ 3/ 199.56	15.1/ 3/ 150.66	16.8/ 3/ 167.63
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	1.0/ 3/ 9.98	1.1/ 3/ 10.98
CO SAMPLE METER/RANGE/PPM	60.3/ 3/2740.91	80.9/ 2/2135.88	61.6/ 3/2841.46
CO BCKGRD METER/RANGE/PPM	.2/ 3/ 4.66	.5/ 2/ 7.83	.4/ 3/ 9.34
CO2 SAMPLE METER/RANGE/PCT	77.0/ 14/ .6068	61.8/ 14/ .3943	71.3/ 14/ .5181
CO2 BCKGRD METER/RANGE/PCT	13.2/ 14/ .0446	13.5/ 14/ .0458	13.3/ 14/ .0450
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	57.1/ 1/ 14.32	21.2/ 1/ 5.37	38.2/ 1/ 9.61
NOX BCKGRD METER/RANGE/PPM	.4/ 1/ .10	.7/ 1/ .18	1.3/ 1/ .34
CH4 SAMPLE PPM (1.120)	17.46	16.40	17.16
CH4 BCKGRD PPM	3.59	3.64	2.95
DILUTION FACTOR	14.83	21.44	16.32
HC CONCENTRATION PPM	191.18	141.15	157.32
CO CONCENTRATION PPM	2648.35	2068.76	2746.33
CO2 CONCENTRATION PCT	.5652	.3506	.4758
NOX CONCENTRATION PPM	14.22	5.20	9.30
CH4 CONCENTRATION PPM	14.11	12.93	14.39
NMHC CONCENTRATION PPM	175.38	126.67	141.20
THC MASS GRAMS	15.202	19.202	12.515
CO MASS GRAMS	412.367	552.536	427.664
CO2 MASS GRAMS	1384.07	1472.74	1165.28
NOX MASS GRAMS	3.796	2.381	2.482
CH4 MASS GRAMS	1.258	1.977	1.283
NMHC MASS GRAMS (FID)	13.525	16.757	10.891
FUEL MASS KG	.675	.779	.609
FUEL ECONOMY MPG (L/100KM)	15.17 (15.51)	14.04 (16.75)	16.83 (13.97)

3-BAG COMPOSITE RESULTS

THC	G/MI	4.355	CH4	G/MI	.430
CO	G/MI	128.971	NMHC	G/MI	3.813
NOX	G/MI	.719	CARBONYL	G/MI	.083
			ALCOHOL	G/MI	.029

FUEL ECONOMY MPG (L/100KM) 14.96 (15.72)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-PH2-1.2-C1	GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA	DATE 4/18/94 RUN 1	FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2	H .139 C .841 O .020 X .000
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)	
ODOMETER 6736 MILES (10838 KM)	TEST WEIGHT 4000 LBS (1814 KG)	

BAROMETER 29.35 IN HG (745.5 MM HG) DRY BULB TEMPERATURE 77.0°F (25.0°C) NOX HUMIDITY C.F. .933

RELATIVE HUMIDITY 42.3 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.5	866.8	505.8
DRY/WET CORRECTION FACTOR, SAMP/BACK	.980/.986	.982/.986	.981/.986
MEASURED DISTANCE MILES (KM)	3.63 (5.84)	3.89 (6.25)	3.63 (5.85)
BLOWER FLOW RATE SCFM (SCMM)	560.2 (15.86)	562.3 (15.92)	560.9 (15.89)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4722. (133.7)	8127. (230.2)	4731. (134.0)
HC SAMPLE METER/RANGE/PPM (BAG)	18.0/ 3/ 179.60	13.8/ 3/ 137.69	15.0/ 3/ 149.67
HC BCKGRD METER/RANGE/PPM	.7/ 3/ 6.98	.8/ 3/ 7.98	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	91.1/ 2/2589.53	79.3/ 2/2068.74	95.0/ 2/2773.18
CO BCKGRD METER/RANGE/PPM	.5/ 2/ 7.83	.6/ 2/ 9.40	.9/ 2/ 14.12
CO2 SAMPLE METER/RANGE/PCT	76.9/ 14/ .6051	61.8/ 14/ .3943	71.1/ 14/ .5152
CO2 BCKGRD METER/RANGE/PCT	13.7/ 14/ .0466	14.0/ 14/ .0478	14.3/ 14/ .0490
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	51.3/ 1/ 12.87	8.1/ 1/ 2.07	21.9/ 1/ 5.55
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .18	1.0/ 1/ .26	1.4/ 1/ .36
CH4 SAMPLE PPM (1.120)	16.21	15.57	16.05
CH4 BCKGRD PPM	3.48	3.34	3.20
DILUTION FACTOR	15.11	21.66	16.51
HC CONCENTRATION PPM	173.08	130.08	142.17
CO CONCENTRATION PPM	2515.80	2015.41	2693.81
CO2 CONCENTRATION PCT	.5616	.3487	.4691
NOX CONCENTRATION PPM	12.70	1.83	5.21
CH4 CONCENTRATION PPM	12.96	12.38	13.04
NMHC CONCENTRATION PPM	158.56	116.21	127.57
THC MASS GRAMS	13.809	17.864	11.458
CO MASS GRAMS	391.639	540.009	420.193
CO2 MASS GRAMS	1374.99	1469.29	1150.80
NOX MASS GRAMS	3.032	.751	1.246
CH4 MASS GRAMS	1.155	1.900	1.164
NMHC MASS GRAMS (FID)	12.226	15.422	9.856
FUEL MASS KG	.660	.770	.599
FUEL ECONOMY MPG (L/100KM)	15.42 (15.25)	14.16 (16.62)	17.01 (13.83)

3-BAG COMPOSITE RESULTS

THC	G/MI	4.035	CH4	G/MI	.407
CO	G/MI	126.102	NMHC	G/MI	3.498
NOX	G/MI	.368	CARBONYL	G/MI	.058
			ALCOHOL	G/MI	.071

FUEL ECONOMY MPG (L/100KM) 15.12 (15.56)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 53M	TEST L-PH2-1.2-C2	GASOLINE PHASE II EM-1701-F
VEHICLE MODEL 93 CHEVY LUMINA	DATE 4/19/94 RUN 1	FUEL DENSITY 6.186 LB/GAL
ENGINE 3.1 L (189 CID)-V-6	DYNO 2 BAG CART 2	H .139 C .841 O .020 X .000
TRANSMISSION L4	ACTUAL ROAD LOAD 6.50 HP (4.85 KW)	
ODOMETER 6747 MILES (10855 KM)	TEST WEIGHT 4000 LBS (1814 KG)	

BAROMETER 29.28 IN HG (743.7 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .991

RELATIVE HUMIDITY 60.9 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.6	867.0	505.5
DRY/WET CORRECTION FACTOR, SAMP/BACK	.977/.983	.980/.983	.978/.983
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.89 (6.26)	3.62 (5.83)
BLOWER FLOW RATE SCFM (SCMM)	558.2 (15.81)	559.7 (15.85)	561.0 (15.89)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4706. (133.3)	8092. (229.2)	4728. (133.9)
HC SAMPLE METER/RANGE/PPM (BAG)	19.3/ 3/ 192.57	13.8/ 3/ 137.69	15.4/ 3/ 153.66
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	.8/ 3/ 7.98	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	91.2/ 2/2594.18	77.9/ 2/2010.95	94.7/ 2/2758.89
CO BCKGRD METER/RANGE/PPM	.5/ 2/ 7.83	.5/ 2/ 7.83	.4/ 2/ 6.26
CO2 SAMPLE METER/RANGE/PCT	76.8/ 14/ .6035	61.6/ 14/ .3919	71.2/ 14/ .5166
CO2 BCKGRD METER/RANGE/PCT	13.7/ 14/ .0466	13.6/ 14/ .0462	13.7/ 14/ .0466
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	43.7/ 1/ 10.98	7.7/ 1/ 1.97	19.4/ 1/ 4.92
NOX BCKGRD METER/RANGE/PPM	.4/ 1/ .10	.3/ 1/ .08	.5/ 1/ .13
CH4 SAMPLE PPM (1.120)	16.68	15.36	16.16
CH4 BCKGRD PPM	3.37	3.20	3.05
DILUTION FACTOR	15.13	21.99	16.54
HC CONCENTRATION PPM	185.12	130.07	146.16
CO CONCENTRATION PPM	2504.90	1948.41	2670.56
CO2 CONCENTRATION PCT	.5600	.3479	.4728
NOX CONCENTRATION PPM	10.88	1.90	4.80
CH4 CONCENTRATION PPM	13.53	12.31	13.30
NMHC CONCENTRATION PPM	169.96	116.29	131.27
THC MASS GRAMS	14.753	17.827	11.767
CO MASS GRAMS	388.639	519.831	416.323
CO2 MASS GRAMS	1366.32	1459.54	1159.24
NOX MASS GRAMS	2.750	.824	1.219
CH4 MASS GRAMS	1.202	1.881	1.187
NMHC MASS GRAMS (FID)	13.061	15.367	10.136
FUEL MASS KG	.657	.757	.600
FUEL ECONOMY MPG (L/100KM)	15.47 (15.21)	14.43 (16.30)	16.92 (13.90)

3-BAG COMPOSITE RESULTS

THC	G/MI	4.110	CH4	G/MI	.409
CO	G/MI	123.031	NMHC	G/MI	3.562
NOX	G/MI	.360	CARBONYL	G/MI	.067
			ALCOHOL	G/MI	.072

FUEL ECONOMY MPG (L/100KM) 15.27 (15.41)

APPENDIX F

COMPUTER PRINTOUTS OF EMISSIONS DATA WITH ETHANOL

Page F-	Test Number	Operating Condition	Catalyst Installation
1	L-ETH-0.8-E1	Lean	Without Catalyst
2	L-ETH-0.8-E2	Lean	Without Catalyst
3	L-ETH-0.8-C1	Lean	With Catalyst
4	L-ETH-0.8-C2	Lean	With Catalyst
5	L-ETH-1.0-E1	Stoich	Without Catalyst
6	L-ETH-1.0-E2	Stoich	Without Catalyst
7	L-ETH-1.0-C2	Stoich	With Catalyst
8	L-ETH-1.0-C3	Stoich	With Catalyst
9	L-ETH-1.2-E1	Rich	Without Catalyst
10	L-ETH-1.2-E2	Rich	Without Catalyst
11	L-ETH-1.2-C1	Rich	With Catalyst
12	L-ETH-1.2-C2	Rich	With Catalyst

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601	TEST C-ETH-0.8-E1	ETHANOL E100	EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA	DATE 6/30/94 RUN	FUEL DENSITY 6.514 LB/GAL	
ENGINE 2.8 L (171 CID)-V-6	DYNO 2 BAG CART 2	H .131 C .521 O .347 X .000	
TRANSMISSION M5	ACTUAL ROAD LOAD 4.50 HP (3.36 KW)	TEMP. FUEL FRACTIONS	
ODOMETER 14994 MILES (24125 KM)	TEST WEIGHT 3500 LBS (1587 KG)		

BAROMETER 29.17 IN HG (740.9 MM HG) DRY BULB TEMPERATURE 74.0°F (23.3°C) NOX HUMIDITY C.F. .978

RELATIVE HUMIDITY 54.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.3	867.3	505.5
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.984	.976/.984	.975/.984
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.86 (6.21)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	556.6 (15.76)	557.2 (15.78)	556.1 (15.75)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4690. (132.8)	8058. (228.2)	4688. (132.8)
HC SAMPLE METER/RANGE/PPM (BAG)	22.8/ 3/ 227.49	22.3/ 3/ 222.50	13.0/ 3/ 129.71
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	.8/ 3/ 7.98	.9/ 3/ 8.98
CO SAMPLE METER/RANGE/PPM	63.6/ 1/ 595.51	79.1/ 12/ 78.37	46.8/ 13/ 107.48
CO BCKGRD METER/RANGE/PPM	.0/ 1/ .00	1.0/ 12/ .95	.5/ 13/ 1.09
CO2 SAMPLE METER/RANGE/PCT	78.9/ 14/ .6393	71.1/ 14/ .5152	77.3/ 14/ .6118
CO2 BCKGRD METER/RANGE/PCT	12.7/ 14/ .0426	13.1/ 14/ .0442	13.3/ 14/ .0450
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	45.9/ 1/ 11.47	14.4/ 1/ 3.60	52.1/ 1/ 13.02
NOX BCKGRD METER/RANGE/PPM	.6/ 1/ .15	.2/ 1/ .05	.6/ 1/ .15
CH4 SAMPLE PPM (1.140)	14.65	6.94	6.47
CH4 BCKGRD PPM	3.05	3.07	3.07
DILUTION FACTOR	17.24	22.85	19.49
HC CONCENTRATION PPM	219.03	214.87	121.19
CO CONCENTRATION PPM	575.54	75.09	102.93
CO2 CONCENTRATION PCT	.5992	.4729	.5692
NOX CONCENTRATION PPM	11.33	3.55	12.88
CH4 CONCENTRATION PPM	11.78	4.01	3.56
NMHC CONCENTRATION PPM	31.63	24.61	1.41
THC MASS GRAMS	35.189	62.212	22.577
CO MASS GRAMS	88.988	19.949	15.908
CO2 MASS GRAMS	1456.91	1975.78	1383.36
NOX MASS GRAMS	2.813	1.515	3.197
CH4 MASS GRAMS	1.043	.611	.315
NMHC MASS GRAMS (FID)	2.422	3.238	.108
FUEL MASS KG	.871	1.113	.760
FUEL ECONOMY MPG (L/100KM)	12.28 (19.16)	10.24 (22.97)	14.06 (16.73)

3-BAG COMPOSITE RESULTS

THC	G/MI	12.068	CH4	G/MI	.166
CO	G/MI	8.999	NMHC	G/MI	.581
NOX	G/MI	.608	CARBONYL	G/MI	1.539
			ALCOHOL	G/MI	9.783

FUEL ECONOMY MPG (L/100KM) 11.51 (20.44)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601	TEST C-ETH-0.8-E2	ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA	DATE 7/ 1/94 RUN	FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6	DYNO 2 BAG CART 2	H .131 C .521 O .347 X .000
TRANSMISSION M5	ACTUAL ROAD LOAD 4.50 HP (3.36 KW)	TEMP. FUEL FRACTIONS
ODOMETER 15005 MILES (24143 KM)	TEST WEIGHT 3500 LBS (1587 KG)	

BAROMETER 29.16 IN HG (740.7 MM HG) DRY BULB TEMPERATURE 74.0°F (23.3°C) NOX HUMIDITY C.F. .957

RELATIVE HUMIDITY 50.8 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.2	867.5	505.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.975/.985	.978/.985	.976/.985
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.87 (6.23)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	557.7 (15.79)	557.6 (15.79)	556.4 (15.76)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4698. (133.1)	8066. (228.4)	4689. (132.8)
HC SAMPLE METER/RANGE/PPM (BAG)	22.3/ 3/ 222.50	16.4/ 3/ 163.64	13.0/ 3/ 129.71
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	.8/ 3/ 7.98	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	64.7/ 1/ 608.21	76.0/ 12/ 75.09	49.2/ 13/ 113.36
CO BCKGRD METER/RANGE/PPM	.3/ 1/ 2.30	1.1/ 12/ 1.04	.4/ 13/ .87
CO2 SAMPLE METER/RANGE/PCT	79.4/ 14/ .6481	70.6/ 14/ .5080	77.3/ 14/ .6118
CO2 BCKGRD METER/RANGE/PCT	12.6/ 14/ .0422	12.9/ 14/ .0434	13.3/ 14/ .0450
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	52.5/ 1/ 13.12	14.9/ 1/ 3.72	48.0/ 1/ 12.00
NOX BCKGRD METER/RANGE/PPM	.6/ 1/ .15	.9/ 1/ .22	.8/ 1/ .20
CH4 SAMPLE PPM (1.140)	15.59	6.73	6.23
CH4 BCKGRD PPM	3.27	3.21	2.96
DILUTION FACTOR	17.04	23.34	19.46
HC CONCENTRATION PPM	214.99	156.00	122.14
CO CONCENTRATION PPM	586.26	71.93	108.96
CO2 CONCENTRATION PCT	.6084	.4664	.5692
NOX CONCENTRATION PPM	12.98	3.51	11.81
CH4 CONCENTRATION PPM	12.52	3.66	3.43
NMHC CONCENTRATION PPM	.22	24.04	9.10
THC MASS GRAMS	37.104	45.488	21.605
CO MASS GRAMS	90.809	19.129	16.845
CO2 MASS GRAMS	1482.00	1950.83	1383.76
NOX MASS GRAMS	3.160	1.467	2.869
CH4 MASS GRAMS	1.110	.558	.303
NMHC MASS GRAMS (FID)	.017	3.167	.697
FUEL MASS KG	.888	1.082	.760
FUEL ECONOMY MPG (L/100KM)	12.04 (19.54)	10.57 (22.26)	14.06 (16.73)

3-BAG COMPOSITE RESULTS

THC	G/MI	9.851	CH4	G/MI	.161
CO	G/MI	9.052	NMHC	G/MI	.477
NOX	G/MI	.596	CARBONYL	G/MI	1.388
			ALCOHOL	G/MI	7.825

FUEL ECONOMY MPG (L/100KM) 11.67 (20.15)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601	TEST C-ETH-0.8-C1	ETHANOL E100	EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA	DATE 7/ 5/94 RUN	FUEL DENSITY 6.514 LB/GAL	
ENGINE 2.8 L (171 CID)-V-6	DYNO 2 BAG CART 2	H .131 C .521 O .347 X .000	
TRANSMISSION M5	ACTUAL ROAD LOAD 4.50 HP (3.36 KW)	TEMP. FUEL FRACTIONS	
ODOMETER 15023 MILES (24172 KM)	TEST WEIGHT 3500 LBS (1587 KG)		

BAROMETER 29.22 IN HG (742.2 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .978

RELATIVE HUMIDITY 60.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.7	866.8	505.5
DRY/WET CORRECTION FACTOR, SAMP/BACK	.973/.984	.975/.984	.974/.984
MEASURED DISTANCE MILES (KM)	3.63 (5.85)	3.88 (6.25)	3.65 (5.87)
BLOWER FLOW RATE SCFM (SCMM)	558.3 (15.81)	559.0 (15.83)	557.9 (15.80)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4708. (133.3)	8079. (228.8)	4703. (133.2)
HC SAMPLE METER/RANGE/PPM (BAG)	11.2/ 3/ 111.75	6.7/ 2/ 6.70	7.4/ 2/ 7.40
HC BCKGRD METER/RANGE/PPM	.7/ 3/ 6.98	6.6/ 2/ 6.60	5.9/ 2/ 5.90
CO SAMPLE METER/RANGE/PPM	62.0/ 14/ 285.15	1.1/ 12/ 1.04	1.8/ 12/ 1.71
CO BCKGRD METER/RANGE/PPM	.0/ 14/ .00	.4/ 12/ .38	.4/ 12/ .38
CO2 SAMPLE METER/RANGE/PCT	83.1/ 14/ .7172	74.7/ 14/ .5695	80.1/ 14/ .6607
CO2 BCKGRD METER/RANGE/PCT	12.6/ 14/ .0422	13.1/ 14/ .0442	13.3/ 14/ .0450
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	43.2/ 1/ 10.80	15.1/ 1/ 3.77	41.1/ 1/ 10.27
NOX BCKGRD METER/RANGE/PPM	.6/ 1/ .15	.8/ 1/ .20	.4/ 1/ .10
CH4 SAMPLE PPM (1.180)	11.52	3.19	4.24
CH4 BCKGRD PPM	3.12	3.09	2.89
DILUTION FACTOR	16.34	21.56	18.58
HC CONCENTRATION PPM	105.19	.41	1.82
CO CONCENTRATION PPM	274.48	.65	1.30
CO2 CONCENTRATION PCT	.6776	.5273	.6181
NOX CONCENTRATION PPM	10.66	3.58	10.18
CH4 CONCENTRATION PPM	8.59	.24	1.50
NMHC CONCENTRATION PPM	6.81	-1.32	-.54
THC MASS GRAMS	16.417	.439	.230
CO MASS GRAMS	42.601	.174	.201
CO2 MASS GRAMS	1653.85	2209.12	1507.16
NOX MASS GRAMS	2.657	1.534	2.535
CH4 MASS GRAMS	.764	.036	.134
NMHC MASS GRAMS (FID)	.523	.000	.000
FUEL MASS KG	.917	1.157	.789
FUEL ECONOMY MPG (L/100KM)	11.70 (20.10)	9.92 (23.71)	13.66 (17.23)

3-BAG COMPOSITE RESULTS

THC	G/MI	1.015	CH4	G/MI	.059
CO	G/MI	2.475	NMHC	G/MI	.030
NOX	G/MI	.548	CARBONYL	G/MI	.061
			ALCOHOL	G/MI	.865

FUEL ECONOMY MPG (L/100KM) 11.12 (21.15)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-ETH-0.8-C2 | ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 7/ 6/94 RUN | FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .131 C .521 O .347 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW) | TEMP. FUEL FRACTIONS
ODOMETER 15034 MILES (24189 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.18 IN HG (741.2 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .979
RELATIVE HUMIDITY 60.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.4	867.1	505.3
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.984	.976/.984	.974/.984
MEASURED DISTANCE MILES (KM)	3.63 (5.84)	3.89 (6.25)	3.63 (5.84)
BLOWER FLOW RATE SCFM (SCMM)	557.5 (15.79)	557.8 (15.80)	557.6 (15.79)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4698. (133.1)	8066. (228.4)	4699. (133.1)
HC SAMPLE METER/RANGE/PPM (BAG)	11.1/ 3/ 110.75	5.9/ 2/ 5.90	6.9/ 2/ 6.90
HC BCKGRD METER/RANGE/PPM	.7/ 3/ 6.98	6.1/ 2/ 6.10	5.3/ 2/ 5.30
CO SAMPLE METER/RANGE/PPM	70.7/ 14/ 333.41	1.1/ 12/ 1.04	2.5/ 12/ 2.38
CO BCKGRD METER/RANGE/PPM	.2/ 14/ .81	.8/ 12/ .76	.7/ 12/ .66
CO2 SAMPLE METER/RANGE/PCT	81.7/ 14/ .6903	74.1/ 14/ .5601	79.3/ 14/ .6464
CO2 BCKGRD METER/RANGE/PCT	12.9/ 14/ .0434	13.4/ 14/ .0454	13.5/ 14/ .0458
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	45.7/ 1/ 11.42	15.6/ 1/ 3.90	49.1/ 1/ 12.27
NOX BCKGRD METER/RANGE/PPM	.8/ 1/ .20	.7/ 1/ .17	.9/ 1/ .22
CH4 SAMPLE PPM (1.190)	11.94	2.84	3.84
CH4 BCKGRD PPM	2.71	2.67	2.50
DILUTION FACTOR	16.85	21.92	19.00
HC CONCENTRATION PPM	104.18	.08	1.88
CO CONCENTRATION PPM	320.41	.30	1.68
CO2 CONCENTRATION PCT	.6494	.5168	.6030
NOX CONCENTRATION PPM	11.23	3.73	12.06
CH4 CONCENTRATION PPM	9.39	.29	1.47
NMHC CONCENTRATION PPM	-.38	-.28	-.09
THC MASS GRAMS	16.726	.052	.167
CO MASS GRAMS	49.631	.079	.260
CO2 MASS GRAMS	1582.05	2161.24	1469.01
NOX MASS GRAMS	2.798	1.595	3.003
CH4 MASS GRAMS	.833	.045	.131
NMHC MASS GRAMS (FID)	.000	.000	.000
FUEL MASS KG	.886	1.131	.769
FUEL ECONOMY MPG (L/100KM)	12.12 (19.41)	10.15 (23.18)	13.94 (16.87)

3-BAG COMPOSITE RESULTS

THC	G/MI	.976	CH4	G/MI	.063
CO	G/MI	2.869	NMHC	G/MI	.000
NOX	G/MI	.600	CARBONYL	G/MI	.059
			ALCOHOL	G/MI	.854

FUEL ECONOMY MPG (L/100KM) 11.40 (20.64)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601	TEST C-ETH-1.0-E1		ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA	DATE 6/28/94 RUN 2		FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6	DYNO 2 BAG CART 2		H .131 C .521 O .347 X .000
TRANSMISSION M5	ACTUAL ROAD LOAD 4.50 HP (3.36 KW)		TEMP. FUEL FRACTIONS
ODOMETER 14940 MILES (24038 KM)	TEST WEIGHT 3500 LBS (1587 KG)		

BAROMETER 29.18 IN HG (741.2 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .971

RELATIVE HUMIDITY 57.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.7	867.4	505.7
DRY/WET CORRECTION FACTOR, SAMP/BACK	.975/.984	.977/.984	.976/.984
MEASURED DISTANCE MILES (KM)	3.61 (5.81)	3.91 (6.29)	3.61 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	556.7 (15.77)	558.7 (15.82)	558.1 (15.81)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4694. (132.9)	8082. (228.9)	4706. (133.3)
HC SAMPLE METER/RANGE/PPM (BAG)	22.1/ 3/ 220.51	76.3/ 2/ 76.26	88.0/ 2/ 87.95
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	7.1/ 2/ 7.10	7.1/ 2/ 7.10
CO SAMPLE METER/RANGE/PPM	66.7/ 1/ 631.54	84.7/ 13/ 205.76	57.3/ 14/ 259.94
CO BCKGRD METER/RANGE/PPM	.0/ 1/ .00	.5/ 13/ 1.09	.3/ 14/ 1.21
CO2 SAMPLE METER/RANGE/PCT	78.8/ 14/ .6376	68.6/ 14/ .4801	75.3/ 14/ .5790
CO2 BCKGRD METER/RANGE/PCT	12.9/ 14/ .0434	13.2/ 14/ .0446	13.4/ 14/ .0454
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	48.9/ 1/ 12.22	17.2/ 1/ 4.30	55.8/ 1/ 13.95
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .17	.7/ 1/ .17	.5/ 1/ .12
CH4 SAMPLE PPM (1.140)	16.28	7.02	7.36
CH4 BCKGRD PPM	3.04	3.00	2.94
DILUTION FACTOR	17.24	24.31	20.14
HC CONCENTRATION PPM	212.99	69.45	81.21
CO CONCENTRATION PPM	609.84	198.48	250.26
CO2 CONCENTRATION PCT	.5967	.4373	.5359
NOX CONCENTRATION PPM	12.06	4.13	13.83
CH4 CONCENTRATION PPM	13.41	4.14	4.56
NMHC CONCENTRATION PPM	4.64	13.31	10.72
THC MASS GRAMS	35.182	19.184	13.392
CO MASS GRAMS	94.384	52.884	38.831
CO2 MASS GRAMS	1452.27	1832.53	1307.65
NOX MASS GRAMS	2.977	1.756	3.423
CH4 MASS GRAMS	1.189	.632	.405
NMHC MASS GRAMS (FID)	.356	1.756	.824
FUEL MASS KG	.873	1.022	.730
FUEL ECONOMY MPG (L/100KM)	12.21 (19.26)	11.30 (20.81)	14.63 (16.08)

3-BAG COMPOSITE RESULTS

THC	G/MI	5.577	CH4	G/MI	.183
CO	G/MI	15.370	NMHC	G/MI	.316
NOX	G/MI	.663	CARBONYL	G/MI	.657
			ALCOHOL	G/MI	4.421

FUEL ECONOMY MPG (L/100KM) 12.28 (19.16)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-ETH-1.0-E2 | ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 6/29/94 RUN | FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .131 C .521 O .347 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW) | TEMP. FUEL FRACTIONS
ODOMETER 14951 MILES (24056 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.26 IN HG (743.2 MM HG) DRY BULB TEMPERATURE 73.0°F (22.8°C) NOX HUMIDITY C.F. .984
RELATIVE HUMIDITY 57.6 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.0	867.2	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.984	.976/.984	.975/.984
MEASURED DISTANCE MILES (KM)	3.61 (5.80)	3.83 (6.17)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	558.9 (15.83)	560.0 (15.86)	559.2 (15.84)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4706. (133.3)	8098. (229.3)	4711. (133.4)
HC SAMPLE METER/RANGE/PPM (BAG)	19.8/ 3/ 197.56	68.1/ 2/ 68.06	75.3/ 2/ 75.26
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	8.9/ 2/ 8.89	9.1/ 2/ 9.09
CO SAMPLE METER/RANGE/PPM	64.4/ 1/ 604.73	91.0/ 13/ 223.24	58.4/ 14/ 265.78
CO BCKGRD METER/RANGE/PPM	.3/ 1/ 2.30	.7/ 13/ 1.52	.4/ 14/ 1.62
CO2 SAMPLE METER/RANGE/PCT	81.1/ 14/ .6790	71.0/ 14/ .5137	75.9/ 14/ .5887
CO2 BCKGRD METER/RANGE/PCT	12.8/ 14/ .0430	13.2/ 14/ .0446	13.3/ 14/ .0450
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	68.6/ 1/ 17.15	21.6/ 1/ 5.40	62.3/ 1/ 15.57
NOX BCKGRD METER/RANGE/PPM	.8/ 1/ .20	1.5/ 1/ .37	2.2/ 1/ .55
CH4 SAMPLE PPM (1.140)	15.16	7.06	7.27
CH4 BCKGRD PPM	3.42	3.28	3.25
DILUTION FACTOR	16.38	22.75	19.84
HC CONCENTRATION PPM	190.06	59.56	66.62
CO CONCENTRATION PPM	581.12	214.80	255.42
CO2 CONCENTRATION PCT	.6386	.4711	.5460
NOX CONCENTRATION PPM	16.96	5.04	15.05
CH4 CONCENTRATION PPM	11.96	3.92	4.19
NMHC CONCENTRATION PPM	10.50	13.31	2.40
THC MASS GRAMS	31.309	16.507	11.563
CO MASS GRAMS	90.167	57.350	39.669
CO2 MASS GRAMS	1558.36	1978.06	1333.51
NOX MASS GRAMS	4.253	2.175	3.778
CH4 MASS GRAMS	1.063	.599	.373
NMHC MASS GRAMS (FID)	.807	1.761	.185
FUEL MASS KG	.921	1.099	.742
FUEL ECONOMY MPG (L/100KM)	11.57 (20.34)	10.30 (22.83)	14.36 (16.38)

3-BAG COMPOSITE RESULTS

THC	G/MI	4.914	CH4	G/MI	.170
CO	G/MI	15.960	NMHC	G/MI	.297
NOX	G/MI	.828	CARBONYL	G/MI	.646
			ALCOHOL	G/MI	3.801

FUEL ECONOMY MPG (L/100KM) 11.48 (20.48)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.2-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601	TEST C-ETH-1.0-C2		ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA	DATE 6/24/94 RUN 2		FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6	DYNO 2 BAG CART 2		H .131 C .521 O .347 X .000
TRANSMISSION M5	ACTUAL ROAD LOAD 4.50 HP (3.36 KW)		TEMP. FUEL FRACTIONS
ODOMETER 14903 MILES (23978 KM)	TEST WEIGHT 3500 LBS (1587 KG)		

BAROMETER 29.06 IN HG (738.1 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .960

RELATIVE HUMIDITY 56.5 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	504.3	867.3	505.6
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.985	.976/.985	.975/.985
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.89 (6.26)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	557.8 (15.80)	556.1 (15.75)	554.0 (15.69)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4691. (132.8)	8042. (227.8)	4671. (132.3)
HC SAMPLE METER/RANGE/PPM (BAG)	9.9/ 3/ 98.78	8.5/ 2/ 8.50	10.1/ 2/ 10.09
HC BCKGRD METER/RANGE/PPM	1.1/ 3/ 10.98	8.0/ 2/ 8.00	7.2/ 2/ 7.20
CO SAMPLE METER/RANGE/PPM	74.7/ 14/ 356.19	2.4/ 12/ 2.28	26.0/ 12/ 25.15
CO BCKGRD METER/RANGE/PPM	.6/ 14/ 2.43	2.4/ 12/ 2.28	2.0/ 12/ 1.90
CO2 SAMPLE METER/RANGE/PCT	83.7/ 14/ .7291	74.8/ 14/ .5711	79.9/ 14/ .6571
CO2 BCKGRD METER/RANGE/PCT	14.4/ 14/ .0494	14.8/ 14/ .0510	15.3/ 14/ .0531
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	52.6/ 1/ 13.15	14.1/ 1/ 3.52	42.0/ 1/ 10.50
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .17	.6/ 1/ .15	1.3/ 1/ .32
CH4 SAMPLE PPM (1.140)	13.59	4.27	6.44
CH4 BCKGRD PPM	4.13	4.13	3.94
DILUTION FACTOR	15.96	21.49	18.61
HC CONCENTRATION PPM	88.49	.87	3.28
CO CONCENTRATION PPM	340.97	.07	22.51
CO2 CONCENTRATION PCT	.6828	.5224	.6068
NOX CONCENTRATION PPM	12.98	3.38	10.19
CH4 CONCENTRATION PPM	9.72	.33	2.70
NMHC CONCENTRATION PPM	.29	.50	.20
THC MASS GRAMS	14.217	.120	.256
CO MASS GRAMS	52.730	.019	3.467
CO2 MASS GRAMS	1660.55	2178.35	1469.66
NOX MASS GRAMS	3.165	1.413	2.473
CH4 MASS GRAMS	.861	.050	.238
NMHC MASS GRAMS (FID)	.022	.065	.016
FUEL MASS KG	.927	1.140	.772
FUEL ECONOMY MPG (L/100KM)	11.54 (20.39)	10.08 (23.35)	13.82 (17.02)

3-BAG COMPOSITE RESULTS

THC	G/MI	.850	CH4	G/MI	.074
CO	G/MI	3.286	NMHC	G/MI	.011
NOX	G/MI	.557	CARBONYL	G/MI	.062
			ALCOHOL	G/MI	.703

FUEL ECONOMY MPG (L/100KM) 11.22 (20.97)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-ETH-1.0-C3 | ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 6/27/94 RUN 2 | FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .131 C .521 O .347 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW) | TEMP. FUEL FRACTIONS
ODOMETER 14921 MILES (24007 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.18 IN HG (741.2 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .971
RELATIVE HUMIDITY 57.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.0	867.1	506.1
DRY/WET CORRECTION FACTOR, SAMP/BACK	.974/.984	.976/.984	.975/.984
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.87 (6.23)	3.63 (5.84)
BLOWER FLOW RATE SCFM (SCMM)	557.7 (15.79)	558.5 (15.82)	558.2 (15.81)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4705. (133.3)	8076. (228.7)	4711. (133.4)
HC SAMPLE METER/RANGE/PPM (BAG)	12.2/ 3/ 121.73	61.6/ 1/ 6.18	74.3/ 1/ 7.45
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	60.6/ 1/ 6.08	55.9/ 1/ 5.61
CO SAMPLE METER/RANGE/PPM	86.0/ 14/ 421.87	1.0/ 12/ .95	10.3/ 12/ 9.87
CO BCKGRD METER/RANGE/PPM	.4/ 14/ 1.62	.8/ 12/ .76	.8/ 12/ .76
CO2 SAMPLE METER/RANGE/PCT	82.0/ 14/ .6960	72.6/ 14/ .5372	78.1/ 14/ .6254
CO2 BCKGRD METER/RANGE/PCT	13.7/ 14/ .0466	13.9/ 14/ .0474	14.0/ 14/ .0478
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	43.2/ 1/ 10.80	13.5/ 1/ 3.37	45.2/ 1/ 11.30
NOX BCKGRD METER/RANGE/PPM	.8/ 1/ .20	.6/ 1/ .15	.9/ 1/ .22
CH4 SAMPLE PPM (1.140)	16.56	3.12	4.45
CH4 BCKGRD PPM	3.01	2.90	2.85
DILUTION FACTOR	16.50	22.86	19.60
HC CONCENTRATION PPM	113.29	.37	2.13
CO CONCENTRATION PPM	405.27	.21	8.83
CO2 CONCENTRATION PCT	.6522	.4919	.5801
NOX CONCENTRATION PPM	10.61	3.23	11.08
CH4 CONCENTRATION PPM	13.72	.34	1.74
NMHC CONCENTRATION PPM	.02	-.01	.17
THC MASS GRAMS	18.265	.067	.176
CO MASS GRAMS	62.871	.055	1.371
CO2 MASS GRAMS	1591.16	2059.77	1416.85
NOX MASS GRAMS	2.626	1.372	2.746
CH4 MASS GRAMS	1.219	.052	.155
NMHC MASS GRAMS (FID)	.002	.000	.013
FUEL MASS KG	.903	1.078	.743
FUEL ECONOMY MPG (L/100KM)	11.84 (19.87)	10.61 (22.17)	14.43 (16.30)

3-BAG COMPOSITE RESULTS

THC	G/MI	1.071	CH4	G/MI	.089
CO	G/MI	3.720	NMHC	G/MI	.001
NOX	G/MI	.542	CARBONYL	G/MI	.087
			ALCOHOL	G/MI	.894

FUEL ECONOMY MPG (L/100KM) 11.74 (20.04)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-ETH-1.2-E1 | ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/22/94 RUN | FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .131 C .521 O .347 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15441 MILES (24844 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.16 IN HG (740.7 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .993
RELATIVE HUMIDITY 61.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.1	867.4	504.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.973/.983	.975/.983	.974/.983
MEASURED DISTANCE MILES (KM)	3.60 (5.80)	3.86 (6.21)	3.61 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	554.6 (15.71)	557.6 (15.79)	556.3 (15.76)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4671. (132.3)	8065. (228.4)	4679. (132.5)
HC SAMPLE METER/RANGE/PPM (BAG)	23.3/ 3/ 232.48	78.8/ 2/ 78.75	11.6/ 3/ 115.74
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	6.4/ 2/ 6.40	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	63.1/ 1/ 589.78	79.9/ 14/ 386.24	79.8/ 14/ 385.65
CO BCKGRD METER/RANGE/PPM	.0/ 1/ .00	.5/ 14/ 2.02	.4/ 14/ 1.62
CO2 SAMPLE METER/RANGE/PCT	82.7/ 14/ .7094	71.5/ 14/ .5210	76.3/ 14/ .5952
CO2 BCKGRD METER/RANGE/PCT	13.6/ 14/ .0462	13.6/ 14/ .0462	13.3/ 14/ .0450
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	82.0/ 1/ 20.49	28.7/ 1/ 7.17	45.2/ 1/ 11.30
NOX BCKGRD METER/RANGE/PPM	.1/ 1/ .02	.0/ 1/ .00	.0/ 1/ .00
CH4 SAMPLE PPM (1.150)	13.43	7.90	9.48
CH4 BCKGRD PPM	2.86	2.75	2.52
DILUTION FACTOR	15.73	21.80	19.19
HC CONCENTRATION PPM	224.07	72.65	108.18
CO CONCENTRATION PPM	567.71	371.71	370.82
CO2 CONCENTRATION PCT	.6662	.4769	.5526
NOX CONCENTRATION PPM	20.47	7.17	11.30
CH4 CONCENTRATION PPM	10.76	5.28	7.09
NMHC CONCENTRATION PPM	1.96	10.23	15.56
THC MASS GRAMS	37.219	19.942	17.243
CO MASS GRAMS	87.429	98.845	57.207
CO2 MASS GRAMS	1613.39	1994.37	1340.63
NOX MASS GRAMS	5.143	3.112	2.843
CH4 MASS GRAMS	.949	.803	.627
NMHC MASS GRAMS (FID)	.150	1.347	1.189
FUEL MASS KG	.954	1.145	.766
FUEL ECONOMY MPG (L/100KM)	11.16 (21.08)	9.96 (23.63)	13.94 (16.87)

3-BAG COMPOSITE RESULTS

THC	G/MI	6.130	CH4	G/MI	.210
CO	G/MI	22.636	NMHC	G/MI	.280
NOX	G/MI	.930	CARBONYL	G/MI	.639
			ALCOHOL	G/MI	5.001

FUEL ECONOMY MPG (L/100KM) 11.10 (21.19)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-ETH-1.2-E2 | ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/23/94 RUN | FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .131 C .521 O .347 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15454 MILES (24865 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.24 IN HG (742.7 MM HG) DRY BULB TEMPERATURE 68.0°F (20.0°C) NOX HUMIDITY C.F. .875
RELATIVE HUMIDITY 42.7 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.4	867.0	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.979/.990	.982/.990	.981/.990
MEASURED DISTANCE MILES (KM)	3.60 (5.79)	3.88 (6.24)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	557.5 (15.79)	559.5 (15.85)	558.5 (15.82)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4698. (133.0)	8089. (229.1)	4705. (133.2)
HC SAMPLE METER/RANGE/PPM (BAG)	23.1/ 3/ 230.49	71.9/ 2/ 71.86	9.8/ 3/ 97.78
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	6.4/ 2/ 6.40	.7/ 3/ 6.98
CO SAMPLE METER/RANGE/PPM	59.3/ 1/ 546.84	71.6/ 14/ 338.51	74.3/ 14/ 353.90
CO BCKGRD METER/RANGE/PPM	.2/ 1/ 1.53	.8/ 14/ 3.23	.6/ 14/ 2.43
CO2 SAMPLE METER/RANGE/PCT	82.9/ 14/ .7133	72.0/ 14/ .5283	75.7/ 14/ .5855
CO2 BCKGRD METER/RANGE/PCT	13.5/ 14/ .0458	13.6/ 14/ .0462	12.7/ 14/ .0426
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	24.4/ 2/ 24.41	40.9/ 1/ 10.22	51.8/ 1/ 12.95
NOX BCKGRD METER/RANGE/PPM	.1/ 2/ .10	.8/ 1/ .20	.9/ 1/ .22
CH4 SAMPLE PPM (1.150)	13.54	6.81	7.65
CH4 BCKGRD PPM	2.46	2.59	2.22
DILUTION FACTOR	15.73	21.70	19.61
HC CONCENTRATION PPM	223.01	65.76	91.15
CO CONCENTRATION PPM	528.13	326.33	341.57
CO2 CONCENTRATION PCT	.6704	.4843	.5450
NOX CONCENTRATION PPM	24.32	10.03	12.73
CH4 CONCENTRATION PPM	11.23	4.34	5.54
NMHC CONCENTRATION PPM	12.10	13.97	14.17
THC MASS GRAMS	36.424	17.689	14.816
CO MASS GRAMS	81.803	87.028	52.981
CO2 MASS GRAMS	1633.09	2031.00	1329.44
NOX MASS GRAMS	5.412	3.844	2.838
CH4 MASS GRAMS	.996	.662	.492
NMHC MASS GRAMS (FID)	.928	1.845	1.089
FUEL MASS KG	.959	1.152	.754
FUEL ECONOMY MPG (L/100KM)	11.09 (21.21)	9.94 (23.66)	14.15 (16.63)

3-BAG COMPOSITE RESULTS

THC	G/MI	5.586	CH4	G/MI	.183
CO	G/MI	20.365	NMHC	G/MI	.383
NOX	G/MI	1.041	CARBONYL	G/MI	.633
			ALCOHOL	G/MI	4.387

FUEL ECONOMY MPG (L/100KM) 11.12 (21.16)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 TEST C-ETH-1.2-C1 ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA DATE 9/26/94 RUN FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 DYNO 2 BAG CART 2 H .131 C .521 O .347 X .000
TRANSMISSION M5 ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15473 MILES (24896 KM) TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.22 IN HG (742.2 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .903
RELATIVE HUMIDITY 45.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.8	867.2	505.0
DRY/WET CORRECTION FACTOR, SAMP/BACK	.976/.988	.979/.988	.978/.988
MEASURED DISTANCE MILES (KM)	3.59 (5.78)	3.88 (6.24)	3.56 (5.74)
BLOWER FLOW RATE SCFM (SCMM)	562.2 (15.92)	562.5 (15.93)	561.5 (15.90)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4742. (134.3)	8133. (230.3)	4728. (133.9)
HC SAMPLE METER/RANGE/PPM (BAG)	11.4/ 3/ 113.75	7.8/ 2/ 7.80	27.4/ 2/ 27.38
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	6.8/ 2/ 6.80	6.6/ 2/ 6.60
CO SAMPLE METER/RANGE/PPM	27.6/ 1/ 229.01	11.5/ 12/ 11.32	48.9/ 13/ 113.50
CO BCKGRD METER/RANGE/PPM	.0/ 1/ .00	2.2/ 12/ 2.18	1.6/ 13/ 3.68
CO2 SAMPLE METER/RANGE/PCT	87.1/ 14/ .8004	76.4/ 14/ .5969	81.5/ 14/ .6865
CO2 BCKGRD METER/RANGE/PCT	14.5/ 14/ .0498	14.7/ 14/ .0506	14.2/ 14/ .0486
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	49.6/ 1/ 12.40	11.1/ 1/ 2.77	24.9/ 1/ 6.22
NOX BCKGRD METER/RANGE/PPM	.5/ 1/ .12	.3/ 1/ .07	.2/ 1/ .05
CH4 SAMPLE PPM (1.150)	13.71	4.35	6.80
CH4 BCKGRD PPM	3.75	3.53	2.95
DILUTION FACTOR	14.81	20.53	17.56
HC CONCENTRATION PPM	106.30	1.33	21.16
CO CONCENTRATION PPM	221.10	8.93	106.49
CO2 CONCENTRATION PCT	.7539	.5487	.6407
NOX CONCENTRATION PPM	12.28	2.70	6.18
CH4 CONCENTRATION PPM	10.22	.99	4.02
NMHC CONCENTRATION PPM	1.98	.26	12.24
THC MASS GRAMS	16.916	.189	2.601
CO MASS GRAMS	34.565	2.396	16.601
CO2 MASS GRAMS	1853.48	2313.95	1570.66
NOX MASS GRAMS	2.848	1.075	1.428
CH4 MASS GRAMS	.915	.152	.359
NMHC MASS GRAMS (FID)	.153	.035	.945
FUEL MASS KG	1.016	1.213	.838
FUEL ECONOMY MPG (L/100KM)	10.44 (22.53)	9.45 (24.89)	12.56 (18.73)

3-BAG COMPOSITE RESULTS

THC	G/MI	1.198	CH4	G/MI	.101
CO	G/MI	3.582	NMHC	G/MI	.086
NOX	G/MI	.417	CARBONYL	G/MI	.102
			ALCOHOL	G/MI	.910

FUEL ECONOMY MPG (L/100KM) 10.37 (22.69)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-ETH-1.2-C2 | ETHANOL E100 EM-1803-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/27/94 RUN | FUEL DENSITY 6.514 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .131 C .521 O .347 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15484 MILES (24913 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.16 IN HG (740.7 MM HG) DRY BULB TEMPERATURE 73.0°F (22.8°C) NOX HUMIDITY C.F. .925
RELATIVE HUMIDITY 46.5 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.3	867.3	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.976/.987	.978/.987	.977/.987
MEASURED DISTANCE MILES (KM)	3.59 (5.78)	3.88 (6.24)	3.63 (5.83)
BLOWER FLOW RATE SCFM (SCMM)	562.8 (15.94)	566.2 (16.03)	563.1 (15.95)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4742. (134.3)	8188. (231.9)	4744. (134.3)
HC SAMPLE METER/RANGE/PPM (BAG)	15.9/ 3/ 158.65	8.2/ 2/ 8.20	19.4/ 2/ 19.39
HC BCKGRD METER/RANGE/PPM	1.0/ 3/ 9.98	6.7/ 2/ 6.70	6.2/ 2/ 6.20
CO SAMPLE METER/RANGE/PPM	53.0/ 1/ 478.11	21.5/ 12/ 21.04	95.5/ 12/ 95.82
CO BCKGRD METER/RANGE/PPM	.2/ 1/ 1.53	1.5/ 12/ 1.49	1.7/ 12/ 1.69
CO2 SAMPLE METER/RANGE/PCT	84.5/ 14/ .7452	75.5/ 14/ .5822	80.8/ 14/ .6735
CO2 BCKGRD METER/RANGE/PCT	13.6/ 14/ .0462	12.9/ 14/ .0434	13.1/ 14/ .0442
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	34.9/ 1/ 8.72	8.8/ 1/ 2.20	32.8/ 1/ 8.20
NOX BCKGRD METER/RANGE/PPM	.6/ 1/ .15	.4/ 1/ .10	.5/ 1/ .12
CH4 SAMPLE PPM (1.150)	23.09	4.19	11.47
CH4 BCKGRD PPM	3.83	2.76	2.53
DILUTION FACTOR	15.32	21.01	17.96
HC CONCENTRATION PPM	149.32	1.82	13.54
CO CONCENTRATION PPM	460.62	19.02	91.20
CO2 CONCENTRATION PCT	.7021	.5409	.6317
NOX CONCENTRATION PPM	8.58	2.10	8.08
CH4 CONCENTRATION PPM	19.51	1.56	9.08
NMHC CONCENTRATION PPM	11.49	.03	2.59
THC MASS GRAMS	22.312	.251	1.126
CO MASS GRAMS	72.016	5.134	14.262
CO2 MASS GRAMS	1726.22	2296.35	1553.77
NOX MASS GRAMS	2.040	.863	1.921
CH4 MASS GRAMS	1.747	.241	.813
NMHC MASS GRAMS (FID)	.890	.004	.201
FUEL MASS KG	.985	1.207	.826
FUEL ECONOMY MPG (L/100KM)	10.77 (21.85)	9.50 (24.77)	12.97 (18.14)

3-BAG COMPOSITE RESULTS

THC	G/MI	1.404	CH4	G/MI	.195
CO	G/MI	5.915	NMHC	G/MI	.067
NOX	G/MI	.379	CARBONYL	G/MI	.067
			ALCOHOL	G/MI	1.075

FUEL ECONOMY MPG (L/100KM) 10.55 (22.30)

APPENDIX G

COMPUTER PRINTOUTS OF EMISSIONS DATA WITH METHANOL

Page G-	Test Number	Operating Condition	Catalyst Installation
1	L-MTH-0.8-E1	Lean	Without Catalyst
2	L-MTH-0.8-E3	Lean	Without Catalyst
3	L-MTH-0.8-C1	Lean	With Catalyst
4	L-MTH-0.8-C2	Lean	With Catalyst
5	L-MTH-1.0-E1	Stoich	Without Catalyst
6	L-MTH-1.0-E2	Stoich	Without Catalyst
7	L-MTH-1.0-C2	Stoich	With Catalyst
8	L-MTH-1.0-C2	Stoich	With Catalyst
9	L-MTH-1.2-E1	Rich	Without Catalyst
10	L-MTH-1.2-E2	Rich	Without Catalyst
11	L-MTH-1.2-C2	Rich	With Catalyst
12	L-MTH-1.2-C3	Rich	With Catalyst

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-0.8-E1 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/ 2/94 RUN 1 | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15233 MILES (24509 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.35 IN HG (745.5 MM HG) DRY BULB TEMPERATURE 75.0°F (23.9°C) NOX HUMIDITY C.F. 1.013
RELATIVE HUMIDITY 58.6 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.6	866.6	504.6
DRY/WET CORRECTION FACTOR, SAMP/BACK	.970/.982	.973/.982	.972/.982
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.88 (6.25)	3.58 (5.76)
BLOWER FLOW RATE SCFM (SCMM)	563.0 (15.94)	564.1 (15.97)	562.3 (15.93)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4747. (134.4)	8151. (230.8)	4732. (134.0)
HC SAMPLE METER/RANGE/PPM (BAG)	12.1/ 3/ 120.73	11.2/ 3/ 111.75	9.9/ 3/ 98.78
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	.9/ 3/ 8.98	.9/ 3/ 8.98
CO SAMPLE METER/RANGE/PPM	74.4/ 14/ 354.47	58.1/ 13/ 136.45	67.2/ 13/ 159.81
CO BCKGRD METER/RANGE/PPM	.4/ 14/ 1.62	.7/ 13/ 1.61	.7/ 13/ 1.61
CO2 SAMPLE METER/RANGE/PCT	77.5/ 14/ .6152	67.2/ 14/ .4613	73.2/ 14/ .5463
CO2 BCKGRD METER/RANGE/PCT	13.2/ 14/ .0446	13.5/ 14/ .0458	14.0/ 14/ .0478
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	40.6/ 1/ 10.15	14.3/ 1/ 3.57	38.4/ 1/ 9.60
NOX BCKGRD METER/RANGE/PPM	1.0/ 1/ .25	.5/ 1/ .12	.6/ 1/ .15
CH4 SAMPLE PPM (1.150)	4.66	4.00	3.94
CH4 BCKGRD PPM	3.65	3.72	3.67
DILUTION FACTOR	17.66	24.13	20.50
HC CONCENTRATION PPM	113.20	103.14	90.24
CO CONCENTRATION PPM	339.83	130.49	152.71
CO2 CONCENTRATION PCT	.5731	.4174	.5008
NOX CONCENTRATION PPM	9.91	3.45	9.45
CH4 CONCENTRATION PPM	1.22	.44	.45
NMHC CONCENTRATION PPM	-80.01	22.55	-7.27
THC MASS GRAMS	45.540	37.723	23.717
CO MASS GRAMS	53.182	35.067	23.822
CO2 MASS GRAMS	1410.59	1764.15	1228.66
NOX MASS GRAMS	2.581	1.545	2.454
CH4 MASS GRAMS	.109	.067	.040
NMHC MASS GRAMS (FID)	.000	3.002	.000
FUEL MASS KG	1.133	1.362	.945
FUEL ECONOMY MPG (L/100KM)	9.57 (24.57)	8.54 (27.53)	11.36 (20.72)

3-BAG COMPOSITE RESULTS

THC	G/MI	9.467	CH4	G/MI	.018
CO	G/MI	9.558	NMHC	G/MI	.401
NOX	G/MI	.542	CARBONYL	G/MI	.813
			ALCOHOL	G/MI	8.234

FUEL ECONOMY MPG (L/100KM) 9.40 (25.02)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-0.8-E3 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/ 7/94 RUN 1 | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15267 MILES (24564 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.29 IN HG (744.0 MM HG) DRY BULB TEMPERATURE 73.0°F (22.8°C) NOX HUMIDITY C.F. 1.006
RELATIVE HUMIDITY 61.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	504.7	867.1	505.1
DRY/WET CORRECTION FACTOR, SAMP/BACK	.971/.983	.974/.983	.972/.983
MEASURED DISTANCE MILES (KM)	3.61 (5.80)	3.86 (6.22)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	565.5 (16.02)	564.6 (15.99)	565.1 (16.00)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.29 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4759. (134.8)	8163. (231.2)	4760. (134.8)
HC SAMPLE METER/RANGE/PPM (BAG)	14.5/ 3/ 144.68	10.6/ 3/ 105.76	9.9/ 3/ 98.78
HC BCKGRD METER/RANGE/PPM	1.0/ 3/ 9.98	.9/ 3/ 8.98	.9/ 3/ 8.98
CO SAMPLE METER/RANGE/PPM	75.6/ 14/ 361.36	52.5/ 13/ 122.40	64.3/ 13/ 152.30
CO BCKGRD METER/RANGE/PPM	.9/ 14/ 3.64	1.2/ 13/ 2.76	1.2/ 13/ 2.76
CO2 SAMPLE METER/RANGE/PCT	77.0/ 14/ .6068	66.7/ 14/ .4548	72.4/ 14/ .5342
CO2 BCKGRD METER/RANGE/PCT	13.7/ 14/ .0466	13.8/ 14/ .0470	14.0/ 14/ .0478
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	39.6/ 1/ 9.90	14.1/ 1/ 3.52	43.8/ 1/ 10.95
NOX BCKGRD METER/RANGE/PPM	.3/ 1/ .07	.4/ 1/ .10	.3/ 1/ .07
CH4 SAMPLE PPM (1.150)	5.87	5.02	5.05
CH4 BCKGRD PPM	5.09	4.82	4.80
DILUTION FACTOR	17.85	24.56	20.98
HC CONCENTRATION PPM	135.26	97.15	90.23
CO CONCENTRATION PPM	344.35	115.73	144.30
CO2 CONCENTRATION PCT	.5628	.4097	.4887
NOX CONCENTRATION PPM	9.83	3.43	10.88
CH4 CONCENTRATION PPM	1.07	.40	.48
NMHC CONCENTRATION PPM	1.36	14.01	1.66
THC MASS GRAMS	32.270	36.853	21.643
CO MASS GRAMS	54.033	31.147	22.644
CO2 MASS GRAMS	1388.89	1733.98	1206.12
NOX MASS GRAMS	2.549	1.525	2.821
CH4 MASS GRAMS	.096	.061	.043
NMHC MASS GRAMS (FID)	.105	1.867	.129
FUEL MASS KG	1.105	1.335	.926
FUEL ECONOMY MPG (L/100KM)	9.79 (24.04)	8.68 (27.10)	11.70 (20.10)

3-BAG COMPOSITE RESULTS

THC	G/MI	8.438	CH4	G/MI	.017
CO	G/MI	9.004	NMHC	G/MI	.266
NOX	G/MI	.566	CARBONYL	G/MI	.674
			ALCOHOL	G/MI	7.481

FUEL ECONOMY MPG (L/100KM) 9.60 (24.50)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-0.8-C1 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/ 8/94 RUN 1 | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15288 MILES (24598 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.28 IN HG (743.7 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .991
RELATIVE HUMIDITY 60.9 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.8	866.7	505.5
DRY/WET CORRECTION FACTOR, SAMP/BACK	.971/.983	.974/.983	.972/.983
MEASURED DISTANCE MILES (KM)	3.63 (5.84)	3.89 (6.27)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	564.3 (15.98)	566.3 (16.04)	563.5 (15.96)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4759. (134.8)	8184. (231.8)	4749. (134.5)
HC SAMPLE METER/RANGE/PPM (BAG)	48.7/ 2/ 48.67	7.5/ 2/ 7.50	71.7/ 1/ 7.19
HC BCKGRD METER/RANGE/PPM	8.0/ 2/ 8.00	7.9/ 2/ 7.90	72.4/ 1/ 7.26
CO SAMPLE METER/RANGE/PPM	77.8/ 13/ 187.74	1.8/ 12/ 1.79	12.4/ 12/ 12.19
CO BCKGRD METER/RANGE/PPM	.9/ 13/ 2.07	1.8/ 12/ 1.79	2.0/ 12/ 1.99
CO2 SAMPLE METER/RANGE/PCT	79.1/ 14/ .6428	70.3/ 14/ .5037	75.5/ 14/ .5822
CO2 BCKGRD METER/RANGE/PCT	13.8/ 14/ .0470	14.3/ 14/ .0490	14.4/ 14/ .0494
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	26.3/ 1/ 6.57	10.9/ 1/ 2.72	28.8/ 1/ 7.20
NOX BCKGRD METER/RANGE/PPM	.4/ 1/ .10	.3/ 1/ .07	.3/ 1/ .07
CH4 SAMPLE PPM (1.150)	5.12	4.04	4.15
CH4 BCKGRD PPM	4.37	4.24	4.13
DILUTION FACTOR	17.64	23.32	20.15
HC CONCENTRATION PPM	41.13	-.06	.29
CO CONCENTRATION PPM	178.57	.05	9.89
CO2 CONCENTRATION PCT	.5985	.4568	.5353
NOX CONCENTRATION PPM	6.48	2.65	7.13
CH4 CONCENTRATION PPM	1.00	-.01	.22
NMHC CONCENTRATION PPM	-8.09	-.09	.04
THC MASS GRAMS	11.247	.026	.025
CO MASS GRAMS	28.020	.013	1.549
CO2 MASS GRAMS	1476.94	1938.36	1318.15
NOX MASS GRAMS	1.656	1.166	1.817
CH4 MASS GRAMS	.090	.000	.020
NMHC MASS GRAMS (FID)	.000	.000	.003
FUEL MASS KG	1.119	1.411	.961
FUEL ECONOMY MPG (L/100KM)	9.73 (24.18)	8.27 (28.43)	11.27 (20.88)

3-BAG COMPOSITE RESULTS

THC	G/MI	.648	CH4	G/MI	.007
CO	G/MI	1.721	NMHC	G/MI	.000
NOX	G/MI	.388	CARBONYL	G/MI	.022
			ALCOHOL	G/MI	.619

FUEL ECONOMY MPG (L/100KM) 9.24 (25.46)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-0.8-C2 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/ 9/94 RUN 1 | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15299 MILES (24616 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.27 IN HG (743.5 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .999
RELATIVE HUMIDITY 64.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.2	867.5	506.0
DRY/WET CORRECTION FACTOR, SAMP/BACK	.970/.983	.973/.983	.972/.983
MEASURED DISTANCE MILES (KM)	3.59 (5.78)	3.85 (6.20)	3.60 (5.79)
BLOWER FLOW RATE SCFM (SCMM)	557.8 (15.80)	559.1 (15.83)	560.8 (15.88)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4699. (133.1)	8088. (229.1)	4732. (134.0)
HC SAMPLE METER/RANGE/PPM (BAG)	50.5/ 2/ 50.47	56.3/ 1/ 5.65	55.6/ 1/ 5.58
HC BCKGRD METER/RANGE/PPM	6.8/ 2/ 6.80	58.5/ 1/ 5.87	54.6/ 1/ 5.48
CO SAMPLE METER/RANGE/PPM	91.8/ 13/ 225.26	1.0/ 12/ .99	7.4/ 12/ 7.31
CO BCKGRD METER/RANGE/PPM	.9/ 13/ 2.07	1.0/ 12/ .99	.9/ 12/ .90
CO2 SAMPLE METER/RANGE/PCT	79.1/ 14/ .6428	69.9/ 14/ .4981	74.9/ 14/ .5727
CO2 BCKGRD METER/RANGE/PCT	13.0/ 14/ .0438	13.3/ 14/ .0450	13.0/ 14/ .0438
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	26.0/ 1/ 6.50	10.6/ 1/ 2.65	26.4/ 1/ 6.60
NOX BCKGRD METER/RANGE/PPM	.2/ 1/ .05	.1/ 1/ .02	.1/ 1/ .02
CH4 SAMPLE PPM (1.150)	3.50	2.86	2.75
CH4 BCKGRD PPM	2.71	2.94	2.62
DILUTION FACTOR	17.54	23.59	20.50
HC CONCENTRATION PPM	44.06	.03	.37
CO CONCENTRATION PPM	214.38	.03	6.20
CO2 CONCENTRATION PCT	.6015	.4550	.5310
NOX CONCENTRATION PPM	6.45	2.63	6.57
CH4 CONCENTRATION PPM	.94	.05	.26
NMHC CONCENTRATION PPM	-5.61	-.11	.07
THC MASS GRAMS	11.293	.044	.030
CO MASS GRAMS	33.216	.007	.967
CO2 MASS GRAMS	1465.70	1908.10	1302.79
NOX MASS GRAMS	1.641	1.149	1.684
CH4 MASS GRAMS	.083	.007	.023
NMHC MASS GRAMS (FID)	.000	.000	.005
FUEL MASS KG	1.116	1.389	.950
FUEL ECONOMY MPG (L/100KM)	9.64 (24.39)	8.31 (28.30)	11.37 (20.69)

3-BAG COMPOSITE RESULTS

THC	G/MI	.661	CH4	G/MI	.008
CO	G/MI	1.994	NMHC	G/MI	.000
NOX	G/MI	.378	CARBONYL	G/MI	.026
			ALCOHOL	G/MI	.626

FUEL ECONOMY MPG (L/100KM) 9.28 (25.36)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-1.0-E1 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 8/30/94 RUN | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15170 MILES (24408 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.20 IN HG (741.7 MM HG) DRY BULB TEMPERATURE 76.0°F (24.4°C) NOX HUMIDITY C.F. .984
RELATIVE HUMIDITY 52.0 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.3	867.3	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.972/.984	.975/.984	.973/.984
MEASURED DISTANCE MILES (KM)	3.62 (5.83)	3.83 (6.16)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	555.2 (15.72)	557.3 (15.78)	558.1 (15.81)
GAS METER FLOW RATE SCFM (SCMM)	.26 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4678. (132.5)	8059. (228.2)	4701. (133.1)
HC SAMPLE METER/RANGE/PPM (BAG)	12.0/ 3/ 119.73	57.6/ 2/ 57.57	77.9/ 2/ 77.85
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	7.9/ 2/ 7.90	7.6/ 2/ 7.60
CO SAMPLE METER/RANGE/PPM	96.0/ 14/ 480.25	93.7/ 13/ 230.35	59.6/ 14/ 272.20
CO BCKGRD METER/RANGE/PPM	.6/ 14/ 2.43	.7/ 13/ 1.61	.4/ 14/ 1.62
CO2 SAMPLE METER/RANGE/PCT	77.4/ 14/ .6135	66.0/ 14/ .4457	72.4/ 14/ .5342
CO2 BCKGRD METER/RANGE/PCT	15.2/ 14/ .0527	14.4/ 14/ .0494	14.9/ 14/ .0515
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	42.8/ 1/ 10.70	15.6/ 1/ 3.90	46.5/ 1/ 11.62
NOX BCKGRD METER/RANGE/PPM	.3/ 1/ .07	.2/ 1/ .05	.3/ 1/ .07
CH4 SAMPLE PPM (1.150)	5.49	4.47	4.57
CH4 BCKGRD PPM	3.71	3.82	3.90
DILUTION FACTOR	17.43	24.78	20.64
HC CONCENTRATION PPM	111.27	49.99	70.63
CO CONCENTRATION PPM	461.24	221.93	261.82
CO2 CONCENTRATION PCT	.5638	.3983	.4853
NOX CONCENTRATION PPM	10.63	3.85	11.55
CH4 CONCENTRATION PPM	1.99	.81	.86
NMHC CONCENTRATION PPM	-27.60	5.48	3.00
THC MASS GRAMS	32.507	19.092	16.274
CO MASS GRAMS	71.142	58.972	40.584
CO2 MASS GRAMS	1367.68	1664.37	1182.94
NOX MASS GRAMS	2.649	1.654	2.894
CH4 MASS GRAMS	.176	.123	.076
NMHC MASS GRAMS (FID)	.000	.721	.230
FUEL MASS KG	1.110	1.298	.924
FUEL ECONOMY MPG (L/100KM)	9.78 (24.04)	8.85 (26.59)	11.74 (20.04)

3-BAG COMPOSITE RESULTS

THC	G/MI	5.684	CH4	G/MI	.032
CO	G/MI	15.127	NMHC	G/MI	.114
NOX	G/MI	.596	CARBONYL	G/MI	.442
			ALCOHOL	G/MI	5.095

FUEL ECONOMY MPG (L/100KM) 9.72 (24.21)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-1.0-E2 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 8/31/94 RUN | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15184 MILES (24431 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.22 IN HG (742.2 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .992
RELATIVE HUMIDITY 60.9 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.1	867.5	505.1
DRY/WET CORRECTION FACTOR, SAMP/BACK	.972/.983	.975/.983	.973/.983
MEASURED DISTANCE MILES (KM)	3.62 (5.82)	3.88 (6.24)	3.58 (5.76)
BLOWER FLOW RATE SCFM (SCMM)	557.0 (15.77)	558.8 (15.83)	559.5 (15.84)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4691. (132.9)	8083. (228.9)	4712. (133.4)
HC SAMPLE METER/RANGE/PPM (BAG)	12.7/ 3/ 126.72	55.4/ 2/ 55.37	72.4/ 2/ 72.36
HC BCKGRD METER/RANGE/PPM	.9/ 3/ 8.98	8.1/ 2/ 8.10	7.4/ 2/ 7.40
CO SAMPLE METER/RANGE/PPM	90.5/ 14/ 448.23	46.2/ 14/ 203.02	52.9/ 14/ 236.93
CO BCKGRD METER/RANGE/PPM	.4/ 14/ 1.62	.3/ 14/ 1.21	.3/ 14/ 1.21
CO2 SAMPLE METER/RANGE/PCT	76.4/ 14/ .5969	65.3/ 14/ .4368	71.8/ 14/ .5254
CO2 BCKGRD METER/RANGE/PCT	12.8/ 14/ .0430	13.1/ 14/ .0442	13.8/ 14/ .0470
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	39.5/ 1/ 9.87	16.0/ 1/ 4.00	37.7/ 1/ 9.42
NOX BCKGRD METER/RANGE/PPM	.2/ 1/ .05	.2/ 1/ .05	.3/ 1/ .07
CH4 SAMPLE PPM (1.150)	4.79	4.01	4.06
CH4 BCKGRD PPM	3.45	3.46	3.38
DILUTION FACTOR	17.94	25.42	21.13
HC CONCENTRATION PPM	118.24	47.59	65.31
CO CONCENTRATION PPM	430.01	195.26	227.45
CO2 CONCENTRATION PCT	.5562	.3943	.4806
NOX CONCENTRATION PPM	9.82	3.95	9.35
CH4 CONCENTRATION PPM	1.53	.68	.84
NMHC CONCENTRATION PPM	-8.78	4.26	.43
THC MASS GRAMS	29.921	18.329	15.443
CO MASS GRAMS	66.511	52.038	35.336
CO2 MASS GRAMS	1353.06	1652.73	1174.18
NOX MASS GRAMS	2.477	1.716	2.368
CH4 MASS GRAMS	.136	.104	.075
NMHC MASS GRAMS (FID)	.000	.562	.033
FUEL MASS KG	1.091	1.281	.911
FUEL ECONOMY MPG (L/100KM)	9.94 (23.67)	9.07 (25.93)	11.79 (19.95)

3-BAG COMPOSITE RESULTS

THC	G/MI	5.351	CH4	G/MI	.027
CO	G/MI	13.482	NMHC	G/MI	.078
NOX	G/MI	.553	CARBONYL	G/MI	.397
			ALCOHOL	G/MI	4.848

FUEL ECONOMY MPG (L/100KM) 9.89 (23.79)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-1.0-C1 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 8/26/94 RUN | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15134 MILES (24350 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.30 IN HG (744.2 MM HG) DRY BULB TEMPERATURE 73.0°F (22.8°C) NOX HUMIDITY C.F. .983
RELATIVE HUMIDITY 57.5 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	504.9	867.0	505.7
DRY/WET CORRECTION FACTOR, SAMP/BACK	.971/.984	.975/.984	.973/.984
MEASURED DISTANCE MILES (KM)	3.61 (5.81)	3.85 (6.20)	3.60 (5.80)
BLOWER FLOW RATE SCFM (SCMM)	559.2 (15.84)	560.1 (15.86)	559.6 (15.85)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4708. (133.3)	8098. (229.3)	4719. (133.6)
HC SAMPLE METER/RANGE/PPM (BAG)	58.2/ 2/ 58.17	7.6/ 2/ 7.60	7.4/ 2/ 7.40
HC BCKGRD METER/RANGE/PPM	7.9/ 2/ 7.90	7.6/ 2/ 7.60	7.2/ 2/ 7.20
CO SAMPLE METER/RANGE/PPM	60.3/ 14/ 275.96	2.0/ 12/ 2.04	14.5/ 12/ 14.50
CO BCKGRD METER/RANGE/PPM	.4/ 14/ 1.62	1.1/ 12/ 1.12	.9/ 12/ .92
CO2 SAMPLE METER/RANGE/PCT	78.6/ 14/ .6341	68.0/ 14/ .4720	74.3/ 14/ .5632
CO2 BCKGRD METER/RANGE/PCT	13.4/ 14/ .0454	13.7/ 14/ .0466	13.8/ 14/ .0470
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	30.0/ 1/ 7.50	9.6/ 1/ 2.40	27.7/ 1/ 6.92
NOX BCKGRD METER/RANGE/PPM	.3/ 1/ .07	.3/ 1/ .07	.4/ 1/ .10
CH4 SAMPLE PPM (1.150)	5.20	3.97	3.97
CH4 BCKGRD PPM	4.01	3.96	3.66
DILUTION FACTOR	17.62	24.88	20.81
HC CONCENTRATION PPM	50.72	.31	.55
CO CONCENTRATION PPM	264.16	.91	13.13
CO2 CONCENTRATION PCT	.5913	.4273	.5185
NOX CONCENTRATION PPM	7.43	2.33	6.83
CH4 CONCENTRATION PPM	1.42	.17	.48
NMHC CONCENTRATION PPM	-7.56	.01	-.03
THC MASS GRAMS	13.152	.078	.051
CO MASS GRAMS	41.005	.244	2.043
CO2 MASS GRAMS	1443.38	1793.94	1268.59
NOX MASS GRAMS	1.862	1.004	1.716
CH4 MASS GRAMS	.126	.026	.043
NMHC MASS GRAMS (FID)	.000	.001	.000
FUEL MASS KG	1.111	1.306	.926
FUEL ECONOMY MPG (L/100KM)	9.74 (24.14)	8.84 (26.61)	11.67 (20.15)

3-BAG COMPOSITE RESULTS

THC	G/MI	.772	CH4	G/MI	.014
CO	G/MI	2.552	NMHC	G/MI	.000
NOX	G/MI	.373	CARBONYL	G/MI	.027
			ALCOHOL	G/MI	.731

FUEL ECONOMY MPG (L/100KM) 9.69 (24.28)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-1.0-C2 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 8/29/94 RUN | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15152 MILES (24379 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.23 IN HG (742.4 MM HG) DRY BULB TEMPERATURE 71.0°F (21.7°C) NOX HUMIDITY C.F. .978
RELATIVE HUMIDITY 60.4 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.1	867.5	505.1
DRY/WET CORRECTION FACTOR, SAMP/BACK	.972/.984	.975/.984	.973/.984
MEASURED DISTANCE MILES (KM)	3.58 (5.76)	3.82 (6.15)	3.60 (5.80)
BLOWER FLOW RATE SCFM (SCMM)	557.2 (15.78)	558.9 (15.83)	559.5 (15.85)
GAS METER FLOW RATE SCFM (SCMM)	.27 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4693. (132.9)	8084. (229.0)	4712. (133.5)
HC SAMPLE METER/RANGE/PPM (BAG)	47.5/ 2/ 47.47	8.8/ 2/ 8.79	7.2/ 2/ 7.20
HC BCKGRD METER/RANGE/PPM	9.2/ 2/ 9.19	8.8/ 2/ 8.79	7.0/ 2/ 7.00
CO SAMPLE METER/RANGE/PPM	50.7/ 14/ 225.64	1.6/ 12/ 1.63	15.7/ 12/ 15.68
CO BCKGRD METER/RANGE/PPM	.2/ 14/ .81	.8/ 12/ .82	1.0/ 12/ 1.02
CO2 SAMPLE METER/RANGE/PCT	78.3/ 14/ .6289	67.8/ 14/ .4693	74.7/ 14/ .5695
CO2 BCKGRD METER/RANGE/PCT	13.0/ 14/ .0438	13.6/ 14/ .0462	13.7/ 14/ .0466
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	29.1/ 1/ 7.27	8.8/ 1/ 2.20	25.3/ 1/ 6.32
NOX BCKGRD METER/RANGE/PPM	.3/ 1/ .07	.2/ 1/ .05	.3/ 1/ .07
CH4 SAMPLE PPM (1.150)	5.88	4.89	4.55
CH4 BCKGRD PPM	4.97	4.83	4.20
DILUTION FACTOR	17.93	25.02	20.58
HC CONCENTRATION PPM	38.79	.35	.54
CO CONCENTRATION PPM	216.30	.81	14.16
CO2 CONCENTRATION PCT	.5875	.4249	.5252
NOX CONCENTRATION PPM	7.20	2.15	6.25
CH4 CONCENTRATION PPM	1.19	.26	.56
NMHC CONCENTRATION PPM	.62	.05	-.15
THC MASS GRAMS	8.701	.055	.065
CO MASS GRAMS	33.467	.215	2.200
CO2 MASS GRAMS	1429.63	1781.26	1283.21
NOX MASS GRAMS	1.790	.921	1.561
CH4 MASS GRAMS	.105	.039	.050
NMHC MASS GRAMS (FID)	.047	.006	.000
FUEL MASS KG	1.088	1.297	.937
FUEL ECONOMY MPG (L/100KM)	9.86 (23.85)	8.83 (26.63)	11.53 (20.41)

3-BAG COMPOSITE RESULTS

THC	G/MI	.518	CH4	G/MI	.015
CO	G/MI	2.143	NMHC	G/MI	.004
NOX	G/MI	.348	CARBONYL	G/MI	.025
			ALCOHOL	G/MI	.475

FUEL ECONOMY MPG (L/100KM) 9.68 (24.30)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.2-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-1.2-E1 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/16/94 RUN | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15377 MILES (24741 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.20 IN HG (741.7 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. .993
RELATIVE HUMIDITY 60.9 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	506.4	867.3	505.8
DRY/WET CORRECTION FACTOR, SAMP/BACK	.971/.983	.974/.983	.972/.983
MEASURED DISTANCE MILES (KM)	3.61 (5.81)	3.84 (6.17)	3.62 (5.82)
BLOWER FLOW RATE SCFM (SCMM)	557.6 (15.79)	557.1 (15.78)	556.9 (15.77)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4708. (133.3)	8056. (228.2)	4697. (133.0)
HC SAMPLE METER/RANGE/PPM (BAG)	12.3/ 3/ 122.73	39.7/ 2/ 39.68	4.5/ 3/ 44.90
HC BCKGRD METER/RANGE/PPM	1.3/ 3/ 12.97	6.0/ 2/ 6.00	.8/ 3/ 7.98
CO SAMPLE METER/RANGE/PPM	87.8/ 14/ 432.42	66.6/ 14/ 310.43	73.6/ 14/ 349.89
CO BCKGRD METER/RANGE/PPM	.7/ 14/ 2.83	.7/ 14/ 2.83	.6/ 14/ 2.43
CO2 SAMPLE METER/RANGE/PCT	78.5/ 14/ .6323	66.6/ 14/ .4535	74.0/ 14/ .5586
CO2 BCKGRD METER/RANGE/PCT	14.4/ 14/ .0494	12.0/ 14/ .0399	14.1/ 14/ .0482
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	94.0/ 1/ 23.49	46.8/ 1/ 11.70	25.4/ 2/ 25.41
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ .17	.0/ 1/ .00	.2/ 2/ .20
CH4 SAMPLE PPM (1.150)	5.24	3.02	4.43
CH4 BCKGRD PPM	4.07	2.29	3.48
DILUTION FACTOR	17.04	24.10	19.68
HC CONCENTRATION PPM	110.52	33.93	37.32
CO CONCENTRATION PPM	413.22	297.50	334.98
CO2 CONCENTRATION PCT	.5858	.4152	.5128
NOX CONCENTRATION PPM	23.33	11.70	25.22
CH4 CONCENTRATION PPM	1.42	.83	1.13
NMHC CONCENTRATION PPM	-61.91	-1.00	-9.58
THC MASS GRAMS	40.084	14.110	11.160
CO MASS GRAMS	64.141	79.020	51.870
CO2 MASS GRAMS	1430.08	1734.38	1248.79
NOX MASS GRAMS	5.904	5.066	6.368
CH4 MASS GRAMS	.126	.126	.100
NMHC MASS GRAMS (FID)	.000	.000	.000
FUEL MASS KG	1.155	1.367	.980
FUEL ECONOMY MPG (L/100KM)	9.37 (25.09)	8.41 (27.97)	11.08 (21.23)

3-BAG COMPOSITE RESULTS

THC	G/MI	5.061	CH4	G/MI	.032
CO	G/MI	18.273	NMHC	G/MI	.000
NOX	G/MI	1.507	CARBONYL	G/MI	.358
			ALCOHOL	G/MI	4.671

FUEL ECONOMY MPG (L/100KM) 9.24 (25.47)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-1.2-E2 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/19/94 RUN | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15395 MILES (24770 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.32 IN HG (744.7 MM HG) DRY BULB TEMPERATURE 75.0°F (23.9°C) NOX HUMIDITY C.F. .928
RELATIVE HUMIDITY 44.3 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.3	867.2	505.8
DRY/WET CORRECTION FACTOR, SAMP/BACK	.975/.987	.978/.987	.976/.987
MEASURED DISTANCE MILES (KM)	3.61 (5.80)	3.86 (6.21)	3.61 (5.81)
BLOWER FLOW RATE SCFM (SCMM)	558.4 (15.81)	560.4 (15.87)	560.2 (15.87)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.28 (.01)
TOTAL FLOW SCF (SCM)	4705. (133.3)	8103. (229.5)	4725. (133.8)
HC SAMPLE METER/RANGE/PPM (BAG)	12.9/ 3/ 128.71	40.4/ 2/ 40.38	41.3/ 2/ 41.28
HC BCKGRD METER/RANGE/PPM	.8/ 3/ 7.98	8.2/ 2/ 8.20	7.5/ 2/ 7.50
CO SAMPLE METER/RANGE/PPM	90.6/ 14/ 448.81	58.0/ 14/ 263.65	69.6/ 14/ 327.20
CO BCKGRD METER/RANGE/PPM	.5/ 14/ 2.02	.5/ 14/ 2.02	.5/ 14/ 2.02
CO2 SAMPLE METER/RANGE/PCT	77.8/ 14/ .6203	67.6/ 14/ .4666	74.6/ 14/ .5679
CO2 BCKGRD METER/RANGE/PCT	13.5/ 14/ .0458	13.8/ 14/ .0470	14.1/ 14/ .0482
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	26.3/ 2/ 26.31	41.9/ 1/ 10.47	87.7/ 1/ 21.92
NOX BCKGRD METER/RANGE/PPM	.1/ 2/ .10	.4/ 1/ .10	.5/ 1/ .12
CH4 SAMPLE PPM (1.150)	4.08	3.59	3.98
CH4 BCKGRD PPM	2.80	2.94	3.15
DILUTION FACTOR	17.30	23.67	19.46
HC CONCENTRATION PPM	121.19	32.53	34.17
CO CONCENTRATION PPM	432.29	254.34	315.14
CO2 CONCENTRATION PCT	.5772	.4216	.5222
NOX CONCENTRATION PPM	26.22	10.38	21.80
CH4 CONCENTRATION PPM	1.44	.78	1.00
NMHC CONCENTRATION PPM	-19.45	-2.25	-5.12
THC MASS GRAMS	32.643	14.358	9.476
CO MASS GRAMS	67.062	67.951	49.091
CO2 MASS GRAMS	1408.09	1771.48	1279.29
NOX MASS GRAMS	6.203	4.228	5.179
CH4 MASS GRAMS	.128	.120	.089
NMHC MASS GRAMS (FID)	.000	.000	.000
FUEL MASS KG	1.134	1.382	.997
FUEL ECONOMY MPG (L/100KM)	9.53 (24.69)	8.38 (28.08)	10.86 (21.67)

3-BAG COMPOSITE RESULTS

THC	G/MI	4.526	CH4	G/MI	.030
CO	G/MI	16.708	NMHC	G/MI	.000
NOX	G/MI	1.319	CARBONYL	G/MI	.336
			ALCOHOL	G/MI	4.160

FUEL ECONOMY MPG (L/100KM) 9.19 (25.59)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-1.2-C2 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/14/94 RUN | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15348 MILES (24694 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.28 IN HG (743.7 MM HG) DRY BULB TEMPERATURE 72.0°F (22.2°C) NOX HUMIDITY C.F. 1.014
RELATIVE HUMIDITY 64.9 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.3	867.3	505.4
DRY/WET CORRECTION FACTOR, SAMP/BACK	.969/.982	.973/.982	.971/.982
MEASURED DISTANCE MILES (KM)	3.57 (5.74)	3.82 (6.15)	3.59 (5.77)
BLOWER FLOW RATE SCFM (SCMM)	558.1 (15.81)	560.2 (15.87)	557.5 (15.79)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4702. (133.2)	8102. (229.5)	4698. (133.1)
HC SAMPLE METER/RANGE/PPM (BAG)	69.9/ 2/ 69.86	7.7/ 2/ 7.70	9.8/ 2/ 9.79
HC BCKGRD METER/RANGE/PPM	8.0/ 2/ 8.00	7.6/ 2/ 7.60	7.1/ 2/ 7.10
CO SAMPLE METER/RANGE/PPM	29.6/ 14/ 124.70	1.6/ 12/ 1.59	59.9/ 13/ 141.02
CO BCKGRD METER/RANGE/PPM	.4/ 14/ 1.62	1.2/ 12/ 1.19	.7/ 13/ 1.61
CO2 SAMPLE METER/RANGE/PCT	81.7/ 14/ .6903	68.9/ 14/ .4842	75.9/ 14/ .5887
CO2 BCKGRD METER/RANGE/PCT	13.7/ 14/ .0466	13.8/ 14/ .0470	14.5/ 14/ .0498
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	7.4/ 2/ 7.40	10.1/ 1/ 2.52	73.7/ 1/ 18.42
NOX BCKGRD METER/RANGE/PPM	.0/ 2/ .00	.3/ 1/ .07	.3/ 1/ .07
CH4 SAMPLE PPM (1.150)	3.82	3.14	4.55
CH4 BCKGRD PPM	3.21	3.18	3.30
DILUTION FACTOR	16.55	24.26	19.51
HC CONCENTRATION PPM	62.35	.41	3.06
CO CONCENTRATION PPM	118.06	.41	134.11
CO2 CONCENTRATION PCT	.6465	.4391	.5414
NOX CONCENTRATION PPM	7.40	2.45	18.35
CH4 CONCENTRATION PPM	.81	.09	1.42
NMHC CONCENTRATION PPM	-6.72	.29	-1.69
THC MASS GRAMS	15.665	.064	.820
CO MASS GRAMS	18.303	.111	20.774
CO2 MASS GRAMS	1576.26	1844.76	1318.92
NOX MASS GRAMS	1.913	1.092	4.736
CH4 MASS GRAMS	.072	.013	.126
NMHC MASS GRAMS (FID)	.000	.039	.000
FUEL MASS KG	1.184	1.343	.985
FUEL ECONOMY MPG (L/100KM)	9.04 (26.03)	8.53 (27.58)	10.92 (21.53)

3-BAG COMPOSITE RESULTS

THC	G/MI	.983	CH4	G/MI	.016
CO	G/MI	2.678	NMHC	G/MI	.005
NOX	G/MI	.623	CARBONYL	G/MI	.029
			ALCOHOL	G/MI	.934

FUEL ECONOMY MPG (L/100KM) 9.21 (25.54)

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.5-R 3-BAG CARB FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-6068-001

VEHICLE NUMBER 601 | TEST C-MTH-1.2-C3 | METHANOL EM-1791-F
VEHICLE MODEL 88 CHEVY CORSICA | DATE 9/15/94 RUN | FUEL DENSITY 6.610 LB/GAL
ENGINE 2.8 L (171 CID)-V-6 | DYNO 2 BAG CART 2 | H .123 C .375 O .502 X .000
TRANSMISSION M5 | ACTUAL ROAD LOAD 4.50 HP (3.36 KW)
ODOMETER 15359 MILES (24712 KM) | TEST WEIGHT 3500 LBS (1587 KG)

BAROMETER 29.20 IN HG (741.7 MM HG) DRY BULB TEMPERATURE 70.0°F (21.1°C) NOX HUMIDITY C.F. 1.008
RELATIVE HUMIDITY 68.2 PCT.

BAG NUMBER	1	2	3
BAG DESCRIPTION	COLD TRANSIENT (0-505 SEC.)	STABILIZED (505-1372 SEC.)	HOT TRANSIENT (0- 505 SEC.)
RUN TIME SECONDS	505.2	867.3	505.2
DRY/WET CORRECTION FACTOR, SAMP/BACK	.970/.983	.973/.983	.971/.983
MEASURED DISTANCE MILES (KM)	3.60 (5.78)	3.83 (6.16)	3.55 (5.71)
BLOWER FLOW RATE SCFM (SCMM)	556.3 (15.76)	558.4 (15.82)	557.3 (15.78)
GAS METER FLOW RATE SCFM (SCMM)	.28 (.01)	.28 (.01)	.27 (.01)
TOTAL FLOW SCF (SCM)	4687. (132.7)	8076. (228.7)	4695. (133.0)
HC SAMPLE METER/RANGE/PPM (BAG)	57.8/ 2/ 57.77	8.4/ 2/ 8.40	11.5/ 2/ 11.49
HC BCKGRD METER/RANGE/PPM	8.3/ 2/ 8.30	8.1/ 2/ 8.10	7.2/ 2/ 7.20
CO SAMPLE METER/RANGE/PPM	46.8/ 14/ 206.00	23.7/ 12/ 23.18	56.7/ 13/ 132.91
CO BCKGRD METER/RANGE/PPM	.4/ 14/ 1.62	1.0/ 12/ .99	.9/ 13/ 2.07
CO2 SAMPLE METER/RANGE/PCT	80.5/ 14/ .6680	70.8/ 14/ .5108	75.7/ 14/ .5855
CO2 BCKGRD METER/RANGE/PCT	13.8/ 14/ .0470	14.1/ 14/ .0482	14.6/ 14/ .0502
NOX SAMPLE METER/RANGE/PPM (BAG) (D)	73.6/ 1/ 18.39	25.4/ 1/ 6.35	78.8/ 1/ 19.69
NOX BCKGRD METER/RANGE/PPM	.5/ 1/ .12	.4/ 1/ .10	.5/ 1/ .12
CH4 SAMPLE PPM (1.150)	4.73	4.23	4.91
CH4 BCKGRD PPM	3.63	3.64	3.69
DILUTION FACTOR	16.94	22.90	19.63
HC CONCENTRATION PPM	49.96	.65	4.66
CO CONCENTRATION PPM	195.91	21.39	125.76
CO2 CONCENTRATION PCT	.6238	.4648	.5378
NOX CONCENTRATION PPM	18.28	6.25	19.58
CH4 CONCENTRATION PPM	1.32	.75	1.40
NMHC CONCENTRATION PPM	-2.57	-.21	-1.71
THC MASS GRAMS	11.856	.122	1.182
CO MASS GRAMS	30.271	5.694	19.466
CO2 MASS GRAMS	1515.72	1946.14	1309.07
NOX MASS GRAMS	4.678	2.758	5.019
CH4 MASS GRAMS	.117	.115	.124
NMHC MASS GRAMS (FID)	.000	.000	.000
FUEL MASS KG	1.150	1.423	.976
FUEL ECONOMY MPG (L/100KM)	9.37 (25.09)	8.06 (29.18)	10.90 (21.58)

3-BAG COMPOSITE RESULTS

THC	G/MI	.795	CH4	G/MI	.032
CO	G/MI	4.027	NMHC	G/MI	.000
NOX	G/MI	1.032	CARBONYL	G/MI	.028
			ALCOHOL	G/MI	.735

FUEL ECONOMY MPG (L/100KM) 8.97 (26.22)

APPENDIX H

MAXIMUM INCREMENTAL REACTIVITY ADJUSTMENT FACTORS (MIRs)[5]

COMPOUND	MIR
METHANE	0.0148
ETHANE	0.25
ETHYLENE	7.29
PROPANE	0.48
PROPYLENE	9.4
ACETYLENE	0.5
PROPADIENE	7.29
BUTANE	1.02
TRANS-2-BUTENE	9.94
1-BUTENE	8.91
2-METHYLPROPENE (ISOBUTYLENE)	5.31
2,2-DIMETHYLPROPANE (NEOPENTANE)	0.37
PROPYNE	4.1
1,3-BUTADIENE	10.89
2-METHYLPROPANE (ISOBUTANE)	1.21
1-BUTYNE	9.24
METHANOL	0.56
CIS-2-BUTENE	9.94
3-METHYL-1-BUTENE	6.22
ETHANOL	1.34
2-METHYLBUTANE (ISOPENTANE)	1.38
2-BUTYNE	9.24
1-PENTENE	6.22
2-METHYL-1-BUTENE	4.9
PENTANE	1.04
2-METHYL-1,3-BUTADIENE	9.08
TRANS-2-PENTENE	8.8
3,3-DIMETHYL-1-BUTENE	4.42
CIS-2-PENTENE	8.8
2-METHYL-2-BUTENE	6.41
CYCLOPENTADIENE	7.66
2,2-DIMETHYLBUTANE	0.82
CYCLOPENTENE	7.66
4-METHYL-1-PENTENE	4.42
3-METHYL-1-PENTENE	4.42
CYCLOPENTANE	2.38
2,3-DIMETHYLBUTANE	1.07
MTBE	0.62
2,3-DIMETHYL-1-BUTENE	4.42
4-METHYL-CIS-2-PENTENE	6.69
2-METHYLPENTANE	1.53
4-METHYL-TRANS-2-PENTENE	6.69

COMPOUND	MIR
3-METHYLPENTANE	1.52
2-METHYL-1-PENTENE	4.42
1-HEXENE	4.42
HEXANE	0.98
TRANS-3-HEXENE	6.69
CIS-3-HEXENE	6.69
TRANS-2-HEXENE	6.69
3-METHYL-TRANS-2-PENTENE	6.69
2-METHYL-2-PENTENE	6.69
3-METHYLCYCLOPENTENE	5.67
CIS-2-HEXENE	6.69
ETBE	1.98
3-METHYL-CIS-2-PENTENE	6.69
2,2-DIMETHYLPENTANE	1.4
METHYLCYCLOPENTANE	2.82
2,4-DIMETHYLPENTANE	1.78
2,3,3-TRIMETHYL-1-BUTENE	3.48
2,2,3-TRIMETHYLBUTANE	1.32
3,4-DIMETHYL-1-PENTENE	3.48
1-METHYLCYCLOPENTENE	5.67
BENZENE	0.42
3-METHYL-1-HEXENE	3.48
3,3-DIMETHYLPENTANE	0.71
CYCLOHEXANE	1.28
2-METHYLHEXANE	1.08
2,3-DIMETHYLPENTANE	1.51
1,1-DIMETHYLCYCLOPENTANE	1.85
CYCLOHEXENE	5.67
3-METHYLHEXANE	1.4
CIS-1,3-DIMETHYLCYCLOPENTANE	2.55
3-ETHYLPENTANE	1.4
TRANS-1,2-DIMETHYLCYCLOPENTANE	1.85
TRANS-1,3-DIMETHYLCYCLOPENTANE	2.55
1-HEPTENE	3.48
2,2,4-TRIMETHYLPENTANE	0.93
2-METHYL-1-HEXENE	3.48
TRANS-3-HEPTENE	5.53
HEPTANE	0.81
2-METHYL-2-HEXENE	5.53
3-METHYL-TRANS-3-HEXENE	5.53
TRANS-2-HEPTENE	6.45
3-ETHYL-CIS-2-PENTENE	5.53

COMPOUND	MIR
2,4,4-TRIMETHYL-1-PENTENE	2.69
2,2,4-TRIMETHYL-1-PENTENE	2.69
2,3-DIMETHYL-2-PENTENE	5.53
CIS-2-HEPTENE	5.53
METHYLCYCLOHEXANE	1.85
CIS-1,2-DIMETHYLCYCLOPENTANE	1.85
2,2-DIMETHYLHEXANE	1.2
1,1,3-TRIMETHYLCYCLOPENTANE	1.94
2,4,4-TRIMETHYL-2-PENTENE	5.29
2,2,3-TRIMETHYLPENTANE	1.2
2,5-DIMETHYLHEXANE	1.63
ETHYLCYCLOPENTANE	2.31
2,4-DIMETHYLHEXANE	1.5
1-TRANS-2-CIS-4-TRIMETHYLCYCLOPENTANE	1.94
3,3-DIMETHYLHEXANE	1.2
1-TRANS-2-CIS-3-TRIMETHYLCYCLOPENTANE	1.94
2,3,4-TRIMETHYLPENTANE	1.6
2,3,3-TRIMETHYLPENTANE	1.2
TOLUENE	2.73
2,3-DIMETHYLHEXANE	1.32
1,1,2-TRIMETHYLCYCLOPENTANE	1.94
2-METHYLHEPTANE	0.96
3,4-DIMETHYLHEXANE	1.2
2,2,4,4-TETRAMETHYLPENTANE	1.14
4-METHYLHEPTANE	1.2
2-METHYL-3-ETHYLPENTANE	1.2
2,6-DIMETHYLHEPTANE	1.14
3-METHYLHEPTANE	0.99
1-CIS,2-TRANS,3-TRIMETHYLCYCLOPENTANE	1.94
CIS-1,3-DIMETHYLCYCLOHEXANE	1.94
TRANS-1,4-DIMETHYLCYCLOHEXANE	1.94
3-ETHYLHEXANE	1.2
2,2,5-TRIMETHYLHEXANE	0.97
CIS-1-METHYL-3-ETHYLCYCLOPENTANE	1.94
1,1-DIMETHYLCYCLOHEXANE	1.94
TRANS-1-METHYL-2-ETHYLCYCLOPENTANE	1.94
1-METHYL-1-ETHYL-CYCLOPENTANE	1.94
2,4,4-TRIMETHYLHEXANE	1.14
2,2,4-TRIMETHYLHEXANE	1.14
TRANS-1,2-DIMETHYLCYCLOHEXANE	1.94
1-OCTENE	2.69
TRANS-4-OCTENE	5.29

COMPOUND	MIR
OCTANE	0.61
TRANS-2-OCTENE	5.29
TRANS-1,3-DIMETHYLCYCLOHEXANE	1.94
CIS-1,4-DIMETHYLCYCLOHEXANE	1.94
CIS-2-OCTENE	5.29
2,3,5-TRIMETHYLHEXANE	1.14
CIS-1-METHYL-2-ETHYLCYCLOPENTANE	1.94
2-METHYL-2-ETHYLHEPTANE	1.01
2,4-DIMETHYLHEPTANE	1.34
4,4-DIMETHYLHEPTANE	1.14
CIS-1,2-DIMETHYLCYCLOHEXANE	1.94
ETHYLCYCLOHEXANE	1.94
PROPYLCYCLOHEXANE	1.17
2-METHYL-4-ETHYLHEXANE	1.14
2,6-DIMETHYLHEPTANE	1.14
1,1,3-TRIMETHYLCYCLOHEXANE	2.3
2,5-DIMETHYLHEPTANE	1.14
3,3-DIMETHYLHEPTANE	1.14
3,5-DIMETHYLHEPTANE	1.14
ETHYLBENZENE	2.7
2,3-DIMETHYLHEPTANE	1.14
m-& p-XYLENE	7.38
4-METHYLOCTANE	1.14
2-METHYLOCTANE	1.14
3-METHYLOCTANE	1.14
STYRENE	2.22
o-XYLENE	6.46
2,4,6-TRIMETHYLHEXANE	1.14
1-NONENE	2.23
NONANE	0.54
ISOPROPYLBENZENE (CUMENE)	2.24
2,2-DIMETHYLOCTANE	1.01
2,4-DIMETHYLOCTANE	1.01
n-PROPYLBENZENE	2.12
1-METHYL-3-ETHYLBENZENE	7.2
1-METHYL-4-ETHYLBENZENE	7.2
1,3,5-TRIMETHYLBENZENE	10.12
1-METHYL-2-ETHYLBENZENE	7.2
1,2,4-TRIMETHYLBENZENE	8.83
DECANE	0.47
ISOBUTYLBENZENE	1.87
METHYLPROPYLBENZENE	6.45

COMPOUND	MIR
S-BUTYLBENZENE	1.89
1-METHYL-3-ISOPROPYLBENZENE	5.84
1,2,3-TRIMETHYLBENZENE	8.85
1-METHYL-4-ISOPROPYLBENZENE	5.84
INDAN	1.06
1-METHYL-2-ISOPROPYLBENZENE	5.84
1,3-DIETHYLBENZENE	6.45
1,4-DIETHYLBENZENE	6.45
1-METHYL-3-N-PROPYLBENZENE	6.45
1-METHYL-4-N-PROPYLBENZENE	6.45
1,2 DIETHYLBENZENE	6.45
1-METHYL-2-N-PROPYLBENZENE	6.45
1,4-DIMETHYL-2-ETHYLBENZENE	9.07
1,3-DIMETHYL-4-ETHYLBENZENE	9.07
1,2-DIMETHYL-4-ETHYLBENZENE	9.07
1,3-DIMETHYL-2-ETHYLBENZENE	9.07
UNDECANE	0.42
1,2-DIMETHYL-3-ETHYLBENZENE	9.07
1,2,4,5-TETRAMETHYLBENZENE	9.07
2-METHYLBUTYLBENZENE (sec AMYLBENZENE)	1.7
1,2,3,5-TETRAMETHYLBENZENE	9.07
TERT-1-BUT-2-METHYLBENZENE	5.84
1,2,3,4-TETRAMETHYLBENZENE	9.07
N-PENT-BENZENE	1.7
TERT-1-BUT-3,5-DIMETHYLBENZENE	7.5
NAPHTHALENE	1.18
DODECANE	0.38
FORMALDEHYDE	7.15
ACETALDEHYDE	5.52
ACROLEIN	6.77
ACETONE	0.56
PROPIONALDEHYDE	6.53
CROTONALDEHYDE	5.42
ISOBUTYRALDEHYDE	5.26
METHYL ETHYL KETONE	1.18
BENZALDEHYDE	-0.55
HEXANALDEHYDE	3.79

APPENDIX I

AVERAGE SPECIATED EMISSIONS RESULTS FROM FTPs WITH LPG

TABLE I-1. SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM LPG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
METHANE	90.3		71.8		95.6		123.4		365.8		449.5	
ETHANE	93.2	1.9	25.1	5.1	32.1	1.8	11.4	6.8	42.0	1.7	190.3	10.7
ETHYLENE	471.5	9.7	10.3	2.1	290.0	15.8	8.5	5.0	426.6	17.1	213.6	12.0
PROPANE	3365.8	69.3	434.9	88.6	1097.8	59.9	130.3	77.7	1479.0	59.2	1209.9	68.1
PROPYLENE	500.2	10.3	10.5	2.1	205.3	11.2	6.7	4.0	209.4	8.4	110.3	6.2
ACETYLENE	56.1	1.2	0.2	<0.1	78.5	4.3	1.1	0.6	217.9	8.7	3.5	0.2
PROPADIENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUTANE	5.7	0.1	0.5	0.1	2.7	0.1	0.5	0.3	5.3	0.2	6.5	0.4
TRANS-2-BUTENE	0.6	<0.1	ND	ND	0.3	<0.1	0.1	<0.1	0.5	<0.1	3.8	0.2
1-BUTENE	11.1	0.2	0.2	<0.1	6.0	0.3	0.2	0.1	4.9	0.2	3.0	0.2
2-METHYLPROPENE (ISOBUTYLENE)	4.2	0.1	0.2	<0.1	1.7	0.1	0.1	0.1	2.2	0.1	1.9	0.1
2,2-DIMETHYLPROPANE (NEOPENTANE)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
PROPYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-BUTADIENE	3.1	0.1	0.1	<0.1	1.8	0.1	0.1	<0.1	1.6	0.1	0.3	<0.1
2-METHYLPROPANE (ISOBUTANE)	22.0	0.5	1.4	0.3	5.8	0.3	0.7	0.4	11.0	0.4	9.6	0.5
1-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHANOL	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CIS-2-BUTENE	0.5	<0.1	ND	ND	0.3	<0.1	0.1	<0.1	0.4	<0.1	4.2	0.2
3-METHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHANOL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLBUTANE (ISOPENTANE)	9.9	0.2	0.4	0.1	1.8	0.1	0.6	0.3	2.6	0.1	2.6	0.1
2-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	0.2	<0.1	0.1	<0.1
2-METHYL-1-BUTENE	0.3	<0.1	ND	ND	<0.1	<0.1	ND	ND	0.1	<0.1	0.2	<0.1
PENTANE	1.3	<0.1	0.2	<0.1	0.2	<0.1	0.2	0.1	0.2	<0.1	0.2	<0.1
2-METHYL-1,3-BUTADIENE	0.3	<0.1	ND	ND	0.5	<0.1	ND	ND	0.1	<0.1	ND	ND
TRANS-2-PENTENE	0.4	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	0.2	<0.1
3,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-PENTENE	0.3	<0.1	0.1	<0.1	0.4	<0.1	<0.1	<0.1	0.4	<0.1	0.3	<0.1
2-METHYL-2-BUTENE	0.4	<0.1	0.1	<0.1	0.2	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1

TABLE I-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM LPG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
CYCLOPENTADIENE	0.2	<0.1	ND	ND	<0.1	<0.1	ND	ND	0.5	<0.1	0.4	<0.1
2,2-DIMETHYLBUTANE	0.5	<0.1	0.4	0.1	0.4	<0.1	0.2	0.1	0.1	<0.1	0.5	<0.1
CYCLOPENTENE	0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
4-METHYL-1-PENTENE	0.1	<0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1	<0.1	<0.1
3-METHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLBUTANE	0.6	<0.1	<0.1	<0.1	0.2	<0.1	0.1	0.1	0.3	<0.1	0.1	<0.1
MTBE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLPENTANE	1.1	<0.1	<0.1	<0.1	0.7	<0.1	0.1	<0.1	0.3	<0.1	0.2	<0.1
4-METHYL-TRANS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLPENTANE	0.3	<0.1	0.1	<0.1	0.5	<0.1	0.2	0.1	0.1	<0.1	0.4	<0.1
2-METHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-HEXENE	0.2	<0.1	ND	ND	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1
HEXANE	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1
TRANS-3-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
CIS-3-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
TRANS-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-TRANS-2-PENTENE	<0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-METHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
3-METHYLCYCLOPENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
ETBE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-CIS-2-PENTENE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	0.1	<0.1	0.1	<0.1
2,2-DIMETHYLPENTANE	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	<0.1	0.1	<0.1
METHYLCYCLOPENTANE	0.2	<0.1	<0.1	<0.1	0.2	<0.1	ND	ND	0.2	<0.1	ND	ND
2,4-DIMETHYLPENTANE	0.3	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
2,3,3-TRIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLBUTANE	ND	ND	ND	ND	ND	ND	<0.1	<0.1	0.1	<0.1	<0.1	<0.1

TABLE I-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM LPG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3,4-DIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYLCYCLOPENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
BENZENE	0.7	<0.1	ND	ND	0.6	<0.1	0.1	0.1	0.7	<0.1	3.5	0.2
3-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1	0.2	<0.1
CYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
2-METHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLPENTANE	0.5	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.3	<0.1
1,1-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYCLOHEXENE	ND	ND	ND	ND	ND	ND	ND	ND	0.2	<0.1	ND	ND
3-METHYLHEXANE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
CIS-1,3-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1
3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLPENTANE	0.6	<0.1	0.1	<0.1	0.4	<0.1	0.3	0.2	0.2	<0.1	0.6	<0.1
2-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-3-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTANE	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1
2-METHYL-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-TRANS-3-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-2-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-ETHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-1-PENTENE	1.5	<0.1	ND	ND	0.6	<0.1	ND	ND	<0.1	<0.1	ND	ND
2,2,4-TRIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
METHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE I-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM LPG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
2,2-DIMETHYLHEXANE	ND	ND	ND	ND	0.1	<0.1	ND	ND	ND	ND	ND	ND
1,1,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEXANE	0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.3	<0.1
1-TRANS-2-CIS-4-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-TRANS-2-CIS-3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,3-TRIMETHYLPENTANE	0.6	<0.1	ND	ND	0.1	<0.1	ND	ND	0.1	<0.1	0.1	<0.1
TOLUENE	0.9	<0.1	0.2	<0.1	0.4	<0.1	0.4	0.2	0.4	<0.1	1.2	0.1
2,3-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,4-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4,4-TETRAMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLHEPTANE	<0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND	0.2	<0.1	ND	ND
1-CIS,2-TRANS,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,4-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,5-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1-METHYL-3-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE I-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM LPG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1-METHYL-1-ETHYL-CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-4-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
OCTANE	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1
TRANS-2-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,4-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,5-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-2-ETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEPTANE	0.4	<0.1	0.6	0.1	0.2	<0.1	0.7	0.4	0.4	<0.1	0.7	<0.1
4,4-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PROPYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-4-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,3-TRIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.2	<0.1	0.2	<0.1
2,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-& p-XYLENE	0.4	<0.1	0.2	<0.1	0.6	<0.1	<0.1	<0.1	0.5	<0.1	0.7	<0.1
4-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE I-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM LPG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3-METHYLOCTANE	ND	ND	ND	ND	ND	ND	0.1	<0.1	ND	ND	ND	ND
STYRENE	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND
o-XYLENE	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1
2,4,6-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-NONENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NONANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOPROPYLBENZENE (CUMENE)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2-DIMETHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLOCTANE	<0.1	<0.1	ND	ND	0.1	<0.1	0.1	0.1	0.2	<0.1	0.4	<0.1
n-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-3-ETHYLBENZENE	0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1-METHYL-4-ETHYLBENZENE	0.1	<0.1	<0.1	<0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1
1,3,5-TRIMETHYLBENZENE	0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-2-ETHYLBENZENE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND	0.1	<0.1	0.5	<0.1
1,2,4-TRIMETHYLBENZENE	0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
DECANE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	<0.1	0.2	<0.1
ISOBUTYLBENZENE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	0.2	<0.1
METHYLPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-BUTYLBENZENE	ND	ND	0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-3-ISOPROPYLBENZENE	ND	ND	ND	ND	<0.1	<0.1	<0.1	<0.1	ND	ND	0.1	<0.1
1,2,3-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-4-ISOPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
INDAN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-2-ISOPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
1,3-DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	0.2	<0.1	0.1	<0.1
1-METHYL-3-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-4-N-PROPYLBENZENE	<0.1	<0.1	<0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND
1,2 DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-2-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE I-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM LPG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1,4-DIMETHYL-2-ETHYLBENZENE	<0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DIMETHYL-4-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DIMETHYL-4-ETHYLBENZENE	<0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1
1,3-DIMETHYL-2-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
UNDECANE	ND	ND	ND	ND	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1
1,2-DIMETHYL-3-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4,5-TETRAMETHYLBENZENE	ND	ND	0.2	<0.1	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLBUTYLBENZENE (sec AMYLBENZENE)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,4 DIMETHYLCUMENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,5-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERT-1-BUT-2-METHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,4-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-PENT-BENZENE	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1	ND	ND
TERT-1-BUT-3,5-DIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DODECANE	ND	ND	ND	ND	0.1	<0.1	<0.1	<0.1	0.1	<0.1	ND	ND
FORMALDEHYDE	199.8	4.1	2.4	0.5	53.1	2.9	1.0	0.6	52.7	2.1	1.6	0.1
ACETALDEHYDE	38.9	0.8	0.7	0.1	17.7	1.0	0.4	0.2	10.3	0.4	1.2	0.1
ACROLEIN	0.2	<0.1	ND	ND	0.2	<0.1	ND	ND	ND	ND	ND	ND
ACETONE	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1
PROPIONALDEHYDE	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1
CROTONALDEHYDE	2.0	<0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
ISOBUTYRALDEHYDE	0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	<0.1	<0.1	0.2	<0.1
METHYL ETHYL KETONE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZALDEHYDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXANALDEHYDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SUMMATION OF NONMETHANE COMPOUNDS	4849.7	99.9	490.2	99.8	1825.4	99.6	166.6	99.4	2494.4	99.9	1776.1	99.9

ND - not detected

APPENDIX J

AVERAGE SPECIATED EMISSIONS RESULTS FROM FTPs WITH CNG

TABLE J-1. SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM CNG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
METHANE	2127.7		964.3		2688.0		809.5		10540.2		8826.1	
ETHANE	139.7	30.8	41.8	68.5	208.2	38.3	27.2	60.9	708.8	39.2	290.5	65.3
ETHYLENE	106.8	23.5	1.4	2.3	98.9	18.2	2.7	6.1	381.8	21.1	33.2	7.5
PROPANE	54.3	12.0	11.0	18.0	94.3	17.4	7.2	16.1	341.2	18.9	90.8	20.4
PROPYLENE	12.1	2.7	0.2	0.3	12.6	2.3	0.4	0.9	30.4	1.7	5.4	1.2
ACETYLENE	25.7	5.7	0.1	0.2	27.5	5.1	0.3	0.7	169.5	9.4	2.1	0.5
PROPADIENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUTANE	0.5	0.1	0.3	0.4	2.2	0.4	0.3	0.6	2.4	0.1	1.5	0.3
TRANS-2-BUTENE	0.2	0.1	<0.1	0.1	0.3	<0.1	<0.1	0.1	0.4	<0.1	<0.1	<0.1
1-BUTENE	0.9	0.2	ND	ND	0.8	0.2	0.1	0.2	1.0	0.1	0.1	<0.1
2-METHYLPROPENE (ISOBUTYLENE)	1.5	0.3	0.1	0.2	1.6	0.3	0.1	0.1	3.4	0.2	0.3	0.1
2,2-DIMETHYLPROPANE (NEOPENTANE)	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
PROPYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-BUTADIENE	0.8	0.2	<0.1	<0.1	0.6	0.1	0.1	0.3	0.4	<0.1	<0.1	<0.1
2-METHYLPROPANE (ISOBUTANE)	0.2	<0.1	<0.1	<0.1	1.0	0.2	<0.1	0.1	2.1	0.1	0.3	0.1
1-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHANOL	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CIS-2-BUTENE	0.2	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	0.1	0.3	<0.1	0.1	<0.1
3-METHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHANOL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLBUTANE (ISOPENTANE)	1.4	0.3	0.5	0.8	5.5	1.0	0.5	1.0	5.5	0.3	2.7	0.6
2-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-PENTENE	0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2-METHYL-1-BUTENE	0.2	<0.1	0.1	0.1	0.2	<0.1	<0.1	<0.1	0.3	<0.1	0.2	<0.1
PENTANE	0.2	<0.1	0.1	0.2	0.6	0.1	0.1	0.2	0.7	<0.1	1.8	0.4
2-METHYL-1,3-BUTADIENE	<0.1	<0.1	0.1	0.1	0.2	<0.1	<0.1	0.1	<0.1	<0.1	0.2	<0.1
TRANS-2-PENTENE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.3	0.1
3,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-PENTENE	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
2-METHYL-2-BUTENE	0.3	0.1	<0.1	0.1	0.4	0.1	<0.1	0.1	0.5	<0.1	0.4	0.1

TABLE J-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM CNG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
CYCLOPENTADIENE	0.1	<0.1	ND	ND	0.1	<0.1	ND	ND	0.1	<0.1	ND	ND
2,2-DIMETHYLBUTANE	0.1	<0.1	<0.1	0.1	0.2	<0.1	<0.1	<0.1	0.4	<0.1	0.6	0.1
CYCLOPENTENE	0.2	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
4-METHYL-1-PENTENE	0.1	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1	ND	ND	0.1	<0.1
3-METHYL-1-PENTENE	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLBUTANE	0.3	0.1	0.1	0.1	0.2	<0.1	<0.1	0.1	0.5	<0.1	0.7	0.2
MTBE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLPENTANE	0.6	0.1	0.1	0.2	0.6	0.1	0.1	0.2	1.1	0.1	1.5	0.3
4-METHYL-TRANS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLPENTANE	0.6	0.1	0.1	0.1	0.4	0.1	0.1	0.2	0.5	<0.1	0.9	0.2
2-METHYL-1-PENTENE	<0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
1-HEXENE	0.2	<0.1	<0.1	0.1	0.1	<0.1	0.1	0.2	0.3	<0.1	0.1	<0.1
HEXANE	0.3	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	0.3	<0.1	0.5	0.1
TRANS-3-HEXENE	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
CIS-3-HEXENE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
TRANS-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-TRANS-2-PENTENE	<0.1	<0.1	ND	ND	0.2	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2-METHYL-2-PENTENE	<0.1	<0.1	ND	ND	0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1
3-METHYLCYCLOPENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEXENE	<0.1	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1	ND	ND	0.1	<0.1
ETBE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-CIS-2-PENTENE	0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2,2-DIMETHYLPENTANE	0.6	0.1	0.1	0.1	0.3	0.1	<0.1	<0.1	1.3	0.1	0.3	0.1
METHYLCYCLOPENTANE	ND	ND	<0.1	0.1	0.1	<0.1	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLPENTANE	0.2	<0.1	0.1	0.1	0.2	<0.1	0.1	0.1	0.4	<0.1	0.4	0.1
2,3,3-TRIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLBUTANE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	0.1	<0.1	0.1	<0.1

TABLE J-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM CNG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3,4-DIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYLCYCLOPENTENE	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1	0.1	<0.1
BENZENE	0.5	0.1	0.1	0.2	0.5	0.1	0.2	0.5	0.8	<0.1	1.0	0.2
3-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLPENTANE	0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
CYCLOHEXANE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
2-METHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLPENTANE	0.2	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.5	<0.1	0.8	0.2
1,1-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYCLOHEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLHEXANE	0.1	<0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.2	<0.1
CIS-1,3-DIMETHYLCYCLOPENTANE	<0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND
3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLPENTANE	0.3	0.1	0.2	0.2	0.3	0.1	0.1	0.3	0.6	<0.1	0.9	0.2
2-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-3-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTANE	0.2	<0.1	0.1	0.2	0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1
2-METHYL-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-TRANS-3-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-2-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-ETHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-1-PENTENE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEPTENE	ND	ND	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	ND	ND	<0.1	<0.1
METHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE J-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM CNG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
2,2-DIMETHYLHEXANE	0.2	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
1,1,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEXANE	<0.1	<0.1	ND	ND	0.1	<0.1	<0.1	0.1	0.1	<0.1	0.1	<0.1
1-TRANS-2-CIS-4-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEXANE	0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-TRANS-2-CIS-3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,3-TRIMETHYLPENTANE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1
TOLUENE	0.4	0.1	<0.1	0.1	0.5	0.1	0.4	0.9	0.9	0.1	0.3	0.1
2,3-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLHEPTANE	ND	ND	ND	ND	ND	ND	0.1	0.1	<0.1	<0.1	0.2	<0.1
3,4-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4,4-TETRAMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYLHEPTANE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND
2-METHYL-3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLHEPTANE	<0.1	<0.1	ND	ND	<0.1	<0.1	0.1	0.1	<0.1	<0.1	0.1	<0.1
1-CIS,2-TRANS,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,4-DIMETHYLCYCLOHEXANE	0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1
3-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,5-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1-METHYL-3-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE J-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM CNG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1-METHYL-1-ETHYL-CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-4-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
OCTANE	ND	ND	ND	ND	ND	ND	<0.1	0.1	ND	ND	0.1	<0.1
TRANS-2-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,4-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,5-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-2-ETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEPTANE	0.2	<0.1	0.4	0.7	0.5	0.1	0.6	1.4	0.3	<0.1	0.5	0.1
4,4-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PROPYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-4-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,3-TRIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	0.1	<0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-& p-XYLENE	0.3	0.1	0.2	0.2	0.1	<0.1	0.1	0.1	0.3	<0.1	0.2	0.1
4-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE J-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM CNG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3-METHYLOCTANE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND
STYRENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-XYLENE	0.2	<0.1	0.1	0.2	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2,4,6-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-NONENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NONANE	<0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOPROPYLBENZENE (CUMENE)	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND
2,2-DIMETHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLOCTANE	0.3	0.1	0.1	0.1	0.2	<0.1	0.1	0.2	<0.1	<0.1	0.2	<0.1
n-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-3-ETHYLBENZENE	0.1	<0.1	0.1	0.2	<0.1	<0.1	0.1	0.2	0.1	<0.1	<0.1	<0.1
1-METHYL-4-ETHYLBENZENE	<0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND
1,3,5-TRIMETHYLBENZENE	0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND
1-METHYL-2-ETHYLBENZENE	0.4	0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
1,2,4-TRIMETHYLBENZENE	0.1	<0.1	0.1	0.1	0.2	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1
DECANE	0.1	<0.1	<0.1	0.1	0.1	<0.1	0.1	0.2	0.1	<0.1	0.1	<0.1
ISOBUTYLBENZENE	0.1	<0.1	<0.1	0.1	0.1	<0.1	0.1	0.2	0.1	<0.1	0.1	<0.1
METHYLPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-BUTYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-3-ISOPROPYLBENZENE	<0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
1,2,3-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-4-ISOPROPYLBENZENE	ND	ND	ND	ND	0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND
IND AN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-2-ISOPROPYLBENZENE	ND	ND	ND	ND	0.1	<0.1	ND	ND	0.1	<0.1	ND	ND
1,3-DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DIETHYLBENZENE	<0.1	<0.1	ND	ND	0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1
1-METHYL-3-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND
1-METHYL-4-N-PROPYLBENZENE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND
1,2 DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-2-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE J-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM CNG

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1,4-DIMETHYL-2-ETHYLBENZENE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1
1,3-DIMETHYL-4-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DIMETHYL-4-ETHYLBENZENE	ND	ND	<0.1	0.1	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DIMETHYL-2-ETHYLBENZENE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND
UND ECANE	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	0.3	<0.1	<0.1	<0.1	<0.1
1,2-DIMETHYL-3-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4,5-TETRAMETHYLBENZENE	1.2	0.3	0.1	0.2	ND	ND	ND	ND	<0.1	<0.1	ND	ND
2-METHYLBUTYLBENZENE (sec AMYLBENZENE)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,4 DIMETHYLCUMENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,5-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERT-1-BUT-2-METHYLBENZENE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND
1,2,3,4-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-PENT-BENZENE	0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND
TERT-1-BUT-3,5-DIMETHYLBENZENE	<0.1	<0.1	ND	ND	0.1	<0.1	0.1	0.2	ND	ND	ND	ND
NAPHTHALENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DODECANE	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.4	1.0	<0.1	<0.1	<0.1	<0.1
FORMALDEHYDE	92.3	20.3	1.2	2.0	70.4	13.0	0.9	2.0	137.0	7.6	1.5	0.3
ACETALDEHYDE	4.2	0.9	0.1	0.2	3.7	0.7	0.1	0.2	7.9	0.4	0.3	0.1
ACROLEIN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACETONE	0.1	<0.1	0.1	0.2	<0.1	<0.1	0.1	0.1	<0.1	<0.1	ND	ND
PROPIONALDEHYDE	0.1	<0.1	0.1	0.2	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1
CROTONALDEHYDE	0.2	0.1	0.3	0.5	0.9	0.2	0.4	0.8	1.3	0.1	0.3	0.1
ISOBUTYRALDEHYDE	<0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL ETHYL KETONE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZALDEHYDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEXANALDEHYDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SUMMATION OF NON-METHANE COMPOUNDS	451.5	99.4	60.3	98.7	538.0	99.1	44.1	98.8	1805.7	99.8	443.5	99.7

ND - not detected

APPENDIX K

AVERAGE SPECIATED EMISSIONS RESULTS FROM FTPs WITH REFORMULATED GASOLINE

TABLE K-1. SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM REFORMULATED GASOLINE

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
METHANE	87.7		57.0		76.2		33.1		365.8		355.6	
ETHANE	63.4	0.6	7.1	3.8	31.0	1.3	4.6	2.4	32.2	0.9	38.4	1.1
ETHYLENE	442.1	3.9	12.1	6.4	173.0	7.2	12.6	6.7	260.4	7.2	385.8	10.7
PROPANE	3.6	<0.1	0.2	0.1	1.6	0.1	0.3	0.2	2.5	0.1	2.7	0.1
PROPYLENE	441.5	3.9	8.6	4.6	141.1	5.9	8.8	4.7	134.3	3.7	146.7	4.1
ACETYLENE	82.8	0.7	4.6	2.4	93.4	3.9	5.4	2.9	319.1	8.8	91.3	2.5
PROPADIENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUTANE	136.1	1.2	1.8	0.9	18.6	0.8	2.0	1.1	30.0	0.8	29.1	0.8
TRANS-2-BUTENE	44.5	0.4	0.7	0.4	11.6	0.5	0.8	0.4	10.4	0.3	12.5	0.3
1-BUTENE	61.5	0.5	1.1	0.6	17.4	0.7	1.1	0.6	14.5	0.4	18.0	0.5
2-METHYLPROPENE (ISOBUTYLENE)	473.0	4.2	9.2	4.9	130.7	5.4	10.1	5.4	124.3	3.4	240.0	6.7
2,2-DIMETHYLPROPANE (NEOPENTANE)	4.6	<0.1	0.1	<0.1	0.6	<0.1	0.1	<0.1	1.1	<0.1	1.2	<0.1
PROPYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-BUTADIENE	61.7	0.5	1.2	0.6	21.3	0.9	1.1	0.6	18.2	0.5	18.7	0.5
2-METHYLPROPANE (ISOBUTANE)	5.2	<0.1	0.1	0.1	1.4	0.1	0.1	<0.1	1.3	<0.1	2.1	0.1
1-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHANOL	132.9	1.2	ND	ND	35.1	1.5	ND	ND	29.0	0.8	71.5	2.0
CIS-2-BUTENE	32.5	0.3	0.7	0.4	8.5	0.4	0.6	0.3	7.8	0.2	11.6	0.3
3-METHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHANOL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLBUTANE (ISOPENTANE)	606.4	5.4	7.6	4.0	89.1	3.7	9.6	5.1	146.8	4.0	143.3	4.0
2-BUTYNE	33.5	0.3	ND	ND	0.3	<0.1	ND	ND	0.3	<0.1	0.3	<0.1
1-PENTENE	26.6	0.2	ND	ND	4.0	0.2	0.1	<0.1	4.3	0.1	5.2	0.1
2-METHYL-1-BUTENE	56.5	0.5	0.6	0.3	11.8	0.5	0.6	0.3	11.1	0.3	10.2	0.3
PENTANE	105.7	0.9	1.4	0.7	15.4	0.6	1.6	0.8	25.5	0.7	25.8	0.7
2-METHYL-1,3-BUTADIENE	37.0	0.3	0.7	0.3	11.3	0.5	0.6	0.3	9.6	0.3	9.4	0.3
TRANS-2-PENTENE	29.7	0.3	0.3	0.2	5.3	0.2	0.3	0.2	6.7	0.2	7.5	0.2
3,3-DIMETHYL-1-BUTENE	4.1	<0.1	ND	ND	0.9	<0.1	ND	ND	0.6	<0.1	0.6	<0.1
CIS-2-PENTENE	17.0	0.2	0.2	0.1	3.0	0.1	0.2	0.1	4.0	0.1	4.3	0.1
2-METHYL-2-BUTENE	70.3	0.6	1.1	0.6	14.9	0.6	1.0	0.5	16.5	0.5	21.4	0.6

TABLE K-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM REFORMULATED GASOLINE

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
CYCLOPENTADIENE	15.6	0.1	0.4	0.2	7.2	0.3	0.4	0.2	13.0	0.4	6.4	0.2
2,2-DIMETHYLBUTANE	35.0	0.3	0.6	0.3	6.1	0.3	0.7	0.4	9.7	0.3	9.0	0.3
CYCLOPENTENE	8.1	0.1	0.1	0.1	2.8	0.1	0.1	<0.1	2.7	0.1	2.2	0.1
4-METHYL-1-PENTENE	32.8	0.3	0.1	0.1	1.9	0.1	0.1	0.1	2.0	0.1	2.0	0.1
3-METHYL-1-PENTENE	15.8	0.1	0.1	<0.1	4.5	0.2	0.1	<0.1	2.8	0.1	1.5	<0.1
CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLBUTANE	116.6	1.0	1.5	0.8	19.1	0.8	1.8	1.0	29.0	0.8	29.6	0.8
MTBE	838.7	7.4	4.5	2.4	130.2	5.4	3.8	2.0	225.3	6.2	72.5	2.0
2,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLPENTANE	4.1	<0.1	2.6	1.4	0.2	<0.1	3.1	1.7	2.3	0.1	2.1	0.1
4-METHYL-TRANS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLPENTANE	116.0	1.0	1.6	0.9	17.4	0.7	1.8	1.0	30.2	0.8	30.8	0.9
2-METHYL-1-PENTENE	14.8	0.1	0.1	0.1	1.9	0.1	0.1	0.1	3.0	0.1	2.8	0.1
1-HEXENE	9.7	0.1	0.2	0.1	1.6	0.1	0.1	0.1	1.7	<0.1	1.8	<0.1
HEXANE	70.3	0.6	1.0	0.5	10.4	0.4	1.1	0.6	18.8	0.5	19.3	0.5
TRANS-3-HEXENE	10.1	0.1	0.1	0.1	1.5	0.1	0.1	0.1	2.4	0.1	2.5	0.1
CIS-3-HEXENE	17.6	0.2	0.2	0.1	2.9	0.1	0.2	0.1	4.1	0.1	4.3	0.1
TRANS-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-TRANS-2-PENTENE	22.1	0.2	0.2	0.1	3.7	0.2	0.2	0.1	5.4	0.1	5.7	0.2
2-METHYL-2-PENTENE	16.0	0.1	0.2	0.1	2.9	0.1	0.2	0.1	3.9	0.1	3.8	0.1
3-METHYLCYCLOPENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEXENE	8.4	0.1	0.1	0.1	1.3	0.1	0.1	<0.1	2.1	0.1	2.2	0.1
ETBE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-CIS-2-PENTENE	17.8	0.2	0.2	0.1	3.1	0.1	0.2	0.1	4.6	0.1	4.9	0.1
2,2-DIMETHYLPENTANE	44.9	0.4	0.6	0.3	6.3	0.3	0.7	0.3	11.4	0.3	11.6	0.3
METHYLCYCLOPENTANE	8.4	0.1	0.1	<0.1	1.7	0.1	0.1	<0.1	1.4	<0.1	1.3	<0.1
2,4-DIMETHYLPENTANE	215.5	1.9	3.0	1.6	33.5	1.4	3.4	1.8	58.1	1.6	60.0	1.7
2,3,3-TRIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLBUTANE	5.0	<0.1	0.2	0.1	0.7	<0.1	0.2	0.1	3.0	0.1	2.7	0.1

TABLE K-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM REFORMULATED GASOLINE

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3,4-DIMETHYL-1-PENTENE	3.4	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	<0.1	0.8	<0.1	0.9	<0.1
1-METHYLCYCLOPENTENE	11.9	0.1	<0.1	<0.1	1.5	0.1	0.2	0.1	3.6	0.1	3.8	0.1
BENZENE	168.5	1.5	7.2	3.8	63.4	2.6	7.9	4.2	120.0	3.3	126.3	3.5
3-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLPENTANE	7.1	0.1	0.1	0.1	2.5	0.1	0.1	<0.1	2.3	0.1	2.2	0.1
CYCLOHEXANE	2.5	<0.1	0.1	<0.1	0.5	<0.1	0.1	<0.1	0.6	<0.1	0.5	<0.1
2-METHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLPENTANE	440.2	3.9	5.9	3.1	66.2	2.8	7.0	3.7	119.4	3.9	122.0	3.4
1,1-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYCLOHEXENE	3.6	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	<0.1	0.6	<0.1	0.6	<0.1
3-METHYLHEXANE	96.5	0.9	1.3	0.7	14.3	0.6	1.5	0.8	27.0	0.7	25.5	0.7
CIS-1,3-DIMETHYLCYCLOPENTANE	11.6	0.1	0.1	0.1	1.5	0.1	0.1	0.1	3.0	0.1	3.0	0.1
3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLPENTANE	763.0	6.8	11.3	6.0	120.7	5.0	12.9	6.9	214.3	5.9	218.5	6.1
2-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-3-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTANE	66.0	0.6	1.1	0.6	10.3	0.4	1.0	0.6	19.1	0.5	19.5	0.5
2-METHYL-2-HEXENE	14.0	0.1	0.2	0.1	1.9	0.1	0.2	0.1	3.8	0.1	4.0	0.1
3-METHYL-TRANS-3-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-2-HEPTENE	7.5	0.1	0.1	<0.1	1.2	0.1	0.1	<0.1	2.0	0.1	1.8	0.1
3-ETHYL-CIS-2-PENTENE	1.9	<0.1	ND	ND	0.3	<0.1	ND	ND	0.4	<0.1	0.5	<0.1
2,4,4-TRIMETHYL-1-PENTENE	10.1	0.1	0.1	0.1	1.5	0.1	0.1	0.1	2.6	0.1	2.3	0.1
2,2,4-TRIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEPTENE	7.6	0.1	0.1	0.1	1.4	0.1	0.1	0.1	2.0	0.1	2.1	0.1
METHYLCYCLOHEXANE	6.7	0.1	0.1	0.1	1.1	<0.1	0.1	0.1	2.0	0.1	2.1	0.1
CIS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE K-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM REFORMULATED GASOLINE

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
2,2-DIMETHYLHEXANE	78.1	0.7	1.2	0.6	12.5	0.5	1.4	0.8	23.1	0.6	24.2	0.7
1,1,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-2-PENTENE	2.9	<0.1	ND	ND	ND	ND	ND	ND	ND	ND	2.0	0.1
2,2,3-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEXANE	98.0	0.9	1.5	0.8	15.3	0.6	1.7	0.9	28.6	0.8	29.1	0.8
1-TRANS-2-CIS-4-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEXANE	9.8	0.1	0.1	0.1	1.6	0.1	0.2	0.1	2.8	0.1	2.9	0.1
1-TRANS-2-CIS-3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,3-TRIMETHYLPENTANE	176.9	1.6	2.4	1.3	26.2	1.1	3.0	1.6	49.0	1.3	50.3	1.4
TOLUENE	842.1	7.5	16.1	8.5	181.4	7.6	16.5	8.8	287.4	7.9	293.3	8.2
2,3-DIMETHYLHEXANE	176.2	1.6	2.0	1.1	24.1	1.0	2.0	1.1	45.6	1.3	45.6	1.3
1,1,2-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLHEPTANE	53.2	0.5	0.8	0.4	7.9	0.3	0.9	0.5	16.6	0.5	16.9	0.5
3,4-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4,4-TETRAMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYLHEPTANE	16.7	0.1	0.2	0.1	2.6	0.1	0.3	0.1	5.3	0.1	5.4	0.1
2-METHYL-3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLHEPTANE	74.2	0.7	1.1	0.6	11.7	0.5	1.3	0.7	23.7	0.6	23.9	0.7
1-CIS,2-TRANS,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,4-DIMETHYLCYCLOHEXANE	103.0	0.9	1.6	0.9	16.9	0.7	1.9	1.0	32.1	0.9	32.6	0.9
3-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,5-TRIMETHYLHEXANE	6.2	0.1	0.1	<0.1	0.9	<0.1	0.1	<0.1	1.8	0.0	1.8	0.1
CIS-1-METHYL-3-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE K-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM REFORMULATED GASOLINE

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1-METHYL-1-ETHYL-CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-OCTENE	5.5	<0.1	0.1	<0.1	1.2	<0.1	0.1	0.1	1.9	0.1	2.0	0.1
TRANS-4-OCTENE	5.3	<0.1	0.1	<0.1	0.9	<0.1	0.1	<0.1	1.7	<0.1	1.6	<0.1
OCTANE	34.4	0.3	0.5	0.3	5.7	0.2	0.6	0.3	11.3	0.3	11.6	0.3
TRANS-2-OCTENE	7.3	0.1	0.1	<0.1	1.2	<0.1	0.1	<0.1	2.3	0.1	2.4	0.1
TRANS-1,3-DIMETHYLCYCLOHEXANE	9.2	0.1	0.1	<0.1	1.5	0.1	0.1	<0.1	2.8	0.1	2.5	0.1
CIS-1,4-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-OCTENE	3.4	<0.1	ND	ND	0.3	<0.1	ND	ND	0.5	<0.1	0.5	<0.1
2,3,5-TRIMETHYLHEXANE	18.4	0.2	0.2	0.1	2.9	0.1	0.3	0.2	5.3	0.1	5.4	0.1
CIS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-2-ETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEPTANE	7.8	0.1	0.7	0.4	1.6	0.1	0.5	0.2	2.6	0.1	2.9	0.1
4,4-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOHEXANE	10.6	0.1	0.1	0.1	1.5	0.1	0.2	0.1	2.9	0.1	3.1	0.1
ETHYLCYCLOHEXANE	17.7	0.2	0.2	0.1	2.8	0.1	0.4	0.2	5.3	0.1	5.4	0.2
PROPYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-4-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,3-TRIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	301.0	2.7	5.3	2.8	61.6	2.6	4.9	2.6	96.0	2.6	99.3	2.8
2,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-& p-XYLENE	662.5	5.9	13.1	6.9	137.2	5.7	12.2	6.5	226.3	6.2	232.6	6.5
4-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLOCTANE	25.3	0.2	0.4	0.2	4.3	0.2	0.5	0.2	9.0	0.2	9.2	0.3

TABLE K-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM REFORMULATED GASOLINE

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3-METHYLOCTANE	16.5	0.1	0.3	0.1	2.7	0.1	0.3	0.2	5.7	0.2	6.3	0.2
STYRENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-XYLENE	219.7	1.9	4.4	2.4	44.5	1.9	4.0	2.1	72.7	2.0	76.3	2.1
2,4,6-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-NONENE	23.0	0.2	0.2	0.1	4.2	0.2	0.4	0.2	8.5	0.2	8.6	0.2
NONANE	18.5	0.2	0.3	0.1	2.9	0.1	0.3	0.2	5.7	0.2	6.4	0.2
ISOPROPYLBENZENE (CUMENE)	11.0	0.1	0.2	0.1	2.1	0.1	0.2	0.1	3.5	0.1	3.7	0.1
2,2-DIMETHYLOCTANE	10.3	0.1	0.1	<0.1	1.9	0.1	0.2	0.1	3.4	0.1	3.5	0.1
2,4-DIMETHYLOCTANE	50.6	0.4	1.0	0.5	10.8	0.5	0.3	0.1	8.1	0.2	5.6	0.2
n-PROPYLBENZENE	33.4	0.3	0.3	0.1	6.4	0.3	0.5	0.3	11.3	0.3	11.6	0.3
1-METHYL-3-ETHYLBENZENE	116.9	1.0	2.6	1.4	26.3	1.1	2.2	1.2	41.7	1.1	43.5	1.2
1-METHYL-4-ETHYLBENZENE	44.3	0.4	1.1	0.6	10.5	0.4	0.9	0.5	16.8	0.5	16.9	0.5
1,3,5-TRIMETHYLBENZENE	44.4	0.4	1.0	0.5	9.4	0.4	0.8	0.4	16.7	0.5	17.3	0.5
1-METHYL-2-ETHYLBENZENE	35.3	0.3	0.5	0.3	10.9	0.5	0.3	0.1	18.3	0.5	12.9	0.4
1,2,4-TRIMETHYLBENZENE	134.5	1.2	3.3	1.7	29.8	1.2	2.4	1.3	50.6	1.4	51.4	1.4
DECANE	2.7	<0.1	0.1	0.1	0.5	<0.1	0.1	<0.1	0.9	<0.1	0.9	<0.1
ISOBUTYLBENZENE	2.6	<0.1	0.1	0.1	0.4	<0.1	0.1	<0.1	0.8	<0.1	0.9	<0.1
METHYLPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-BUTYLBENZENE	4.1	<0.1	0.1	<0.1	0.8	<0.1	0.1	<0.1	1.3	<0.1	1.3	<0.1
1-METHYL-3-ISOPROPYLBENZENE	29.4	0.3	0.6	0.3	5.7	0.2	0.5	0.3	9.8	0.3	10.3	0.3
1,2,3-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-4-ISOPROPYLBENZENE	4.1	<0.1	ND	ND	0.2	<0.1	ND	ND	0.2	<0.1	0.3	<0.1
IND AN	13.7	0.1	ND	ND	1.9	0.1	0.2	0.1	2.7	0.1	5.3	0.1
1-METHYL-2-ISOPROPYLBENZENE	7.5	0.1	0.2	0.1	3.6	0.2	0.2	0.1	7.0	0.2	1.9	0.1
1,3-DIETHYLBENZENE	1.1	<0.1	ND	ND	2.7	0.1	ND	ND	0.3	<0.1	0.3	<0.1
1,4-DIETHYLBENZENE	44.8	0.4	0.4	0.2	11.0	0.5	0.3	0.2	7.6	0.2	8.2	0.2
1-METHYL-3-N-PROPYLBENZENE	11.1	0.1	0.4	0.2	5.2	0.2	0.2	0.1	6.1	0.2	8.6	0.2
1-METHYL-4-N-PROPYLBENZENE	23.4	0.2	0.5	0.2	0.4	<0.1	0.4	0.2	9.3	0.3	9.3	0.3
1,2 DIETHYLBENZENE	20.7	0.2	ND	ND	3.5	0.1	0.1	<0.1	4.7	0.1	1.9	0.1
1-METHYL-2-N-PROPYLBENZENE	1.9	<0.1	ND	ND	0.4	<0.1	0.1	<0.1	0.6	<0.1	0.3	<0.1

TABLE K-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM REFORMULATED GASOLINE

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1,4-DIMETHYL-2-ETHYLBENZENE	12.6	0.1	0.4	0.2	1.4	0.1	0.2	0.1	5.0	0.1	4.6	0.1
1,3-DIMETHYL-4-ETHYLBENZENE	4.2	<0.1	0.1	<0.1	4.7	0.2	ND	ND	1.3	<0.1	1.4	<0.1
1,2-DIMETHYL-4-ETHYLBENZENE	22.8	0.2	0.6	0.3	0.8	<0.1	0.3	0.2	8.9	0.2	8.7	0.2
1,3-DIMETHYL-2-ETHYLBENZENE	2.5	<0.1	ND	ND	0.5	<0.1	0.1	<0.1	0.6	<0.1	0.6	<0.1
UND ECANE	1.3	<0.1	0.2	0.1	0.3	<0.1	0.1	0.1	1.6	<0.1	2.4	0.1
1,2-DIMETHYL-3-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4,5-TETRAMETHYLBENZENE	15.8	0.1	0.4	0.2	3.6	0.1	0.2	0.1	6.2	0.2	5.9	0.2
2-METHYLBUTYLBENZENE (sec AMYLBENZENE)	0.6	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	0.9	<0.1
3,4 DIMETHYLCUMENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,5-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
TERT-1-BUT-2-METHYLBENZENE	10.2	0.1	0.2	0.1	1.0	<0.1	0.1	0.1	3.9	0.1	2.4	0.1
1,2,3,4-TETRAMETHYLBENZENE	ND	ND	ND	ND	1.7	0.1	ND	ND	2.4	0.1	1.1	<0.1
N-PENT-BENZENE	9.3	0.1	0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND	1.8	<0.1
TERT-1-BUT-3,5-DIMETHYLBENZENE	ND	ND	0.8	0.4	8.5	0.4	ND	ND	0.3	<0.1	0.5	<0.1
NAPHTHALENE	1.4	<0.1	ND	ND	0.2	<0.1	ND	ND	0.5	<0.1	0.6	<0.1
DODECANE	1.5	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	0.4	<0.1	1.2	<0.1
FORMALDEHYDE	485.0	4.3	2.7	1.4	97.3	4.1	2.7	1.4	53.8	1.5	20.5	0.6
ACETALDEHYDE	82.4	0.7	0.9	0.5	18.3	0.8	0.8	0.4	9.3	0.3	20.4	0.6
ACROLEIN	51.3	0.5	0.2	0.1	7.2	0.3	0.2	0.1	3.7	0.1	1.4	<0.1
ACETONE	41.4	0.4	0.7	0.4	11.7	0.5	0.9	0.5	7.1	0.2	13.5	0.4
PROPIONALDEHYDE	15.8	0.1	0.1	<0.1	3.8	0.2	0.1	0.1	1.8	<0.1	0.8	<0.1
CROTONALDEHYDE	25.6	0.2	0.1	<0.1	2.2	0.1	0.1	0.1	0.7	<0.1	<0.1	<0.1
ISOBUTYRALDEHYDE	7.8	0.1	<0.1	<0.1	1.8	0.1	0.1	<0.1	0.7	<0.1	0.4	<0.1
METHYL ETHYL KETONE	7.8	0.1	<0.1	<0.1	1.8	0.1	0.1	<0.1	0.7	<0.1	0.4	<0.1
BENZALDEHYDE	60.6	0.5	0.5	0.3	14.0	0.6	0.1	0.1	6.9	0.2	5.1	0.1
HEXANALDEHYDE	4.7	<0.1	ND	ND	1.5	0.1	ND	ND	0.7	<0.1	0.3	<0.1
SUMMATION OF NON-METHANE SPECIES	10773.6	95.4	178.5	94.5	2296.9	95.7	181.8	97.0	3486.0	95.8	3427.0	95.5

ND - not detected

APPENDIX L

AVERAGE SPECIATED EMISSIONS RESULTS FROM FTPs WITH ETHANOL

TABLE L-1. SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM ETHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
METHANE	144.5		54.0		158.1		69.9		166.4		121.6	
ETHANE	35.6	0.3	4.9	0.5	31.1	0.6	5.3	0.6	29.4	0.5	11.9	1.0
ETHYLENE	455.2	4.2	29.2	3.0	310.8	6.0	28.8	3.1	279.8	4.9	32.2	2.8
PROPANE	0.7	<0.1	0.3	<0.1	1.3	<0.1	0.2	<0.1	1.5	<0.1	0.6	<0.1
PROPYLENE	3.8	<0.1	0.6	0.1	3.4	0.1	0.7	0.1	3.0	0.1	1.4	0.1
ACETYLENE	50.4	0.5	15.5	1.6	70.8	1.4	16.5	1.8	80.4	1.4	18.6	1.6
PROPADIENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUTANE	0.2	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
TRANS-2-BUTENE	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.2	<0.1	0.2	<0.1
1-BUTENE	0.5	<0.1	0.2	<0.1	0.4	<0.1	0.2	<0.1	0.3	<0.1	0.3	<0.1
2-METHYLPROPENE (ISOBUTYLENE)	1.2	<0.1	0.1	<0.1	0.7	<0.1	0.1	<0.1	0.5	<0.1	0.1	<0.1
2,2-DIMETHYLPROPANE (NEOPENTANE)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PROPYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-BUTADIENE	1.0	<0.1	0.2	<0.1	0.7	<0.1	0.1	<0.1	0.6	<0.1	0.3	<0.1
2-METHYLPROPANE (ISOBUTANE)	0.2	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	ND	ND	0.8	0.1
1-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHANOL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-BUTENE	0.1	<0.1	0.2	<0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1	0.1	<0.1
3-METHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHANOL	8799.2	81.2	860.2	87.9	4111.0	79.1	798.4	85.5	4694.3	81.8	992.0	85.7
2-METHYLBUTANE (ISOPENTANE)	0.7	<0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1	0.4	<0.1	0.1	<0.1
2-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
1-PENTENE	0.8	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	ND	ND	ND	ND
2-METHYL-1-BUTENE	<0.1	<0.1	<0.1	<0.1	ND	ND	<0.1	<0.1	0.1	<0.1	0.2	<0.1
PENTANE	<0.1	<0.1	0.7	0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.1	<0.1
2-METHYL-1,3-BUTADIENE	0.1	<0.1	ND	ND	0.4	<0.1	<0.1	<0.1	ND	ND	<0.1	<0.1
TRANS-2-PENTENE	0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
3,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-PENTENE	4.3	<0.1	0.1	<0.1	ND	ND	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
2-METHYL-2-BUTENE	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.4	<0.1	0.1	<0.1

TABLE L-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM ETHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
CYCLOPENTADIENE	0.2	<0.1	0.1	<0.1	ND	ND	0.1	<0.1	0.1	<0.1	0.1	<0.1
2,2-DIMETHYLBUTANE	ND	ND	<0.1	<0.1	3.3	0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1
CYCLOPENTENE	<0.1	<0.1	ND	ND	0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1
4-METHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	<0.1	<0.1	0.1	<0.1	ND	ND
3-METHYL-1-PENTENE	0.2	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLBUTANE	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1
MTBE	1.5	<0.1	0.1	<0.1	1.2	<0.1	0.1	<0.1	ND	ND	ND	ND
2,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLPENTANE	0.5	<0.1	0.2	<0.1	0.3	<0.1	0.2	<0.1	0.2	<0.1	<0.1	<0.1
4-METHYL-TRANS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLPENTANE	0.2	<0.1	0.6	0.1	0.8	<0.1	0.2	<0.1	0.3	<0.1	0.1	<0.1
2-METHYL-1-PENTENE	0.3	<0.1	<0.1	<0.1	0.3	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1
1-HEXENE	0.3	<0.1	<0.1	<0.1	0.3	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1
HEXANE	0.2	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
TRANS-3-HEXENE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1
CIS-3-HEXENE	0.1	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
TRANS-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-TRANS-2-PENTENE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	0.1	<0.1	0.1	<0.1
2-METHYL-2-PENTENE	ND	ND	<0.1	<0.1	0.3	<0.1	ND	ND	0.1	<0.1	ND	ND
3-METHYLCYCLOPENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEXENE	2.5	<0.1	0.1	<0.1	ND	ND	0.1	<0.1	0.3	<0.1	0.1	<0.1
ETBE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-CIS-2-PENTENE	ND	ND	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1
2,2-DIMETHYLPENTANE	0.3	<0.1	0.1	<0.1	0.4	<0.1	<0.1	<0.1	0.5	<0.1	<0.1	<0.1
METHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLPENTANE	0.3	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2,3,3-TRIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLBUTANE	0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1

TABLE L-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM ETHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3,4-DIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYLCYCLOPENTENE	<0.1	<0.1	<0.1	<0.1	ND	ND	<0.1	<0.1	0.4	<0.1	<0.1	<0.1
BENZENE	1.8	<0.1	0.6	0.1	1.6	<0.1	0.7	0.1	1.6	<0.1	1.0	0.1
3-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYCLOHEXANE	0.3	<0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1
2-METHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLPENTANE	0.6	<0.1	0.1	<0.1	0.2	<0.1	0.2	<0.1	0.2	<0.1	1.1	0.1
1,1-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYCLOHEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLHEXANE	0.2	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	2.3	0.2
CIS-1,3-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND
3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLPENTANE	1.8	<0.1	0.2	<0.1	0.7	<0.1	0.4	<0.1	0.7	<0.1	0.2	<0.1
2-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-3-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTANE	0.2	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2-METHYL-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
3-METHYL-TRANS-3-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-2-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-ETHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
2,2,4-TRIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE L-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM ETHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
2,2-DIMETHYLHEXANE	0.3	<0.1	0.1	<0.1	ND	ND	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
1,1,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-2-PENTENE	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEXANE	0.3	<0.1	<0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1-TRANS-2-CIS-4-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-TRANS-2-CIS-3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,3-TRIMETHYLPENTANE	0.3	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.3	<0.1	0.1	<0.1
TOLUENE	2.3	<0.1	0.5	<0.1	1.0	<0.1	0.5	0.1	1.7	<0.1	0.8	0.1
2,3-DIMETHYLHEXANE	0.4	<0.1	ND	ND	0.1	<0.1	ND	ND	0.1	<0.1	0.1	<0.1
1,1,2-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
3,4-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4,4-TETRAMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
1-CIS,2-TRANS,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,4-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1	<0.1	<0.1
3-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,5-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
CIS-1-METHYL-3-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE L-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM ETHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1-METHYL-1-ETHYL-CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-4-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
OCTANE	ND	ND	ND	ND	<0.1	<0.1	ND	ND	ND	ND	0.2	<0.1
TRANS-2-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,4-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,5-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-2-ETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEPTANE	0.6	<0.1	1.4	0.1	1.0	<0.1	1.2	0.1	0.3	<0.1	0.8	0.1
4,4-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
ETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PROPYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-4-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,3-TRIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	0.4	<0.1	0.1	<0.1	0.3	<0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1
2,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-& p-XYLENE	1.0	<0.1	0.1	<0.1	0.5	<0.1	0.2	<0.1	0.3	<0.1	0.3	<0.1
4-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLOCTANE	ND	ND	ND	ND	0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1

TABLE L-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM ETHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	<0.1
STYRENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-XYLENE	0.3	<0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.2	<0.1
2,4,6-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-NONENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NONANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOPROPYLBENZENE (CUMENE)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
2,2-DIMETHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
2,4-DIMETHYLOCTANE	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND	0.1	<0.1
n-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1	<0.1	<0.1
1-METHYL-3-ETHYLBENZENE	0.3	<0.1	0.1	<0.1	0.2	<0.1	0.1	<0.1	0.3	<0.1	0.1	<0.1
1-METHYL-4-ETHYLBENZENE	0.1	<0.1	<0.1	<0.1	ND	ND	<0.1	<0.1	0.1	<0.1	0.2	<0.1
1,3,5-TRIMETHYLBENZENE	0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	0.2	<0.1	0.4	<0.1
1-METHYL-2-ETHYLBENZENE	0.1	<0.1	ND	ND	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1
1,2,4-TRIMETHYLBENZENE	0.5	<0.1	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.3	<0.1	0.2	<0.1
DECANE	0.1	<0.1	0.2	<0.1	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1
ISOBUTYLBENZENE	0.1	<0.1	0.2	<0.1	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1
METHYLPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-BUTYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-3-ISOPROPYLBENZENE	0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2,3-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-4-ISOPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
IND AN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
1-METHYL-2-ISOPROPYLBENZENE	<0.1	<0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1	<0.1	<0.1
1,3-DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	<0.1
1-METHYL-3-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-4-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2 DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-2-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE L-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM ETHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1,4-DIMETHYL-2-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DIMETHYL-4-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DIMETHYL-4-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
1,3-DIMETHYL-2-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
UND ECANE	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1
1,2-DIMETHYL-3-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
1,2,4,5-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLBUTYLBENZENE (sec AMYLBENZENE)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,4 DIMETHYLCUMENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,5-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERT-1-BUT-2-METHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1
1,2,3,4-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-PENT-BENZENE	0.2	<0.1	0.3	<0.1	0.1	<0.1	0.2	<0.1	ND	ND	ND	ND
TERT-1-BUT-3,5-DIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DODECANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1
FORMALDEHYDE	318.2	2.9	6.1	0.6	166.1	3.2	5.3	0.6	172.4	3.0	7.2	0.6
ACETALDEHYDE	1131.2	10.4	52.5	5.4	478.1	9.2	66.2	7.1	458.4	8.0	63.4	5.5
ACROLEIN	10.5	0.1	0.4	<0.1	5.8	0.1	0.6	0.1	3.1	0.1	0.4	<0.1
ACETONE	0.1	<0.1	0.2	<0.1	0.2	<0.1	2.8	0.3	0.4	<0.1	9.9	0.9
PROPIONALDEHYDE	1.6	<0.1	0.2	<0.1	0.6	<0.1	0.9	0.1	0.9	<0.1	0.8	0.1
CROTONALDEHYDE	0.2	<0.1	0.3	<0.1	ND	ND	0.5	0.1	0.1	<0.1	0.8	0.1
ISOBUTYRALDEHYDE	ND	ND	0.1	<0.1	ND	ND	0.2	<0.1	0.2	<0.1	0.7	0.1
METHYL ETHYL KETONE	ND	ND	0.1	<0.1	ND	ND	0.2	<0.1	0.2	<0.1	0.7	0.1
BENZALDEHYDE	0.9	<0.1	<0.1	<0.1	0.5	<0.1	0.2	<0.1	0.5	<0.1	0.1	<0.1
HEXANALDEHYDE	ND	ND	ND	ND	ND	ND	0.1	<0.1	ND	ND	0.8	0.1
SUMMATION OF NON-METHANE COMPOUNDS	10836.6	100.0	978.3	100.0	5198.0	100.0	933.6	99.9	5737.8	99.9	1155.2	99.8

ND - not detected

APPENDIX M

AVERAGE SPECIATED EMISSIONS RESULTS FROM FTPs WITH METHANOL

TABLE M-1. SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM METHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
METHANE	14.1		6.3		27.5		12.5		27.5		23.9	
ETHANE	0.4	<0.1	0.1	<0.1	0.8	<0.1	0.2	<0.1	0.7	<0.1	0.4	0.1
ETHYLENE	7.4	0.1	0.3	0.1	10.6	0.2	0.6	0.1	7.5	0.2	0.3	<0.1
PROPANE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PROPYLENE	1.9	<0.1	0.1	<0.1	1.9	<0.1	0.1	<0.1	1.7	<0.1	0.1	<0.1
ACETYLENE	2.7	<0.1	0.8	0.1	4.2	0.1	0.3	0.1	4.4	0.1	0.5	0.1
PROPADIENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUTANE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
TRANS-2-BUTENE	0.2	<0.1	ND	ND	0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1
1-BUTENE	0.3	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
2-METHYLPROPENE (ISOBUTYLENE)	0.9	<0.1	0.1	<0.1	0.7	<0.1	<0.1	<0.1	0.7	<0.1	0.1	<0.1
2,2-DIMETHYLPROPANE (NEOPENTANE)	<0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1
PROPYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-BUTADIENE	0.6	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.4	<0.1	ND	ND
2-METHYLPROPANE (ISOBUTANE)	ND	ND	ND	ND	<0.1	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1
1-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHANOL	7860.0	91.0	623.1	95.4	4969.8	91.7	602.9	95.2	4403.5	92.1	747.3	95.2
CIS-2-BUTENE	0.1	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3-METHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHANOL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLBUTANE (ISOPENTANE)	0.8	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	0.4	<0.1	0.1	<0.1
2-BUTYNE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-PENTENE	ND	ND	ND	ND	0.1	<0.1	ND	ND	0.2	<0.1	0.1	<0.1
2-METHYL-1-BUTENE	0.2	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1
PENTANE	0.3	<0.1	0.1	<0.1	0.3	<0.1	0.1	<0.1	0.7	<0.1	0.3	<0.1
2-METHYL-1,3-BUTADIENE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND
TRANS-2-PENTENE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
3,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1	ND	ND
CIS-2-PENTENE	0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-METHYL-2-BUTENE	0.2	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1

TABLE M-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM METHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
CYCLOPENTADIENE	0.2	<0.1	ND	ND	0.1	<0.1	ND	ND	0.1	<0.1	ND	ND
2,2-DIMETHYLBUTANE	0.2	<0.1	0.1	<0.1	0.3	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
CYCLOPENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-1-PENTENE	0.1	<0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
3-METHYL-1-PENTENE	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND	0.1	<0.1	0.1	<0.1
CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLBUTANE	0.2	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
MTBE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLPENTANE	0.3	<0.1	0.2	<0.1	0.4	<0.1	0.1	<0.1	0.6	<0.1	0.4	<0.1
4-METHYL-TRANS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLPENTANE	0.3	<0.1	0.4	0.1	0.3	<0.1	0.1	<0.1	0.3	<0.1	0.5	0.1
2-METHYL-1-PENTENE	0.1	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1-HEXENE	0.1	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HEXANE	0.2	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	0.2	<0.1
TRANS-3-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1	0.1	<0.1
CIS-3-HEXENE	0.2	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TRANS-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-TRANS-2-PENTENE	0.1	<0.1	ND	ND	0.1	<0.1	ND	ND	0.1	<0.1	0.1	<0.1
2-METHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	0.1	<0.1	<0.1	<0.1
3-METHYLCYCLOPENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEXENE	<0.1	<0.1	ND	ND	ND	ND	ND	ND	0.1	<0.1	0.1	<0.1
ETBE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-CIS-2-PENTENE	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2,2-DIMETHYLPENTANE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
METHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLPENTANE	0.3	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2,3,3-TRIMETHYL-1-BUTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLBUTANE	0.2	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1

TABLE M-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM METHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3,4-DIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYLCYCLOPENTENE	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1
BENZENE	1.4	<0.1	0.1	<0.1	1.4	<0.1	0.1	<0.1	1.6	<0.1	0.2	<0.1
3-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYCLOHEXANE	0.2	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
2-METHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYLPENTANE	0.4	<0.1	0.1	<0.1	0.3	<0.1	0.1	<0.1	0.3	<0.1	0.4	<0.1
1,1-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYCLOHEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLHEXANE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
CIS-1,3-DIMETHYLCYCLOPENTANE	ND	ND	<0.1	<0.1	ND	ND	ND	ND	0.1	<0.1	<0.1	<0.1
3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLPENTANE	1.7	<0.1	0.2	<0.1	1.1	<0.1	0.1	<0.1	1.2	<0.1	0.4	0.1
2-METHYL-1-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-3-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTANE	0.2	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
2-METHYL-2-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYL-TRANS-3-HEXENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-2-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-ETHYL-CIS-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYL-1-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3-DIMETHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-HEPTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE M-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM METHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
2,2-DIMETHYLHEXANE	0.3	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1
1,1,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYL-2-PENTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,3-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEXANE	0.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEXANE	0.3	<0.1	0.1	<0.1	0.2	<0.1	ND	ND	0.2	<0.1	0.1	<0.1
1-TRANS-2-CIS-4-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-TRANS-2-CIS-3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4-TRIMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,3-TRIMETHYLPENTANE	0.5	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	0.3	<0.1	0.1	<0.1
TOLUENE	2.9	<0.1	0.7	0.1	0.6	<0.1	0.2	<0.1	1.8	<0.1	0.7	0.1
2,3-DIMETHYLHEXANE	0.4	<0.1	ND	ND	ND	ND	ND	ND	0.1	<0.1	ND	ND
1,1,2-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLHEPTANE	ND	ND	<0.1	<0.1	ND	ND	ND	ND	ND	ND	ND	ND
3,4-DIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4,4-TETRAMETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-METHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-3-ETHYLPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-METHYLHEPTANE	ND	ND	<0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	ND	ND
1-CIS,2-TRANS,3-TRIMETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,4-DIMETHYLCYCLOHEXANE	0.1	<0.1	ND	ND	0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND
3-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,5-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1-METHYL-3-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE M-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM METHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1-METHYL-1-ETHYL-CYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-4-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
OCTANE	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
TRANS-2-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRANS-1,3-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,4-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-2-OCTENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,5-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1-METHYL-2-ETHYLCYCLOPENTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-2-ETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLHEPTANE	0.4	<0.1	1.0	0.2	0.6	<0.1	1.0	0.2	0.5	<0.1	0.9	0.1
4,4-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-DIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PROPYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYL-4-ETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,3-TRIMETHYLCYCLOHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,5-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETHYLBENZENE	0.2	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1
2,3-DIMETHYLHEPTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m-& p-XYLENE	0.6	<0.1	0.1	<0.1	0.3	<0.1	0.1	<0.1	0.4	<0.1	0.1	<0.1
4-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE M-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM METHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
3-METHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
STYRENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
o-XYLENE	0.2	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.3	<0.1	0.1	<0.1
2,4,6-TRIMETHYLHEXANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-NONENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NONANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOPROPYLBENZENE (CUMENE)	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
2,2-DIMETHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DIMETHYLOCTANE	ND	ND	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
n-PROPYLBENZENE	ND	ND	<0.1	<0.1	ND	ND	ND	ND	<0.1	<0.1	ND	ND
1-METHYL-3-ETHYLBENZENE	0.3	<0.1	ND	ND	0.2	<0.1	<0.1	<0.1	0.3	<0.1	0.1	<0.1
1-METHYL-4-ETHYLBENZENE	0.1	<0.1	ND	ND	0.2	<0.1	<0.1	<0.1	0.1	<0.1	ND	ND
1,3,5-TRIMETHYLBENZENE	0.1	<0.1	ND	ND	0.1	<0.1	ND	ND	0.1	<0.1	<0.1	<0.1
1-METHYL-2-ETHYLBENZENE	<0.1	<0.1	ND	ND	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND
1,2,4-TRIMETHYLBENZENE	0.6	<0.1	0.2	<0.1	0.3	<0.1	0.1	<0.1	0.6	<0.1	0.1	<0.1
DECANE	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.2	<0.1
ISOBUTYLBENZENE	0.2	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1
METHYLPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-BUTYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-3-ISOPROPYLBENZENE	<0.1	<0.1	ND	ND	ND	ND	ND	ND	<0.1	<0.1	ND	ND
1,2,3-TRIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-4-ISOPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IND AN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-2-ISOPROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-3-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-4-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2 DIETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-METHYL-2-N-PROPYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE M-1 (CONT'D). SUMMARY OF SPECIATED EXHAUST EMISSIONS FROM METHANOL

Compound	Operating Conditions											
	Lean				Stoichiometric				Rich			
	Without Catalyst		With Catalyst		Without Catalyst		With Catalyst		Without Catalyst		With Catalyst	
	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %	FTP mg/mi	NMOG wt %
1,4-DIMETHYL-2-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DIMETHYL-4-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DIMETHYL-4-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DIMETHYL-2-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
UND ECANE	<0.1	<0.1	ND	ND	<0.1	<0.1	0.1	<0.1	ND	ND	ND	ND
1,2-DIMETHYL-3-ETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4,5-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-METHYLBUTYLBENZENE (sec AMYLBENZENE)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,4 DIMETHYLCUMENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,5-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERT-1-BUT-2-METHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3,4-TETRAMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-PENT-BENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TERT-1-BUT-3,5-DIMETHYLBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPHTHALENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DODECANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FORMALDEHYDE	736.1	8.5	23.9	3.7	409.3	7.6	24.4	3.8	343.8	7.2	29.7	3.8
ACETALDEHYDE	6.3	0.1	0.1	<0.1	8.7	0.2	0.9	0.1	1.9	<0.1	0.1	<0.1
ACROLEIN	0.8	<0.1	ND	ND	1.4	<0.1	<0.1	<0.1	0.3	<0.1	ND	ND
ACETONE	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PROPIONALDEHYDE	0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CROTONALDEHYDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ISOBUTYRALDEHYDE	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1
METHYL ETHYL KETONE	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1	ND	ND	<0.1	<0.1
BENZALDEHYDE	0.5	<0.1	ND	ND	0.1	<0.1	0.5	0.1	<0.1	<0.1	<0.1	<0.1
HEXANALDEHYDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SUMMATION OF NON-METHANE COMPOUNDS	8634.5	99.9	653.0	99.9	5418.6	100.0	633.1	100.0	4778.9	100.0	785.1	100.0

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13. ABSTRACT *(Maximum 200 words)* This report describes the laboratory effort to identify and quantify organic exhaust species generated from alternative fuel light-duty vehicles operating over the Federal Test Procedure on compressed natural gas, liquefied petroleum gas, methanol, ethanol, and reformulated gasoline. The exhaust species from these vehicles were identified and quantified for fuel/air equivalence ratios of 0.8, 1.0, and 1.2, nominally, and were analyzed with and without a vehicle catalyst in place to determine the influence of a catalytic converter on species formation.

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