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# Evaluation of Aftermarket LPG Conversion Kits in Light-Duty Vehicle Applications

## Final Report

E.A. Bass

*Southwest Research Institute*
*San Antonio, TX*

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393
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# Preface

The National Renewable Energy Laboratory (NREL), as the field program manager for the U.S. Department of Energy (DOE) Alternative Fuels Utilization Program, seeks to assist and promote the development of technology required to facilitate the use of alternative fuels for transportation applications. Alternative fuels include compressed natural gas (CNG) and liquefied petroleum gas (LPG).

There are two major reasons for advancing these fuels. The first is the potential for reducing harmful vehicle emissions. Much has been published on the emissions of CNG-fueled vehicles, but not nearly as much published on the subject of LPG emissions. The second reason for advancing the use of CNG and LPG is that their use could displace a portion of the imported petroleum required by the transportation sector.

The conversion of existing vehicles to allow the utilization of alternative fuels is one means of facilitating a commercial market. Several manufacturers and conversion facilities are already in this market. It is essential that the commercial conversion technology provide acceptable safety, power, fuel economy, and emissions. This project was conducted to provide precise, independent evaluations of current-technology LPG fuel conversion systems in a light-duty vehicle. The evaluation focused on fuel economy and emissions, using three current conversion systems.

The author would like to thank the sponsors and their representatives who were responsible for funding this project: Brent Bailey of NREL, and Steve Jaeger of the Texas Railroad Commission's Alternative Fuels Research and Education Division (TRRC-AFRED). The project also would not have been possible without the dedicated and efficient laboratory staff at Southwest Research Institute (SwRI), including Wayne Costello, Rudy Guerra, Sharon Tondre, Andy Maldonado, Lisa Swaim, and Sylvia Niño.

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# Introduction

SwRI was contracted by NREL to evaluate three LPG conversion kits on a Chevrolet Lumina. The objective of the project was to measure the Federal Test Procedure (FTP) emissions and fuel economy of these kits, and compare their performance to gasoline-fueled operation and to each other. Varying LPG fuel blends allowed a preliminary look at the potential for fuel system disturbance. The project required kit installation and adjustment according to manufacturer's instructions. A limited amount of trouble diagnosis was also performed on the fuel systems.

A simultaneous contract from the Texas Railroad Commission, in cooperation with NREL, provided funds for additional testing with market fuels (HD5 propane and industry average gasoline) and hydrocarbon (HC) emissions speciation to determine the ozone-forming potential of LPG HC emissions.

# Test Program

The approach was designed to evaluate current LPG conversion kits, with a range of fuel compositions on a late model light-duty vehicle. To meet NREL's requirements (and emissions speciation for the Texas Railroad Commission), SwRI developed a project based on the following elements.

| | |
|---|---|
| Test Vehicle: | 1992 Chevrolet Lumina, 3.1 L, with port fuel injection |
| Test Kits: | (1) IMPCO ADP adaptive digital processor<br>(2) IMPCO AFCP-1 automated fuel control processor<br>(3) MOGAS ECOLO feedback control system |
| Test Fuels: | (1) 98% propane, 2% butane<br>(2) 92% propane, 8% butane<br>(3) 85% propane, 5% propylene, 10% butane<br>(4) 96% propane, HD5 market LPG (procured by TRRC-AFRED) |
| Evaluations: | FTP emissions and fuel economy<br>Baseline gasoline and LPG conversions with fuel blends<br>HC emissions speciation sponsored by the TRRC-AFRED |

### Task 1: Test Vehicle Procurement

The test vehicle configuration prescribed by NREL was analogous to a variable-fuel vehicle (VFV M85/E85) Chevrolet Lumina. The first test vehicle selected was a 1991 Lumina, which was purchased new by SwRI for use in an intake valve deposit (IVD) test. This test is an industry standard procedure that consists of 10% city driving, 20% suburban driving, and 70% highway driving. All maintenance during the 41,600 miles of testing was logged by SwRI staff. Based on the known history of the vehicle, (which was commuter service), inspection of engine and emissions control components, a preliminary tailpipe emissions check, and the reasonable results of the first FTP baseline test, the vehicle was believed to be a good test bed to represent typical late model vehicles that could be converted to LPG fuel.

At the request of the sponsor, an alternate test vehicle was rented from Avis. This was necessary to meet an objective that results be compared to other data collected in the DOE Alternative Fuels Utilization Program. The vehicle was a 1992 Chevrolet Lumina two-door with 17,800 miles. Some of the vehicle assembly codes are listed in Table 1. The SwRI staff performed a computer diagnostic check, inspected the engine and emission control components, and compared the engine identification codes with Environmental Protection Agency (EPA) certification data prior to accepting the vehicle. Average results of the FTP baseline tests on this vehicle with "EEE" reference gasoline are presented in Table 2.

**Table 1. Test Vehicle Assembly Codes**

| Option | Code | Description |
|---|---|---|
| Engine | LHO | 3.1 L port fuel injection |
| Emission System | NA5 | not available |
| Exhaust System | NC6 | not available |
| Transmission | MD9 | three-speed automatic |
| Transaxle Ratio | F17 | 2.84:1 |
| Wheels | PH3 | 15-inch diameter |
| Tires | DIN | P205/70R15 |
| Plant Code | OSH | not available |

**Table 2. Chevrolet Lumina Emission Test Data Comparison (FTP Cycle)**

| Test Results | HC g/mile | CO g/mile | NOx g/mile |
|---|---|---|---|
| EPA Standard | 0.41 | 3.4 | 1.0 |
| EPA '91-'92 Certification Data | 0.22 | 2.5 | 0.53 |
| NREL '92 Published Data | 0.15 | 1.00 | 0.12 |
| NREL '92 M-85 Lumina | 0.11 | 1.70 | 0.07 |
| SwRI '91-'92 Luminas (range of 6 cars) | 0.17-0.73 | 2.11-6.14 | 0.27-0.51 |
| '91 Test Car Baseline (Test 1) | 0.38 | 4.06 | 0.55 |
| **'92 Test Car Baseline (EEE) Average** | **0.32** | **4.25** | **0.40** |
| NREL Lumina Data Base (average of 9 runs on 4 cars) | 0.26 | 3.10 | 0.33 |

The project vehicle can be compared to previous data in Table 2. These data illustrate how results vary between vehicles sampled. Even within one laboratory, CO varied about 4 g/mile among 6 identically configured Luminas with less than 10,000 miles on the odometers. The '91 test car exhibited emissions slightly above normal. The '92 test car (employed for the conversion project) was closer to expected levels, but still slightly above the CO standard.

## Task 2: LPG Conversion Kit Procurement

### *Kit Availability/Procurement*

LPG conversion kits were not as readily available as reported by manufacturers and suppliers. SwRI found that there were very few organizations ready to supply conversion kits (without adaptation) for the Chevrolet Lumina.

Stewart and Stevenson GFI could not deliver a kit until "sometime in January 1993." Evidently, the system was not yet commercially available. Century Products (affiliated with Vialle Autogas Systems and also known as Pacer Industries) has "never developed this specific kit" either. This was confirmed by both Vialle and Pacer company representatives. Garretson (which was taken over by MESA, Inc.) was originally planned as the second kit supplier, but there was negative response to our purchase order. MESA reported that the Garretson conversion system would not be a good candidate for evaluation, and that some parts would have required custom fabrication. SwRI did not believe this was the intent of the project, so did not pursue this source. MOGAS Fuel Systems Inc. was selected as an alternative kit supplier because this group had a kit readily available for the Lumina.

Other kit suppliers, not listed in the NREL statement of work, were also investigated. Eagle Propane (which supplies OHG, Inc. systems) responded negatively. SLP Engineering is a company that has publicized a kit for the Lumina that achieves California's low emission vehicle (LEV) standard; however, the SLP product will not be available until late 1993. S. Jaeger of the Texas Railroad Commission (sponsor of the HC speciation), procured an additional electronic closed-loop control system from Autotronics, Inc. This system utilizes IMPCO hardware with the exception of the fuel control valve. Interestingly, it specifies an adjustment for vehicles with DIS (direct ignition system) spark control such as the Lumina.

The Autotronics kit was not included in the evaluation because three kits had already been selected. The three kits selected for evaluation were the IMPCO ADP, IMPCO AFCP-1, and the MOGAS ECOLO systems; and they are discussed in detail below.

### *IMPCO ADP Kit*

The ADP is IMPCO's best offering for the Lumina. As received from the IMPCO supplier, L.E. Klein, Inc., the package included paper packing material; but only the electronic components were enclosed in individual boxes. The outer box was badly crushed near the bottom, but no parts were visibly damaged. Components inventoried by SwRI were as follows.

- Autotronics 8690 dual curve ignition accessories (instruction sheet indicates it monitors "Service Engine" codes)
- IMPCO AH3-14209 ADP module
- IMPCO VFF30-2 (SN290911) fuel lock/filter including hoses and fittings
- IMPCO JB (SN290114) regulator
- IMPCO 225 fuel mixer
- 350 psi weatherhead hose
- Heater hose
- Wire reinforced 1-in. Hose
- Instructions (IMPCO 23600-71 ADP)

The IMPCO ADP and AFCP-1 fuel systems use "air valve" (or above throttle) vacuum as the signal to actuate both the fuel lock and the converter (or regulator). Closed-loop control actuation is performed by a "fuel control valve." This is a solenoid valve installed in the air valve vacuum line. It limits the response of the converter diaphragm by restricting the vent when the fuel processor sends a pulsed signal to open and close the valve. The ADP system uses a speed-density control algorithm and an original equipment manufacturer (OEM) exhaust oxygen sensor to control the solenoid valve. It reportedly has 16 "cells" in a non-volatile memory table to store learned responses. The AFCP-1 does not have the learning feature, nor does it use manifold pressure as a control signal. Both systems are limited in their range of control because the solenoid valve can only be used to restrict the converter diaphragm. This gives only a lean control mode.

### *IMPCO AFCP-1 Kit*

The IMPCO AFCP-1 was the second IMPCO kit selected for evaluation. It was the predecessor of the ADP kit. The AFCP-1 used the same fuel lock, converter, and mixer as the ADP system.

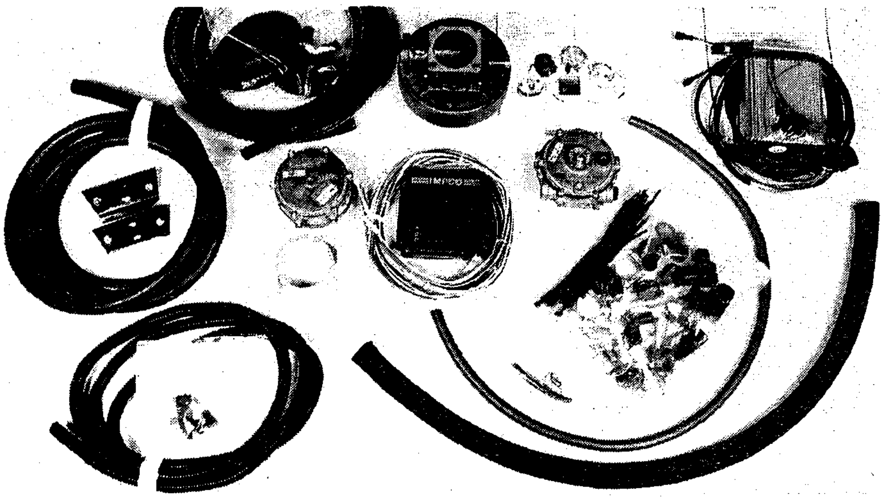
### *MOGAS ECOLO Kit*

MOGAS Sales' of Canada "ECOLO Feedback" propane conversion system (Kit No. 3 of this project) was received on December 28 in good condition. The inventory of the MOGAS kit is shown below.

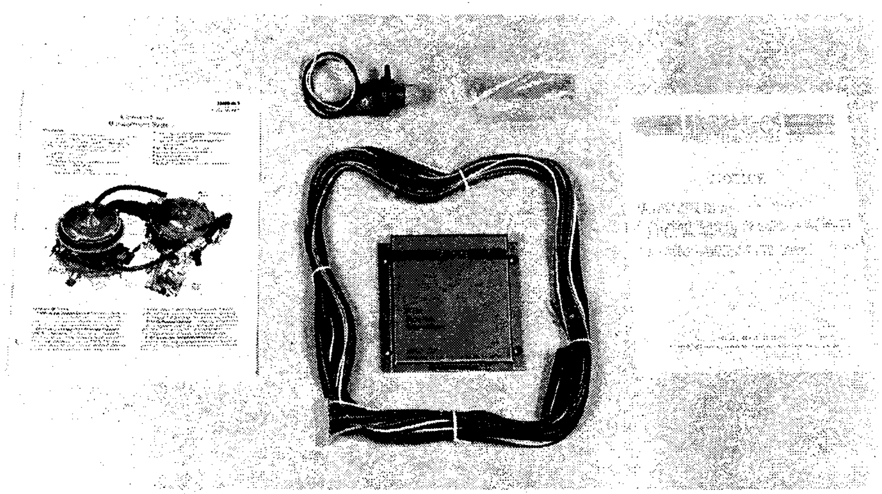
- 16.100.100 ECOLO feedback control (small)
- 09.01.505/5 regulator LPG R90/1/E (product of Italy)
- 16.40.031 kit mixer GM 3.1L M.P.F.I.
- 09.02.142 lock off and filter LP gas (AFC)
- 05.50.146 kit computer support, 8690 CARB approved-GM Autotronics
- 05.00.111 electric shut-off (E.S.O.) programmable
- 07.70.601 hose assy. 3/8-in. x 1-ft high pressure hose
- Mounting bracket ~1 in. x 12 in. x 0.25 in. with 2 holes and a mounted stud
- Low pressure hose - 1 in. x 4 ft
- Heater hose - 5/8 in. x 6 ft
- 2 miscellaneous bags of hose fittings, clamps, ties, and fasteners
- MOGAS systems diagrams and Autotronic Controls instructions

The MOGAS ECOLO closed-loop control system uses only the exhaust oxygen sensor to regulate its control valve. The fuel control valve in this case is installed between the regulator and the mixer. It has a diaphragm with a vacuum source regulated by a solenoid valve. Manual adjustments are possible on the fuel control valve, the regulator, and the fuel lock solenoid. The fuel lock solenoid is controlled by the ESO, which is signaled by the ignition switch and spark plug ignition.

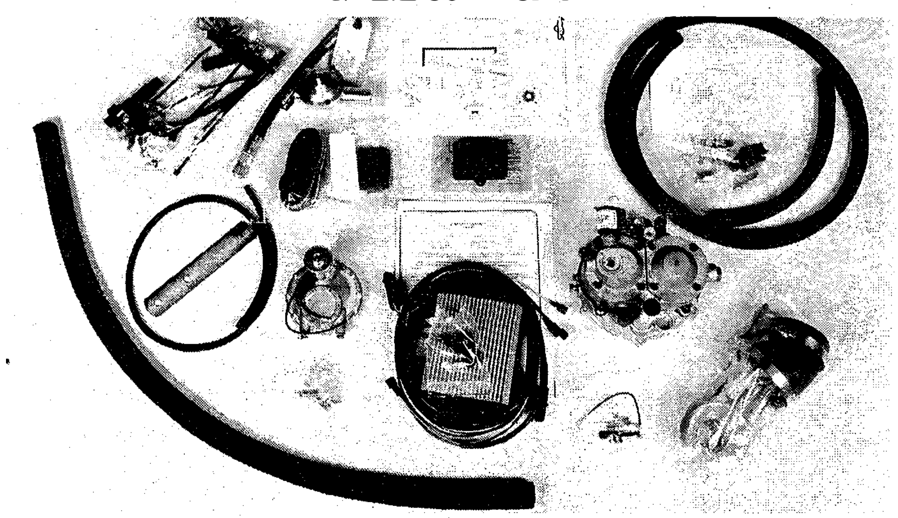
One observation about the kits was that the Autotronic Controls Corp. No. 8690 computer-code module is a common component for each. Another observation was that all three used engine coolant in the regulator to control fuel temperature. The hardware of the kits was photographed for further documentation of the components (see Figure 1). Photographs were also taken of the engine before and after IMPCO and MOGAS hardware was installed on the test vehicle, as shown in Fi_ure 2.




a. IMPCO ADP

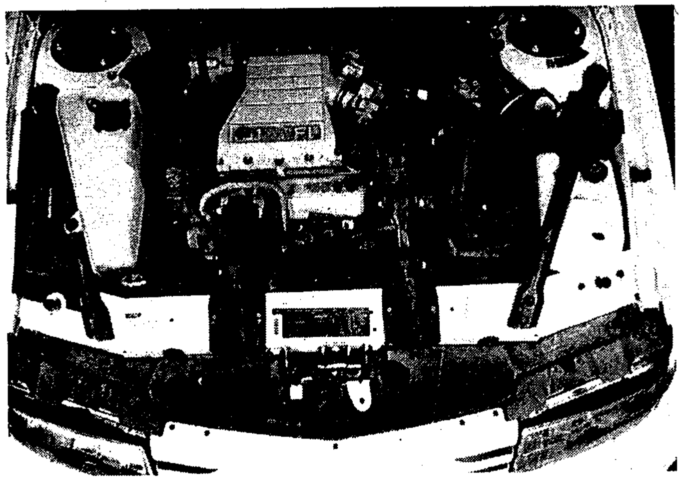


b. IMPCO AFCP-1

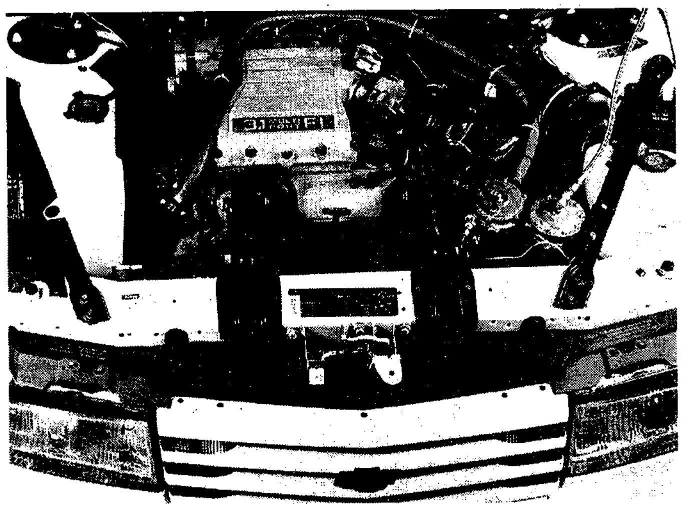


c. MOGAS ECOLO

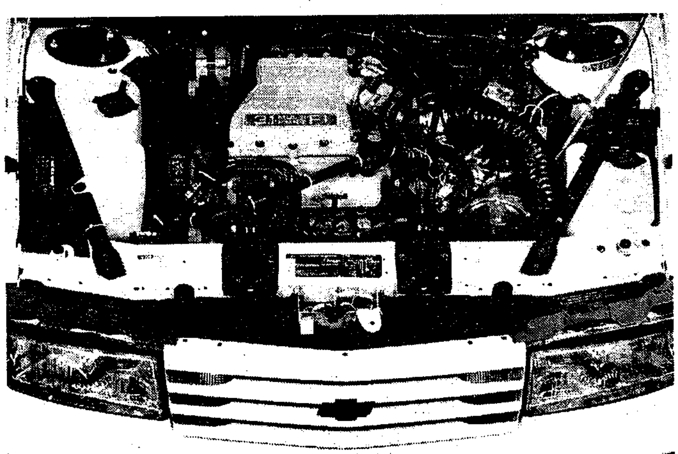
**Figure 1. LPG Conversion Kit Components**



a. Original Lumina 3.1 L Engine Compartment



b. IMPCO ADP and AFCP-1 Installations



c. MOGAS ECOLO Installation

**Figure 2. LPG Kit Installation**

## Task 3: Test Fuel Procurement

The effect of CNG composition on emissions has been documented (King 1992). The current project included multiple LPG fuel blends to study the effects on vehicle emissions. Liquid Carbonic Specialty Gas Corporation delivered three test fuels in December 1992. The Railroad Commission also procured a market grade fuel, designed to meet the HD5 specification, from Petrolane Gas Company. This HD5 fuel, unlike the three blends, is a typical refinery product. The following compositions were obtained by SwRI using a Varian 1700 FID Gas Chromatograph with 10-ft x 1/8-in. Hayesep D Column and Valco 10-port injection valve. Results are shown in Table 3. The test fuels were within 1% of the NREL specifications for this project, which were an average composition LPG (approximately 92% propane), a low propane composition LPG (approximately 85% propane, 5% propylene), and a high propane composition LPG (approximately 98%).

**Table 3. LPG Fuel Analysis by SWRI**

| Fuel Code | Cylinder Code | Propane Mole % | Butane Mole % | Propylene Mole % | Ethane Mole % | Other Mole % | Hydrogen/ Carbon Ratio |
|---|---|---|---|---|---|---|---|
| P98 | R249933 | 98.0 | 2.0 | 0.0 | 0.0 | 0.0 | 2.66 |
| P92 | B0059036 | 91.6 | 8.4 | 0.0 | 0.0 | 0.0 | 2.65 |
| P85 | A01468845 | 84.7 | 10.3 | 5.0 | 0.0 | 0.0 | 2.62 |
| HD5 | A55393 | 95.5 | 0.3 | 0.1 | 4.0 | 0.1 | 2.68 |

## Task 4: Conversion Kit Installation

We observed several installation discrepancies on the IMPCO ADP system. These comments also apply to the AFCP system (Kit No. 2).

- The kit did not include duct hoses to connect the mixer to the air cleaner and the mixer to the throttle body. The OEM hose could not be adapted for these uses.
- The mixer (or carburetor) could not fit between the air cleaner and the throttle body. To accommodate the mixer, the air cleaner had to be relocated.
- Instructions were incomplete. This is particularly true with regard to the mixer (the direction of air flow is not labeled), the filter/fuel lock (the air valve vacuum port was not described), and the plumbing (connections for the components, the fuel tank, and the coolant).
- The initial adjustments could not be performed as described by the manual. The idle fuel mixture was monitored with a calibrated portable CO instrument. A jumper wire must be connected, but the terminals are not clearly identified. An incorrect connection (on the first attempt) caused very lean operation.

- The IMPCO FSA (fuel system analyzer) was essential for adjustment and diagnosis of the system, but it was not included in the kits.

The MOGAS system was installed more easily than the IMPCO because it had fewer sensor wires and vacuum hoses. There were, however, several discrepancies in the installation process.

- Flow direction is not shown on the fuel mixer or feedback valves, nor in the instructions.

- A "Hydrostatic Relief Valve" called for in the diagram was not in the kit. This valve is a safety to prevent fuel line explosion in the event overheating occurs in the high pressure line.

- The wiring diagram appears to show several wires connected together. Actually, they must not be connected. For example, the Computer Support (Autotronics) Module has a yellow wire to indicate if the vehicle has been switched to gasoline operation. It is shown connected to the MOGAS LPG fuel activation relay, but this contradicts the Autotronics instructions.

- A manual control valve (apparently for use in a mechanical system) was received in addition to the feedback control valve. The manual control valve should not be used.

- A small screw on the feedback valve was used to trim the response of the system at the advice of the MOGAS service representative, but this screw was not described in the MOGAS information.

We resolved the discrepancies noted above by contacting the supplier and/or the manufacturer. Clearly, some field installers might use their own judgment where the instructions are unclear or incomplete. The result could be poor emissions or safety hazards, even if driveability is acceptable.

## Discussion of Results

Several steps were taken to ensure precision of the FTP tests. All tests other than the gasoline baselines were performed by the same driver and CVS operator, on the same dynamometer, and with the same emissions analyzers. Furthermore, all conversion installations were performed by one technician. Some bi-fuel conversion systems are normally started on gasoline. However, the engine was started with LPG in every test to eliminate this variable during this project.

### *Temperature Effects*

The effect of fuel temperature on gaseous fuel management and resulting emissions and performance has been documented in previous studies at SwRI. For example, according to (King 1992), a 25°F change in fuel temperature, relative to intake air temperature, will cause about 2.5% variation in equivalence ratio. A 0.5% variation in equivalence ratio around stoichiometric operation can cause significant differences in exhaust emissions. The effect is particularly important on mechanical systems, which normally have no provision for direct temperature change compensation. Pressure regulators cause temperature changes, dependent on tank pressure and engine demand. Of course, ambient temperature can influence the results. Since the vehicle was always soaked overnight in the lab before tests, and the temperature did not vary more than five degrees; ambient temperature was well controlled. SwRI measured fuel temperature at approximately the same position (regulator outlet) for each installation.

The IMPCO AFCP and ADP tests showed an average fuel temperature change of 137°F (from cold start to hot test) during the FTP. The MOGAS results appeared slightly better, with an average change of 117°F. Catalytic converter inlet and outlet temperatures were also measured for information about the performance of the converter. As discussed for each kit below, catalyst outlet temperature did confirm our observations about the fuel control of the kits.

### *Fuel Composition Effects*

Figure 3 shows the average total hydrocarbons determined by flame ionization detector (FID) (a), carbon monoxide (b), and nitrogen oxides (c) emissions as a function of LPG fuel propane mole percent for each of the three kits. The fuel composition changes apparently are an air/fuel ratio disturbance. In general, the decrease in propane content caused increases in HC and CO, and a decrease in $NO_x$, indicating a richer mixture. These effects were minimal for the MOGAS system, showing that in feedback control, fuel mixture variation can be tolerated. More study is needed to determine if it is the propane, butane, or hydrogen-to-carbon ratio which is most significant in the fuel composition.

### *IMPCO ADP Kit*

As shown in Table 4, the IMPCO ADP system produced consistently high $NO_x$ results. On the Chevrolet Lumina, this could be caused by EGR malfunction or lean operation. The vehicle's on-board diagnostic codes revealed only an intermittent air cleaner temperature signal. When this was corrected, no difference in results was observed. Because the EGR wiring was not disturbed by the kit installation, we surmised that the IMPCO kit was probably operating slightly lean. This was confirmed with an $O_2$ analyzer, the indicator light on the IMPCO ADP module, and the catalyst outlet temperature (which was an average of 128°F lower than that measured with gasoline).

The IMPCO supplier (in Dallas, Texas) and the service representatives (California) were consulted about the lean operation of the ADP system. Two different mixer diaphragms were then delivered to SwRI for comparison. Apparently the diaphragms are flow tested after production, then assigned a rating. IMPCO stated that perhaps the system under evaluation may have a #88 diaphragm; however, the original diaphragm in the mixer was a #93 rating. The alternatives were #88 and #92. These two are reported to run leaner than the #93, although even at IMPCO, there was no consensus about what the overall effect of the different diaphragms would be.

### *IMPCO AFCP-1 Kit*

The second kit evaluated (IMPCO AFCP-1) produced high CO and HC emissions (see Figure 3). Diagnostics with the IMPCO FSA, which was sent on request, revealed that the processor was not regulating the fuel control valve at all. In this mode, the electronic fuel control was inactive, and the system operated only with mechanical feedback. Catalyst outlet temperature showed lower activity compared to gasoline as a result of low oxygen in the exhaust. This measurement along with the near constant "rich" indication of the IMPCO FSA instrument confirmed the hypothesis that the high CO and HC were caused by rich air/fuel mixtures. By comparison, the ADP (Kit No. 1) switched the fuel control valve at about 30% duty cycle, producing lean results. A second AFCP processor was shipped to SwRI and produced the same indications.

One hypothesis for the problems with both IMPCO systems is that the direct (distributor-less) ignition system (DIS) on the Lumina fires each cylinder twice per revolution. This could cause a false high speed indication for the processor. The IMPCO documents do not offer instructions for a vehicle with this system.

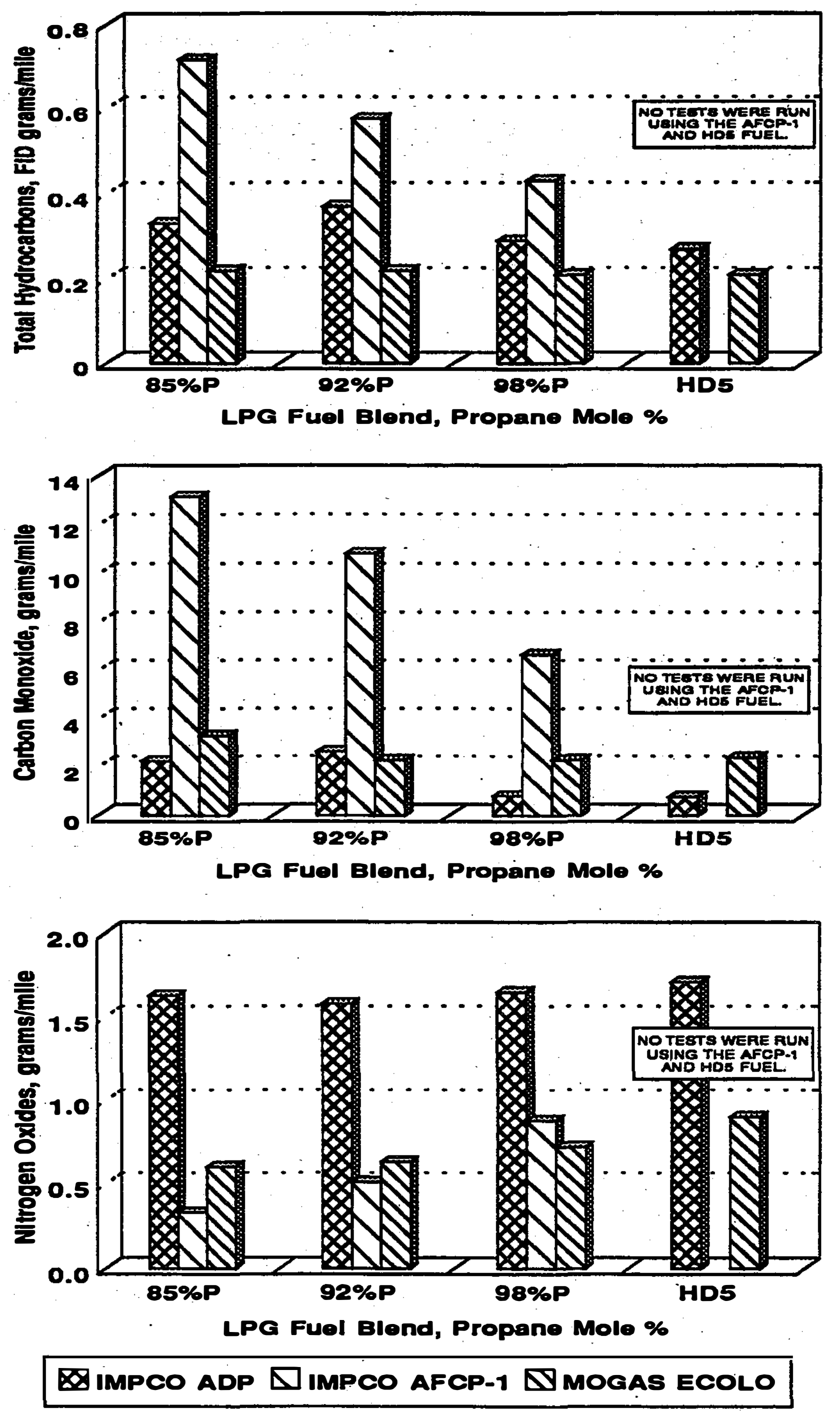



**Figure 3. Average Emissions of Total HC, CO, and $NO_X$ as a Function of LPG Fuel Blend**

**Table 4. Evaluation of Aftermarket LPG Conversion Kits in Light-Duty Vehicle, 1992 Chevrolet Lumina**

| Date | Test ID | Fuel | Emission Results, g/mile | | | | Fuel Economy, mpg |
|---|---|---|---|---|---|---|---|
| | | | HC | CO | $NO_x$ | $CO_2$ | |
| **Baseline Tests: Original Vehicle Condition** | | | | | | | |
| 12/11/92 | L2-00-EEE1 | EM1540 Baseline | 0.27 | 3.15 | 0.41 | 427.4 | 20.47 |
| 12/29/92 | L2-00-EEE2 | EM1540 Baseline | 0.37 | 5.26 | 0.41 | 475.8 | 18.28 |
| 12/30/92 | L2-00-EEE3 | EM1540 Baseline | 0.33 | 4.33 | 0.36 | 469.0 | 18.60 |
| **Average** | | | **0.32** | **4.25** | **0.40** | **457.4** | **19.12** |
| 12/31/92 | L2-00-RFA1 | EM1215 TRC Base | 0.37 | 6.76 | 0.46 | 454.4 | 19.02 |
| 1/06/93 | L2-00-RFA2 | EM1215 TRC Base | 0.42 | 5.71 | 0.43 | 430.4 | 20.39 |
| 1/07/93 | L2-00-RFA3 | EM1215 TRC Base | 0.45 | 6.32 | 0.44 | 431.1 | 20.31 |
| **Average** | | | **0.41** | **6.26** | **0.44** | **438.6** | **19.91** |
| **Overall Average** | | | **0.37** | **5.40** | **0.42** | **446.7** | **19.57** |
| **IMPCO ADP LPG Conversion Tests (Kit #1)** | | | | | | | |
| 1/20/93 | L2-01-P85 | 85% Propane | 0.32 | 2.34 | 1.53 | 388.1 | 14.56 |
| 1/21/93 | RUN 2 | 85% Propane | 0.33 | 2.18 | 1.73 | 391.3 | 14.45 |
| 1/22/93 | L2-01-P92 | 92% Propane | 0.37 | 3.06 | 1.47 | 386.6 | 14.48 |
| 1/26/93 | RUN 2 | 92% Propane | 0.36 | 2.23 | 1.69 | 390.9 | 14.38 |
| 1/28/93 | L2-01-P98 | 98% Propane | 0.30 | 0.83 | 1.72 | 394.1 | 14.19 |
| 1/29/93 | RUN 2 | 98% Propane | 0.28 | 0.79 | 1.57 | 387.9 | 14.42 |
| **Average** | | | **0.33** | **1.90** | **1.62** | **389.8** | **14.41** |
| **Additional Test Sponsored by TRRC** | | | | | | | |
| 2/2/93 | L2-01-HD5 | Market HD5 | 0.27 | 0.78 | 1.71 | 388.1 | 14.10 |
| **IMPCO AFCP-1 LPG Conversion Tests (Kit #2)** | | | | | | | |
| 2/13/93 | L2-02-P92 | 92% Propane | 0.58 | 10.85 | 0.51 | 385.6 | 14.07 |
| 2/14/93 | L2-02-P98 | 98% Propane | 0.43 | 6.69 | 0.88 | 390.2 | 14.00 |
| 2/15/93 | L2-02-P85 | 85% Propane | 0.70 | 13.16 | 0.33 | 384.1 | 14.07 |
| **Average** | | | **0.57** | **10.23** | **0.57** | **386.6** | **14.08** |
| **MOGAS ECOLO LPG Conversion Tests (Kit #3)** | | | | | | | |
| 2/22/93 | L2-03-P92 | 92% Propane | 0.22 | 2.30 | 0.63 | 397.7 | 14.14 |
| 2/23/93 | L2-03-P98 | 98% Propane | 0.20 | 1.98 | 0.76 | 393.4 | 14.16 |
| 2/24/93 | L2-03-P98 | 98% Propane | 0.21 | 2.61 | 0.68 | 389.2 | 14.30 |
| 2/25/93 | L2-03-P85 | 85% Propane | 0.22 | 3.32 | 0.60 | 401.3 | 14.05 |
| **Average** | | | **0.21** | **2.55** | **0.67** | **395.4** | **14.16** |
| **Additional Test Sponsored by TRRC** | | | | | | | |
| 2/26/93 | L2-03-HD5 | Market HD5 | 0.21 | 2.40 | 0.90 | 389.3 | 13.97 |
| **Final Baseline Tests: Restored Vehicle Condition** | | | | | | | |
| 3/3/93 | L2-00-EEE4 | EM1540 | 0.39 | 6.67 | 0.53 | 448.7 | 19.27 |
| 3/5/93 | L2-00-EEE5 | EM1540 | 0.28 | 3.15 | 0.43 | 468.2 | 18.71 |
| **Average** | | | **0.34** | **4.91** | **0.48** | **458.5** | **18.99** |

### *MOGAS ECOLO Kit*

Driveability of the converted Lumina was generally excellent. Two observations were made on the MOGAS system. Starting required at least 10 seconds of cranking. It was suspected that the inductive winding on the spark plug or the ESO (electronic shut-off) caused the delay in de-activating the fuel lock. Also, the engine appeared to oscillate under certain high speed and load conditions. The MOGAS monitor indicated that the engine was slightly lean. This condition occurred during the Hot 505 portion of the FTP test. Under most operating conditions, the MOGAS monitor showed that the air-fuel ratio was oscillating at about stoichiometry. This is ideal for the catalytic converter so that it receives oxygen periodically to oxidize CO and HC, and it was typically imperceptible to the driver. As expected, catalyst outlet temperatures were close to gasoline measurements.

## Hydrocarbon Emissions Speciation

Emissions of non-methane hydrocarbons (NMHC) from mobile sources have traditionally been given in terms of total mass. This approach fails to account for the highly variable reactivity of the different hydrocarbon species, which actually controls their ability to contribute to the formation of ozone. With the introduction of Carter's maximum incremental reactivity (MIR) scale and the ability of researchers to speciate hydrocarbon emissions from light-duty gasoline, natural gas and alcohol-fueled vehicles, regulators have been able to apply (and incorporate into law) reactivity adjustment factors to the hydrocarbon mass emissions of these vehicles.

HC speciation was conducted for the TRRC-AFRED as part of the NREL project. The Texas Railroad Commission test plan called for a baseline test on industry-average gasoline. Three tests were actually conducted to check vehicle and test repeatability, but only one included speciation of exhaust HC. The speciation process is shown in generalized form in Figure 4. A summary of the results (gasoline and LPG Kits No. 1 and No.3) of the speciation are shown in Table 5. Maximum incremental reactivity factors used in the table are from the California Air Resources Board's most recent proposed regulations (California ARB, 1992). The first four species are the toxics, and the remainder are listed in order of increasing carbon number. Mass rates of toxic emissions are listed separately in Table 6. These data show that, compared to industry average gasoline, the ozone formation potential and the level of toxics were reduced with LPG.

A combined three-GC method was used to obtain the hydrocarbon emissions speciation because it gives the lowest overall detection limits. This three-GC method and the aldehyde and ketone techniques are described below:

- GC # 1 - $C_1$ - $C_3$ Hydrocarbons, Benzene, and Toluene - For measurement of selected individual hydrocarbons; methane, ethane, ethylene, acetylene, propane, propylene, benzene, and toluene; a sample of CVS-diluted exhaust is collected in a Tedlar bag. This bagged sample is then analyzed for individual hydrocarbons using a gas chromatographic system containing four separate columns and a flame ionization detector. The peak areas are compared to an external calibration blend, and the individual hydrocarbon concentrations are obtained using a networked PE Nelson Model 2600 data acquisition system.

- GC #2 - 1,3-Butadiene - The procedure was developed to measure 1,3-butadiene in dilute vehicle exhaust from CVS bag samples. It also provides separation and measurement for six other $C_4$ hydrocarbons including: isobutane, butane, 1-butene, isobutylene, cis-2-

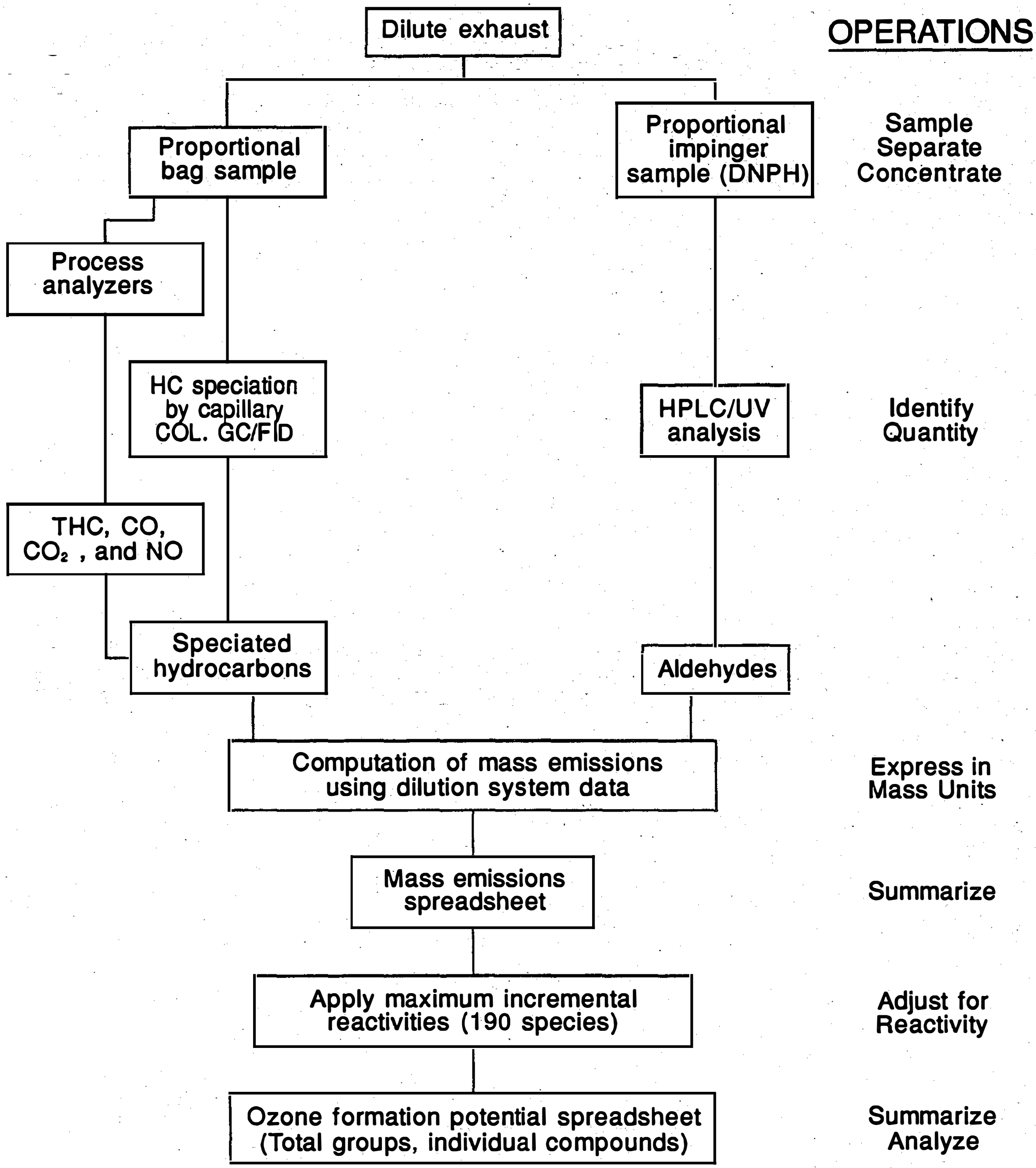



**Figure 4. Exhaust Organic Speciation Flow Chart**

## Table 5. Selected HC Species Contribution to Potential Ozone

| Hydrocarbon Species | Maximum Incremental Reactivity | Gasoline Baseline Data | | IMPCO ADP Kit | | | |
|---|---|---|---|---|---|---|---|
| | | Industry Average Fuel (RFA) | | 98% Propane | | HD5 (96% Propane) | |
| | | Average Ozone Formation Potential (mg/mile) | Average Weight % Ozone | Average Ozone Formation Potential (mg/mile) | Average Weight % Ozone | Average Ozone Formation Potential (mg/mile) | Average Weight % Ozone |
| Formaldehyde | 7.15 | 22.34 | 2.43 | 11.07 | 3.78 | 0.58 | 0.19 |
| Benzene | 0.42 | 7.03 | 0.76 | 0.91 | 0.31 | 0.27 | 0.09 |
| 1,3-Butadiene | 10.89 | 26.92 | 2.93 | 0.00 | 0.00 | 0.00 | 0.00 |
| Acetaldehyde | 5.52 | 8.21 | 0.89 | 3.53 | 1.20 | 1.27 | 0.41 |
| Ethylene | 7.29 | 194.9 | 21.18 | 124.79 | 42.56 | 165.90 | 53.08 |
| Ethane | 0.25 | 2.22 | 0.24 | 1.53 | 0.52 | 2.75 | 0.88 |
| Propane | 0.48 | 0.33 | 0.04 | 92.05 | 31.39 | 99.60 | 31.87 |
| Propylene | 9.40 | 104.87 | 11.40 | 34.46 | 11.75 | 38.59 | 12.35 |
| 1-Butene | 8.91 | 15.09 | 1.64 | 1.61 | 0.55 | 1.59 | 0.51 |
| Isobutylene | 5.31 | 19.63 | 2.13 | 0.00 | 0.00 | 0.47 | 0.15 |
| cis-2-Butene | 9.94 | 6.39 | 0.69 | 0.00 | 0.00 | 0.00 | 0.00 |
| trans-2-Butene | 9.94 | 7.09 | 0.77 | 0.00 | 0.00 | 0.00 | 0.00 |
| Toluene | 2.73 | 71.93 | 7.82 | 0.00 | 0.00 | 0.00 | 0.00 |
| Isopentane | 1.38 | 4.26 | 0.46 | 0.00 | 0.00 | 1.50 | 0.48 |
| 2,2,4-Trimethylpentane | 0.93 | 7.30 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,3,4-Trimethylpentane | 1.60 | 0.74 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,3,3-Trimethylpentane | 1.20 | 0.55 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4-Methyl-2-Pentene | 6.69 | 57.81 | 6.28 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3-Methyl-Pentane | 1.52 | 10.28 | 1.12 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,3-Dimethylpentane/2-Methylhexane | 1.30 | 8.95 | 0.97 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ethylbenzene | 2.70 | 24.23 | 2.63 | 0.00 | 0.00 | 0.00 | 0.00 |
| Xylenes[a] | 7.38[b]/6.46[c] | 211.94 | 23.04 | 8.13 | 2.77 | 0.00 | 0.00 |
| 1,2,4-Trimethylbenzene | 8.83 | 19.36 | 2.10 | 15.15 | 5.17 | 0.00 | 0.00 |
| 1,3,5-Trimethylbenzene | 10.12 | 87.67 | 9.53 | 0.00 | 0.00 | 0.00 | 0.00 |
| TOTAL FOR ALL SPECIES | --- | 920.0 | 100.0 | 293.2 | 100.0 | 312.5 | 100.0 |

[a] xylenes (p-,m-,o-)
[b] MIR for (p-,m-)
[c] MIR for (o-)

## Table 5. Selected HC Species Contribution to Potential Ozone (Concluded)

| Hydrocarbon Species | Maximum Incremental Reactivity | Gasoline Baseline Data: Industry Average Fuel (RFA) | | MOGAS ECOLO Kit: 98% Propane | | MOGAS ECOLO Kit: HD5 (96% Propane) | |
|---|---|---|---|---|---|---|---|
| | | Average Ozone Formation Potential (mg/mile) | Average Weight % Ozone | Average Ozone Formation Potential (mg/mile) | Average Weight % Ozone | Average Ozone Formation Potential (mg/mile) | Average Weight % Ozone |
| Formaldehyde | 7.15 | 22.34 | 2.43 | 10.89 | 5.21 | 8.86 | 5.01 |
| Benzene | 0.42 | 7.03 | 0.76 | 0.31 | 0.15 | 0.00 | 0.00 |
| 1,3-Butadiene | 10.89 | 26.92 | 2.93 | 1.41 | 0.67 | 0.00 | 0.00 |
| Acetaldehyde | 5.52 | 8.21 | 0.89 | 2.55 | 1.22 | 1.77 | 1.00 |
| Ethylene | 7.29 | 194.9 | 21.18 | 55.98 | 26.77 | 54.05 | 30.57 |
| Ethane | 0.25 | 2.22 | 0.24 | 1.65 | 0.79 | 2.97 | 1.68 |
| Propane | 0.48 | 0.33 | 0.04 | 57.63 | 27.56 | 55.14 | 31.19 |
| Propylene | 9.40 | 104.87 | 11.40 | 39.44 | 18.86 | 36.42 | 20.60 |
| 1-Butene | 8.91 | 15.09 | 1.64 | 1.99 | 0.95 | 1.21 | 0.68 |
| Isobutylene | 5.31 | 19.63 | 2.13 | 0.48 | 0.23 | 0.24 | 0.14 |
| cis-2-Butene | 9.94 | 6.39 | 0.69 | 1.07 | 0.51 | 0.00 | 0.00 |
| trans-2-Butene | 9.94 | 7.09 | 0.77 | 0.00 | 0.00 | 0.00 | 0.00 |
| Toluene | 2.73 | 71.93 | 7.82 | 1.65 | 0.79 | 0.00 | 0.00 |
| Isopentane | 1.38 | 4.26 | 0.46 | 0.42 | 0.20 | 0.00 | 0.00 |
| 2,2,4-Trimethylpentane | 0.93 | 7.30 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,3,4-Trimethylpentane | 1.60 | 0.74 | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,3,3-Trimethylpentane | 1.20 | 0.55 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4-Methyl-2-Pentene | 6.69 | 57.81 | 6.28 | 1.63 | 0.78 | 0.00 | 0.00 |
| 3-Methyl-Pentane | 1.52 | 10.28 | 1.12 | 0.47 | 0.22 | 0.00 | 0.00 |
| 2,3-Dimethylpentane/2-Methylhexane | 1.30 | 8.95 | 0.97 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ethylbenzene | 2.70 | 24.23 | 2.63 | 0.76 | 0.36 | 0.00 | 0.00 |
| Xylenes[a] | 7.38[b]/6.46[c] | 211.94 | 23.04 | 10.06 | 4.81 | 3.61 | 2.04 |
| 1,2,4-Trimethylbenzene | 8.83 | 19.36 | 2.10 | 20.72 | 9.91 | 12.52 | 7.08 |
| 1,3,5-Trimethylbenzene | 10.12 | 87.67 | 9.53 | 0.00 | 0.00 | 0.00 | 0.00 |
| TOTAL FOR ALL SPECIES | --- | 920.0 | 100.0 | 209.1 | 100.0 | 176.8 | 100.0 |

[a] xylenes (p-,m-,o-)
[b] MIR for (p-,m-)
[c] MIR for (o-)

**Table 6. Toxic Emissions Measured in FTP Tests**

| System | Fuel | Form-aldehyde mg/mile | Acet-aldehyde mg/mile | Benzene mg/mile | 1,3-Butadiene mg/mile | Total mg/mile |
|---|---|---|---|---|---|---|
| Baseline | RF-A | 3.1 | 1.5 | 16.7 | 2.5 | 23.8 |
| IMPCO ADP | 98% Propane | 1.5 | 0.6 | 0.1 | 0.0 | 2.2 |
| IMPCO ADP | HD5 | 0.1 | 0.2 | 0.6 | 0.0 | 0.9 |
| MOGAS ECOLO | 98% Propane | 1.5 | 0.5 | 0.7 | 0.1 | 2.8 |
| MOGAS ECOLO | HD5 | 1.2 | 0.3 | 0.0 | 0.0 | 1.5 |

butene, and trans-2-butene. The gas chromatograph system is a Perkin-Elmer Model 3920B gas chromatograph with an FID, two pneumatically-operated and electrically-controlled Seiscor valves, and an analytical column. The analytical column is a 9 ft. × 1/8-in. stainless steel column containing 80/100 Carbopack C with 0.19% picric acid. Carrier gas is helium, which flows through the column at a rate of 27 mL/min. The column temperature is maintained at 40°C for analysis. External 1,3-butadiene standards in zero air are used to quantify the results via a P.E. Nelson 2600 data acquisition system. This system was developed and validated under an EPA contract, and has been used in two programs for CARB.

- <u>GC #3 - $C_5$ - $C_{10}$ Hydrocarbons Including MTBE</u> - This procedure permits the quantitative determination of more than 80 individual hydrocarbon species in CVS-diluted exhaust. The gas chromatograph system utilizes a Perkin-Elmer Model 3920B gas chromatograph with subambient oven temperature capability. The capillary column used in the system is a Perkin-Elmer F-50 Versilube, 150 ft × 0.02-in. WCOT stainless steel column. FID response is integrated using the P.E. Nelson 2600 data acquisition system.

- <u>Aldehyde and Ketone Emissions</u> - The aldehydes and ketones that were included in this analysis are: formaldehyde, acetaldehyde, acrolein, acetone, propionaldehyde, crotonaldehyde, isobutyraldehyde/methylethylketone (not resolved from each other under normal operating conditions and so reported together), benzaldehyde, and hexanaldehyde. Measurement of the aldehydes and ketones in exhaust is accomplished by bubbling dilute exhaust at 4 L/min. through chilled glass impingers containing an acetonitrile solution of 2,4-dinitrophenylhydrazine (DNPH) and perchloric acid. The exhaust sample is collected continuously during the test cycle. For analysis, a portion of the acetonitrile solution is injected into a liquid chromatograph equipped with a UV detector. External standards of the aldehyde and ketone DNPH derivatives are used to quantify the results. Detection limits for this procedure are on the order of 0.005 ppm aldehyde or ketone in dilute exhaust.

### *Discussion of HC Speciation Results*

The California Air Resources Board (CARB) uses speciation data on a specific fuel and vehicle combination to calculate non-methane organic gases (NMOG) for the TLEV category. Hydrocarbon emissions with low reactivity (or ozone formation potential, as defined by CARB) can reduce the effective NMOG by an adjustment factor. This factor is the reactivity adjustment factor (RAF). For example, a light duty vehicle using M-85 fuel may use the RAF determined by CARB (multiplying by 0.41 for M-85) to reduce the effective NMOG result. In 1991, California published data on LPG (and other alternative fuels) based on two IMPCO-equipped GM 1989 vehicles. The RAF reported at that time was 0.50 for LPG (California ARB 9/27/91). Speciation of emissions from the LPG-fueled Chevrolet Lumina in this project illustrated the potential for LPG to produce emissions of lower reactivity than gasoline, i.e. a low RAF.

CARB has determined an industry average gasoline value for the potential grams of ozone formed per gram of NMOG emissions for specific emissions categories (e.g. TLEV) of vehicles. This value (3.42 for TLEV) is used to compare any specific fuel and vehicle combination. From the speciation data, the calculated value of gram of ozone per gram of NMOG is divided by 3.42 to determine the RAF. Table 7 shows the RAFs for the IMPCO and MOGAS kits tested with HD5 LPG and 98% propane fuels. The FTP hydrocarbon data and RAF for RF-A (industry average) gasoline on the Lumina in its as-received condition is also shown for comparison. Since this value was 1.15 (rather than 1.0), this particular Lumina produced hydrocarbons with slightly more reactivity than the California ARB average for TLEV. Total hydrocarbons obtained by the FID instrument (THC by FID - the standard instrument for bulk HC measurement) are shown along with the total hydrocarbons by the gas chromatograph speciation (THC by GC - summed from the individual species contributions) so that the agreement of the two measurements can be seen. The difference between the two measurements was ≤ 14% for the five tests shown. The lowest RAF (0.292) was obtained with the MOGAS LPG system and the HD5 propane fuel. This is as expected, since the air-fuel ratio was controlled near stoichiometry, and the catalyst appeared to be more active with the MOGAS kit.

**Table 7. Comparison of Reactivity Adjustment Factors**

| System | Fuel | NMOG g/mile | Ozone g/mile | RAF | THC by GC g/mile | THC by FID g/mile |
|---|---|---|---|---|---|---|
| Baseline | RF-A | 0.27 | 1.06 | 1.15 | 0.32 | 0.37 |
| IMPCO ADP | 98% Propane | 0.23 | 0.30 | 0.377 | 0.28 | 0.30 |
| IMPCO ADP | HD5 | 0.25 | 0.33 | 0.374 | 0.29 | 0.27 |
| MOGAS ECOLO | 98% Propane | 0.15 | 0.22 | 0.336 | 0.19 | 0.20 |
| MOGAS ECOLO | HD5 | 0.15 | 0.18 | 0.292 | 0.18 | 0.21 |

# Related Work and Recommendations

Work related to this project at SwRI includes a catalyst study for the Gas Research Institute (GRI) on the evaluation of existing and developmental precious metal catalysts for stoichiometric and lean-burn natural gas fueled engines; multiple projects on the development and emissions certification of upstream, multi-point and lean-burn CNG engine management systems; and modal/transient evaluation of LPG conversion systems. However, much work remains to be done to evaluate the potential of LPG for engine emissions, performance, and durability, particularly on dedicated engines.

IMPCO and MOGAS systems had no spark timing adjustment built into their control systems. This may be important because LPG has a higher octane rating than gasoline, allowing ignition timing to be advanced for more complete combustion. The Autotronic Controls "Dual-Curve" ignition system, which has gasoline and LPG timing curves, was not tested.

A simple electronic fuel management system, the DAI Translator, is suggested as a system for further evaluation. Under a contract with the GRI, SwRI patented this new gaseous fuel system concept, which requires almost no engine mapping. It was designed specifically for the conversion of modern gasoline light-duty vehicles that already have electronic fuel injection systems. Engine mapping is nearly eliminated because the OEM engine control unit (ECU) logic remains in this system. The "Translator" converts the output of the ECU to a control signal for a continuous-flow gas control valve. Production versions of the system will be built by DAI Technologies, Inc. of Lisle, Illinois.

The fuel effects observed in this project bear further investigation. Keys to a clean LPG fuel specification may be obtained with additional work. The problems with IMPCO kits should also be researched. It is likely that there is something about the Chevrolet Lumina's electronic systems or sensors which defeats the IMPCO processor.

# Conclusions

This project allowed a comparison of LPG kits; and emissions, drivability, and fuel economy using LPG relative to gasoline. Remarks concerning installation and diagnosis are included because of their importance to acceptable operation.

- Although the MOGAS system excelled in ease of installation and emissions, the IMPCO systems had better starting and driveability, despite rich or lean operation. Neither IMPCO system gave acceptable emissions results, but the ADP system was better than the older AFCP system (Table 4).

- One problem with all kits was poor (or even incorrect) documentation. Important details, such as direction of flow on gas valves, were not found in any of the documentation. Better photos (specific to the application) would be helpful. The IMPCO AFCP instructions were perhaps the most complete, but even this older system document (1990) had an error, acknowledged by IMPCO service personnel, in the wiring schematic information. One electrical connection was incorrect on the MOGAS wiring diagram, also. Except for the MOGAS and Autotronics (computer support module used in each conversion) diagram, the documentation of installation procedures was not specifically for the Chevrolet Lumina, or even for General Motors vehicles.

  Tuning instructions were generally hard to follow and incomplete. These instructions are very important because the initial mechanical settings of the regulator (MOGAS) and mixer (MOGAS and IMPCO) determine the default and limiting conditions of the fuel system. For example, on the IMPCO systems, the fuel control valve acts on the vacuum signal to the regulator, limiting its response to engine vacuum. If the mechanical mixture screws are set lean, or even near lean, the fuel control system can not enrich the fuel mixture.

- The installer must have diagnostic equipment, such as the IMPCO FSA or another frequency instrument to monitor the fuel control actuator, and at least a 4-gas analyzer to check the settings and verify the oxygen sensor voltage. MOGAS did provide oxygen sensor voltages (from CNG experience) to target for mechanical adjustment of the system.

  The kit suppliers are aware of undocumented techniques of modifying the response of the LPG equipment that may improve the tuning. Examples are the diaphragms from IMPCO and the trim screw in the MOGAS control valve. Again, the problem is lack of good documentation. Installers will not necessarily be aware of or concerned about emissions, so documentation of installation and tuning are critical to obtaining acceptable operation.

- Off-the-shelf conversion kits did demonstrate good driveability, making the LPG conversion transparent to the vehicle operator.

- HC and CO emissions were better with LPG than gasoline using the MOGAS and the IMPCO ADP LPG systems, but worse with the IMPCO AFCP-1 system (Table 4).

- In all cases, $CO_2$ (a greenhouse gas) emissions were significantly lower with LPG, but $NO_x$ was higher than with gasoline (Table 4).

- Fuel composition did influence emissions results (Figure 3). The effect of fuel composition diminished under good AFR control as shown using the MOGAS system.

- HC speciation revealed that the reactivity of the LPG-fueled engine HC emissions was much lower than that of the gasoline emissions. It appears that LPG can be one approach to reducing ozone in Southern California and other non-attainment areas.

- The volumetric fuel economy reduction (~27%) was consistent with the energy content difference between LPG and gasoline.

- Most of the problems observed with LPG conversion kits could be overcome with minor hardware and documentation changes. Perhaps the manufacturers should document a conversion and conduct an FTP emissions test for one example of an engine family for which the kit is intended, before offering it commercially for that engine.

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# APPENDIX A

## CONVERSION KIT INSTRUCTIONS AND ORIGINAL DOCUMENTATION

- IMPCO ADP
- IMPCO AFCP-1
- MOGAS ECOLO

**IMPCO ADP**

# Adaptive Digital Processor Clean Fuel Management System

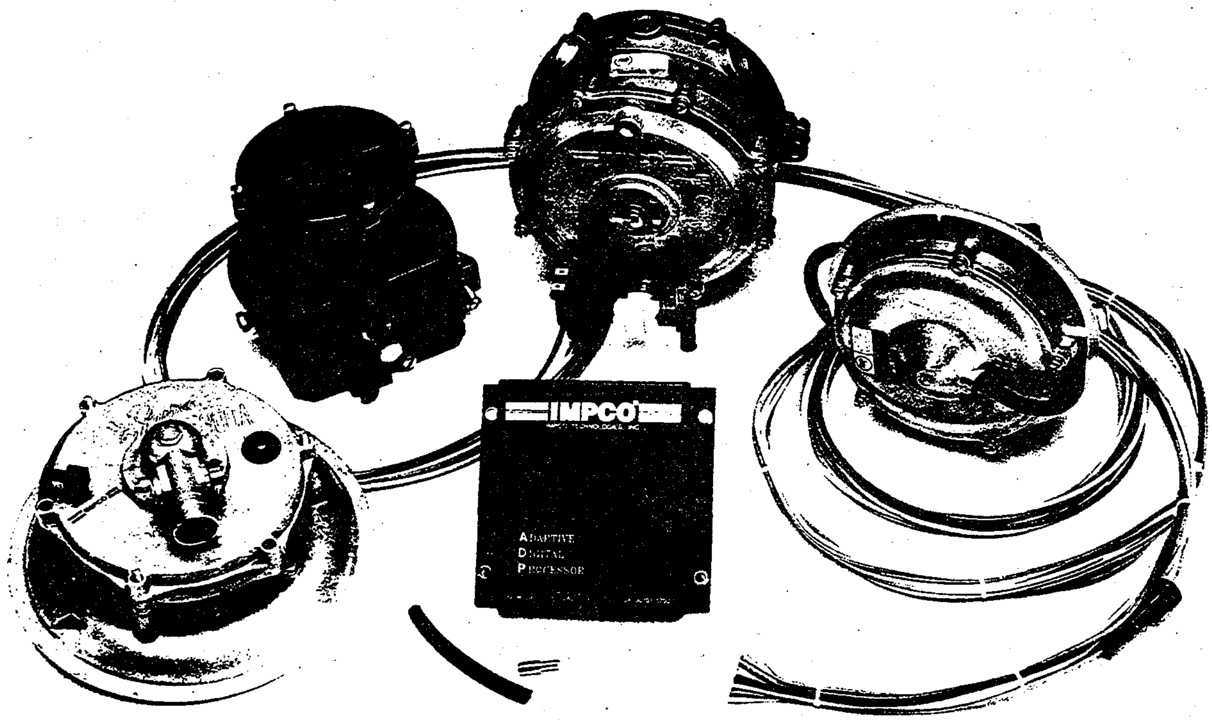
**Introduction**

The IMPCO® Adaptive Digital Processor (ADP)TM is an electronic closed loop fuel control system which adapts to each individual vehicle and the alternate fuel components installed on the vehicle. The memory of the ADP is non-volatile and will remain stored until the memory is cleared by the installing technician.

The ADP is mechanically and electrically interchangable with the AFCP-1 **GREEN STRIPE** processor. The addition of an intake manifold vacuum line is all that is required to upgrade the vehicle to the ADP.

The areas covered are:

- Before you begin
- Glossary of terms
- Understanding the OEM "Feedback" system
- Principals of Operation
  - Cold start/Open loop
  - Stabilized Engine Operation/Closed loop
- ADP Theory and Operation
- Typical Installation Information
- Adjustment Procedures
- Tech Tips on the ADP
- Maintenance Schedule
- IMPCO "Feedback" carburetion parts list




IMPCO

ALTERNATIVE FUEL SYSTEMS

# Before You Begin

## WARNING

The ADP engine management system is intended to be used with volatile gaseous fuels and if improperly installed may create a hazardous condition leading to a fire and/or explosion. Engine emissions and performance may also be affected by improper installation. Accordingly, the system and associated equipment should be installed only by duly trained and qualified personnel in accordance with the instructions in this manual. Failure to install the system in accordance with this manual voids system warranty.

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This entire manual should be carefully studied and understood BEFORE you convert your vehicle. Some installations may require additional parts. Also, you must be qualified on, or have access to, specialized testing equipement.

It is important to be thoroughly familiar with all of the warnings and precautions we have provided you.

The internatinally accepted warning symbol ⚠ is in our manual for your protection.

This symbol means: **ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!** If you come across an unfamiliar or potentially hazardous condition, call our technical representative for clarification before proceeding.

The symbol ☛ is to call your attention to special notes or features. This is to alert you as to unique tools, condition, parts or exceptions you may encounter while installing our system on your vehicle.

⚠ To prevent ignition of leaking gaseous fuels which may cause a fire and/or explosion, avoid open sparks, flames, and operation of electrical devices in or about the engine compartment and always perform wiring modifications with battery cables disconnected.

⚠ Always follow installation regulations that apply to you. These requirements are found in NFPA-52 for natural gas and NFPA-58 for LPG. These are U.S. standards. For Canadian codes see National Standards **CANADA**. Additionally, some states or province may also have certain requirements you must be aware of.

**WARNING: IMPROPER INSTALLATION OR USE OF THIS PRODUCT MAY CAUSE SERIOUS INJURY AND/OR PROPERTY DAMAGE.**

**SERVICE TECHNICIANS AND USERS**
SHOULD CAREFULLY READ AND ABIDE BY THE PROVISIONS SET FORTH IN NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET #37 FOR STATIONARY ENGINES, #52 FOR CNG VEHICULAR FUEL SYSTEMS OR #58 FOR LPG SYSTEMS.

**INSTALLERS**
**LPG INSTALLATIONS IN THE UNITED STATES** MUST BE DONE IN ACCORDANCE WITH FEDERAL, STATE, OR LOCAL LAW, WHICHEVER IS APPLICABLE AND NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET #58, STANDARD FOR STORAGE AND HANDLING OF LIQUIFIED PETROLEUM GASES TO THE EXTENT THESE STANDARDS ARE NOT IN VIOLATION WITH FEDERAL, STATE OR LOCAL LAW.

**IN CANADA** REFER TO CAN/CGA-B149.2, PROPANE INSTALLATION CODES.

**CNG INSTALLATIONS IN THE UNITED STATES** MUST BE DONE IN ACCORDANCE WITH FEDERAL, STATE OR LOCAL LAW AND NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET #52, COMPRESSED NATURAL GAS (CNG) VEHICULAR FUEL SYSTEMS TO THE EXTENT THESE STANDARDS ARE NOT IN VIOLATION WITH FEDERAL, STATE OR LOCAL LAW.

**IN CANADA** REFER TO CAN/CGA-B149.1 CNG INSTALLATION CODES.

**LPG AND/OR NATURAL GAS INSTALLATIONS ON STATIONARY ENGINES** MUST BE DONE IN ACCORDANCE WITH FEDERAL, STATE OR LOCAL LAW AND NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET #37, STATIONARY COMBUSTION ENGINES AND GAS TURBINE ENGINES, TO THE EXTENT THESE STANDARDS ARE NOT IN VIOLATION WITH FEDERAL, STATE OR LOCAL LAW.

FAILURE TO ABIDE BY THE ABOVE WILL VOID ANY IMPCO WARRANTY ON THE PRODUCTS AND MAY CAUSE SERIOUS INJURY OR PROPERTY DAMAGE.

DUE TO THE INHERANT DANGER OF GASEOUS FUELS THE IMPCO PRODUCTS SHOULD NOT BE INSTALLED OR USED BY PERSONS NOT KNOWLEDGEABLE OF THE HAZARDS ASSOCIATED WITH THE USE OF GASEOUS FUELS.

**Glossary Of Terms**

**Exhaust Gas Oxygen Sensor.** Located in the exhaust gas stream, it monitors the amount of oxygen present. The computer uses this information to control the air/fuel ratio for most engine operating modes.

**Manifold Absoute Pressure Sensors.** The M.A.P. sensor monitors intake manifold vacuum. Manifold absolute pressure if defined as barometric pressure minus manifold vacuum. With this signal the ADP will change the control strategy of the air fuel mixture related to engine load and speed.

**Engine Coolant Temperature Sensor.** Inputs information about engine temperature which is used to process EGR flow, ignition timing and open-or closed-loop logic.

**Knock Sensor.** Normally mounted on the intake manifold. Its signal is used to retard ignition timing during spark knock.

**Understanding the OEM Feedbadk System**

The OEM Feedback System is based on the functions of the onboard computer which monitors and controls critical engine functions. The computer is dependent on a system of engine sensors that feed information it uses to control engine operation functions.

The input signals are processed and the correct computation for each operating mode is relayed through the computer drivers to the various engine controls.

The engine controls normally include:

- Air fuel ratio control
- Ignition timing
- EGR control
- Air injection control
- Canister purge
- Throttle solenoid or automatic idle speed control

The computer itself is a logic switching device that has non-volatile memory. This allows it to act rather than just react. It has two basic methods of operation, open loop and closed loop. In the open-loop mode, the computer ignores most of the sensors and utilizes various predetermined operating conditions estabished by the program in its memory. "Special" conditions such as cold start or wide-open throttle can cause the computer to switch to the open-loop modes. The computer selects the correct open loop conditions to operation from.

In closed loop, the computer processes the signals of all sensors. It utilizes this information to determine how to set the fuel, ignition and other engine-controllable functions for routine conditions. With a wide range of control in closed loop, the computer can optimize engine performance. It is the computer's ability to quickly and correctly react that allows for the most efficient use of the fuel.

**Principle of Operation**

**Cold Start/Open Loop Oeration.** The cold start operation mode is activated by the engine coolant temperature sensor telling the computer a cold engine condition exists.

On some OEM vehicles, during cold start, "fresh" air from the air injection pump or thermactor pump is directed into the engine exhaust manifold. The fresh air provides additional oxygen in the exhaust manifold to promote continued burnoff of excess fuel and a further reduction in HC (hydro-carbon) and CO (carbon monoxide) emission levels until the catalytic converter reaches operating temperatures. During the cold-start operating mode, the engine is metered a pre-determined rich fuel mixture, via computer command to the fuel injector. The oxygen sensor is automatically "locked out" since it would sense an excess of oxygen and send a lean-mixture signal to the computer. Once the oxygen sensor temperature reachers a specified temperature (above 600F), the computer switches from an "open loop" condition to a "closed loop" stabilized engine operating condition. Fuel enrichment is then controlled with input from the oxygen sensor. Also, the "fresh" air from the air injection pump or thermactor pump is dircted to the catalytic converter or vented to the atmosphere depending on how the computer is programmed.

**Stabilized Engine Operation/Closed Loop.** The oxygen sensor located in the exhaust system ahead of the catalytic converter is the reference control for "stabilized engine" closed loop operation. The oxygen sensor interacts with the computer via electrical signals. When oxygen is sensed in the exhaust gases (lean mixture) the oxygen sensor generates a voltage signal of .5 or less to the computer. The level of voltage transmitted is dependent on the amount of oxygen detected. An absence of oxygen in the exhaust (rich mixture), genreates a voltage from .5 to 1.0 depending on the richness of the mixture. The computer processes this information and reacts to the voltage transmitted, commanding the Fuel Injector to assume a richer or leaner cycle.

**ADP Theory and Operation**

The IMPCO Technologies, ADP is an Adaptive Digital Processor that is interchangeable with the AFCP-1. The only addition is the use of a vacuum line that is connected to the ADP MAP sensor.

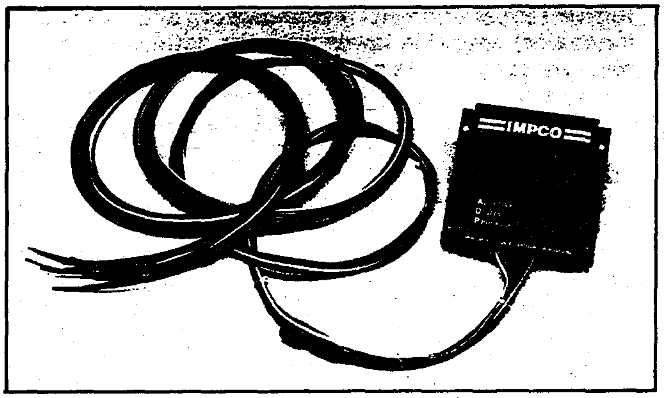
The additional features that the ADP has is the ability to store in non volatile memory the changes that occur during normal operation of the vehicle as mileage increases.

The ADP contains 16 "cells" that allow the non volatile memory to change or update the air fuel mixtures, related to the wear of the mixer, the engine and OEM emission components.

The cells will begin with a value of 50% duty cycle when the ADP is first installed.

When the installer adjusts the idle base mixture and the ADP enters into the quick learn stage of operation, the ɔlls will be updated within a very short period of time. After the ADP passes the 3 timed quick learn stages, the ADP enters into continuous update. During this operational mode, the ADP updates the cells in a much slower rate.

# Installation on Fuel-Injection Engines Using the Adaptive Digital Process

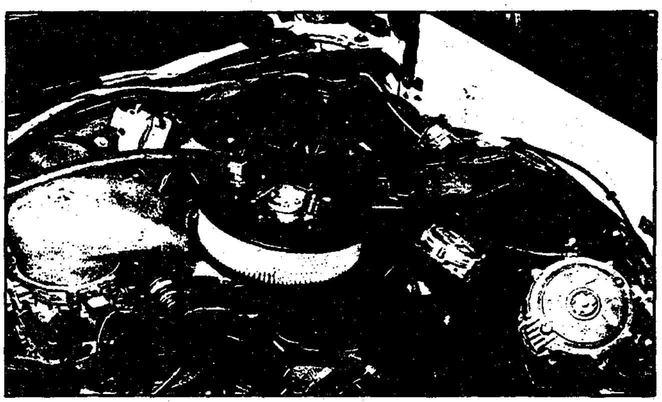



**1.** The ADP is designed for installation inside the passenger compartment, away form engine heat and road splash. Mount the ADP securely using the provided screws and mounting holes. Pass the wiring harness through a convenient knockout in the firewall.

Connect all wiring for the ADP as described in the schematic on page 6. All electrical connections must be soldered and sealed to prevent corrosion.

Also install a ¼" vacuum line from a manifold vacuum source on the engine of the vehicle. Route the vacuum line along the path of the wiring harness inside the vehicle to the location of the mounting of the ADP.

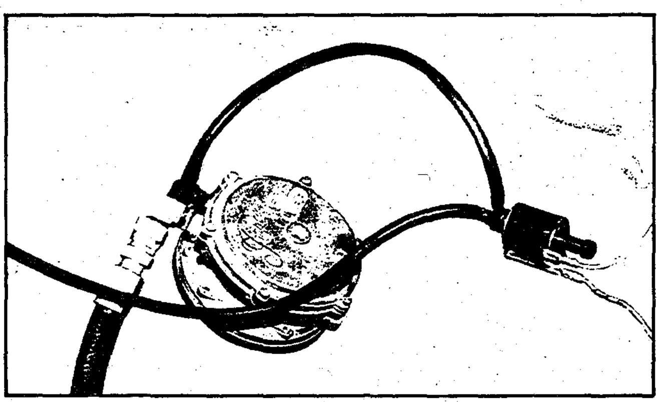
Install the supplied 3/16" vacuum line to the vacuum port of the ADP, use the tubing adapter to connect the 3/16" vacuum line to the ¼" vacuum line from the engine.



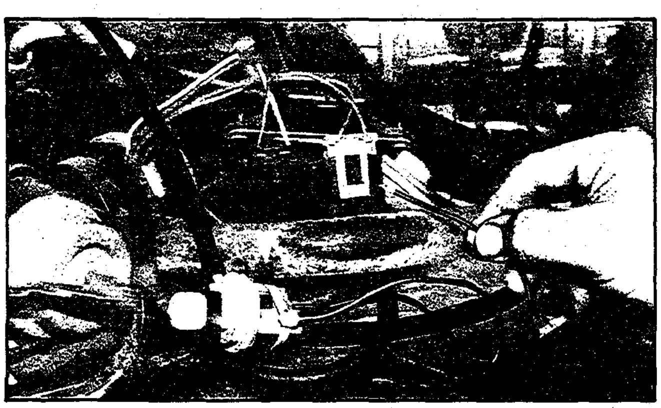
**2.** Install the required IMPCO® adapter assembly between OEM EFI throttle body and the IMPCO® mixer.

Preset the wide open fuel adjustment at the middle mark of the rich/lean scale.

On the CA425, Adjust the Hex Head Bolt to a measurement of 1¼" from the body to the outside edge of the Hex Head Bolt.



**3.** An alternate method of installation, using a CA300A-1 mixer, utilizes an optional 3-way vacuum control solenoid (part #VCS) to control VFF30 operation. In this installation, the Boden cable and CA300A lifter cam are not required. Insert the solenoid into the vacuum line, between the vacuum source and the VFF30. Connect one electrical lead to secure ground, the other to the alternate fuel side of the fuel selector switch located inside the driver's compartment. Fuel selection is made with this switch, rather than a Boden wire. See: 23600-50 in the ISM for correct wiring of the VCS.



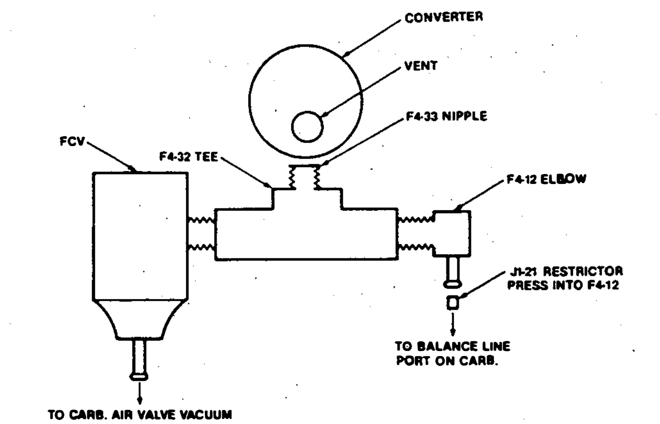
**4.** On vehicles equiped with air pumps:
Chevrolet: Connect the gray wire from the ADP to the brown wire at the air pump diverter valve on the air pump. This is on pre-1992 vehicles.

Ford: Locate the thermactor air pump diveter solenoid (TAD). Using a co tinuity light or meter, locate the power to the TAD. Splice the gray wire into the power wire for the TAD.

Chrysler: Use the VS-2A vacuum switch. Cut off the red wire and insulate the cut. Solder the yellow wire from the VS-2A to the gray wire in the ADP wiring harness. Locate the vacuum line to the air pump diverter valve on the air pump. Splice in a vacuum line to the vacuum line to the diverter valve, connect the vacuum line to the vacuum port on the VS-2A. Attach the black wire to ground.

5. Install IMPCO® Fuel Control Valve (FCV) and fitting into the cover of the converter (see #6). If an air valve vacuum source is not available for the FCV, tap into the adapter under the mixer. Install an F4-8 fitting in the adapter and connect a vacuum hose from the fitting to the FCV. **NOTE:** The FCV must have an independent air valve vacuum source. Install the FCV so the vacuum connection is in the down position.

FUEL CONTROL VALVE WITH BALANCE LINE




6. Install the ADP wire harness as indicated. See complete typical schematic on page 6.

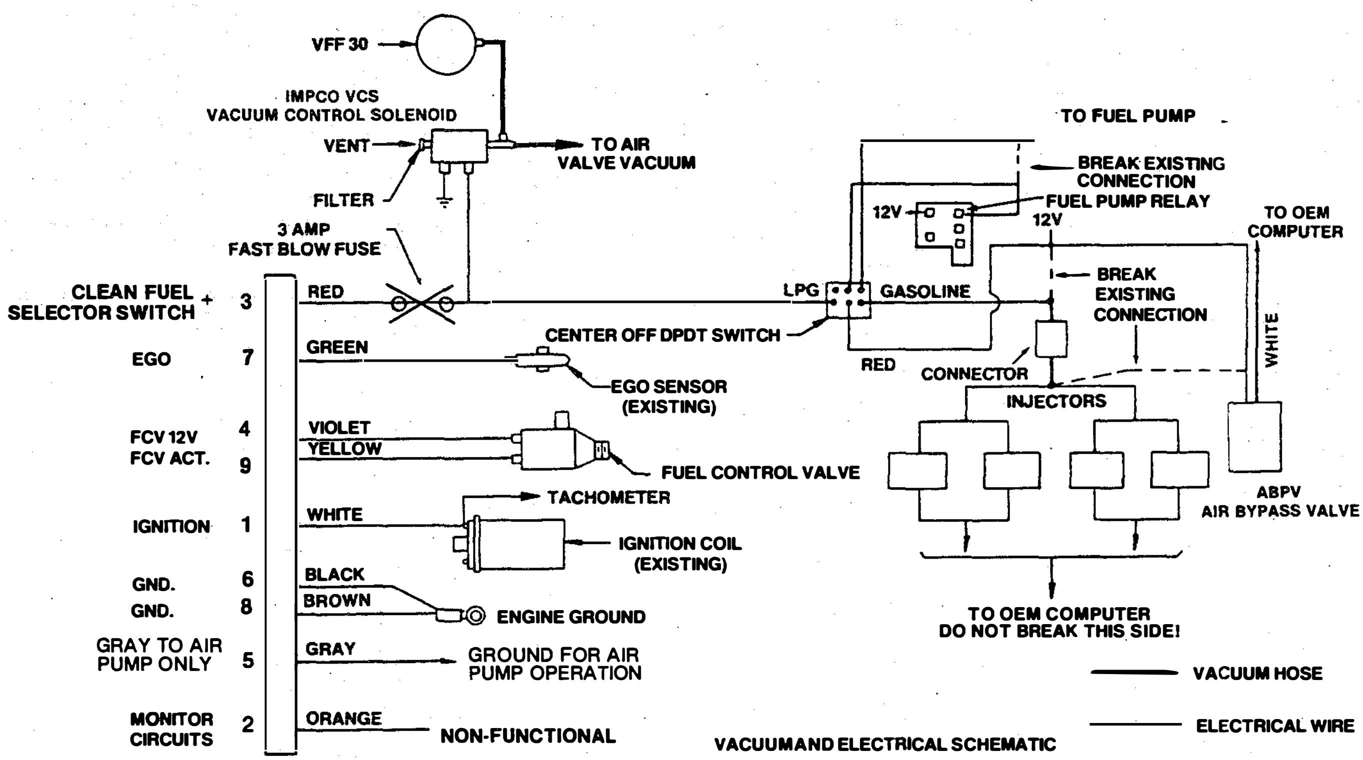
Installation is simple. It is done in the following sequence:(Note: Only procedures that involve the computer feedpack system are listed below. Other standard conversion steps are not described.)

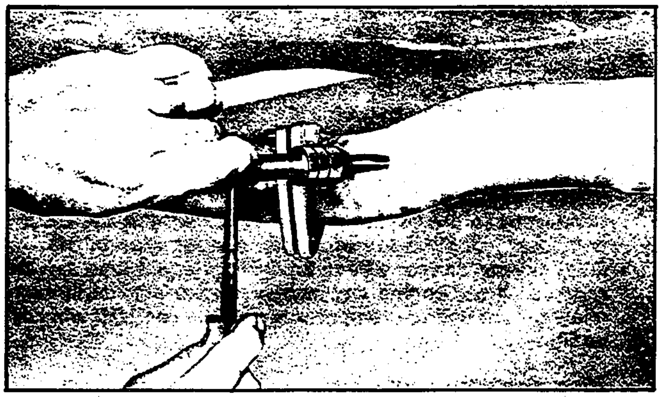
1. Check to ensure that all computer sensors and controls are connected and working.
2. Install Impco alternate fuel feedback carburetor.
3. Remove screen from converter cover vent and screw in 1/8" nipple (part #F4-33) and 1/8" tee (part #F4-32), as shown.
4. Screw Fuel Control Valve (part #FCV) into one side of tee fitting.
5. Install F4-12 elbow and J1-21 restrictor as shown. The F4-12 must be used to provide adequate flow.
6. Connect fuel control valve to air valve vacuum port at the carburetor/mixer.

## THE COLOR-CODED WIRES ON THE ADP KEYED CONNECTOR:

| PIN NO. | COLOR | FUNCTION | CONNECTION |
|---|---|---|---|
| 6 | Black | Signal Ground | To Vehicle Ground |
| 8 | Brown | Solenoid Ground | To Vehicle Ground |
| 3 | Red | ADP Power | To Fused LPG Switch plus 12 volts |
| 4 | Violet | Solenoid Power | To FCV on Converter |
| 9 | Yellow | Solenoid Active | to FCV on Converter |
| 1 | White | Ignition Tach (RPM) Input | To Ignition Coil Tach Side |
| 7 | Green | EGO Sensor Signal | To EGO Sensor |
| 5 | Gray | Open loop with Air Pump On or Air Pump Signal | To Air Pump (See Page 4, Photo-4) |
| 2 | Orange | Non-Functional | |

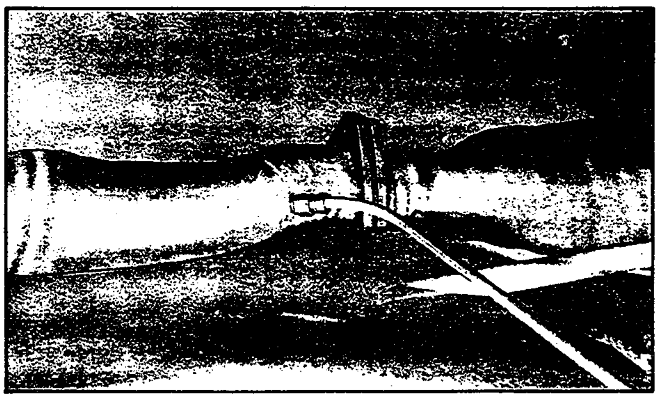
## TYPICAL ADP FUEL CONTROL PROCESSOR WIRING SCHEMATIC



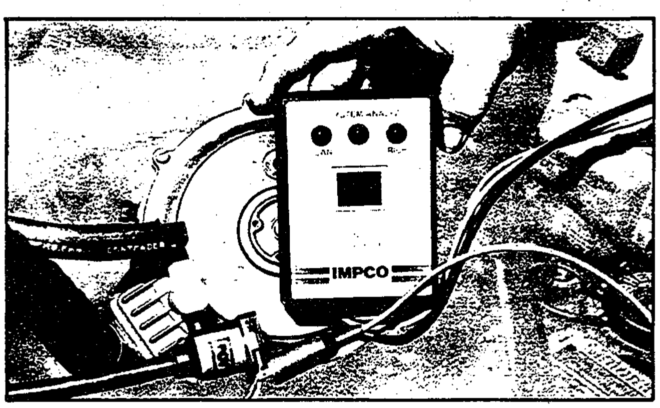


**7.** If CO analyzer is available, drill a 21/64" hole in the exhaust pipe before the catalytic converter and near the exhaust manifold, if possible. Tap with a 1/8"x27 NPT for installation of probe to measure CO.

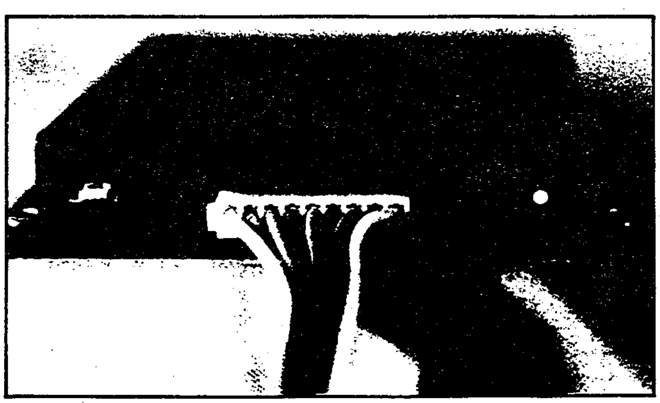
**NOTE:** When using a CO Meter, you must be assured of no air induction into the exhaust ahead of the probe for correct readings. Check exhaust system for leaks before the EGO sensor.



**8.** Install exhaust gas probe and connect to CO meter.




**9.** Connect the IMPCO® Fuel System Analyzer (FSA-1) to the FCV. Refer to 23800-27 "Fuel System Analyzer Instructions." If a tach/dwell meter is used, it should be attached to the post connected to the yellow wire. Set Dwell meter to dwell position and 6-cylinder mode, regardless of the number of engine cylinders.



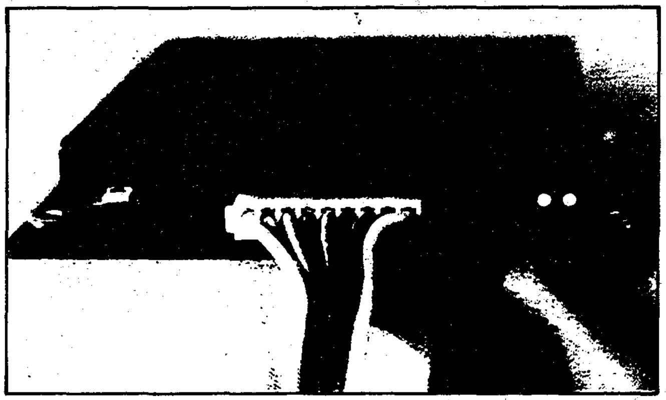
**10.** **To Set Idle Mixture**
**(ON AIR PUMP VEHICLES ONLY)**
Disconnect the gray wire from the air pump, prevent the wire from grounding. Divert the air to atmosphere or away from the exhaust manifold.

**BEFORE STARTING THE ENGINE:**
Inside the vehicle:
Ensure that the jumper/shorting clip is installed on the 4 pin header on the left side of the ADF

**NOTE:** There are a total of 4 pins on the header. The two right pins are the connections that must be made to initialize the ADP. The left two pins are not used in the field.

Turn the key to the run position, **DO NOT START THE ENGINE.**

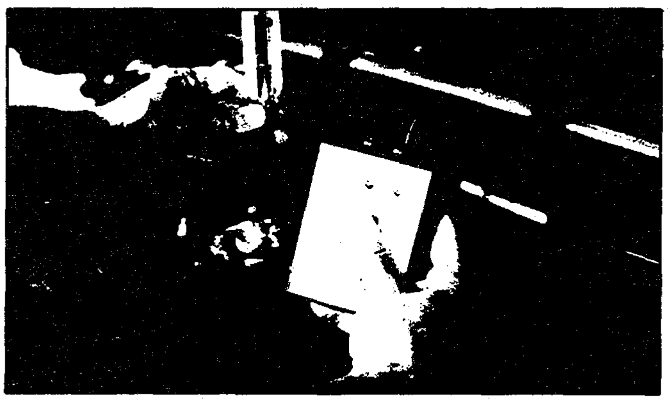
On the right side of the ADP you will see a green and a red LED.



**11.** With the key on and the engine off, the green LED will flash, this is the duty cycle of the ADP. Check the FCV. It should be operational and clicking.

If the green LED is not lit, or the FCV is not clicking. Check the wiring to the FCV valve on the converter. The red LED should be on. This is the oxygen sensor voltage light, when this LED is lit the oxygen sensor voltage is low , below .5 volts (lean mixture).

If the red LED is not lit, check that the green oxygen sensor wire in the wiring loom of the ADP is properly connected to the oxygen sensor signal wire to the OEM computer. Confirm the wire color and location of the OEM oxygen sensor wire in an OEM or equal type service manual. If the engine and oxygen sensor are hot, it may show a high voltage temporarily and the red LED will not be lit.



**12.** **START THE ENGINE**

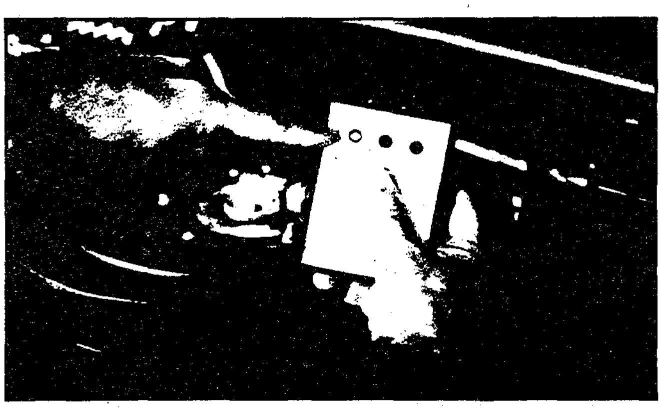
☞ Allow the engine to come up to operational temperature.

With no load on the engine, air conditioning off, lights off, fans off, adjust the idle mixture screw on the IMPCO mixer/carburetor so a smooth transition is noted on the FSA-1 oxygen sensor voltage lights.

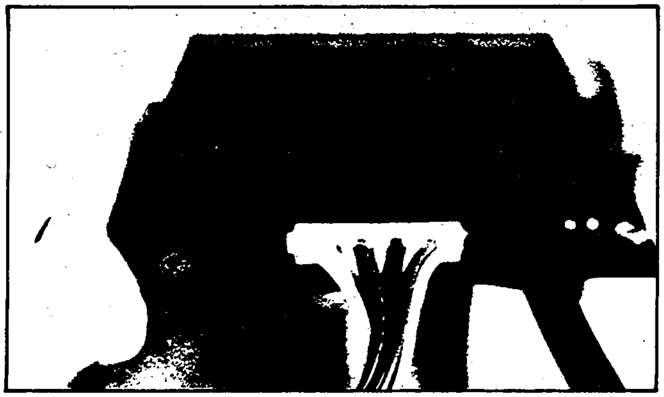
In photo 12 we have blocked the duty cycle window. During this adjustment procedure, **IGNORE THE READING ON THE DUTY CYCLE OF THE FSA-1.** The duty cycle reading on the FSA-1 will remain fixed between 45% and 55% reading on the FSA-1 regardless of the adjustment. The duty cycle reading will not change until the jumper/shorting clip is removed in the next step.

If you are not using the FSA-1, monitor the red LED on the ADP. A smooth transition of the red LED turning on and off should be achieved. The transition time should be 2 seconds or less between rich to lean and back to rich.

**NOTE:** The adjustment may become somewhat difficult on engines equipped with the CA300 series of mixers. To lessen the effect of this, support the weight of the screwdriver with your hand. Do not press down on the idle adjustment screw of the CA300 series mixer as this will tend to lean the mixture and give a false reading to the FSA-1 and the ADP.



**13.** After achieving a smooth transition. Allow the engine to idle for 60 seconds, monitor the oxygn sensor lights on the FSA-1 or the ADP for smooth transitions. Ignore the duty cycle reading during review.



14. Remove the jumper/shorting clip from it's installed position. Retain the jumper/shorting clip.

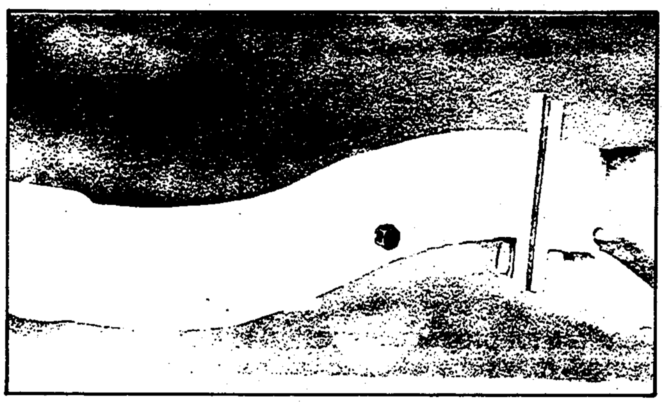
You will notice a change in engine operation and a change in the duty cycle reading on the FSA-1 and the transition of the oxygen sensor voltage lights on the FSA-1 and the ADP. **THIS IS NORMAL.**

Allow the engine to operate for a minimum of 60 seconds after the jumper/shorting clip has been removed.

**NOTE:** During this 60 second period, the ADP is counting the number of engine revolutions, determining the number of cylinders of the engine and reading the MAP sensor in the ADP to determine the operational condition of the engine.

Turn the engine off and check to see that the key is in the **OFF** position.

**NOTE:** By removing the jumper/shorting clip and allowing the engine to idle and then stopping the engine. This porcedure presets the ADP to enter into the fast learn mode.



15. ☞ Prior to drive cycle disconnect CO Meter Probe and plug opening with 1/8" pipe plug.

Using a stop watch or other timing device. Start the vehicle and drive the vehicle in as many different driving modes as possible during the first 24 minutes of operation.

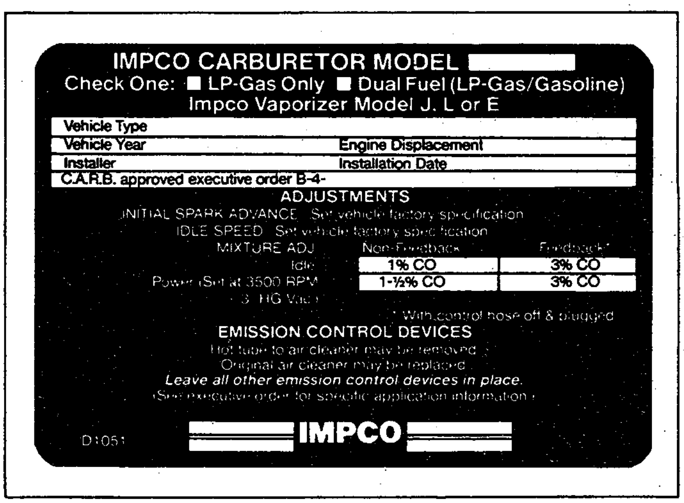
**NOTE:** The drive cycle should include, stop and go traffic, long accelerations and decelerations, Wide Open Throttle, and steady speed cruise operations.

During this operation, the duty cycle readings on the FSA-1 will be slow. This operational speed will change as the ADP establishes each cells operational value.

**NOTE:** During this phase of the installation, the ADP stores correction factors in a calibration table in the Random Access Memory (RAM). This is a short term memory. Every 8 minutes after the start up the ADP will copy this data into the Read Only Memory (ROM). This is the long term memory. After the third 8 minute update period, the ADP switches to normal operation.

**IMPORTANT:** If the vehicle is turned off and power is removed from the ADP during the first 10 minutes of operation. The short term memory in the ADP is lost and will begin again when the vehicle is restarted.

If a cell is not filled during the drive cycle. The non updated cell will be updated during normal driving.




16. Install decals as necessary.

# "TECH TIP'S" ON THE IMPCO ADAPTIVE DIGITAL PROCESSOR

The ADP is designed to be an independent fuel control processor. It is very important to check the OEM system first to confirm that the OEM system is operating properly before checking the IMPCO ADP alternate fuel system.

Required tool:

IMPCO FSA-1
Digital Volt-Ohm Meter
Tachometer
General shop tools

**1.0** Normal duty cycle reading of the ADP will range from 30% to 70%. This range will vary as the vehicle changes engine speed and load. The oxygen sensor lights will be showing a lean reading during start up. When the engine and oxygen sensor are at operational temperatures. The oxygen sensor lights will be in a constant transition once the vehicle is in closed loop operation.

**2.0** No reading on the oxygen sensor lights or duty cycle of the FSA-1 or LED's of the ADP:

**2.1** No power to the ADP:

**2.1.1** Inspect the brown and black ground wires for proper connection to an engine ground. If a faulty ground is suspected, move the wires to the negative side of the battery to confirm that a proper ground has been achieved.

**2.1.2** Also use a continuity meter to confirm continuity between the wiring connector at the ADP and the engine ground of the brown and black wires. Ensure the use of properly sized wiring lugs to attach the brown and black grounding wires.

**2.2** The red power wire should be attached to the fuel selection switch, on dual fuel installations.

**2.2.1** Place the switch in the alternate fuel position, and the ignition key in the on position.

**2.2.2** Check the switch with a continuity light for power to the alternate fuel terminal. If none is found troubleshoot the wiring harness and the connections to the fuel selection switch.

**2.2.3** Check the wiring connector to the ADP with a volt meter or continuity meter, for 12 volt power at the red wire connector.

**2.2.4** Inspect the in-line 3 amp quick blow fuse.

**NOTE: Preform the above test prior to starting this section.**

**3.0 Reading of 00 duty cycle on the FSA-1 or no flashing of the green LED on the ADP.**

**3.1 Check the white wire in the ADP harness for connection to the negative side of the ignition coil.**

**3.1.1 Use a tachometer attached to the white wire to read engine RPM.**

**3.1.1.1 If no RPM is seen, the white wire is connected to the wrong side of the coil or an improper tachometer lead.**

**3.2** Check the wiring connections to the Fuel Control Valve (FCV).

**3.2.1** With the key on:

**3.2.1.1 Use a volt meter to check for 12 volt reading on the violet wire at** the Fuel Control Valve (FCV).

**3.2.1.2** If no voltage is found, check the wiring connector at the ADP.

**3.2.1.3** Check the wiring route for cut or shorted wiring.

**3.2.2** Check the yellow wire for 12 volts.

**3.2.2.1** If no voltage is found, replace the FCV.

**3.2.2.2** If voltage found, check the ground wires. (See 2.1.1)

**4.0** After start up a 99 duty cycle reading is shown and the rich light is lit on the FSA-1.

**NOTE:** It is not possible to view this condition by viewing the LED's on the ADP.

**4.1** With the key on the engine off:

**4.1.1** Check the green wire in the ADP wiring harness with DVOM, if the voltage is above 2.0 volts, the green ADP wire has heen attached to an OEM wire other than the oxygen sensor wire.

**4.2** With the engine running:

**4.2.1** Check the route of the green wire from the oxygen sensor wire to the ADP connector. It is possible that two wires have been crossed or connected together.

**4.2.2** Check to see that no ignition wire is located next to the green ADP wire.

**5.0** After start up a 00 duty cycle reading is shown and the lean light is lit on the FSA-1.

**5.1** Check the intake system for vacuum leaks.

**5.1.1** Check the air management system for constant air into the exhaust manifold.

**5.1.1.1** If found, service the OEM air management system according to OEM service manuals and technic.

**5.1.2** Check the IMPCO adapter for proper fit and tightness.

**5.2** Check the green oxygen sensor wire for shorting to ground.

**6.0** During normal driving one of the following occur:

**6.1** Duty cycle remains at or near 50%, oxygen sensor voltage lights transition.

**6.1.1** Check the gray wire connection, the wire maybe attached to the wrong control solenoid.

**6.1.2** If using the VS-2A vacuum switch, check to see that the gray wire is connected to the yellow wire of the VS-2A.

**6.1.3** Installation jumper is still installed in the initialization mode. Restart the intialization procedures in this manual.

**6.2** Duty cycle varies between 30% and 70%, the oxygen sensor lights do not lite.

**6.2.1** Check connections of the FSA-1.

**6.3** Duty cycle remains very low (below 30%) or very high (above 70%) during a cruise mode.

**6.3.1** The wide open throttle adjustment is not proper. Readjust the WOT adjustment to the middle of the WOT scale.

**6.4** Duty cycle during WOT is at or near 00:

**6.4.1** Check the intake system for vacuum leaks.

**6.4.2** Check the exhaust system for leaks before the oxygen sensor.

**NOTE:** Preform the above checks before attempting the following.

**6.4.3** WOT Adjustment is adjusted too lean, readjust the WOT 1 mark richer on the WOT scale.

**6.4.4** Recheck WOT operation, and continue adjusting the mixture rich until a reading above 50% duty cycle is achieved.

# RECOMMENDED SERVICE INTERVALS

| CARBURETION SECTION | CONVERSION DATE | 1K | 5K | 10K | 15K | 20K | 25K | 30K | 35K | 40K | 45K | 50K | 55K | 60K | 65K | 70K | 75K | 80K | 85K | 90K | 95K | 100K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MILEAGE | | | | | | | | | | | | | | | | | | | | |
| Adjust idle mixture Note 1 | X | X | | | | | X | | | | | X | | | | | | | | | | X |
| Adjust wide open throttle mixture Note 1 | X | X | | | | | X | | | | | X | | | | | X | | | | | X |
| Check air/gas valve diaphragm | | | | X | | | X | | | | | X | | | | | X | | | | | X |
| Replace air/gas valve assy Note 3 | | | | | | | | | | | | X | | | | | | | | | | X |
| Check idle diaphragm CA425 | | | | X | | | X | | | | | X | | | | | X | | | | | X |
| Replace CA425 idle diaphragm if needed | | | | | | | | | | | | X | | | | | | | | | | X |
| Check for vacuum leaks on complete intake system including adapters | | | | X | | | X | | | | | X | | | | | X | | | | | X |
| Check gas orifice for wear | | | | | | | X | | | | | X | | | | | X | | | | | X |
| Service open air cleaner: | | | | | | | | | | | | | | | | | | | | | | |
| • Normal conditions | | | | | | X | | | | X | | | | X | | | | X | | | | X |
| • Dirty conditions | | | | X | | X | | X | | X | | X | | X | | X | | X | | X | | X |
| **REGULATOR SECTION** | | | | | | | | | | | | | | | | | | | | | | |
| Check FCV for proper OHM reading Note 5 | X | | | | | | X | | | | | X | | | | | X | | | | | X |
| Replace FCV | | | | | | | | | | | | X | | | | | | | | | | X |
| Inspect secondary diaphragm Note 4 | | | | X | | | X | | | | | X | | | | | X | | | | | X |
| Test secondary pressures Note 2 | | | | X | | | X | | | | | X | | | | | X | | | | | X |
| Test primary pressures Note 2 | | | | X | | | X | | | | | X | | | | | X | | | | | X |
| Rebuild regulator | | | | | | | | | | | | X | | | | | | | | | | X |
| **LOCKOFF SECTION** | | | | | | | | | | | | | | | | | | | | | | |
| Replace filter | | | | | | | X | | | | | X | | | | | X | | | | | X |
| **GENERAL MAINTENANCE** | | | | | | | | | | | | | | | | | | | | | | |
| Check all vacuum lines and fittings (Replace as needed) | X | | | | | | X | | | | | X | | | | | X | | | | | X |
| Check all fuel fittings and hoses (Replace as needed) | X | | | | | | X | | | | | X | | | | | X | | | | | X |

**NOTES:**

1. See air fuel ratio adjustment procedures
2. See ITK-1 test procedures
3. Side draft CA425 - Inspect each 10,000 miles for wear.
4. If oil appears on diaphragm, disassemble and clean regulator of all oil and contaminants.
5. No less than 22 OHM

# FUEL MANAGEMENT SYSTEM PARTS LIST

## AIR GAS VALVE ASSEMBLY

| PART NO. | APPLICATION |
|---|---|
| AV1-1447 | Model 125 |
| AV1-1447-2 | Model 125 Silicone |
| AV1-1447-4 | Model 125M-10 Vacuum Lift |
| AV1-1447-4-2 | Model 125M-10 Vacuum Lift Silicone |
| AV1-1245 | Model 225 |
| AV1-1245-2 | Model 225 Silicone |
| AV1-1651 | Model 425 |
| *Gas Valve Only Required* | |
| V2-49 | Model 300A-1, CA300A-20 |
| V2-50 | Model 300A-50, CA300A-70 |
| V2-58 | Model 175A-2, Optional for CA175-1 (Anodized red) |

## FUEL CONTROL PARTS

| PART NO. | APPLICATION |
|---|---|
| FCV | Fuel Control Valve, all feedback |
| FEV | Fuel enrichment Valve (Use SV w/specified jet) |
| SV | Starting Valve, used as Fuel Enrichment Valve |
| VPV | Vacuum Power Valve, light-duty Chrysler feedback installation |
| J1-21 | Jet .100, Balance Line Restrictor |
| J1-20 | Jet .062, SV |
| J1-20-1 | Jet .032, Starting Valve for FEV application |
| J1-20-2 | jet .050, Vacuum Power Valve |
| J1-20-3 | jet .075, Vacuum Power Valve |
| J1-20-4 | Jet .100, Vacuum Power Valve |
| F4-2 | Tube fitting, 1/4" x 1/4" I.D. Hose |
| F4-12 | 1/8" NPT to 3/8" Hose elbow, balance line |
| F4-32 | 1/8" tee, balance line |
| F4-33 | 1/8" nipple, balance line |
| T1-13 | Tube connector |

| PART NO. | APPLICATION |
|---|---|
| D-1051 | Decal for LPG Only and dual fuel LPG/Gasoline |
| D-1052 | Decal for CNG only and dual fuel CNG/Gasoline |

## SPECIAL PARTS NOT SUPPLIED BY IMPCO®

| PART NO. | SOURCE |
|---|---|
| TPS | Ford #EOAE9B989AB |
| *Description:* | Position Sensor; replaces OEM T.P.S. where necessary. |
| DPDP | |
| *Description:* | Double pole double throw switch for Ford feedback installation. |

# Notes

# Notes



23600-71 792(792)T/L 1M PRINTED IN U.S.A.

## COMPUTER SUPPORT 1

**P/N 8690**

### PARTS INCLUDED IN THIS KIT

| | |
|---|---|
| 1-Computer Support 1 | 1-Installation Instructions |
| 6-Wire Tap Devices | 4-Wire Ties |
| 6-FastOn Receptacles | 4-No. 6x3/4 Screws |

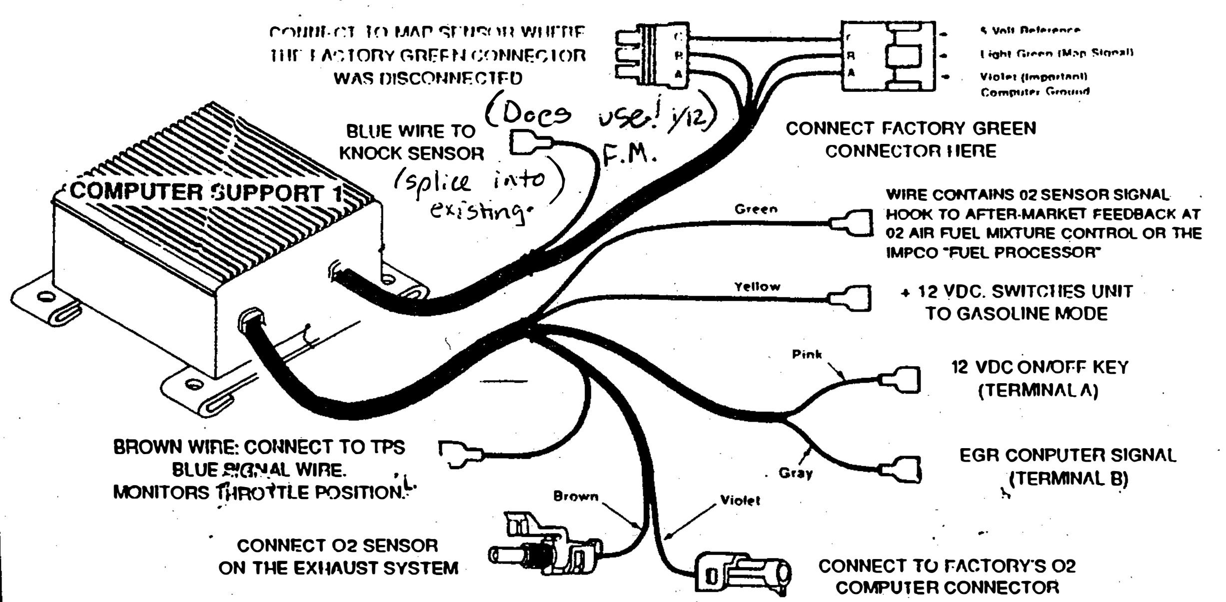
The **Computer Support 1** is designed to work in conjunction with an 02 Feedback Fuel Control System in order to correctly monitor "Service Engine" codes while on alternate fuels.

1. Supplies a correct 02 Feedback signal to the ECM (prevents FALSE 02 sensor malfunction codes (13,44,45) while allowing *TRUE* failure conditions to be recognized and displayed by the factory computer.

2. Monitors ECM signals related to exhaust gas recirculation (EGR), and then responds with the correct sensor signals. Prevents *FALSE* "EGR" malfunction code (32) while allowing *TRUE* "EGR" failure conditions to be recognized and factory vehicle displayed.

3. Monitors "ECM" signals related to the "knock sensor", and then responds with the correct sensor signals. Prevents *FALSE* "knock sensor" malfunction code (43) and computer "limp-mode" spark timing retard on alternate fuels, which leads to poor driving characteristics, low milage, and high exhaust temperatures.

4. Monitors 02 sensor signals related to RICH/LEAN conditions in the exhaust, verifying that the 02 Feedback Fuel Control being used is effectively maintaining the correct AIR/FUEL ratios.




OEM Timing affected by knock signal.


**AUTOTRONIC CONTROLS CORPORATION**

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## MOUNTING AND WIRE HOOK-UP

**Mount the unit in a location where the cables will reach the exhaust O2 sensor, the EGR control solenoid, the knock sensor, and the MAP sensor. Do not mount on the engine or near the exhaust manifold. The extreme temperatures at these locations could cause damage to the unit. Use the sheet metal screws provided in the parts kit.**

WIRE CONNECTIONS

PINK WIRE: Connect to the EGR pink wire or coil + wire for keyed 12 VDC supply.

GREY WIRE: Connect to the EGR control signal wire. (Grey wire at EGR solenoid.)

BLUE WIRE: Connect to blue wire at knock sensor found by starter (350 eng.) or by oil filter (454 & 366 Eng.)

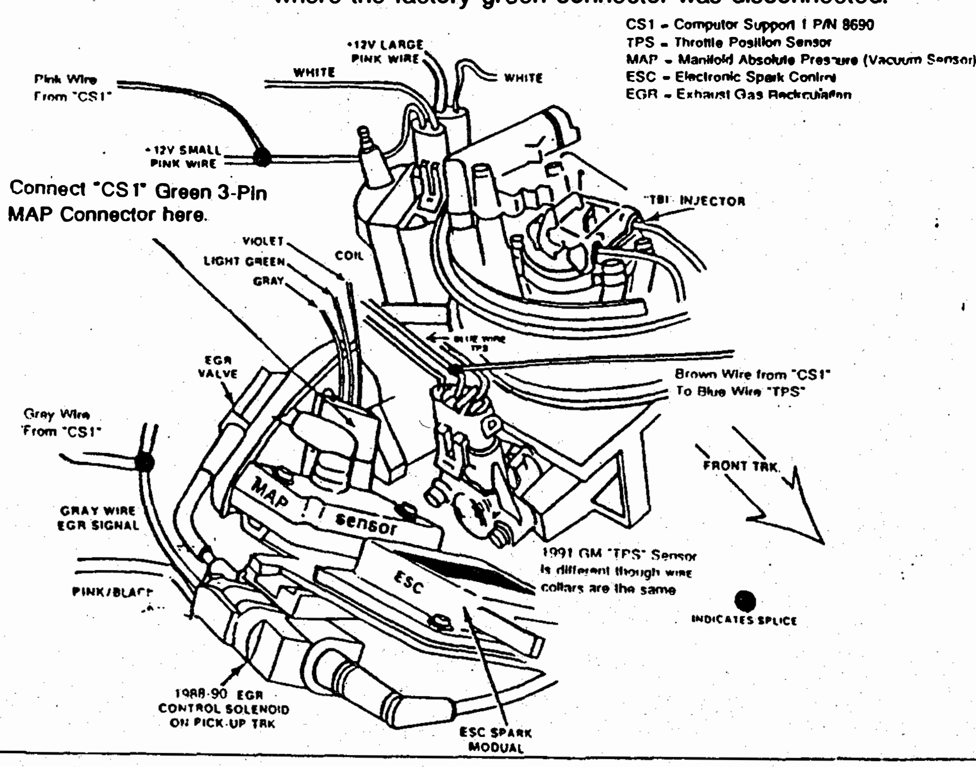
YELLOW WIRE: Connect to a 12 VDC source that is HOT only while on gasoline. 12 VDC on yellow wire indicates gasoline mode.

GREEN WIRE: Connect to O2 Feedback Fuel Control Processor (FCP-1). Green wire contains actual O2 sensor signal for FCP-1.

BROWN WIRE: Connect to throttle position sensor (TPS) signal wire. Wire will be either brown (early model TPS) or blue (late model TPS) at TPS sensor.

O2 SENSOR CONNECTORS: Connect to factory O2 sensor wire connectors with the violet wire going to computer and the brown wire going to factory O2 sensor.

3 PIN MAP CONNECTORS: Connect to factory MAP sensor. Connect factory green connector into black female shroud, and connect the 8690's green connector where the factory green connector was disconnected.





**AUTOTRONIC CONTROLS CORPORATION**

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**IMPCO AFCP-1**

IMPCO TECHNOLOGIES, INC.

# NOTICE

THERE HAVE BEEN CHANGES IN THE INSTALLATION INSTRUCTIONS FOR THE AFCP-1.

IF THE PACKAGE IS MARKED WITH A GREEN STRIP READ THE ENCLOSED INSTRUCTIONS FOR INSTALLATION OF THE VACUUM SWITCH AND THE GRAY WIRE.

IF YOU HAVE ANY QUESTIONS ON THIS INSTALLATION CONTACT YOUR PRODUCT DISTRIBUTOR OR IMPCO DIRECTLY.

IMPCO TECHNOLOGIES,INC.

16804 GRIDLEY PLACE, CERRITOS, CA 90701-1752 (213)860-6666 TELEX 69-8458 FAX (213)809-1240

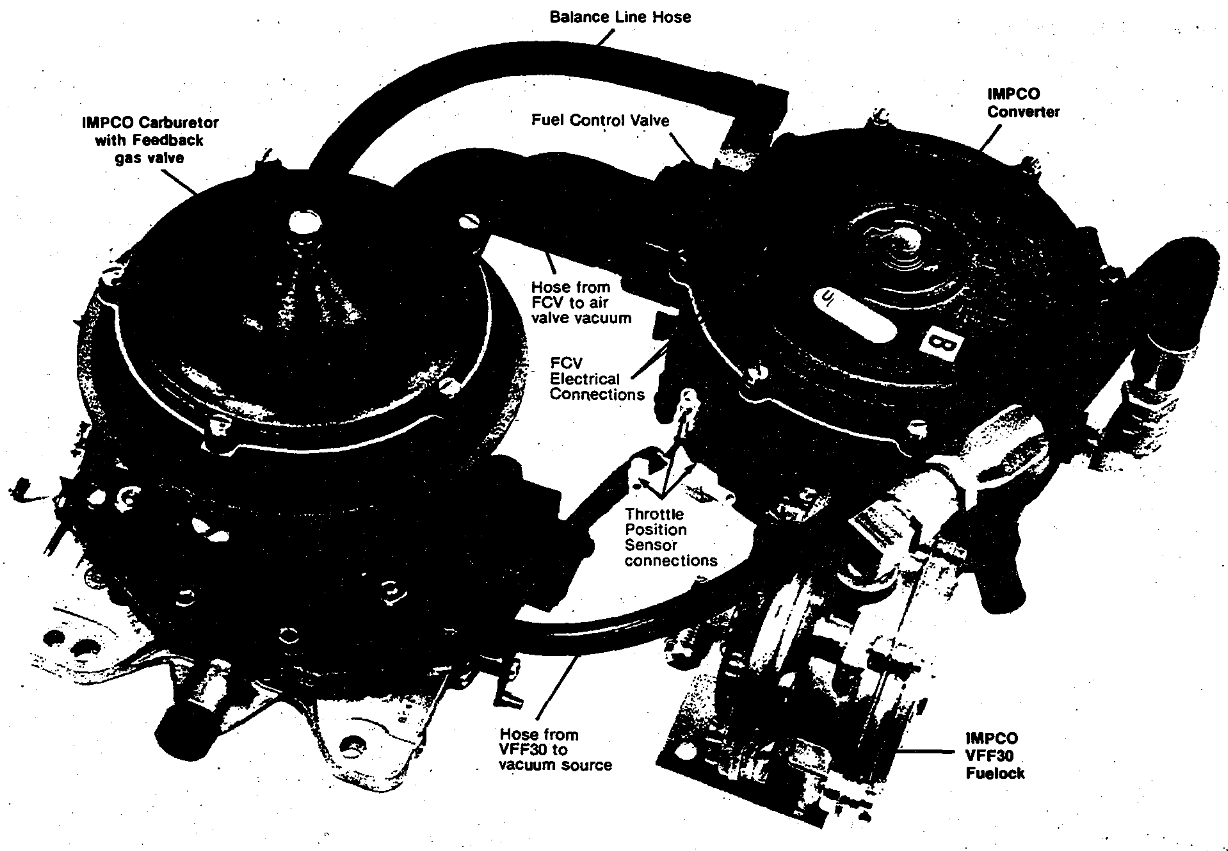
# Alternate Fuel Management System

**Introduction**

The intent of this service bulletin is to provide an overview of Computerized Engine Control (CEC) systems, IMPCO®'s Alternate Fuel Management System including the AFCP-1 Fuel Control Processor, and Typical Installation Information.

The areas covered are:

- Glossary of terms
- Understanding the "Feedback" system
- Principals of Operation
  - Cold start/Open loop
  - Stabilized Engine Operation/Closed loop
- Checking out the on-board computerized engine control system
- Typical Alternate Fuel Management components
- AFCP-1 Fuel Control Processor
- Typical Installation Information
- Adjustment Procedures
- Tech Tips on the AFCP-1
- IMPCO "Feedback" carburetion parts list.




**Glossary Of Terms**

**Exhaust Gas Oxygen Sensor.** Located in the exhaust gas stream, it monitors the amount of oxygen present. The computer uses this information to control the air/fuel ratio for most engine operating modes.

**Barometric and Manifold Absolute Pressure (B.M.A.P.) Sensors.** The Barometric Pressure Sensor measures barometer pressure of the approximate altitude the vehicle is operating. The M.A.P. sensor monitors intake manifold vacuum. Manifold absolute pressure is defined as barometric pressure minus manifold vacuum. With these two signals, the computer will know which mode the engine is operating in and adjust fuel and spark to meet the requirements.

**Throttle Position Sensor.** Connected to the throttle shaft, it registers closed, part, and wide open throttle positions. This permits the computer to determine the proper amount of spark, fuel and EGR flow.

**Engine Coolant Temperature Sensor.** Inputs information about engine temperature which is used to process EGR flow, ignition timing and open- or closed-loop logic.

**Air Charge Temperature Sensor.** Provides mixture temperature information. This input is used as a density corrector for air flow calculations and to proportion the cold enrichment fuel flow.

**Knock Sensor.** Normally mounted on the intake manifold. Its signal is used to retard ignition timing during spark knock.

**Crankshaft Position Sensors.** The computer uses input from this sensor as a reference point to implement the spark table in the program.

All of these signals must be received or the computer will switch to a default mode. If the computer does not have all the input needed to operate the engine properly, it switches to a preset control of fuel and spark. This is intended to permit the engine to continue running with the least possible risk of engine or catalyst damage until repairs can be made. This condition is not optimum for fuel economy or power.

### Understanding the Feedback System

The IMPCO system operates almost exactly the same as the computer-controlled gasoline feed back system. Both systems are based on the functions of the onboard computer which monitors and controls critical engine functions. The computer is dependent on a system of engine sensors that feed information it uses to control engine operating functions.

The input signals are processed and the correct computation for each operating mode is relayed through the computer drivers to the various engine controls. The engine controls normally include:

Feedback carburetion control
(Fuel Control Valve adjusts air/fuel ratio)
Ignition timing
EGR control
Air injection control
Canister purge
Throttle solenoid or automatic idle speed control

IMPCO's Propane Feedback System is engineered to use the existing gasoline onboard computer and sensors without modification.

The computer itself is a logic switching device that retains some memory. This allows it to act rather than just react. It has two basic methods of operation, open loop and closed loop. In the open-loop mode, the computer ignores most of the sensors and utilizes various predetermined operating conditions established by the program in its memory. "Special" conditions such as cold start or wide-open throttle cause the computer to switch in the open-loop modes. The computer selects the correct open loop conditions to operate from. The "default" mode of operation is another example of open loop operation. In closed loop, the computer processes the signals of all sensors. It utilizes this information to determine how to set the fuel, ignition and other engine-controllable functions for routine conditions. With a wide range of control in closed loop, the computer can optimize engine performance. It is the computer's ability to quickly and correctly react that is employed by the IMPCO Propane Feedback System for the most efficient use of the fuel.

### Principle of Operation

**Cold Start/Open Loop Operation.** The cold start operating mode is activated by the engine coolant temperature sensor telling the computer a cold engine condition exists.

During cold start, "fresh" air from the air injection pump or thermactor pump is directed into the engine exhaust manifold. The fresh air provides additional oxygen in the exhaust manifold to prompt continued burnoff of excess fuel and a further reduction in HC (hydro-carbon) and CO (carbon monoxide) emission levels until the catalytic converter reaches operating temperatures. During the cold-start operating mode, the engine is metered a pre-determined rich fuel mixture via computer command to the Fuel Control Valve. The oxygen sensor is automatically "locked out" since it would sense an excess of fuel and send a lean-mixture signal to the computer. Once the oxygen sensor temperature reaches a specified temperature (above 600F), the computer switches from an "open loop" condition to a "closed loop" stabilized engine operating condition. Fuel enrichment is then reduced by the fuel enrichment valve via computer command and input from the oxygen sensor. Also, the "fresh" air from the air injection pump or thermactor pump is directed to the catalytic converter or vented to the atmosphere depending on how the computer is programmed.

The computer is capable of controlling the Fuel Control Valve from full rich to full lean operation. During cold start operation, a rich fuel mixture is normally pre-set in the computer and used for engine operation.

**Stabilized Engine Operation/Closed Loop.** The oxygen sensor located in the exhaust system ahead of the catalytic converter is the reference control for "stabilized engine" closed loop operation. The oxygen sensor interacts with the computer via electrical signals. When oxygen is sensed in the exhaust gases (lean mixture) the oxygen sensor generates a voltage of .5 or less to the computer. The level of voltage transmitted is dependent on the amount of oxygen detected. An absence of oxygen in the exhaust (rich mixture), generates a voltage from .5 to 1.0 depending on the richness of the mixture. The computer processes this information and reacts to the voltage transmitted, commanding the Fuel Control Valve to assume a richer or leaner cycle.

The Fuel Control Valve in the IMPCO Fuel Management System is used to control fuel delivery in a unique fashion. Because the diaphragm of the IMPCO converter is very large, little movement is required to control any amount of fuel change. The IMPCO Fuel Control Valve is connected between the atmospheric side of the converter secondary diaphragm and the air valve venturi of the carburetor. This applies a very low vacuum signal to the atmospheric side of the converter secondary diaphragm.

Any signal less than atmospheric results in a reduction in fuel delivery. This assures extremely accurate fuel delivery and rapid response time.

With the engine at operating temperature and the computer in closed loop, there is a wide range of control. This permits the computer to optimize the air/fuel mixture to varying engine requirements. For wide-open throttle, the computer will switch back to open-loop to meet the increased fuel demand.

**Checking Out The Onboard Computer Feedback System For Proper Operation**

The vehicle computer feedback system should **always** be checked **first** for proper operation, before engine tuning is conducted. The Impco Fuel System Analyzer can be used to isolate and identify problem areas due to computer feedback system malfunction or carburetion system problems.

The onboard computer system can be checked for proper function by following this procedure:

1. Warm up engine.
2. Connect the FSA-1 Fuel System Analyzer as described in the FSA-1 instruction booklet (or 23800-27).
3. Drive vehicle at a steady road speed. The "RICH/LEAN" lights should switch, and the "COMPUTER COMMAND" display will read a varying number if the computer feedback system is operating properly. **NOTE:** Some vehicle manufacturers have chosen "RICH/LEAN" switch points at a level that may cause only the "RICH" (red) light and the "transition" (green) light to flash. The lights may flash so fast that it appears only one light is on. If the feedback system is working properly, close examination will show a second light is switching on.
4. During a W.O.T. test, the lights should continue to change from rich to lean at a constant rate. If either the lean or rich light is on and the duty cycle is a fixed number, the W.O.T. adjustment on the carburetor is improperly adjusted.

THE VEHICLE ONBOARD FUEL CONTROL COMPUTER SYSTEM SHOULD ALWAYS BE CHECKED OUT FOR PROPER OPERATION BEFORE INSTALLING AND/OR ADJUSTING THE CARBURETION SYSTEM FOR OPTIMUM ENGINE PERFORMANCE.

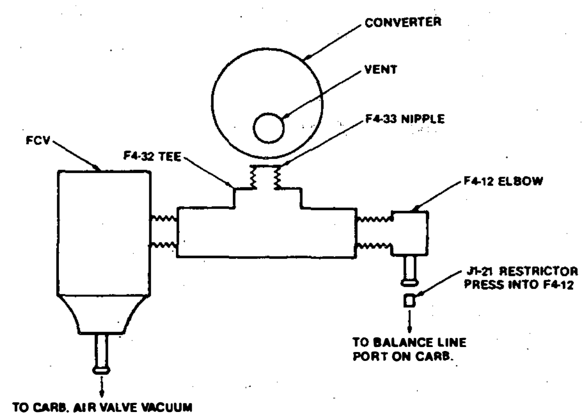
**Typical Propane Fuel Management Component Installation**

Installation is simple. It is done in the following sequence: (Note: Only procedures that involve the computer feedback system are listed below. Other standard conversion steps are not described.)

1. Check to ensure that all computer sensors and controls are connected and working (see "Checking Out The Onboard Computer Feedback System For Proper Operation").
2. Install Impco propane feedback carburetor.
3. Remove screen from converter cover vent and screw in 1/8″ nipple (part #F4-33) and 1/8″ tee (Part #F4-32), as shown in Figure 1.
4. Screw Fuel Control Valve (Part #FCV) into one side of tee fitting.
5. Install F4-12 elbow and J1-21 restrictor as shown in Figure 1.
6. Connect fuel control valve to air valve vacuum at carburetor.
7. Connect 3/8″ I.D. balance line vacuum hose to hose end of F4-12 fitting and balance line port on carburetor (refer to Figure 1).
   **Note:** The F4-12 must be used to provide adequate air flow.

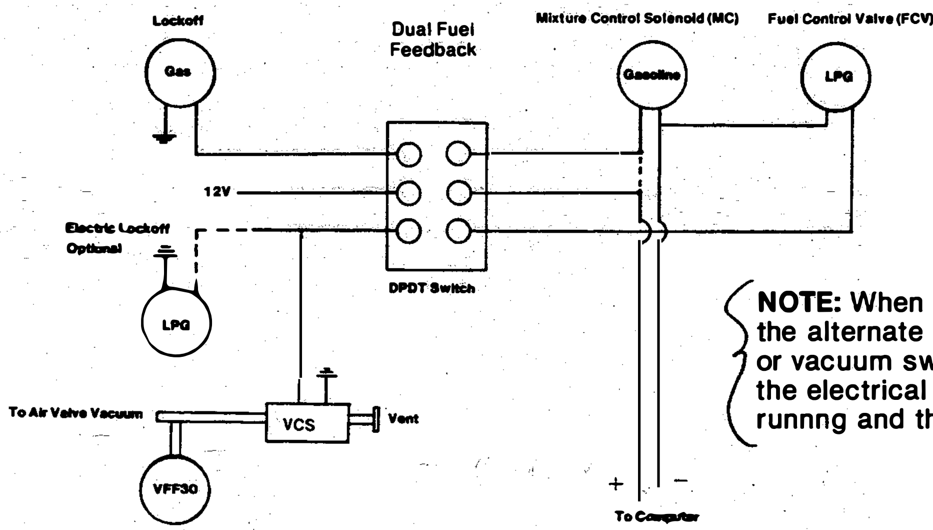
**FIGURE 1.**

FUEL CONTROL VALVE WITH BALANCE LINE




8. For straight fuel conversions, connect the two electrical leads from the original gasoline mixture control solenoid to the Fuel Control Valve. If the conversion is dual fuel, connect the gasoline fuel control solenoid and the propane Fuel Control Valve as shown in Figure 2.

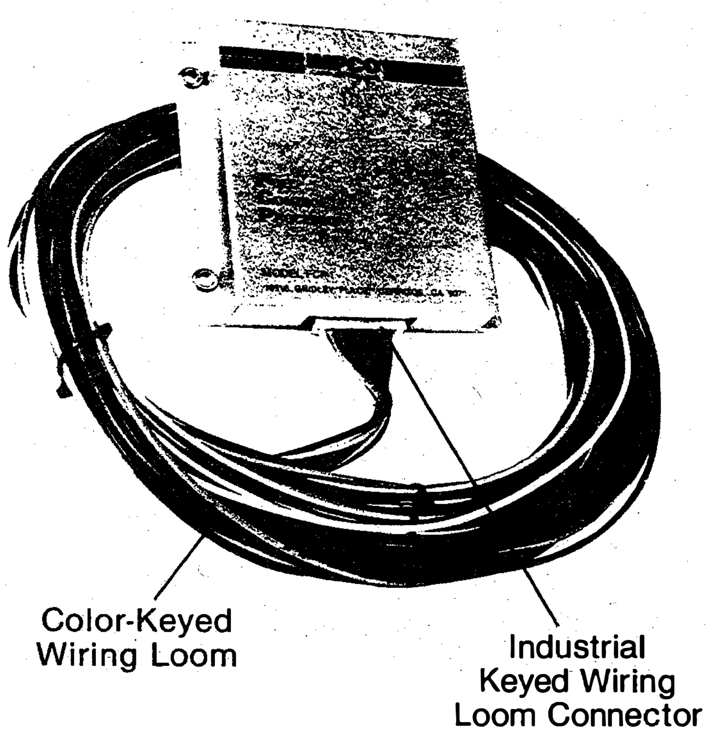
**FIGURE 2.**




**NOTE:** When an electric lockoff is used for the alternate fuel, an approved oil pressure or vacuum switch must be used to interrupt the electrical signal when the engine is not runnng and the ignition is on.

9. Start engine and set curb idle speed.
10. Stop engine and adjust voltage of throttle position sensor to manufacturer's specifications with key on.

    **Note:** This step is for straight fuel conversions on GM when the gasoline carburetor has been removed and a TPS has been installed on the LPG carburetor.
11. Set mixtures according to FSA-1 instructions.

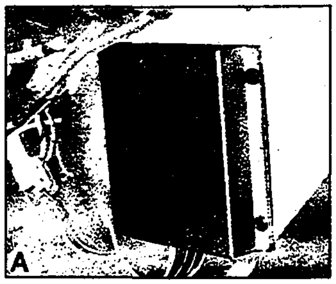


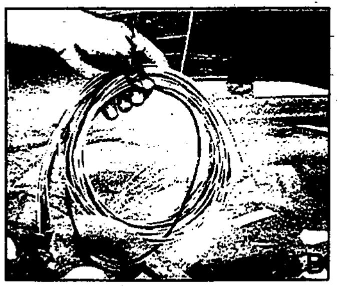

## MODEL AFCP-1 FUEL CONTROL PROCESSOR

The AFCP-1 is IMPCO's control system that utilizes state-of-the-art electronics technology to adjust air/fuel ratio for optimum performance. It monitors engine operating conditions sensing exhaust gas oxygen and RPM. It provides precise fuel control for increased fuel efficiency and lower emissions.

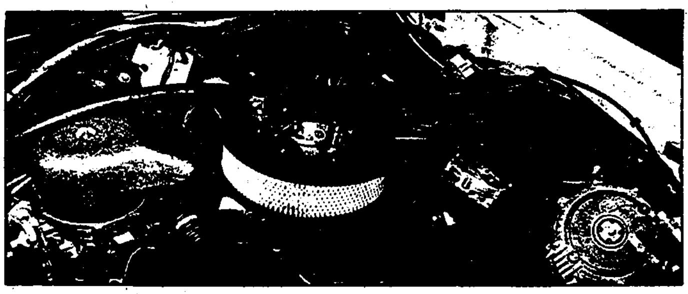
One of the best canididates for conversion to propane fuel is the fuel-injected engine. Spark advance on these engines is aggressive and fuel control is precise, as, almost without exception, these engines are computer-controlled. In fuel-injected models, the FCP-1 operates with the factory installed onboard computer without causing a default condition or increasing emissions. On non-computer-controlled applicaiton, the system requires that an exhaust gas oxygen sensor (IMPCO® part #FOS) be installed in the exhaust manifold. The AFCP-1 is designed to be compatible with most engine systems.

# Instructions for Typical CA300A Installation on Fuel-Injected Engines Using Model AFCP-1 Fuel Control Processor

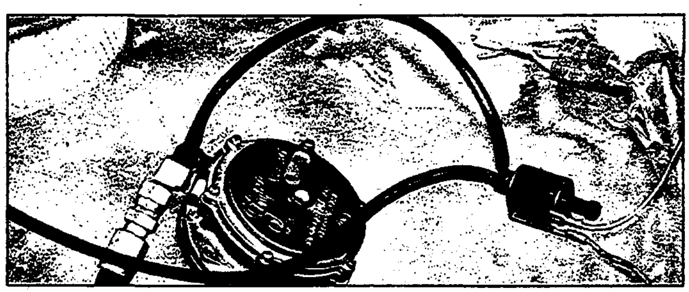


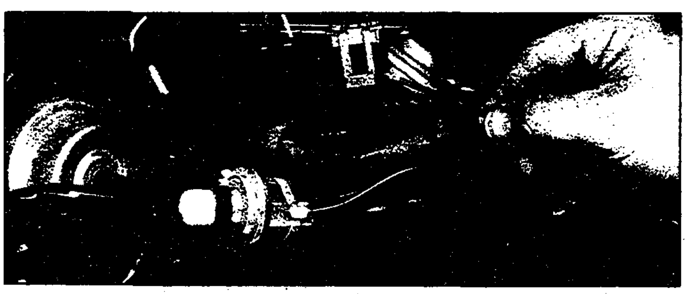

**1.** The FCP-1 box (photo A) is designed for installation inside the passenger compartment, away from engine heat and road splash. An ideal location is on the passenger side kick panel or under the dashboard. Mount the FCP-1 securely using the 4 mounting holes provided. Thread the wiring harness (photo B) through a convenient knockout in the firewall.



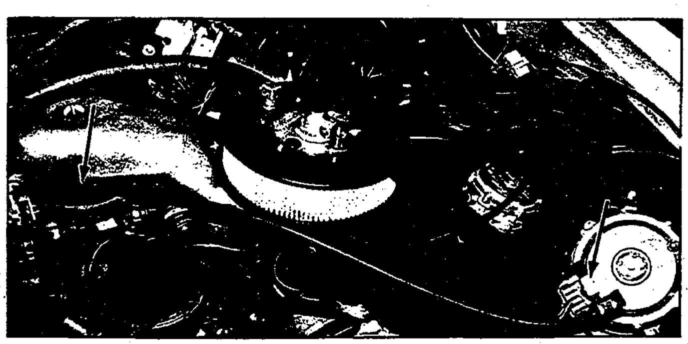
**2.** Install the required IMPCO® adapter assembly between the OEM carburetor or EFI throttle body and the IMPCO® mixer.



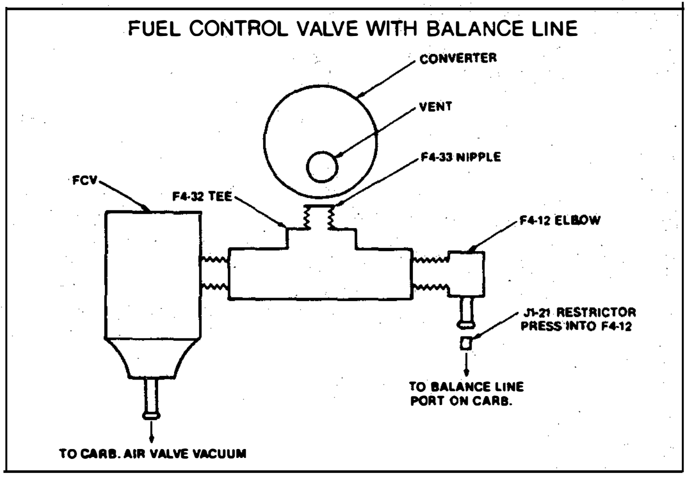
**3.** An alternate method of installation, using a CA300A-1 mixer, utilizes an optional 3-way vacuum control solenoid (part #VCS) to control VFF30 operation. In this installation, the Boden cable and CA300A lifter cam are not required. Insert the solenoid into the vacuum line, between the vacuum source and the VFF30. Connect one electrical lead to secure ground, the other to the alternate fuel side of the fuel selector switch located inside the driver's compartment. Fuel selection is made with this switch, rather than a Boden wire.



**4.** Air Pump Vehicles: ***Chevrolet:*** Connect gray wire from FCP to brown wire at air pump diverter valve. ***Ford & Chrysler:*** Use a VS-2A vacuum switch. When air is diverted into the exhaust manifold prior to the $0^2$ sensor, the VS-2A closes to ground causing open loop operation at/or near 50% duty cycle. Cut and remove the red wire. Solder the yellow wire to the gray wire. Attach the black wire to ground.



**5.** Install IMPCO® Fuel Control Valve (FCV) in the cover of the converter (also Fig. 1, page 3). If an air valve vacuum source is not available for the FCV, tap into the adapter under the mixer. Install an F4-8 fitting in the adapter and connect a vacuum hose from the fitting to the FCV. **NOTE:** The FCV must have an independent air valve vacuum source. Install the FCV so the vacuum connection is in the down position.



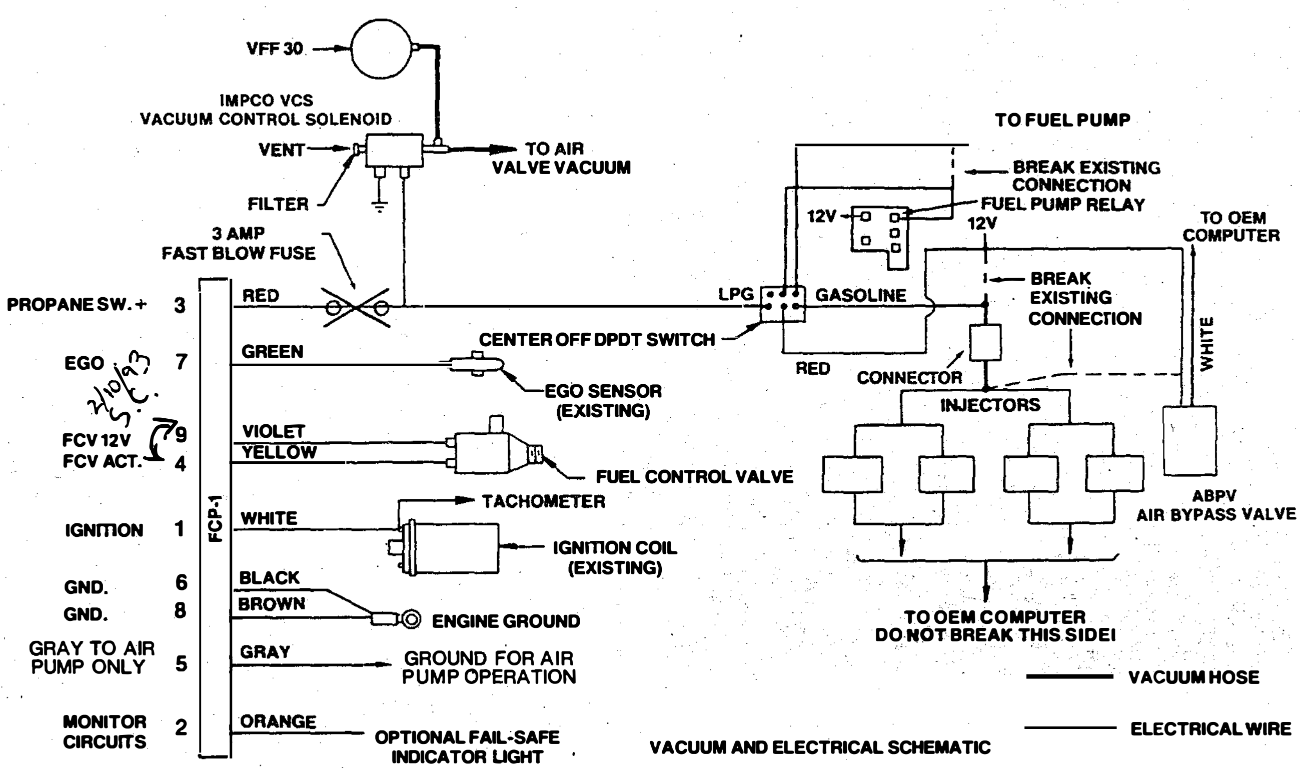

FUEL CONTROL VALVE WITH BALANCE LINE

**6.** Install the FCP-1 wire harness (part *#AW2-3) as indicated. See complete typical schematic below.*

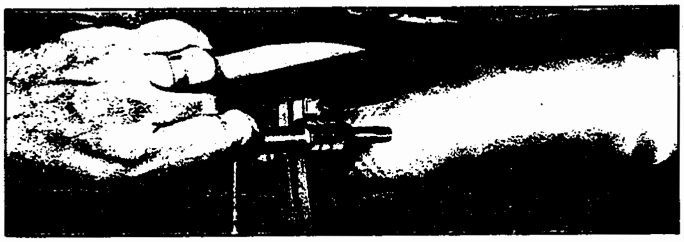
## THE COLOR-CODED WIRES ON THE AFCP-1 KEYED CONNECTOR:

| PIN NO. | COLOR | FUNCTION | CONNECTION |
|---|---|---|---|
| 6 | Black | Signal Ground | To Vehicle Ground |
| 8 | Brown | Solenoid Ground | To Vehicle Ground |
| 3 | Red | FCP-1 Power | To Fused LPG Switch + 12 volts |
| 4 | Violet | Solenoid Active | To FCV on Converter |
| 9 | Yellow | Solenoid Active | To FCV on Converter |
| 1 | White | Ignition Tach | To Ignition Coil Tach Side |
| 7 | Green | EGO Mixture | To EGO Sensor |
| 5 | Gray | open Loop with Air Pump On OR Air Pump Signal | To Air Pump (See Page 5, Photo #4) |
| 2 | Orange | Fail/Safe | To Optional Dashboard Fail/Safe Lamp |

## TYPICAL AFCP-1 FUEL CONTROL PROCESSOR WIRING SCHEMATIC

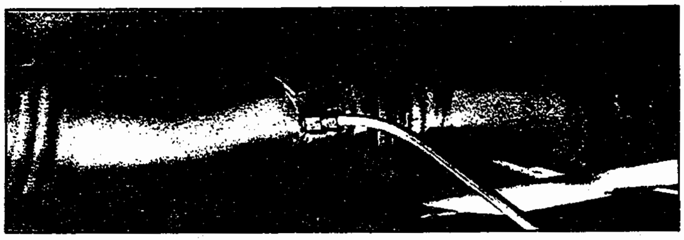



VACUUM AND ELECTRICAL SCHEMATIC

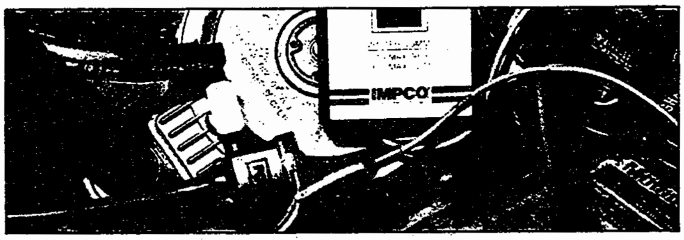


**7.** If a CO analyzer is available, dirll a 21/64" hole in the exhaust pipe before the catalytic converter and near the exhaust manifold, if possible. Tap with a 1/8" x 27 NPT for installation of probe to measure CO.

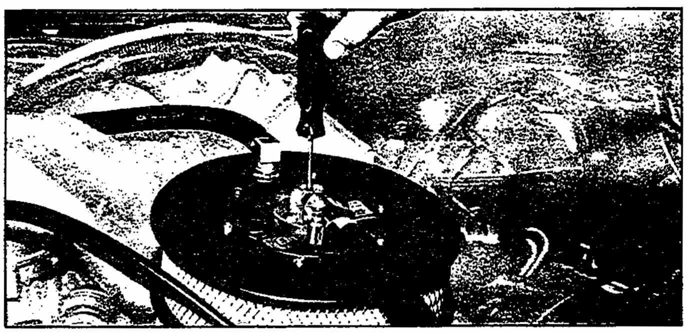
**NOTE:** When using a CO Meter, you must be assured of no air induction into the exhaust ahead of the probe for correct readings.



**8.** Install exhaust gas probe and connect to CO meter.




**9.** Connect the IMPCO® Fuel System Analyzer (FSA-1) yellow lead to the yellow wire from the Fuel Control Valve (FCV). Refer to 23800-27 "Fuel System Analyzer Instructions." If a tach/dwell meter is used, it should be attached to the post connected to the yellow wire. Set dwell meter to dwell position and 6-cylinder mode, regardless of the number of engine cylinders.



**10. To Set Idle Mixture**
**(ON AIR PUMP VEHICLES ONLY)**
Disconnect the gray wire from the processor, prevent the wire from grounding. Divert the air to atmosphere or away from the exhaust manifold. Allow the engine to warm up to operational temperatures. Apply a load to the engine (automatic transmission, place in drive, block wheels and set parking brake).

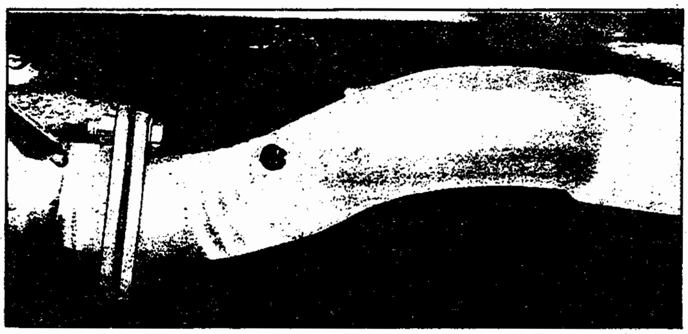
**To Set Idle Mixture**
Set idle mixtures to 40 - 50% duty cycle. If there is any reason to believe that the FCP-1 is not in closed loop operation, depress the primer button on the regulator. If the engine is in closed loop, the duty cycle reading will increase toward 100. Release the primer button and the duty cycle will decrease toward 00. **NOTE:** It is possible to adjust idle air fuel mixtures too lean to prevent the AFCP-1 from going into closed loop operation. In order for the AFCP-1 to go into closed loop, a rich $0^2$ sensor voltage signal must be received by the AFCP-1.


**11.** If analyze or dwell meter reading remains in a fixed "00" or 50% or 100% position **after warm up:**

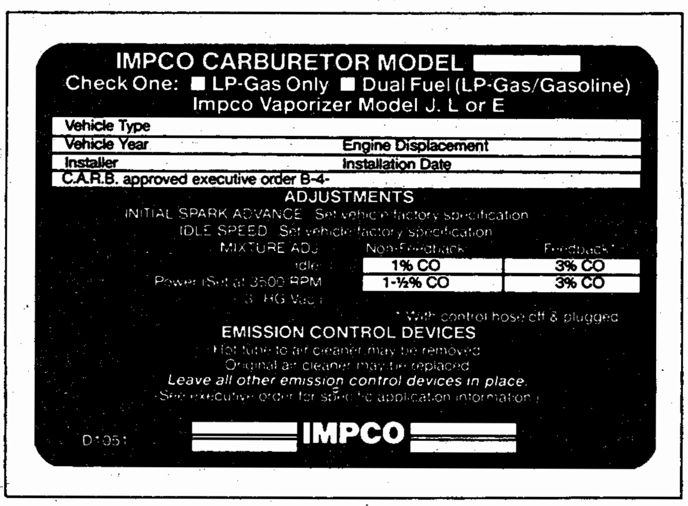
**A.** Fuel mixture setting is wrong or all connections were not properly made or:

**B.** Open loop (gray wire) is grounded or vacuum switch is defective. Gray wire fixed duty cycle is 50%. If gray wire is grounded, it is in open loop at 50% duty cycle or if a vacuum switch is used, the switch may be bad. **Gray wire is for air pump use only.**

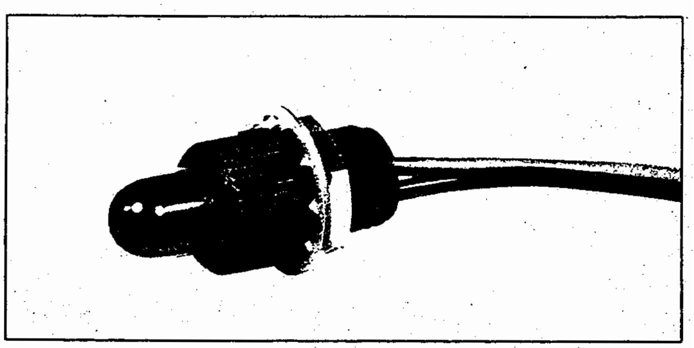

**12.** After engine start, the FSA-1's "Computer Command" number or dwell reading will stay at a fixed duty cycle at or near 50% for 30 to 60 seconds. With the engine warmed to operating temperatures, readings should vary within the "30 to 70" range while the vehicle is being driven.



**13.** Disconnect CO meter probe and plug opening with a 1/8" pipe plug.




**14.** Install decals as necessary.



**15. NOTE:** An optional fail/safe indicator light for the AFCP-1 (part #FS-1, ordered separately) may be installed inside driver's compartment. See appropriate schematic diagram for correct wiring connections.

## ADJUSTMENT PROCEDURES

### Feedback Adjustment:

#### With IMPCO® Fuel System Analyzer:

The Analyzer can be used to adjust the IMPCO® Alternate Fuel Management System or a gasoline feedback system if you do not have a dyno and CO meter. Hook up the unit's black lead to ground, red to 12 volts, green to the oxygen sensor and yellow to the vehicle computer side of the Fuel Control Valve as explained under "Connecting the IMPCO® Fuel System Analyzer" in analyzer instruction booklet. **WARNING: Do not disconnect ground wire while engine is running. Vehicle must be at operational temperature.**

Determine if the vehicle has feedback control during idle by observing the "COMPUTER COMMAND" display. If the number displayed is constant, there is no feedback control during idle. **NOTE:** Some vehicles will revert to "open loop" operation if engine idle is prolonged and the oxygen sensor cools to below its operational temperature.

Check to determine if the IMPCO® Fuel Control System has been installed according to the recommended IMPCO® installation instructions as described in this bulletin.

If the vehicle has ***feedback control*** at idle, adjust the IMPCO® carburetor idle mixture adjustment screw until the "COMPUTER COMMAND" reading is approximately at 50. By setting the reading as close to 50 as possible, the onboard vehicle computer has full range to go rich or lean. **NOTE:** A vehicle with feedback control at idle will show a significant change in the "COMPUTER COMMAND" number upon turning the idle mixture adjustment screw.

For vehicles with ***no feedback control*** at idle, the following procedure should be used: (**NOTE:** Some manufacturers choose to add air from the air pump to the exhaust manifold at idle. Because of this, it is advisable to disconnect and plug the hose from the air pump to the manifold while idle mixture is being set. If this step is not followed, the extra air causes the oxygen sensor to continually sense oxygen. This, in turn, will cause the "LEAN" light to come on even though the actual fuel/air ratio may be correct. As a result, the mixtures might be adjusted too rich in an effort to compensate for the injected air. After idle mixture is properly set, remove plug and reconnect hose to exhaust manifold). Connect the analyzer as instructed above. Watch the "RICH/LEAN" lights as you adjust the idle screw. If the "RICH" light is on, adjust the screw toward lean until the oxygen sensor light just switches from "RICH" to "LEAN". Slowly turn the screw back until "RICH" appears again. If the "LEAN" light was on when you started the adjustment, richen the idle mixture just to the point the "RICH" appears. The final adjustment should have the "RICH" mixture light on. **NOTE:** A vehicle with no feedback control at idle will show no change in the "COMPUTER COMMAND" number upon turning the idle mixture adjustment screw.

A CO meter is not normally needed when the IMPCO® Fuel System Analyzer is used.

#### Power Mixture Adjustment of IMPCO® Feedback Carburetion System.

To adjust the W.O.T. power mixture using a dynamometer, set the power adjustment to 60-65% duty cycle reading on the FSA at 3000 RPM, W.O.T.

W.O.T. power mixture can be adjusted without a dynamometer by road testing and setting the power mixture control to 55-65% duty cycle reading on the FSA at W.O.T. **NOTE:** Due to the fast response of the FSA at W.O.T. excessive road speeds are not necessary for this test.

#### Adjusting Gasoline Fuel Mixtures for Optimum Engine Operation

The Analyzer can be used to adjust gasoline feedback carburetor systems. Adjustment procedures and specifications provided in commercial engine manuals should be followed. In most cases, special adjustment tools are required.

### Final Road Check:

During the road test the "COMPUTER COMMAND" should remain between 30 and 70 under normal "closed loop" driving operation. This verifies that the computer has the amount of control necessary to keep the fuel mixture correct.

During road test with alternate fuel, if the "RICH" or "LEAN" indicator light stays on with no flashing between them when driving at a steady speed under closed loop, there is a problem. If the "LEAN" light remains on, you probably do not have the correct gas valve for feedback, or a balance line needs to be installed to counteract the effect of high RAM air pressure. If the "RICH" light remains on, check to see if a .100" restrictor (J1-21) is installed in the elbow assembly attached to the IMPCO® converter.

ON ALL VEHICLES, THE KEY MUST BE ON AND THE ENGINE RUNNING TO GET THE DESIRED READINGS.

### Feedback Adjustment
### With Dynamometer and CO Meter

1. All exhaust gas samples must be taken ahead of the catalytic converter by drilling a sample hole in the exahust pipe.
2. Warm engine up to normal operating temperature.
3. Check and adjust idle (RPM) to manufacturer' specification.
4. Disconnect the vacuum hose from the Fuel Control Valve and plug hose. This will cause the Fuel Control Valve to be inoperative. The carburetor will then be at maximum rich.
5. Adjust carburetor idle mixture to 1 to 2% CO. (Use "drive" if equipped with an automatic transmission)
6. Set the wide open throttle carburetor power adjustment to obtain a .2 to 1.0% CO reading, without loss of power.
7. Run the vehicle at road load speeds of 20-30-40 and 50 mph. with dynomometer horsepower load as follows:

   | | | |
   |---|---|---|
   | 4 cylinder | | 25 HP at 50 mph |
   | 6 cylinder | — | 40 HP at 50 mph |
   | 8 cylinder | — | 50 HP at 50 mph |

   The CO reading should read between .2 to 1.0%. If the CO reading is considerably higher than that, check to be sure the specified gas/air valve assembly for the IMPCO® Feedback System is installed.
8. Reconnect the vacuum hose to the Fuel Control Valve. The fuel mixture is now being controlled by the computer, which will result in a leaner mixture.
9. Adjust idle speed to manufacturer's recommendations.

## "TECH TIPS" ON IMPCO'S AFCP-1 INSTALLATION AND CHECK-OUT

Even though the FCP-1 is designed as an independent fuel control processor, it is very important that all existing onboard controls and sensors are working properly. Most trouble calls are due to malfunctions in the OEM system. Often the owners are unaware of these failures since mileage and performance usually are better than pre-computer vehicles. After verifying the OEM system is functioning properly, determine that the propane fuel system is also operating correctly. Refer to 23800-27 FSA-1, "Fuel System Analyzer Instruction." It offers information on checking out the IMPCO® Closed Loop Feedback Systems.

Utilizing the IMPCO® FSA-1 Fuel System Analyzer, a tachometer or a good volt meter, perform system checks in the following order:

1. The black and brown ground wires must be attached securely to a chassis ground. Terminating each wire with suitable lugs, these two wires may be attached to a common chassis ground using a #8 or larger screw.

2. The red power wire should be attached to the propane/gasoline switch on dual-fuel models (see current model wiring diagram.) On propane only and FCP-1 stand-alone systems, be sure that +12V DC is supplied in the "on" position. This wire must be equipped with a suitable fast-blow fuse rated at 3 amps.

3. Determine that the white ignition wire is attached to the tachometer side of the ignition coil. This can be verified by connecting a shop tachometer to this lead. With the engine operating, RPM will be indicated on the tachometer.

4. The violet wire is attached to the Fuel Control Valve (FCV) and should have a constant +12 volts during operation.

5. The yellow wire is connected to the FCV. It varies the on-to-off duty cycle of the FCV up to a rate of 10 times per second. This controls air fuel ratio's under all conditions. Connect the Fuel System Analyzer (FSA-1) and adjust idle mixture so that 50 is showing on the FSA-1. This indicates that the FCP-1 is close to the center of its "range of authority" and able to properly control fuel mixtures under all conditions.

6. The green exhaust-gas oxygen (EGO) sensor connector wire of the FCP-1 should be spliced in parallel to the wire coming from the EGO sensor located in the exhaust manifold. The EGO sensor looks very similar to a spark plug. (On non-computer-controlled stand alone applications, the system requires that an EGO sensor be installed.). Connect the FSA-1 following instructions in 23800-27) "Fuel System Analyzer Instructions." Correct operation of the EGO sensor is indicated by flashing of the FSA-1 "Rich," OK, and "Lean" lights. If only the "Lean" light is lit, richen the mixture by momentarily pressing the manual primer button of the converter. If no change is indicated by the FSA-1, the EGO sensor is faulty or the FSA-1 is connected to the wrong wire if only the "Rich" light is lit, increase engine speed at no load. Then lean out fuel mixture until the engine starts to stumble indicating lean conditions. If no change is indicated by the FSA-1 lights, check for vacuum leaks.

7. The orange "fail/safe" indicator wire should be connected directly to the optional "fail/safe" indicator light available from IMPCO® . Install the "fail/safe" light on dashboard in a location visible to the driver. This light is only an indication that the FCP-1 is incapable of maintaining correct fuel mixtures. The FCP-1 will continue to try to control mixtures whether rich or lean while the light is on. The "fail/safe" light being on *does not necessarily* mean the FCP-1 is bad. You should verify all other component operations before replacing the FCP-1.

8. See page 5, photo #4 for installation of the gray wire.

# FUEL MANAGEMENT SYSTEM PARTS LIST

## AIR GAS VALVE ASSEMBLY

| PART NO. | APPLICATION |
|---|---|
| AV1-1447 | Model 125 |
| AV1-1447-2 | Model 125 Silicone |
| AV1-1447-4 | Model 135M-10 Vacuum Lift |
| AV1-1447-4-2 | Model 125M-10 Vacuum Lift Silicone |
| AV1-1245 | Model 225 |
| AV1-1245-2 | Model 225 Silicone |
| AV1-1651 | Model 425 |
| *Gas Valve Only Required* | |
| V2-49 | Model 300A-1, CA300A-20 |
| V2-50 | Model 300A-50, CA300A-70 |
| V2-58 | Model 175A-2, Optional for CA175-1 (Anodized red) |

## FUEL CONTROL PARTS

| PART NO. | APPLICATION |
|---|---|
| FCV | Fuel Control Valve, all feedback |
| FEV | Fuel enrichment Valve (Use SV w/specified jet) |
| SV | Starting Valve, used as Fuel Enrichment Valve |
| VPV | Vacuum Power Valve, light-duty Chrysler feed-back installation |
| J1-21 | Jet .100, Balance Line Restrictor |
| J1-20 | Jet .062, SV |
| J1-20-1 | Jet .032, Starting Valve for FEV application |
| J1-20-2 | jet .050, Vacuum Power Valve |
| J1-20-3 | jet .075, Vacuum Power Valve |
| J1-20-4 | Jet .100, Vacuum Power Valve |
| F4-2 | Tube fitting, 1/4" x 1/4" I.D. Hose |
| F4-12 | 1/8" NPT to 3/8" Hose elbow, balance line |
| F4-32 | 1/8" tee, balance line |
| F4-33 | 1/8" nipple, balance line |
| T1-13 | Tube connector |

| PART NO. | APPLICATION |
|---|---|
| D-1051 | Decal for LPG Only and dual fuel LPG/Gasoline |
| D-1052 | Decal for CNG only and dual fuel CNG/Gasoline |

## SPECIAL PARTS NOT SUPPLIED BY IMPCO®

| PART NO. | SOURCE |
|---|---|
| TPS | Ford #EOAE9B989AB |
| *Description:* | Position Sensor; replaces OEM T.P.S. where necessary. |
| DPDP | |
| *Dexcription:* | Double pole double throw switch for Ford feed-back installation. |

**WARNING: IMPROPER INSTALLATION OR USE OF THIS PRODUCT MAY CAUSE SERIOUS INJURY AND/OR PROPERTY DAMAGE.**

**SERVICE TECHNICIANS AND USERS**
SHOULD CAREFULLY READ AND ABIDE BY THE PROVISIONS SET FORTH IN NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET #37 FOR STATIONARY ENGINES, #52 FOR CNG VEHICULAR FUEL SYSTEMS OR #58 FOR LPG SYSTEMS.

**INSTALLERS**
**LPG INSTALLATIONS IN THE UNITED STATES** MUST BE DONE IN ACCORDANCE WITH FEDERAL, STATE, OR LOCAL LAW, WHICHEVER IS APPLICABLE AND NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET #58, STANDARD FOR STORAGE AND HANDLING OF LIQUIFIED PETROLEUM GASES TO THE EXTENT THESE STANDARDS ARE NOT IN VIOLATION WITH FEDERAL, STATE OR LOCAL LAW.

**IN CANADA** REFER TO CAN/CGA-B149.2, PROPANE INSTALLATION CODES.

**CNG INSTALLATIONS IN THE UNITED STATES** MUST BE DONE IN ACCORDANCE WITH FEDERAL, STATE OR LOCAL LAW AND NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET #52, COMPRESSED NATURAL GAS (CNG) VEHICULAR FUEL SYSTEMS TO THE EXTENT THESE STANDARDS ARE NOT IN VIOLATION WITH FEDERAL, STATE OR LOCAL LAW.

**IN CANADA** REFER TO CAN/CGA-B149.1 CNG INSTALLATION CODES.

**LPG AND/OR NATURAL GAS INSTALLATIONS ON STATIONARY ENGINES** MUST BE DONE IN ACCORDANCE WITH FEDERAL, STATE OR LOCAL LAW AND NATIONAL FIRE PROTECTION ASSOCIATION PAMPHLET #37, STATIONARY COMBUSTION ENGINES AND GAS TURBINE ENGINES, TO THE EXTENT THESE STANDARDS ARE NOT IN VIOLATION WITH FEDERAL, STATE OR LOCAL LAW.

FAILURE TO ABIDE BY THE ABOVE WILL VOID ANY IMPCO WARRANTY ON THE PRODUCTS ANO MAY CAUSE SERIOUS INJURY OR PROPERTY DAMAGE.

DUE TO THE INHERANT DANGER OF GASEOUS FUELS THE IMPCO PRODUCTS SHOULD NOT BE INSTALLED OR USED BY PERSONS NOT KNOWLEDGEABLE OF THE HAZARDS ASSOCIATED WITH THE USE OF GASEOUS FUELS.

**ATTENTION: RISQUE DE DÉGÂTS MATÉRIELS ET/OU DE LÉSIONS CORPORELLES GRAVES EN CAS D'INSTALLATION OU D'USAGE INADÉQUAT.**

**TECHNICIENS D'ENTRETIEN ET UTILISATEURS**
LIRE ATTENTIVEMENT ET RESPECTER LES DISPOSITIONS PRÉVUES AU TITRE DE LA BROCHURE N° 37 DE LA NATIONAL FIRE PROTECTION ASSOCIATION AMÉRICAINE (LA NFPA) POUR LES MOTEURS FIXES, N° 52 POUR LES SYSTÈMES VÉHICULAIRES AU GAZ NATUREL COMPRIMÉ OU N° 58 POUR LES SYSTÈMES AU GAZ DE PÉTROLE LIQUÉFIÉ.

**INSTALLATEURS**
**AUX ÉTATS-UNIS, LES INSTALLATIONS** AU GAZ DE PÉTROLE LIQUÉFIÉ DOIVENT ÊTRE CONFORMES AUX LOIS FÉDÉRALES, D'ÉTAT OU LOCALES APPLICABLES, AINSI QU'AUX NORMES ÉTABLIES AU TITRE DE LA BROCHURE N° 58 DE LA NFPA, RELATIVE AU STOCKAGE ET AU MANIEMENT DES GAZ DE PÉTROLE LIQUÉFIÉS, DANS LA MESURE OÙ CES NORMES SONT ELLES-MÊMES CONFORMES À LA LÉGISLATION FÉDÉRALE, D'ÉTAT OU LOCALE.

**AU CANADA**, S'EN RÉFÉRER À LA RÉGLEMENTATION CAN/CGA-B149.2 RELATIVE AUX INSTALLATIONS AU PROPANE.

**AUX ÉTATS-UNIS, LES INSTALLATIONS AU GAZ NATUREL** COMPRIMÉ DOIVENT ÊTRE CONFORMES AUX LOIS FÉDÉRALES, D'ÉTAT OU LOCALES APPLICABLES, AINSI QU'AUX NORMES ÉTABLIES AU TITRE DE LA BROCHURE N° 52 DE LA NFPA, RELATIVE AUX SYSTÈMES VÉHICULAIRES AU GAZ NATUREL COMPRIMÉ, DANS LA MESURE OÙ CES NORMES SONT ELLES-MÊMES CONFORMES À LA LÉGISLATION FÉDÉRALE, D'ÉTAT OU LOCALE.

**AU CANADA**, S'EN RÉFÉRER À LA RÉGLEMENTATION CAN/CGA-B149.1 RELATIVE AUX INSTALLATIONS AU GAZ NATUREL COMPRIMÉ.

**LES INSTALLATIONS AU GAZ DE PÉTROLE LIQUÉFIÉ ET/OU AU GAZ NATUREL** COMPRIMÉ SUR MOTEURS FIXES DOIVENT ÊTRE CONFORMES AUX LOIS FÉDÉRALES, D'ÉTAT OU LOCALES APPLICABLES, AINSI QU'AUX NORMES ÉTABLIES AU TITRE DE LA BROCHURE N° 37 DE LA NFPA, RELATIVE AUX MOTEURS FIXES À COMBUSTION ET AUX TURBINES À GAZ, DANS LA MESURE OÙ CES NORMES SONT ELLES-MÊMES CONFORMES À LA LÉGISLATION FÉDÉRALE, D'ÉTAT OU LOCALE.

LE NON-RESPECT DES DISPOSITIONS ÉTABLIES CI-DESSUS RENDRA NULLES TOUTES LES GARANTIES IMPCO RELATIVES AUX PRODUITS CONCERNÉS ET POURRA DONNER LIEU À DE SÉRIEUX DÉGÂTS MATÉRIELS OU LÉSIONS CORPORELLES.

EN RAISON DU DANGER INHÉRENT AUX COMBUSTIBLES GAZEUX, LES PRODUITS IMPCO NE DEVRAIENT EN AUCUN CAS ÊTRE INSTALLÉS OU UTILISÉS PAR DES PERSONNES NON CONSCIENTES DES RISQUES ASSOCIÉS À DE TELS COMBUSTIBLES.




23600-26-1 591(492)T/L 1M PRINTED IN U.S.A.

# COMPUTER SUPPORT 1
**P/N 8690**

PARTS INCLUDED IN THIS KIT

| | |
|---|---|
| 1-Computer Support 1 | 1-Installation Instructions |
| 6-Wire Tap Devices | 4-Wire Ties |
| 6-FastOn Receptacles | 4-No. 6x3/4 Screws |

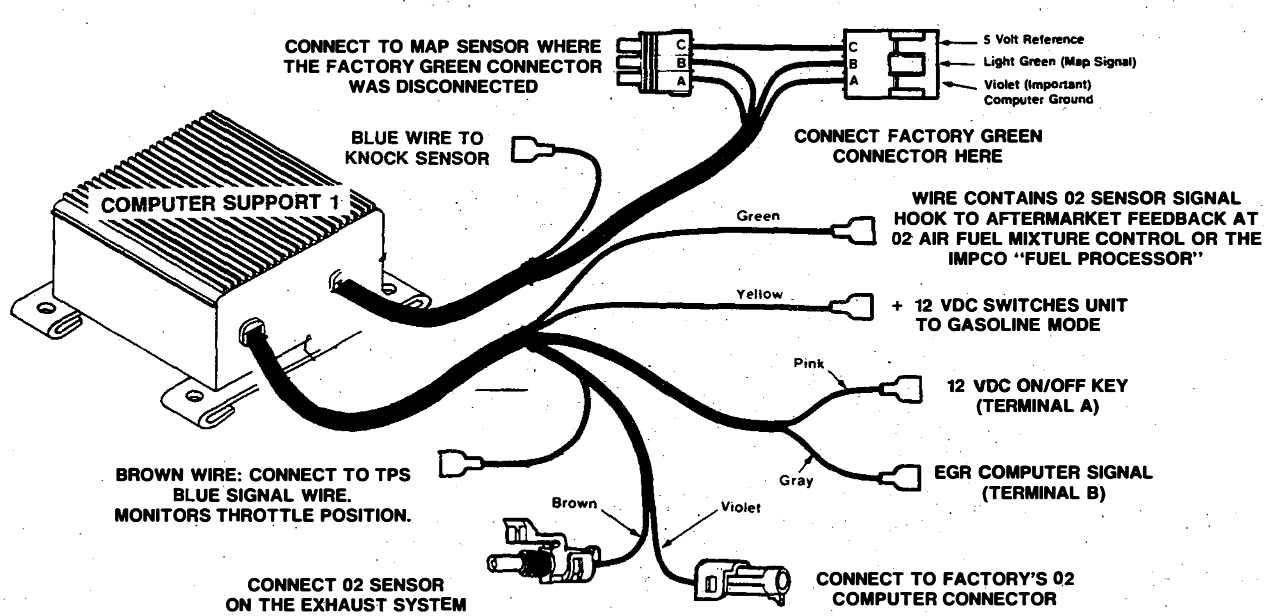
The **Computer Support 1** is designed to work in conjunction with an 02 Feedback Fuel Control System in order to correctly monitor "Service Engine" codes while on alternate fuels.

1. Supplies a correct 02 Feedback signal to the ECM. Prevents *FALSE* 02 sensor malfunction codes (13,44,45) while allowing *TRUE* failure conditions to be recognized and displayed by the factory computer.

2. Monitors ECM signals related to exhaust gas recirculation (EGR), and then responds with the correct sensor signals. Prevents *FALSE* "EGR" malfunction code (32) while allowing *TRUE* "EGR" failure conditions to be recognized and factory vehicle displayed.

3. Monitors "ECM" signals related to the "knock sensor", and then responds with the correct sensor signals. Prevents *FALSE* "knock sensor" malfunction code (43) and computer "limp-mode" spark timing retard on alternate fuels, which leads to poor driving characteristics, low milage, and high exhaust temperatures.

4. Monitors 02 sensor signals related to RICH/LEAN conditions in the exhaust, verifying that the 02 Feedback Fuel Control being used is effectively maintaining the correct AIR/FUEL ratios.





**AUTOTRONIC CONTROLS CORPORATION**

1490 HENRY BRENNAN DR., EL PASO, TEXAS 79936 (915) 857-5200

## MOUNTING AND WIRE HOOK-UP

**Mount the unit in a location where the cables will reach the exhaust O2 sensor, the EGR control solenoid, the knock sensor, and the MAP sensor. Do not mount on the engine or near the exhaust manifold. The extreme temperatures at these locations could cause damage to the unit. Use the sheet metal screws provided in the parts kit.**

WIRE CONNECTIONS

PINK WIRE: Connect to the EGR pink wire or coil + wire for keyed 12 VDC supply.

GREY WIRE: Connect to the EGR control signal wire. (Grey wire at EGR solenoid.)

BLUE WIRE: Connect to blue wire at knock sensor found by starter (350 eng.) or by oil filter (454 & 366 Eng.)

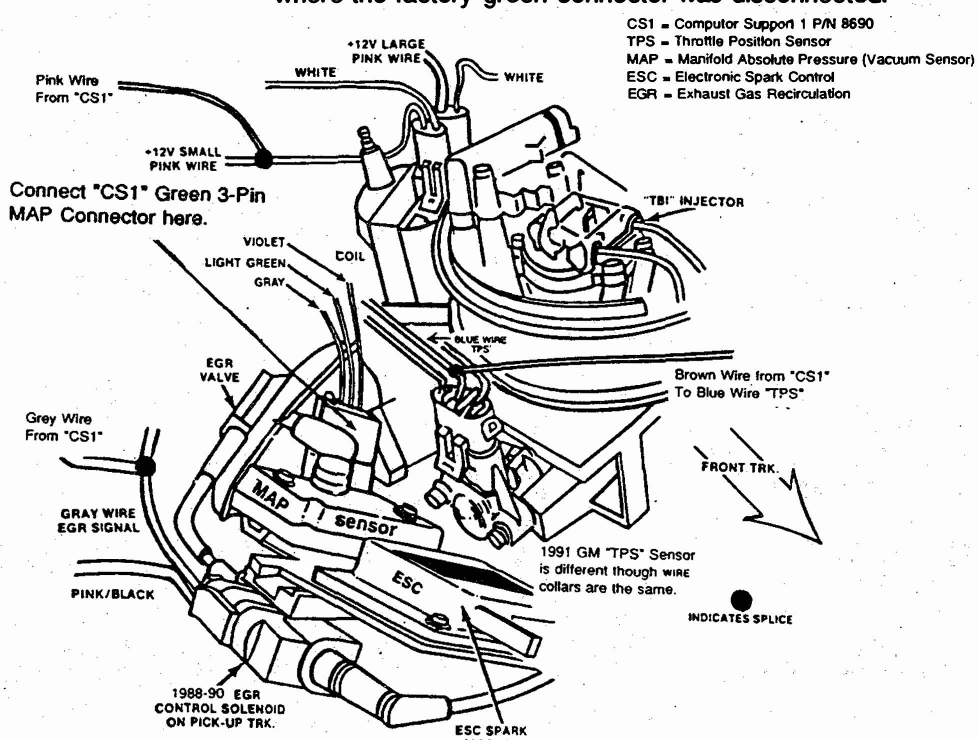
YELLOW WIRE: Connect to a 12 VDC source that is HOT only while on gasoline. 12 VDC on yellow wire indicates gasoline mode.

GREEN WIRE: Connect to O2 Feedback Fuel Control Processor (FCP-1). Green wire contains actual O2 sensor signal for FCP-1.

BROWN WIRE: Connect to throttle position sensor (TPS) signal wire. Wire will be either brown (early model TPS) or blue (late model TPS) at TPS sensor.

O2 SENSOR CONNECTORS: Connect to factory O2 sensor wire connectors with the violet wire going to computer and the brown wire going to factory O2 sensor.

3 PIN MAP CONNECTORS: Connect to factory MAP sensor. Connect factory green connector into black female shroud, and connect the 8690's green connector where the factory green connector was disconnected.

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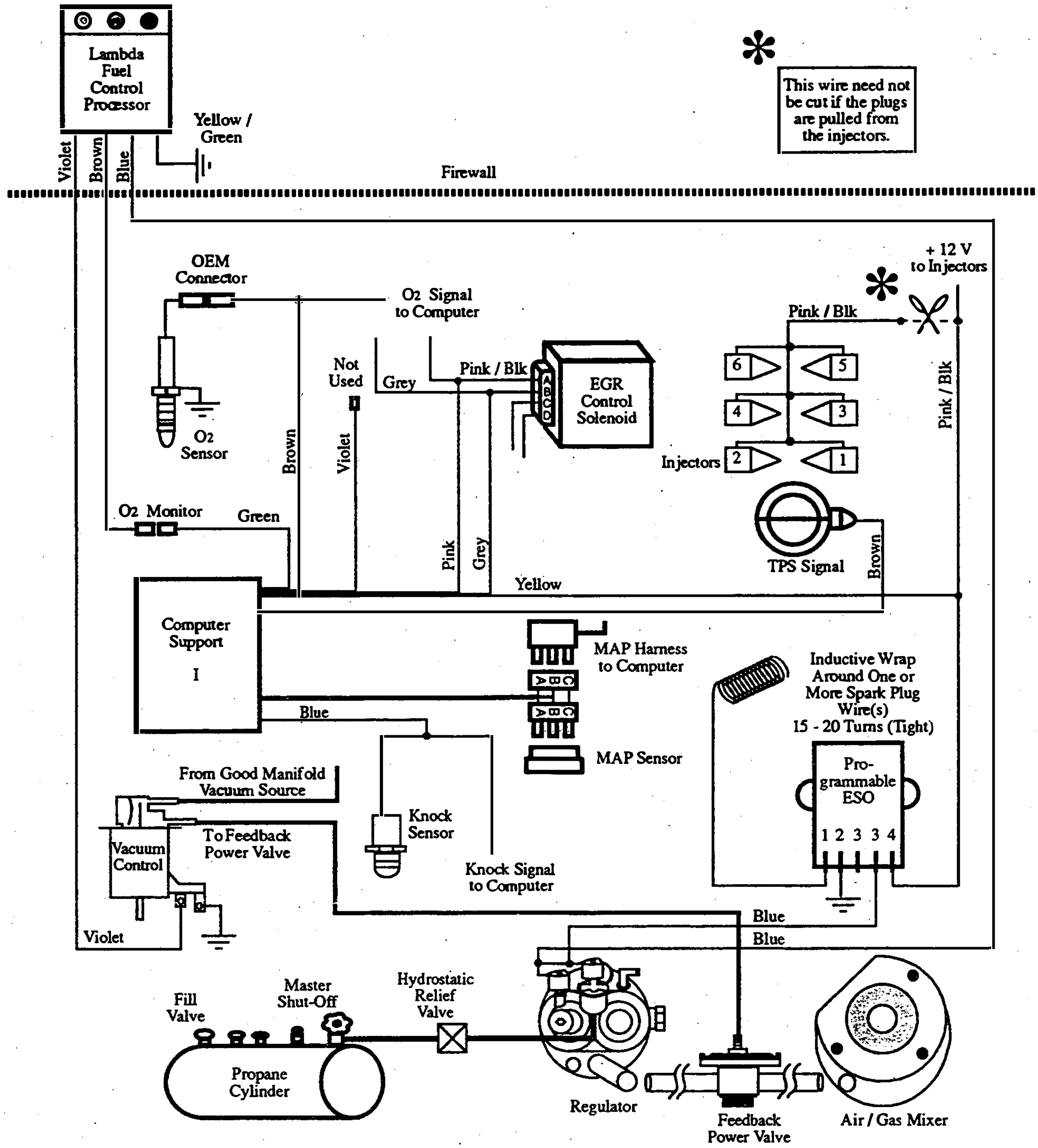
**MOGAS ECOLO**

MoMan/HouseServices/GM3.1LPGnoO2Fix
December 28, 1992
**Part #:**

# System Diagram © 1992




Mogas® Phone: (604) 294-3383
Fax: (604) 291-7331
4467 Juneau Street Burnaby BC Canada V5C 4C4

| | | |
|---|---|---|
| Vehicle: GM | Year: 1992 / 93 | Size: 3.1 L |

Details: MPI
Dedicated LPG
O2 Fix Eliminated

Mogas® FUEL SYSTEMS

# Natural Gas Fuel System

# Installation Procedure Manual

Revised January 16, 1993

# Contents

# Figures



# Glossary

| | |
|---|---|
| CNG | Compressed Natural Gas |
| ECOLO | A Mogas Closed-loop Fuel Control System |
| EGR | Exhaust Gas Recirculation |
| GSS | Gear Select Switch |
| LED | Light Emitting Diode |
| LPG | Liquid Propane Gas |
| MAP | Manifold Absolute Pressure |
| NG | Natural Gas |
| NGV | Natural Gas Vehicle |
| NPT | National Pipe Thread |
| OEM | Original Equipment Manufacturer |
| PRD | Pressure Relief Device |
| SAE | Society of Automotive Engineering |
| Thermistor | Engine coolant temperature sensor |

# Introduction

The intent of this manual is to facilitate the installation of a Natural Gas Mogas Fuel System and to assist the technician in taking advantage of the system features to produce the best possible emissions, performance, and durability.

The suggestions contained herein are not intended to replace any applicable regulations in force at the time and place where the installation takes place or is destined to be in use.

The conversion technician MUST be thoroughly familiar with the regulations governing the installation of Compressed Natural Gas components on motor vehicles in the region(s) involved.

These regulations are usually issued and / or enforced by the State and / or Federal authorities having Jurisdiction, i.e. the Fire Department, Gas Safety Branch, Highway Patrol, Federal or Local Department of Transport, etc.

The local natural gas Utility or the American Gas Association / Canadian Gas Association can best assist in learning which authority and regulations are in force in the specific territory.

**The technician is ultimately responsible to obtain a copy of these regulations and adhere to them when converting vehicles to run on Compressed Natural Gas.**

# Disclaimer

This manual is a guideline for qualified Automotive Technicians. MOGAS SALES Inc. declines any liability directly or indirectly related and / or caused by the interpretation or the execution of any part of this manual.

**The technician will be a qualified, knowledgeable, responsible person. The interpretation, conclusions, final decisions and the quality of execution rest within his / her control.**

# Pre-Conversion Evaluation

Virtually any vehicle can be converted to natural gas, no matter how rare it is or how difficult it is to install the cylinder(s) or the equipment. Therefore, very little will be said about technical feasibility. Emphasis, however, should be placed on the worthiness of converting a vehicle.

The vehicle should be taken for a test drive in order to establish its good working condition, any possible computer codes and the rate of road performance on gasoline.

There are many factors that affect the final performance of natural gas vehicle conversion.
A sound pre-conversion evaluation can prevent embarrassment and customer dissatisfaction.

- Perform a vehicle inspection for the purpose of:
    - Locating available space for the components and cylinder(s).
    - Identifying:
        - the engine size; ignition type and model; fuel system type, configuration and size of air intake / induction system.
        - transmission type and gearing.
        - differential gearing.
        - vehicle load and service.
        - towing habits
        - driving habits.

Once you have gathered all the information above, we suggest that you consult with our sales personnel for availability of a system that will suit the vehicle you intend to convert.

# Pre-Conversion Inspection

Prior to conversion, the vehicle should be taken for a test drive in order to establish its good working condition, any possible computer codes and the rate of road performance on gasoline.

Computer codes that affect the engine and transmission should be resolved before attempting conversion. An engine that does not run well on gasoline may run worse on natural gas. Compression and ignition must also be in top condition for an engine to run well on natural gas.

This is also a good time to assess the driver's habits and expectations. If the vehicle is under-powered on gasoline, because of a small engine or a poor choice of transmission / differential gear ratio, performance on natural gas may not be acceptable.

Prior to conversion, the engine should be thoroughly inspected. The inspection must include a compression test. A Conversion Report form is provided for your convenience.

All of the above may be time consuming, but trying to correct or explain engine problems after conversion is much more time consuming, costly and embarrassing.

# Conversion Report

| | |
|---|---|
| | Installation Date: Year / Month / Day |
| | Warranty Registration No. |

| CUSTOMER | | CONVERSION SHOP | |
|---|---|---|---|
| Name | | Name | |
| Address | | Address | |
| City | Telephone No. | City | Telephone No. |
| Province | Postal Code | Province | Postal Code |
| Vehicle Make / Model | Year | Installed By | Certificate No. |
| Vehicle I.D. No. | Licence No. | | |
| Odometer at installation (KM / MILES) | Displacement (CU INCH / LITRES) | | |

| NGV CONVERSION EQUIPMENT | | Cylinder Make/Size | Serial Number | Test Date |
|---|---|---|---|---|
| Make and Model of Regulator | Serial No. | | | |
| Dual Curve Make and Model | Serial No. | | | |
| Mixer Make and Model | Type | | | |

## PRE-CONVERSION CHECK

| 1. Battery/Starter | Pass | Fail |
|---|---|---|
| Battery Voltage | ☐ | ☐ |
| Cranking Volts | ☐ | ☐ |
| Starter Draw Test (amps) | ☐ | ☐ |

| 2. Coil/Leads/Plugs | Pass | Fail |
|---|---|---|
| Coil Input Cranking | ☐ | ☐ |
| Coil Input Running | ☐ | ☐ |
| Coil Output Volts | ☐ | ☐ |
| Coil Polarity Correct | ☐ | ☐ |
| Spark Plug Condition | ☐ | ☐ |
| High Tension Lead Condition | ☐ | ☐ |

**3. Compression or Cylinder Balance Check**

| Cylinder Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Compression Dry/Wet | | | | | | | | |

(Maximum Difference 20%)

| | Pass | Fail |
|---|---|---|
| Compression Test | ☐ | ☐ |

| 4. Carburetor/Fuel Injection | Pass | Fail |
|---|---|---|
| Air Filter Check | ☐ | ☐ |
| Fuel Filter Check | ☐ | ☐ |
| Carburetor Condition | ☐ | ☐ |
| Carburetor Operation | ☐ | ☐ |
| EFI Fault Codes Readout | ☐ | ☐ |

**5. Inlet Manifold Vacuum**

At an idle ________ " hg at ________ rpm

| | Pass | Fail |
|---|---|---|
| Manifold Leak Check | ☐ | ☐ |
| Exhaust System Check | ☐ | ☐ |

| 6. Distributor | Pass | Fail |
|---|---|---|
| Rotor Condition | ☐ | ☐ |
| Cap Condition | ☐ | ☐ |
| Vacuum Advance Operation | ☐ | ☐ |
| Shaft Condition | ☐ | ☐ |
| Centrifugal Advance Operation | ☐ | ☐ |
| Timing Chain Slack | ☐ | ☐ |

**7. Engine Cooling System**

| 8. Suspension Check | Yes | No |
|---|---|---|
| Repairs or Upgrade Required | ☐ | ☐ |

To the best of my judgement the vehicle is suitable for conversion to NGV

________________________
Cert. Installer Signature

## POST-CONVERSION TEST

**1. Final Engine Adjustments**

Base timing gasoline ________ deg. @ ________ rpm

Base timing natural gas ________ deg. @ ________ rpm

Total centrifugal vacuum advance:

On gasoline ________ deg. @ ________ rpm

On natural gas ________ deg. @ ________ rpm

| 2. Road Test | Pass | Fail |
|---|---|---|
| Switching Fuels | ☐ | ☐ |
| Idle at Emergency Stop | ☐ | ☐ |
| General Engine Response | ☐ | ☐ |
| Acceleration | ☐ | ☐ |
| Deceleration | ☐ | ☐ |
| Cruise | ☐ | ☐ |
| General Vehicle Handling | ☐ | ☐ |

**3. Fuel System - Engine to be at Operating Temperature**

Idle rpm on gasoline ________

Idle rpm on natural gas ________

HC @ idle ________ CO @ idle ________

HC @ 2500 rpm ________

CO @ 2500 rpm ________

| | Pass | Fail |
|---|---|---|
| Fuel Leaks on Gasoline | ☐ | ☐ |
| Fuel Leaks on Natural Gas | ☐ | ☐ |
| Intake Leaks | ☐ | ☐ |
| Throttle Shaft | ☐ | ☐ |
| Carburetor Linkage (Visual) | ☐ | ☐ |
| Choke Operation (Visual) | ☐ | ☐ |

I declare that the above vehicle has been converted to run on natural gas and that it has passed all of the required tests.

________________________
Cert. Installer Signature

# Mogas Fuel System Layout

1 • Natural gas storage cylinder(s); store high pressure natural gas (3000 psi).
2 • Master Shut-off; arrests the gas flow, when in the closed position.
3 • Pressure Regulator; regulates the Natural Gas pressure from storage to supply pressure.
4 • ECOLO Closed-loop Feed-back system's gas flow control valve.
5 • Mixer; draws and mixes the gas with the air in the the engine intake system.
6 • Injector Intercept Relay; interrupts the current to the injector(s), when energized (dual fuel systems).
7 • Selector switch assembly; switches from fuel to fuel (dual fuel systems). It controls the Injector Intercept Relay and the natural gas shut-off solenoid by monitoring the ignition system High tension pulsing. It interrupts the current to the gas shut-off solenoid which is a normally closed device, allowing gas flow only when the engine is revolving and the ignition is operative. It also displays the fraction of fuel pressure left in the storage cylinder and the current fuel selection.
8 • ECOLO Closed-loop Feed-back system's fuel control microprocessor; receives input from the EGR control, the Gear Select Switch and the $O_2$ sensor. It turns 9 • Fuel control vacuum actuator on/off, in logic response to the processed Input data.
9 • ECOLO Closed-loop Feed-back system's fuel control vacuum actuator; receives input from the 8 • microprocessor and in turn controls the opening of the 4 • gas flow control valve.

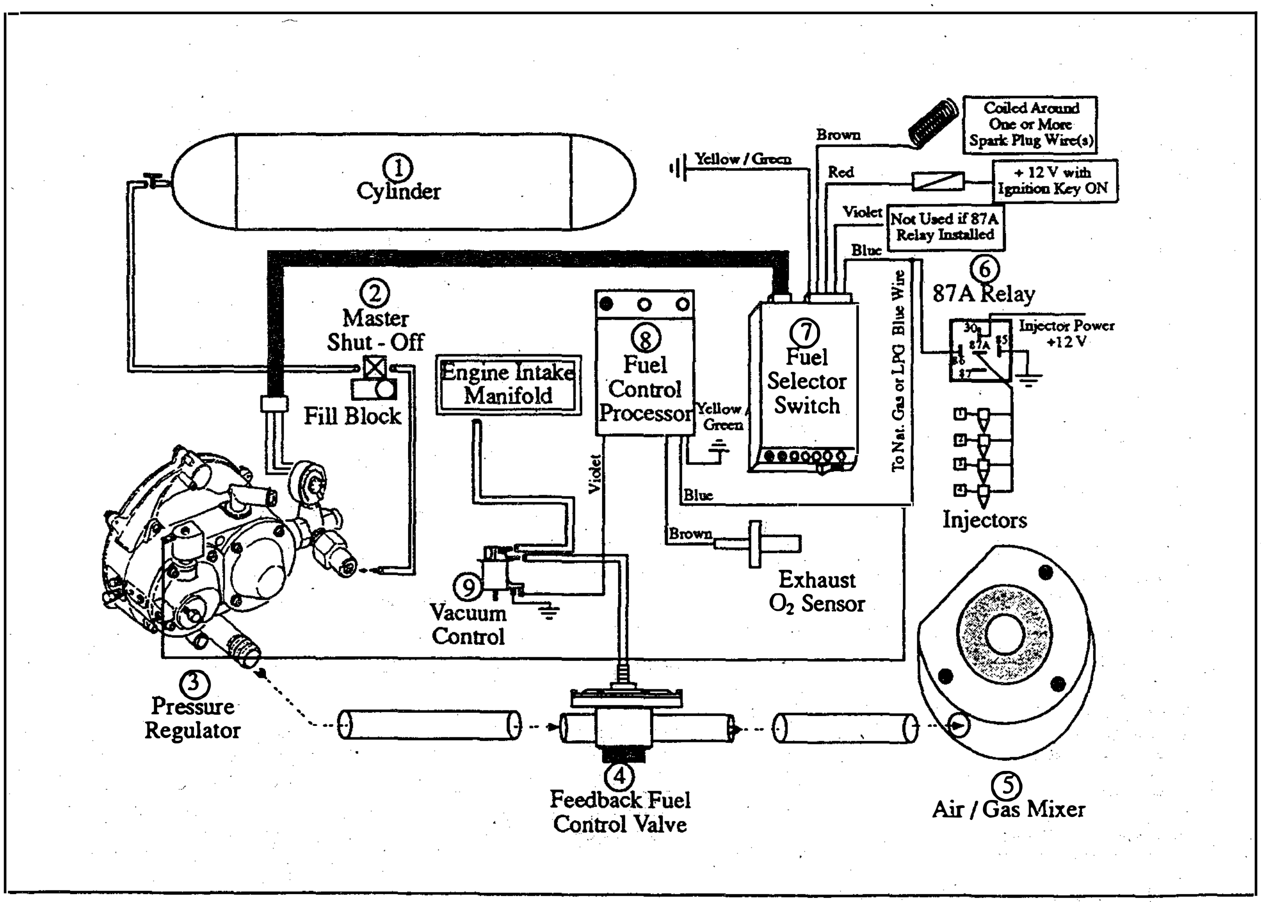



Fig. 1
Typical Mogas ECOLO Closed-loop System

# Component Installation Procedures

A general examination of the vehicle is necessary in order to efficiently pre-select the location and position of components. See page 4, Pre-Conversion Inspection.

More specifically:

- Read this manual prior to attempting the installation.
- Make sure that the correct conversion System is on hand.
- Establish the position the of the cylinder(s) in clear compliance with local installation regulations.
- Locate a handy spot on the driver side for the Gas Master Shut-off valve. Ideally the cylinder valve(s) should be on the same side of the vehicle as the Master Shut-off valve.
- Plan the routing of the high pressure line and its support to conform with local regulations and safe practices. The shortest route is not necessarily the best route.
- Ensure that the location of the master shut-off valve and the filler assembly will be well protected and easily accessible.
- Identify the ideal place for heater hose connections to insure good coolant circulation for the pressure regulator. Caution: On Air Conditioned vehicles the connection must be made before the temperature control valve.
- Select the location for the pressure regulator. Ideally it should be installed in a clear location, near the heater coolant hoses, away from the exhaust manifold and below the radiator coolant level. Consult the regulator installation section for more information.
- Ensure that the mixer or any other component, once installed, will remain clear of the engine hood and its hinges and will not interfere adversely with the function of any other device under the hood.

**Important note:**

In computerized vehicles make extra sure that you know beforehand where to find and intercept the wires for the fuel injectors and other sensors, because a mistake in this area may disarm some devices and / or may cause irreparable damage to the OEM computer.

# Cylinder Size and Location

Select a suitable size and location for the cylinder(s) keeping in mind:

- The size of the cylinder(s) is determined by the available space, after allowance for easy access to the cylinder valve(s) for installation and operation.
- The valve areas must be well protected from road hazards. Design, make and install a deflector or a shield if necessary.
- Avoid positioning the cylinder valve(s) close to vehicle extremities unless they are well behind a protective device i.e. a good solid bumper.
- Transverse mounting is safer than longitudinal. Cylinders mounted longitudinally should be provided with end brackets to absorb thrust forces.
- The location of the cylinder(s) should be 6 inches away from the exhaust system, or a heat shield should be provided, in accordance with jurisdictional authorities' regulations.
- The mounting area must be rigid, solid, able to take 20G longitudinally, 8G laterally.
- Whenever possible, the cylinder valve(s) should be on the same side of the vehicle as the master shut-off valve.
- Cylinders located under the vehicle carriage must ideally maintain the original clearance from the ground, not protruding below the original ground clearance line, or as specified by the local jurisdictional authorities.
- Cylinders installed under the rear over-hang must be contained within an imaginary line that starts at rear of the rear wheel print and extends to the lowest protrusion of the rear end body panel or member, Fig. 2, or as specified by the local jurisdictional authorities.

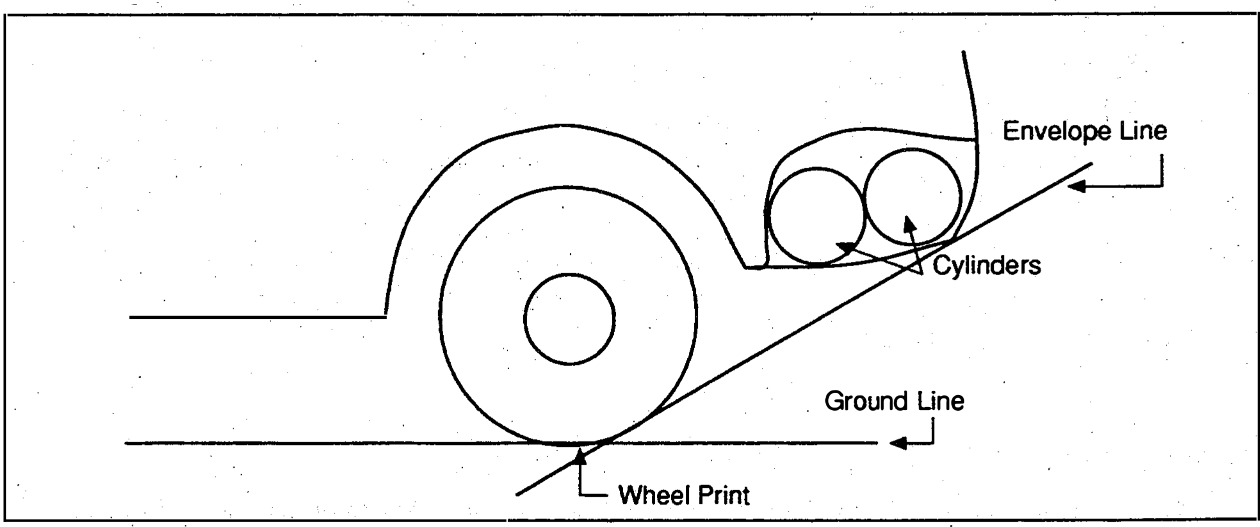



Fig. 2
Maintaining Clearance from the Ground

**Note:** If the weight of the cylinder(s) affects the suspension trim noticeably, it may also affect the vehicle driveability. Suspension servicing and / or modification may be required. Consult local regulations; a vehicle should not be loaded beyond the manufacturer's specifications and tolerance.

# Cylinder Installation

Cylinders can be mounted inside the vehicle or outside, under the carriage.
Steel cylinder(s) should be primed and painted with rust-proof and chip-proof paint before installation, even if they are destined inside the vehicle. The changes in gas temperature cause condensation, therefore cylinders are often wet.

## Cylinder valves:

The MOGAS' OMVL Vented Valve is the most sensible choice for cylinders that are destined to be installed inside the vehicle passenger compartment or inside a closed-in space. It vents itself and all relative attached fittings to the exterior of the vehicle.

***The vented valve is more efficient and slick than its alternative: a plastic bag.***

***See details and Installation Instructions on the following pages.***

Cylinders that are destined to be installed to the outside or under the carriage of the vehicle can be fitted with a regular, non vented valve, as venting is not required when a cylinder is installed in an open well ventilated area.
Non vented valves are available in different brands and configurations i.e. straight or angled at 90°. Each valve series requires a special wrench.

***Valve wrenches are available from our stockroom, individually or in a complete set.***

### Taper Threaded Valves :

When installing a valve on a taper threaded (steel) cylinder, follow the valve manufacturer's instructions and your local Gas safety enforcement regulation as published and enforced by the jurisdictional authorities.

In the absence of directives or regulations as mentioned above, follow this procedure:

- Initially thread-in the cylinder valve, slightly lubricated, into the cylinder. Tighten it by hand until snug and mark the position of the valve in relation to the cylinder neck.
- With its appropriate wrench tighten, loosen and retighten the valve a few times until it has completed 1 to 1.5 revolutions, clockwise. Make a new mark to identify this new position of the valve in relation to the cylinder neck.
- Remove the valve and **clean-up** the tank and valve threads.
- Apply a thin coating of approved thread compound, only to the valve threads. Thread jamming is the real cause for sealing; the compound protects the threads from galling.
- Reinstall and tighten the valve 1/2 turn past the second mark, to 160 ft/lbs.

**Important Note :**

**No matter what, DO NOT use an impact wrench to tighten the valve.**

**Parallel ( straight ) Thread Valves :**

When installing a valve on parallel threaded cylinders, follow the valve manufacturer's instructions and your local Gas safety enforcement regulations as published and enforced by the jurisdictional authorities.

In the absence of directives or regulations as mentioned above, follow this procedure:

Most aluminum composite cylinders have two threaded openings, one at each end.

- Install the chosen cylinder valve with its O-ring and torque to 45 / 50 ft/lbs.
- Install the end cap with O-ring, with or without PRD* at the other end, and torque to 45 / 50 ft/lbs.

***A composite cylinder of 60" or more will have two PRDs, one at each end.**

Consult the installation regulations issued / enforced by the local jurisdictional authorities.

**Important Note :**

**No matter what, DO NOT use an impact wrench to tighten the valve.**

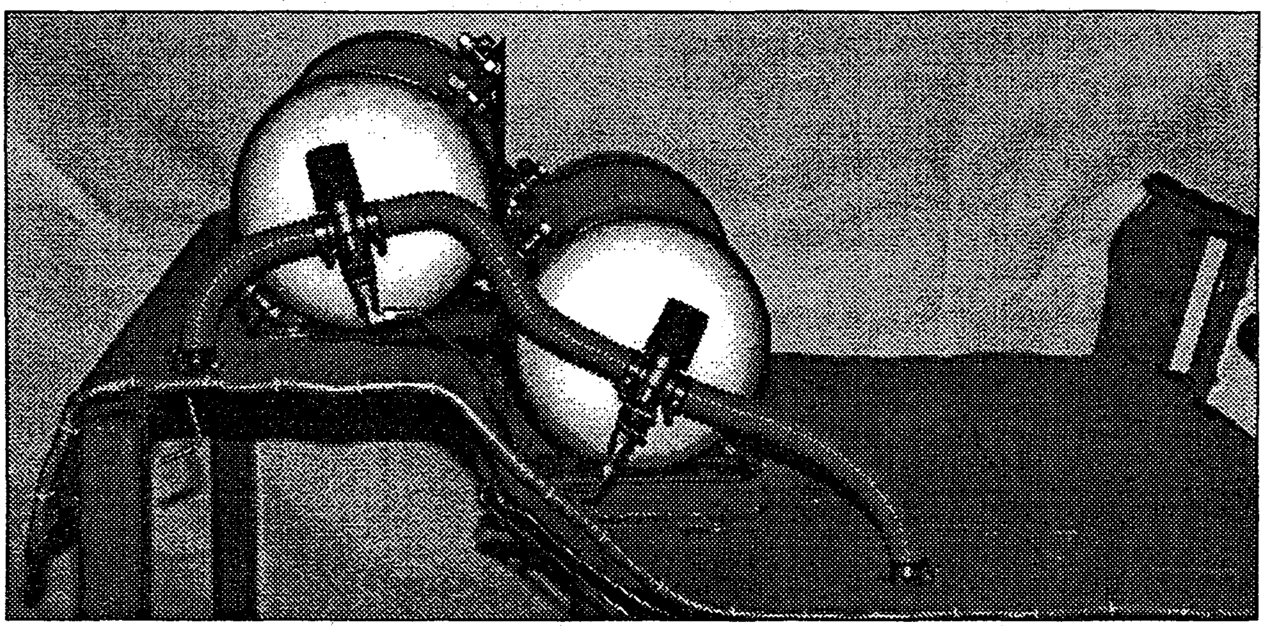
**Cylinder fastening:**

Cylinders must be permanently well secured to the vehicle, to prevent them from breaking loose in case of collision or upset.

- Use good quality brackets. They are available from our stockroom in a variety of shapes and configurations to suit most reoccurring installation configurations.
- Avoid positioning the cylinder(s) close to vehicle extremities. Transverse mounting is safer than longitudinal. Cylinders mounted longitudinally should be provided with end brackets to absorb thrust forces.
- The mounting area must be rigid, solid, able to take 20G longitudinally, 8G laterally.
- Whenever possible, the cylinder valve(s) should be mounted on the same side as the master shut-off valve.
- Fasten the mounting bracket securely to the body of the vehicle. Use reinforcing and back plates, especially when fastening to sheet metal panels.

# Self Vented Valve
# for CNG / NGV Cylinders

This cylinder valve was designed to offer a neat and reliable cylinder installation within the passenger compartment of a motor vehicle.



Finished Installation Sectioned View

## Main Features:

- Integrated positive flush-through venting system.
- Easy manual cylinder shut-off.
- Standard Pipe-away Pressure Relief Device.
- Easy Installation.
- Universal mounting ability.

## Integrated Flush-Through Venting System:

This revolutionary feature is built into the valve body which, when connected to the permanent ventilation flanges (installed in the compartment floor or sides with the ribbed rubber hoses), provides excellent venting of all tubing and related fittings, as well as threaded joints and connections.

## Easy Manual Cylinder Shut Off:

The large, well designed knob stands free for easy access and operation as it **does not require** a plastic venting (bag) envelope / seal.

## Standard Pipe-Away Safety Pressure Relief:

This valve is fitted to accept a standard pipe-away pressure relief device in compliance with National and /or Local Regulations.

## Easy Installation:

This feature makes this valve unquestionably better than any other system currently in use worldwide. It makes venting bags and aprons of any kind **obsolete !!!**

## Universal Mounting Ability:

This valve is available with threads to suit either steel or aluminum CNG / NGV Cylinders.

# Valve Operating Principles

(diagram on the following page Fig. 3)

The valve body has Venting Ports: ( 2 ), ( 3 ), ( 4 ) and ( 5) which vent any possible gas leak to the exterior. This is how it works:

Vent Port ( 2 ) will expel any leak contained by hose ( 1 ) that may occur at the valve to cylinder connection. Hose ( 1 ) will fit on cylinder necks ranging from 1.45" ( 37.0 mm ) to 1.80" ( 45.0 mm ) and is sealed by clamps ( 15 ). **The above is unique to tapered threads cylinders.**

**On parallel (straight ) Threaded cylinders** the valve is sealed with an O-ring at the valve-to-cylinder connection; therefore it does not have vent port (2), hose ( 1 ) and clamps (15).

Vent Port ( 3 ) will expel any leak that may occur at seal ( 6 ) and that would be contained inside the knob ( 7 ) which is sealed by the O-Ring ( 8 ) and clamping ring ( 9 ).

Vent Port ( 4 ) will expel any leak that may occur at the threaded ends of the mounting adapter ( 16 ) which is contained by hose ( 18 ) sealed by clamps ( 19 ).

All Vent Ports are connected to Venting Manifold port ( 5 ).

Beside each end of Venting Manifold ( 5 ) there is a High Pressure Gas Inlet / Outlet ( 10 ).

Each end of the venting manifold ( 5 ) and the Gas Inlet / Outlet tubing ( 12 ) will be ducted inside the venting hose ( 13 ) which, when sealed by clamps ( 15 ) will vent valve(s) to the outside of the vehicle via flanges ( 25 ). This will form a positive venting loop. Fresh air entering the leading flange will exhaust by the trailing flange, page 17.

The P.R.D. ( 17 ) is vented outside the vehicle via port ( 23 ) fitting ( 26 ) and tubing ( 27 ).

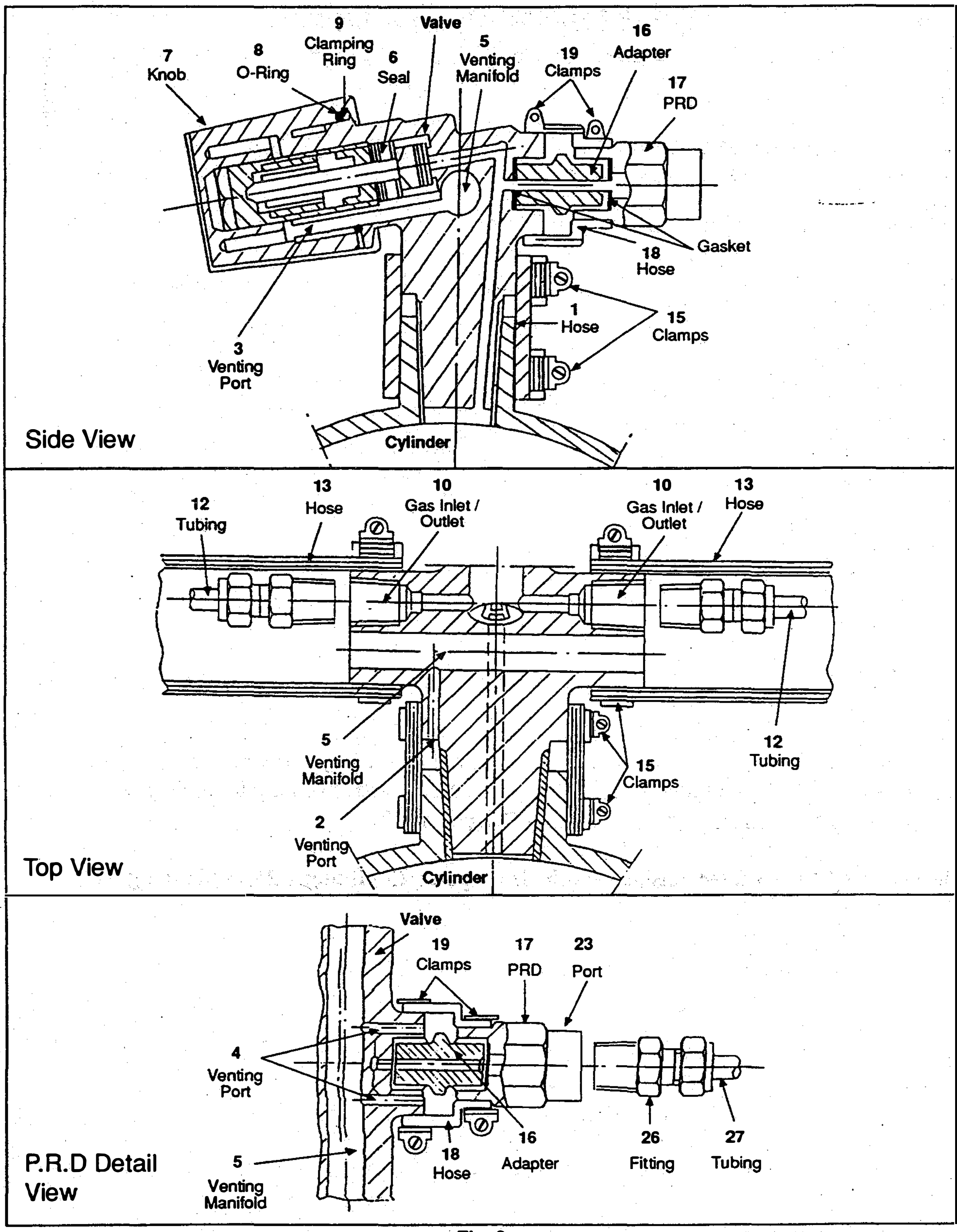



Fig. 3
Self-Venting Valve

# Installation Instructions

1. **CLEAN-UP** the cylinder and valve threads and proceed as follows:

For **Taper Threaded Cylinders :**

- Initially thread-in the cylinder valve, slightly lubricated, into the cylinder. Tighten it by hand until snug. Mark the position of the valve in relation to the cylinder neck.
- **With the special wrench # 09.22.111** (see page 18) tighten, loosen and retighten the valve a few times until the valve has completed 1 to 1.5 revolutions, clockwise. Make a new mark to identify this new position of the valve in relation to the cylinder neck.
- Remove the valve and **clean-up** the tank and valve threads.
- Apply a thin coating of approved thread compound, only to the valve threads. Thread jamming is the real cause for sealing; the compound protects the threads from galling.
- Slide the special rubber hose (1) between the valve and the neck of the cylinder, without clamps (25). ***SEE NOTE :*** **1**
- Reinstall the valve onto the cylinder and **with the special wrench # 09.22.111** torque as per the cylinder manufacturer's specifications, in compliance to local regulations on Gas Tapered Thread joints.
  In absence of the above tighten the valve 1/2 turn past the second mark, to 160 ft/lbs.
  **DO NOT USE AN IMPACT WRENCH.**
- Install fittings and plugs into the valve(s) as required for the desired tubing configuration.

For **Parallel Threaded Cylinders :**

- Clean the threads on the cylinder and on the valve.
- Slide the O-ring onto the valve shank.
- Install the valve into the cylinder by hand.
- **With the special wrench # 09.22.111** (see page 18) torque to the cylinder manufacturer's specifications. In absence of the above torque to 45 / 50 ft. lb.
  **DO NOT USE AN IMPACT WRENCH.**
- Install fittings and plugs into the valve(s) as required for the desired tubing configuration.

2. Position the cylinder(s) in the bracket(s), in the designated place on the vehicle, with the valve pointing in the chosen direction.
   **DO NOT STRAP THE CYLINDER(S) DOWN YET.**
- Determine the safest well sheltered tubing route, and chalk mark the chosen location of the pressure relief tubing exit(s) and vent flanges ( 25 ).
- **BE SURE the venting flanges and tubes will vent to the OPEN AIR through and to the outside of boxed frame structures, away from closed pockets.**
- Move the cylinders aside, as you see fit, for working comfort.
- Drill two 1.25" ( 32.0 mm ) holes in the locations destined for the vent flanges (25).
- Drill one hole for each and to the size of the rubber grommet(s) assigned to the PRD(s) vent-down tube(s).

**Note:** 1) Special hose (1) can be rolled onto itself and the ribbed hose (13) can be backed, compressed onto itself, to make room for leak testing.

3. • Install the rubber grommet(s) in the hole(s) designated for the PRD(s) venting tube(s).
   • Apply a thin coat of caulking compound to the lower lip of flanges ( 25 ) and position them with leading edges opposed as shown on page 17.
   • Fasten the two flanges ( 25 ) to the floorboard (22) with self-tapping screws ( 24 ).

4. • Reposition the cylinder(s) and fasten into place.
   • Prepare the tubing as to planned routing. REMEMBER: the engine supply and the fuelling valve line if separate will be ducted or run through flanges ( 25 ) to the outside of the vehicle.

5. • Install the pressure relief tubing ( 27 ) and route it through the grommeted hole.
   • Cut the vent hose ( 13 ) to lengths for smooth and compact routing.
   • Install all high pressure tubing and vent hoses ( 13 ) at the same time.

   DO NOT FASTEN THE VENT HOSE ENDS AT THIS TIME. ***SEE NOTE :1, page 15.***

6. Leak test all joints, tubing and connections as per local regulation. In the absence of the above proceed as follows:

   • **Close the cylinder valve(s) completely** and pressurize, with caution, the high pressure system tubing. Input the pressure test gas from the refuelling receptacle. This test will take very little gas and will not pose a hazard. Depending on local ruling an inert gas like nitrogen may have to be used instead.
   • Make use of a good gas leak detector and a good leak testing fluid. At times the fluid is more helpful in spotting the exact leak location.
   • If a compression joint leaks: discharge the pressure out of the system, tighten the fitting nut by 1/8 of a turn, repressurize the system and retest for leaks. Repeat this operation if needed. If the leak persists after tightening the fitting 1/4 turn past the original correct installation procedure, discharge the pressure from the system and replace that fitting. Tightening the fitting further may stress it beyond safe acceptability. Check the tubing portion near the joint sealing surfaces for scratches. It may be a good idea at this time to cut the tube tail end off and to install a new fitting nut and ferrules.
   • **Note:**The built-in compression fittings on the vented valve(s) and Pressure Regulator, identified by their male nut, require 2 turns to seal as opposed to 1 1/4 turn required for fittings with a female nut. Nut and ferrules need to be replaced after 3/4 turn over-torque.
   • If an NPT connection is leaking: discharge the pressure from the system, loosen the compression fitting side of that fitting or joint to allow rotation, tighten the fitting NPT joint, and retighten the compression fitting no more than 1/4 tum past the snug point.
   • After correcting all leaks in the system, pressurize it to the full 3600 PSI. If the system is leak-free open one cylinder valve at a time and proceed to refuelling, one cylinder at a time, with caution. Check the cylinder-to-valve threaded connection for leaks; STOP if a leak comes to your attention. Keep the cylinder(s) that are leak-free shut. Empty the cylinder that has a leak in compliance with safety rules /regulations, repair the leak and repeat the procedure until leak-free.

7. • Once cylinder-to-valve threaded connection(s) are leak-free: slip hose (1), ( tapered threaded cylinder(s) ONLY) and tubes (13) onto their collets; fasten with clamps (15).

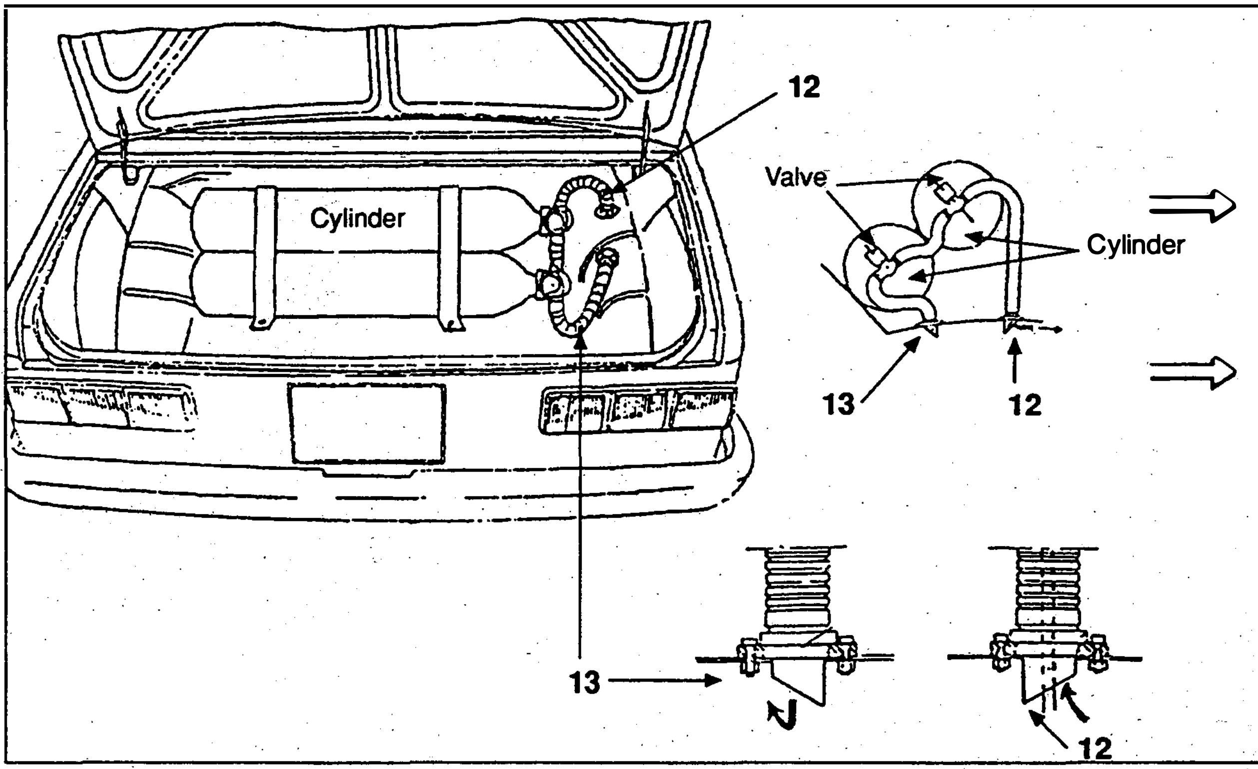



Fig. 4
Venting Loop Generated by Vehicle Motion

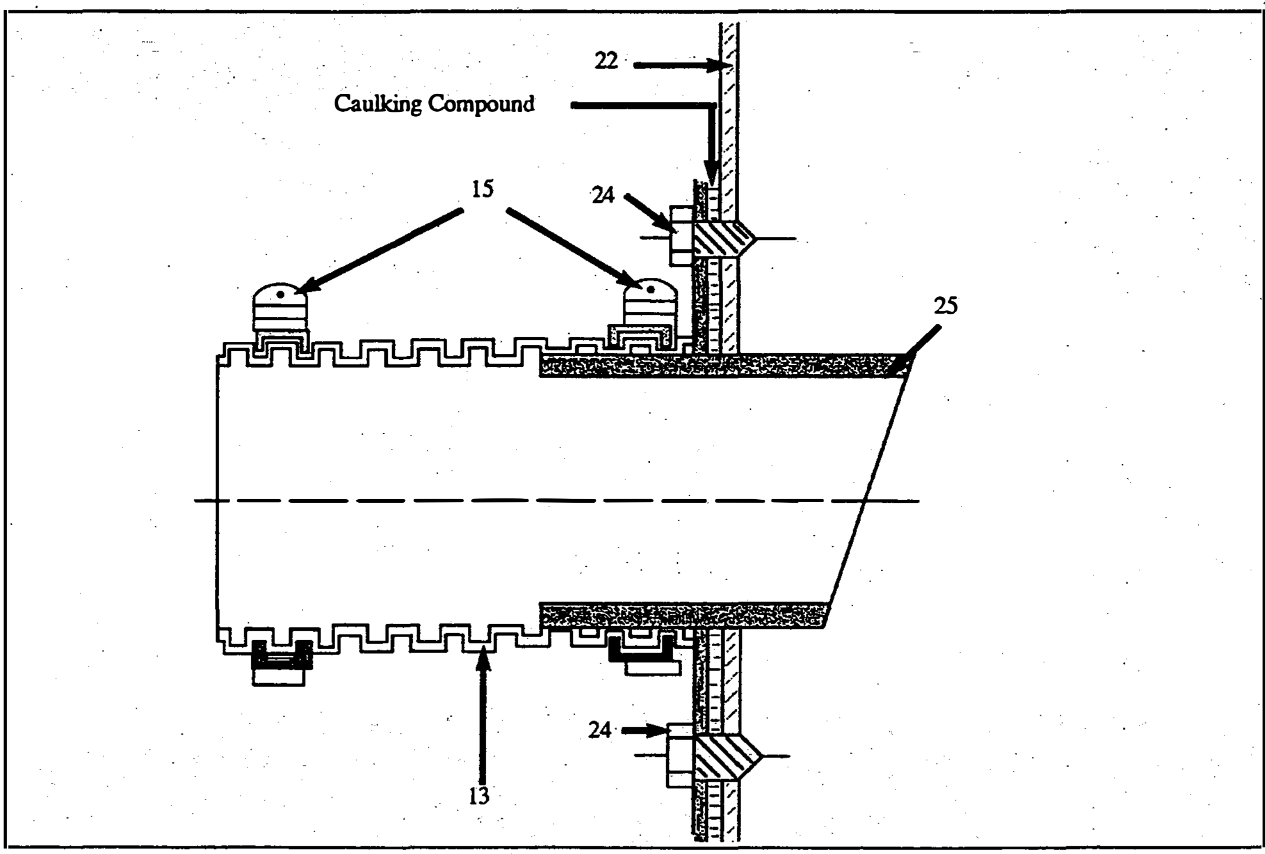



Fig. 5
Vented Valve Installation Detail

# Vented Valve Wrench Assembly Instructions

**Part #: 09.22.111**

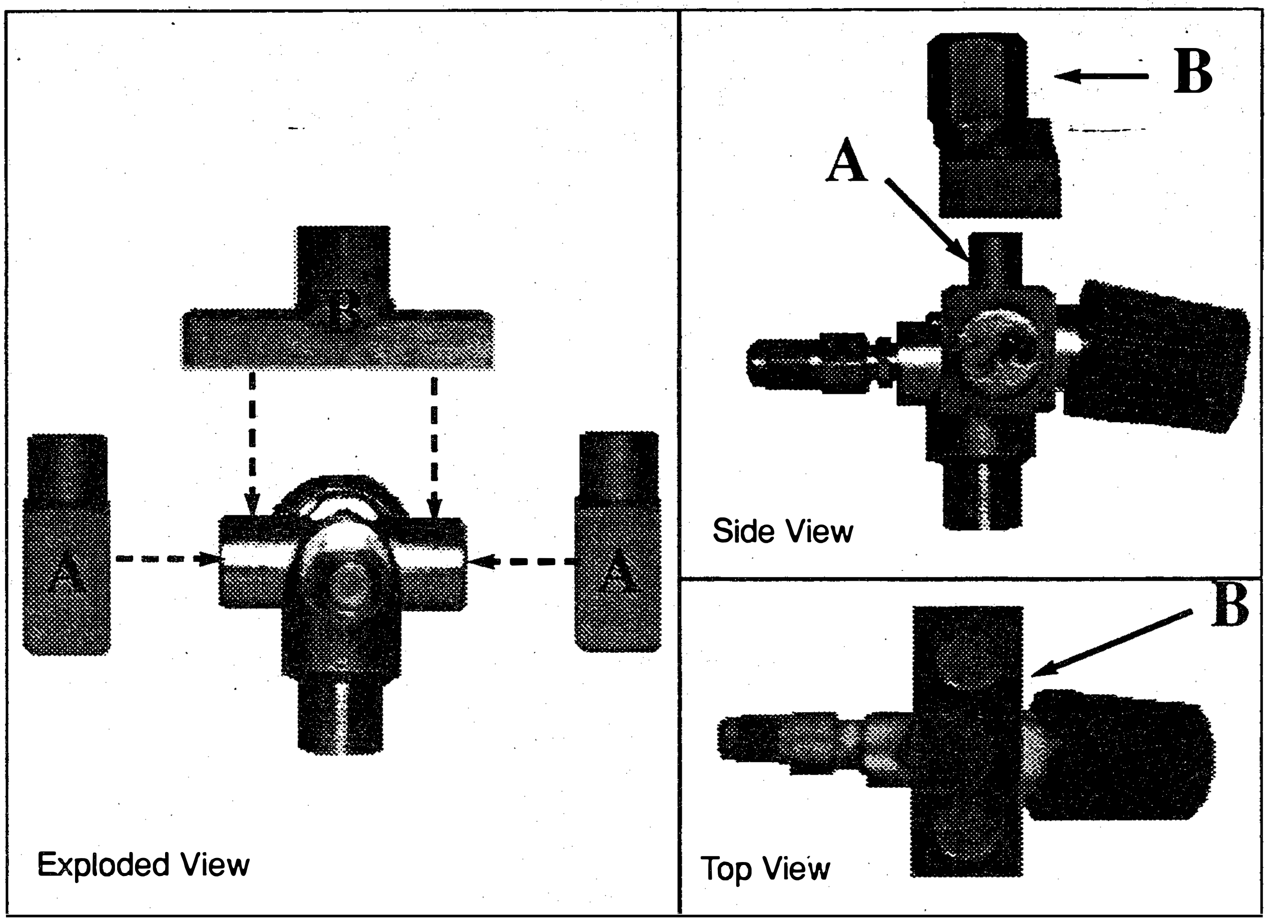



Fig. 6
Views of Vented Valve

1. Slide the two side pieces (A) as in the Exploded View onto the Vented Valve and as completed in the Side View.
2. Slide the top piece (B) so that the post from each side piece (A) fits neatly into the holes of the top piece (B) as shown in the Top View with the nut offset away from the handle.

Torque Specs:

**Cylinders with NPT threads:** As per cylinder manufacturer's specifications and local regulations on Gas tapered threaded joints. In the absence of the above refer to page 15.

**Cylinders with Straight threads and O-Ring:** As per cylinder manufacturer's specifications and local regulations. In the absence of the above refer to page 15.

*DO NOT USE IMPACT WRENCHES*

# Fill Valve and Master Shut-Off Assembly

The method of refuelling, quick versus slow fill, will determine where the fill valve should be located. The master shut-off valve will be in a location that is practical, easy for the driver to access and in compliance with local regulations.

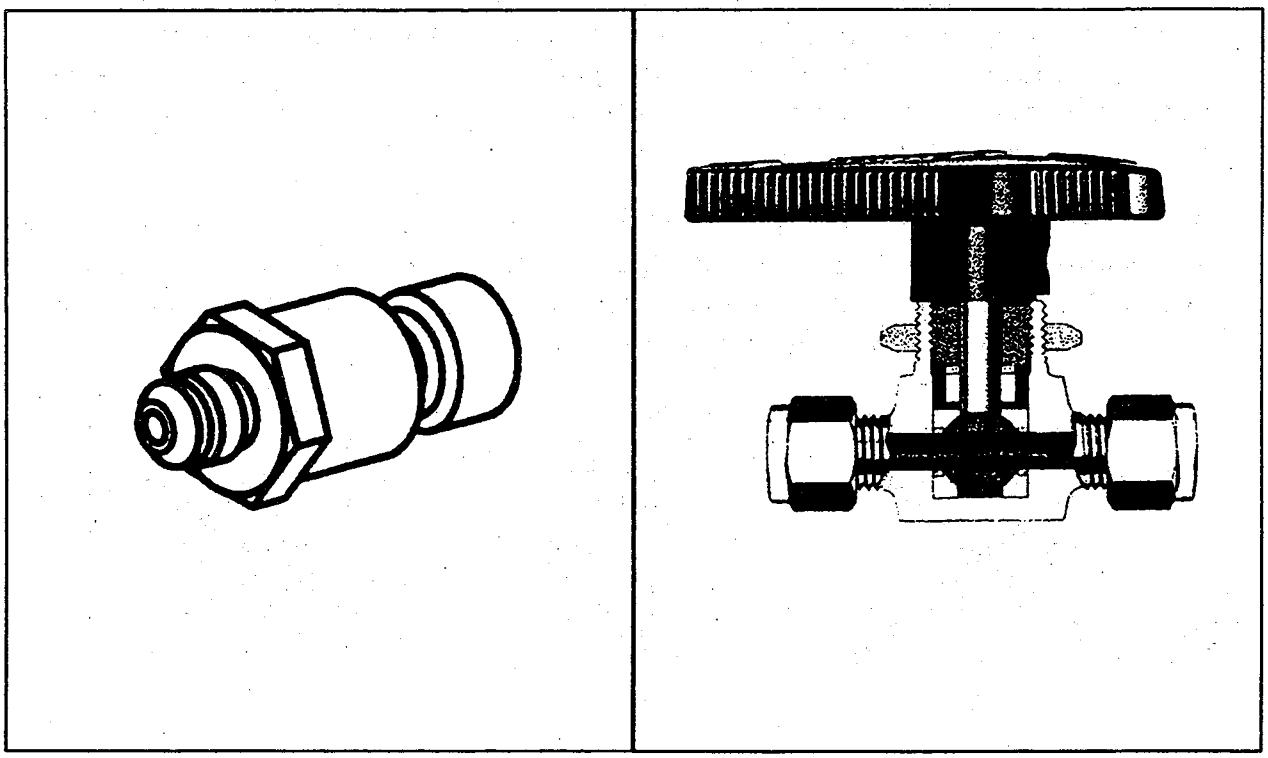


Fig. 7
Fill Valve and Master Shut-Off Valve

For a "Quick Fill" refuelling system, the most common location for the fuel receptacle is under the hood. Since the hood must be opened in order to refuel, it is much less likely for the driver to drive away while the refuelling drop hose is still attached to the vehicle.

For a "Slow Fill" system, the front grills or the rear end panels are commonly selected locations. Exercise care to ensure that the fill valve is well protected from possible collision. Include a back-check valve with your refuelling valve, located as far from the refuelling receptacle as possible, to prevent undesirable fuel discharge in the unfortunate event that the refuelling valve or its tubing may be damaged or severed by collision.

The fill valve mounting bracket must be fastened to a rigid metal surface and be easily accessible with the refuelling nozzle (drop line). It should be located as far away from electrical and heat sources as is practically possible.

If the location chosen for the installation does not offer sufficient protection from the weather and other road hazards the assembly should be enclosed in a protective box.

# Regulator Installation

- Ideally, the regulator should be placed near the heater coolant hoses, below the radiator coolant level, if possible within three feet of the mixer, and in a spacious area to avoid having to remove it when servicing the engine.

- The coolant hoses for the regulator should be slightly longer than needed. The extra length is to be formed into a U shape to prevent heat transfer from the engine to the regulator thermostat as this will cause a false temperature reading. The extra hose length is also handy when performing maintenance tasks, as disconnecting the regulator from the bracket, the high pressure tubing and the wiring to it, will allow it to move out of the way without having to disconnect the hoses.

- The regulator should be well fastened, preferably to the vehicle body, in the engine compartment in a **vertical position** (as shown here below) and in longitude with the driving direction of the vehicle.
  If the regulator must be mounted in an angle, it can be rotated up to 90° ( transversely ), provided the support cover is mounted towards the front of the vehicle.

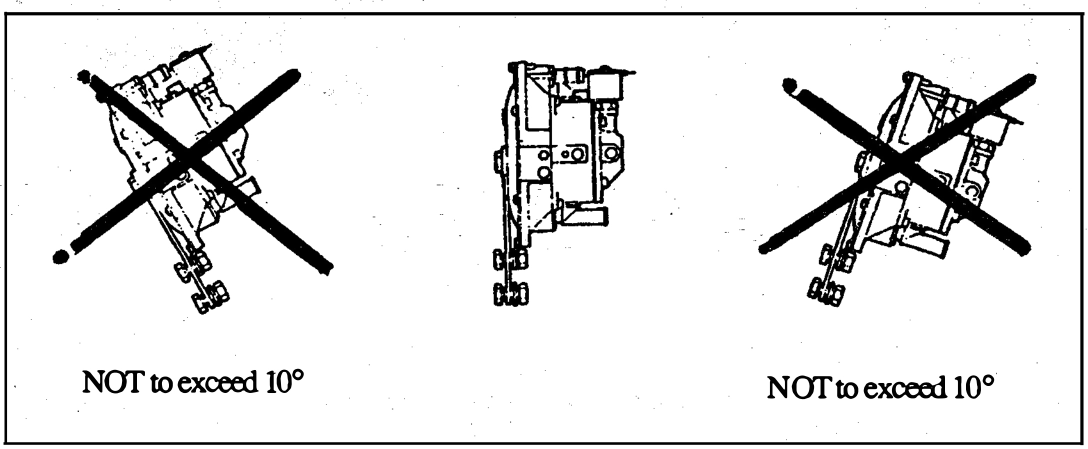



Fig. 8
Regulator Mounting

- **WARNING!!**

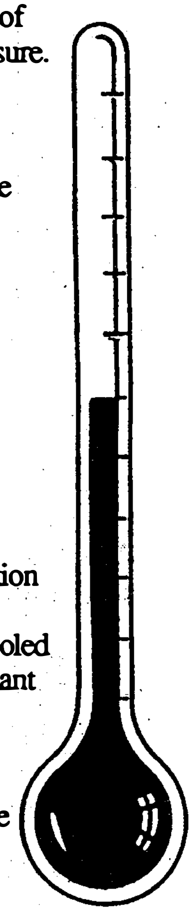
  - Install the regulator away from the exhaust manifold(s), to avoid uncontrolled overheating of GAS output.

  - Install the regulator below the radiator coolant level. Whenever the regulator must be mounted above the radiator coolant level, bleed the regulator coolant circuit before sealing the radiator cap. Air pockets within the water jacket will disrupt the coolant temperature exchange.

  - Installing the regulator on the engine may cause uncontrolled behavior, caused by the engine torque moment and vibrations.

  - Protect the regulator support cover VENT from the radiator fan(s) direct air ram as it may alter the regulator's accurate performance.

# Advantages of a Regulator with a Thermostat



**Stable Carburetion**

The regulator's thermostat will maintain the regulator coolant temperature flow in the region of 122°F (50°C), while engine running at operating temperature, regardless of fuel storage pressure. Thus keeping the Gas output temperature and density stable and the air / fuel ratio consistent.

**Energy Efficiency**

As the gas temperature is kept reasonably constant in the regulator, the engine enjoys accurate fuelling thus optimizing energy efficiency and performance.

**Longer Regulator Life**

All regulator parts last longer because its temperature is moderate and remains reasonably constant.

## Caution:

**Coolant Hoses Installation**

Since the thermostat is incorporated in one of the regulator coolant connectors (elbow) attention must be given to the COOLANT CIRCULATION DIRECTION.

The hot coolant from the engine must enter the regulator via the open port connector. The cooled coolant must exit the regulator through the port housing the thermostat, on its way to the coolant pump suction or return to the radiator, in that order of preference.

**Optional Thermostat Location**

The thermostat may be located at either the upper or the lower coolant connector socket of the regulator. When installed in the upper coolant connector socket, however, it makes air bleeding much easier.

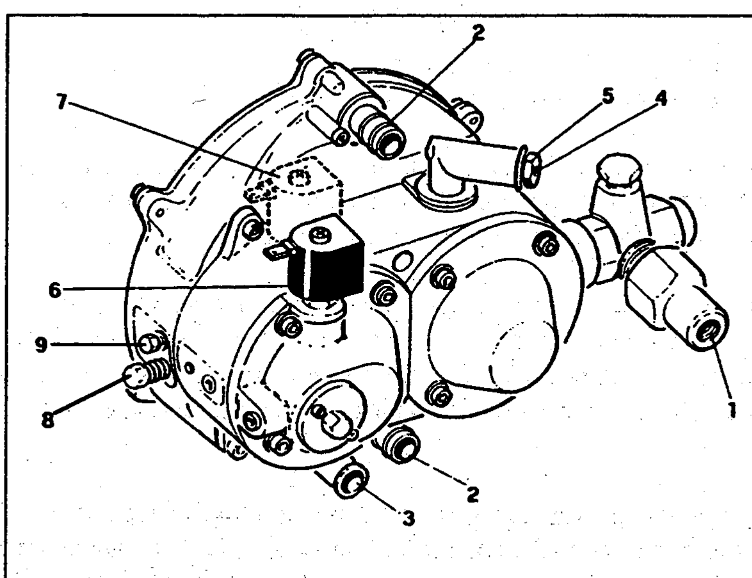



Fig. 9
Regulator Parts

| Part # | Part Name |
|---|---|
| 1 | Gas Inlet |
| 2 | Gas Outlet or Plug |
| 3 | Water Inlet (open port) |
| 4 | Water Outlet - orifice |
| 5 | Thermostat |
| 6 | Solenoid Valve |
| 7 | Electric Priming - Option 1 |
| 8 | Sensitivity Adjustment Screw |
| 9 | Positive Idle Adjustment Screw |

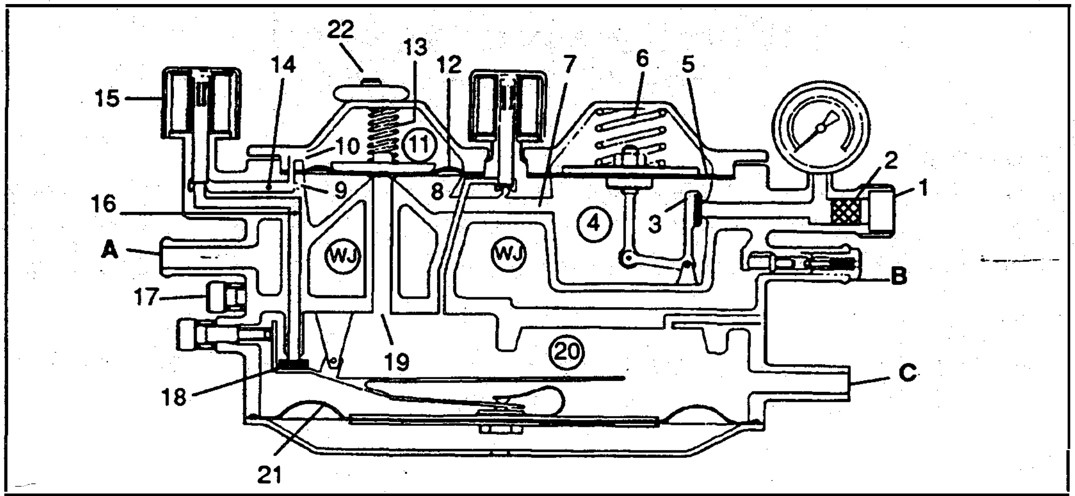



Fig. 10
Regulator Cross Section

# Regulator Operations

(See Fig. 10 for items referred to on this page.)

The CNG /NGV enters the regulator at the gas inlet connector (1). A filter (2) stops any solid impurities from entering the regulator.

Stage 1: The high-pressure valve (3) is controlled by the diaphragm (5) mechanism and spring (6) ; it regulates the gas flow into chamber (4 ), (7) and (8) to working pressure: 24 PSIG +/- 4.

Stage 2: Diaphragm (12) is controlled by pressure differential of chamber (8) & (11) and spring (13) ; it regulates the gas flow into chamber (20), to delivery pressure: 0 PSIG +/- 0.01.

Stage 3: Item (22) is not detailed in Fig. 9. It regulates the gas flow into port (14) and Pilot port (16) to 19 PSIG +/- 1.

Shut-Off solenoid (15) intercepts the gas flow from port (14) to Pilot port (16). This solenoid is normally closed; it stops the gas flow altogether; it must be energized to allow gas flow throughout the pressure regulator.

Stage 4: When solenoid valve (15) is open gas flows to the positive idle adjustment screw (17) and to the low-pressure valve (18). Valve (18) is controlled by the diaphragm (21) mechanism which is connected to the mixer through port (C) and responds to the engine / mixer gas demand, in the form of vacuum.

Closed-loop: Vacuum from the Mixer will cause valve (18) to open; this in turn will lower gas pressure in chamber (11). Thus diaphragm (12) will compress spring (13) allowing gas flow into chamber (20) through main gas port (19). Gas discharge into chamber (20) will also make up the pressure differential of chamber (8) & (11) through Pilot port (16) causing a smooth and immediate response to engine Mixer varying gas demands.

The decompression of natural gas, depending on supply pressure, causes the temperature of the gas to drop considerably. To prevent freezing, the regulator is connected to the engine cooling system. Hot coolant enters the regulator through port (A), passes through water jacket (WJ) and exits through port (B). A special thermostat lodged inside port (B) maintains the regulator's working temperature of approximately 122°F ( 50° C), thus maintaining a stable gas density throughout the working range and conditions.

# Regulator Maintenance

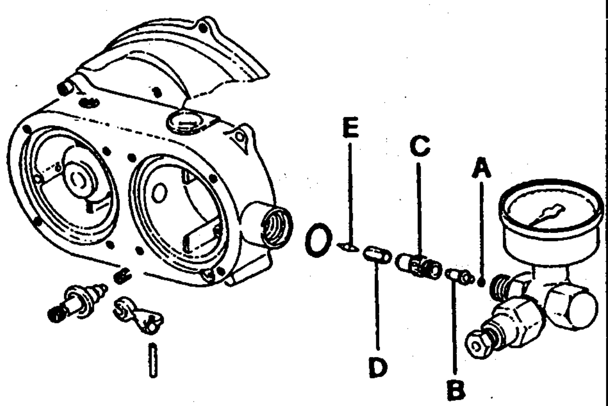



Fig. 11

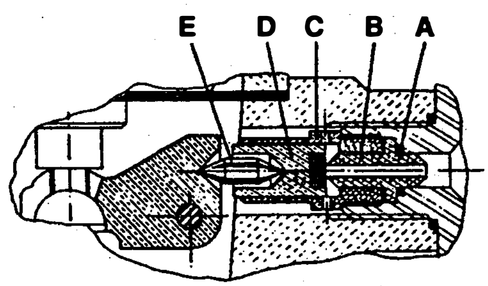



Fig. 12

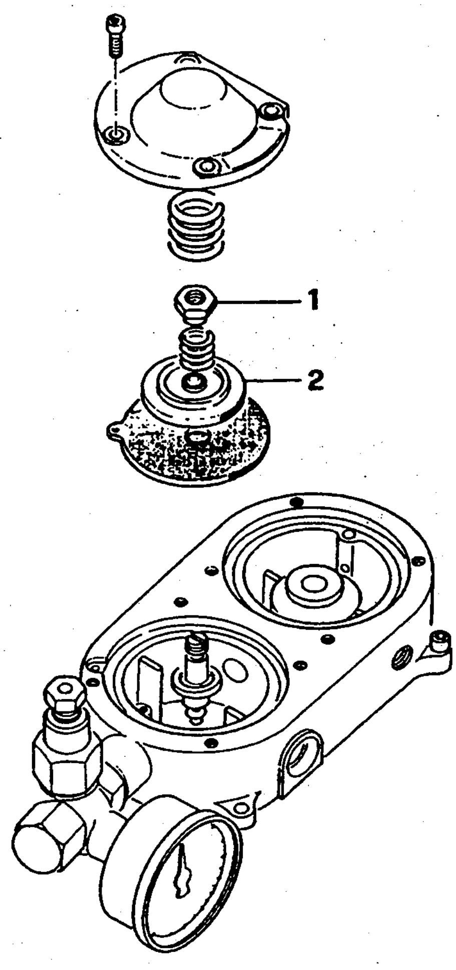



Fig. 13

When re-assembling the plate (2, Fig. 13), take care with the diaphragm centering ring.

The nut (1, Fig. 13) must be screwed, without force, until flush with the stem.

# Regulator Maintenance

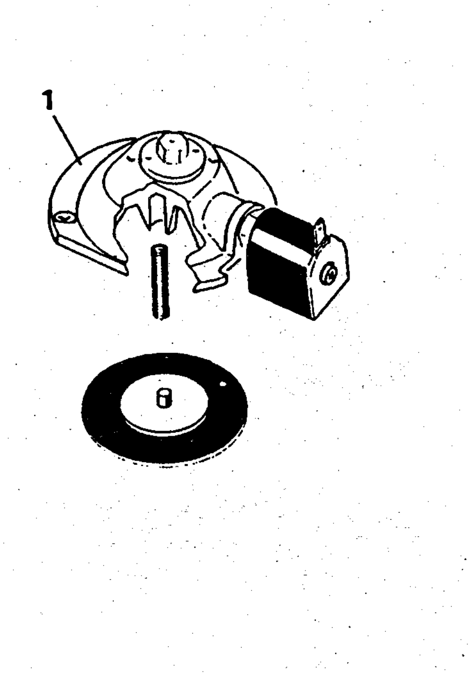



Fig 14

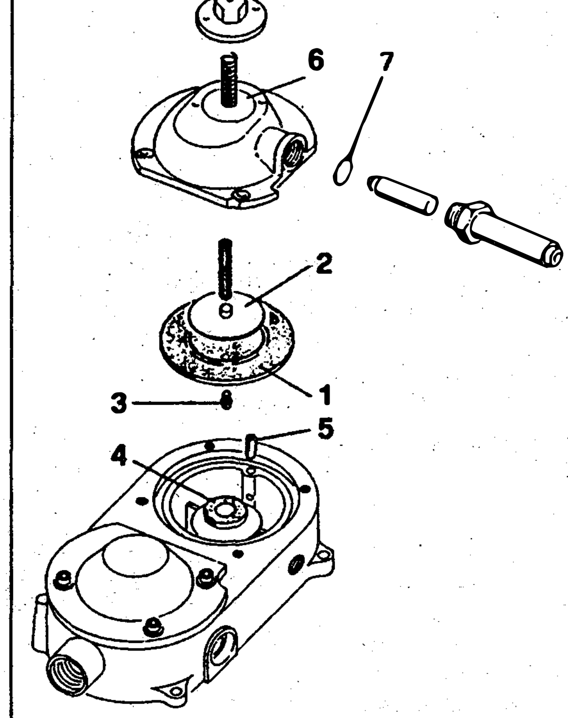



Fig 15

The diaphragm (1, Fig. 15) must be secured to the plate with the proper Ogiva screw (3, Fig. 15) using a drop of LOCKTITE. Tighten the diaphragm enough that it does not spin on the plate, but be careful not to over-tighten causing swelling of the diaphragm.

Make sure that the diaphragm (1, Fig. 15) is centered with respect to the sleeve (4, Fig. 15) and aligned with the tube (5, Fig. 15).

Replace the O-ring on the solenoid piston (7, Fig. 15). When re-assembling the cap (1, Fig. 14) make sure that the spring enters the guide properly.

# Regulator Maintenance

To reassemble the low pressure valve leaf spring use the centering tool (1) Fig. 17. Tighten the holding screw (2) Fig. 17 while holding the pad inside the tool.

Check that the leaf spring pad is perfectly centered. It should be going in and out of the centering tool freely, after the hold screw has been tightened.
Also check that the Pad is closing on its seat evenly, by pushing it at its center dimple toward the seat. Bend the leaf spring (3, Fig. 17) gently, if needed, to obtain good alignment.

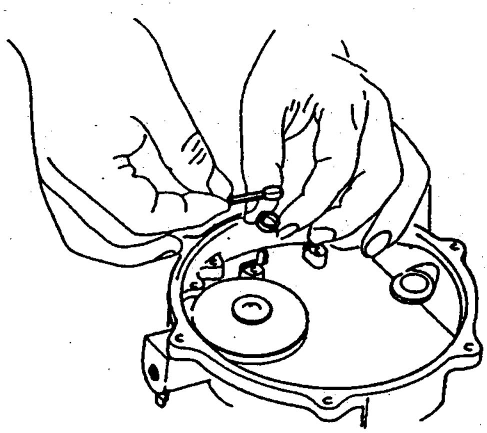


Fig. 16

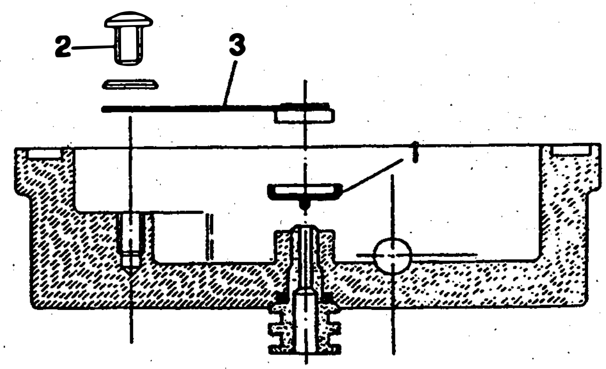



Fig. 17

# Regulator Maintenance

Re-assemble the low pressure lever and then check the height as indicated below.

If the appropriate gauges are not available comply with the measurement in Fig. 19.

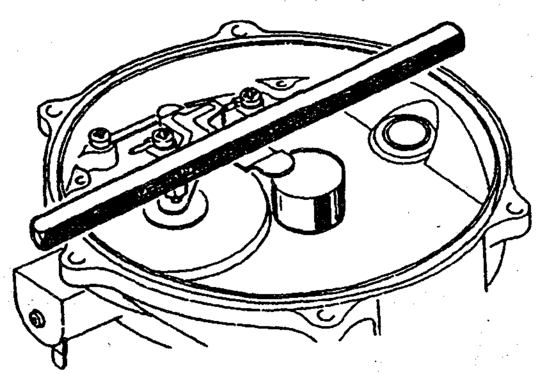


Fig. 18

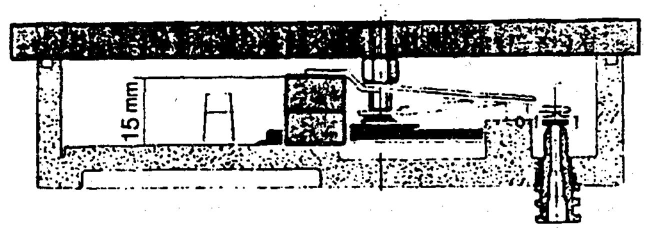



Fig. 19

To re-assemble the low pressure diaphragm, fasten it with the appropriate spring to the low pressure lever, take care in placing the curved part of the spring at the deep end.

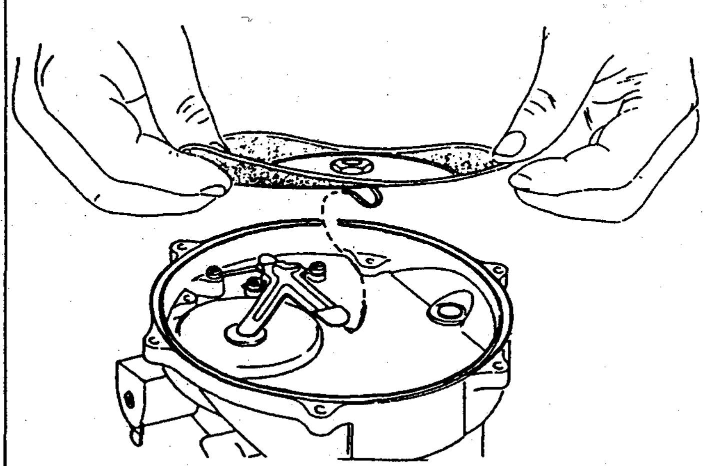


Fig. 20

# Steel Lines and Fittings

At this point, you should have all your major components installed. The next steps are routing, preparation, and assembly of lines and fittings.

All CNG fuel lines between the cylinder and the high pressure side of the regulator, as well as the branches to other fittings must be made from approved high-pressure steel. The line must withstand a pressure of four times the working pressure and each connection in the line must positively lock the tubing in the union by means of a bite type steel compression fitting.

The tubing is annealed and can be shaped with a proper bending tool. Because however, it will harden as it is worked, you must obtain the correct shape with the least amount of bending.

Be careful that the fuel line alignment is exact at the unions before making the connections.

Do not rely on the union nut to pull the line into correct alignment, as this will put stress on the joint. To check the alignment as you make the connections, make sure that the union nut runs freely, by hand.

You must be able to visually inspect the line along its whole length, as well as all the connections used in the line. Use the fewest connectors possible, to reduce potential leak sources.

The natural gas line must be taken from the cylinder to the regulator by a route that does not pass through the driver or the passenger space. Usually the route is under the floor pan or along the chassis. If the cylinder is fitted inside the vehicle body, the line should take the shortest convenient route to the outside. Keep the line away from body protrusions to prevent it from being damaged by impact. Construct a guard to protect any section of the line that is particularly vulnerable to mechanical and road damage.

If you must run the line close to the exhaust, shield it from direct radiated heat.

Do not run the line through boxed body sections or through the inside of the vehicle. Whenever the fuel line passes through a panel make an oversized hole and protect it with a grommet, centering the line in the hole. Clearance should allow good visual inspection throughout the passage.

Route the steel tube from one component to the next to determine the length required. For a short line, include enough material for one vibration loop of approximately 2 1/2" in diameter (6.5 cm). Add to the total measurement of the line about 8" per loop, Fig. 21.

A longer tube which requires securing at approximately 24" (60 cm) intervals needs vibration loops at both ends. Remember that vibration loops are needed to absorb vibrations, and are not just for appearance.

If the length of the line or the surrounding space does not allow for a loop, a 180° curve in the line will serve the same purpose. Before bending the tube allow at least 1.5" (32 cm) of straight ends for the compression fitting. Cut the ends of the tube at a right angle, and if the edges are rough file them smooth. Be careful not to scratch the tubing, as this will cause a leak.

Deburr the ends of the tube with a deburring tool, being careful that the tool does not leave the wall of the tube too thin. Do not mark, scratch or twist the tubing. Use compressed air to clear the tube of chips and filings.

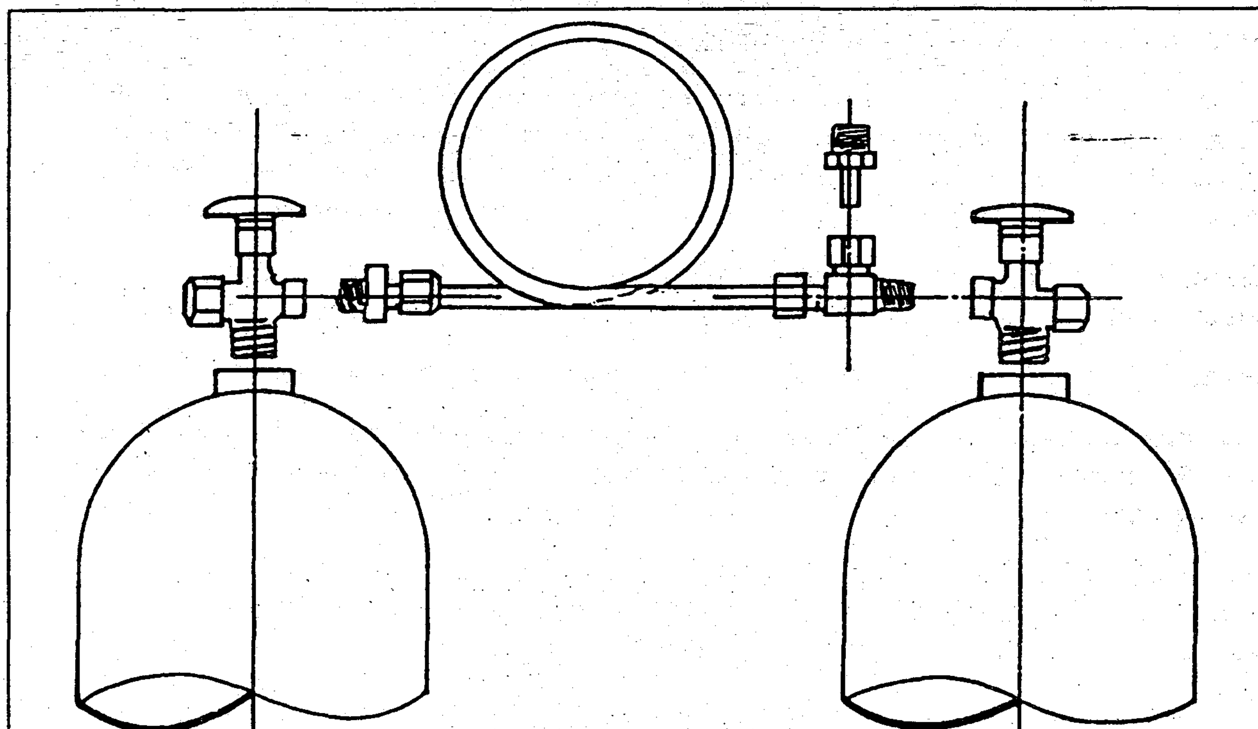


Fig. 21
Expansion Loop Illustrated

## Fittings

As you know, the purpose of any tube fitting is to form a reliable tube/line connection which will seal the fluid media being used in the system or application.

Each fitting manufacturer has its own recommendations for fitting installation. You should follow their instructions.

As a general rule, tube fittings come to you completely assembled, finger tight. They are ready for immediate use. Disassembly before use can result in dirt or other foreign material getting into the fitting and this will cause undesirable leaks.

Most fittings are installed in three easy steps:

1. Simply insert the tubing into the fitting nut and ferrules and into the fitting; make sure that the tubing rests firmly on the shoulder of the fitting and that the nut is finger tight.
2. Before tightening the fitting, scribe / mark the nut at the 12:00 o'clock position.
3. Now, while holding the fitting body steady with a wrench, tighten the nut 1 1/4 turns. Watch the scribe mark make one complete revolution and continue to the 3:00 o'clock position. In this way, the fitting has been properly installed.

# Mixers and Fuel Flow Control Valve

The p rpose of the mixer is to draw fuel from the pressure regulator and to mix it, in the right proportion with air, for the best possible results in emissions, performance and economy.

Mogas offers many models of mixer, the most popular type being:

1. In-Line
2. Lift Plate
3. Fix Gap
4. Special Application

The type of mixer to be used is determined by engine displacement, air intake configuration, type of fuel delivery system and under-the-hood clearance.

All MOGAS mixers are of modular design. Many interchangeable mounting flanges and adapters are available. Please consult our main catalog.

Our stockroom staff will be happy to assist in choosing the right fit, size and calibration.

The mixer must be well secured to the air intake system, in a leak-free manner. When the mixer is installed inside the air cleaner assembly, a longer fastening stud is often required.

- Make sure to install it well inside the anchor threads and use the lock nut to prevent the stud from coming loose during use or at the time of service.
- Make sure the air horn gasket is in good service shape.
- Fasten the air filter base to the throttle body with the lock nut and large washer so that the mixer seal will not have to be disturbed every time the air filter is replaced.

When installing vacuum lift mixers, ensure that:

- The three way vacuum solenoid is installed in a reasonably cool spot away from the firewall to prevent the clicking noise being heard from inside the vehicle.
- The three way vacuum solenoid is properly connected so that it is energized during CNG operation only.
- The vacuum source for the above is intake manifold vacuum.

For more details on availability please consult a current copy of our main catalog. Technical information is included in the Mogas Natural Gas Fuel System Description and Operation Manual.

**Appendix A** contains a fair representation of the most frequently used mixers.

# MOGAS ECOLO
# Closed-loop Feed-back Fuel Flow Control

The ECOLO fuel flow control valve is installed between the pressure regulator and the mixer, as near as possible to the mixer assembly. It is supplied with an assembly diagram, as shown below.

The Mogas ECOLO closed-loop Feed-back fuel control will increase and decrease the fuel flow in response to the $O_2$ signal and other input data. It is designed to maintain ideal air / fuel ratio and to fulfill the expectations of the O.E.M. computer diagnostics.

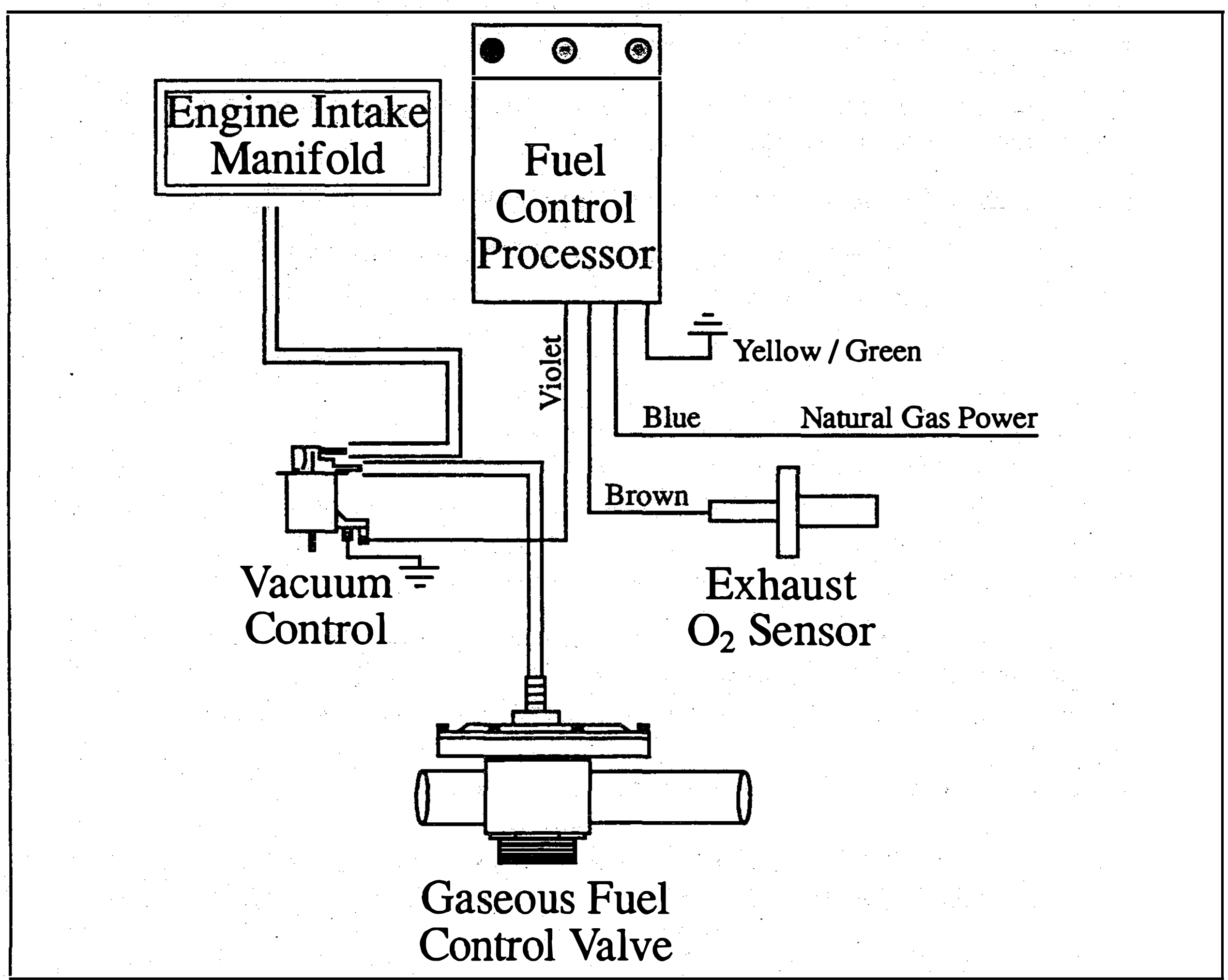



Fig. 22
ECOLO Closed-Loop Feed-Back System

If the engine tuning deteriorates beyond the ECOLO System control, or if the ECOLO itself is temporarily out of order, the O.E.M. computer diagnostics will turn on the "check engine" light and record the associated trouble code.

# Electronic Equipment

In modern computerized vehicles, wiring is the most critical phase of the installation. At this stage of the installation:

- Be careful in interfacing with computer sensors. There is little or no room for error.
- Do not use temporary connections, electric tape, "crimp-on" connectors.
- Route your wiring so that it is not in the way of parts that need routine maintenance or may need replacement. Make it easy for the next technician; use the wire harnesses supplied and follow the colour coding throughout the whole installation, if a wire(s) need be extended.
  In our experience many electrical malfunctions on natural gas systems occur after the engine has been serviced or repaired. Poor connection will likely loose conductivity when the wires are disturbed by the repairer.
- Soldering all connections is **a must**. Use good quality resin core solder, **not acid core.** Acid core will corrode the wires and in due time will create resistance and generate trouble codes in the computer. These malfunctions are difficult and expensive to trace.
- All wiring should be well routed and well protected; use a loom wherever possible.
- Secure the loom so that it is held tightly away from high voltage wires and heat sources.
- When wiring must run close to the engine (or on top of the engine itself), consider that the engine will be very hot when running, and that wires, hoses, nylon ties, and other objects that appear to be secure will relax and tend to fall down. If wires fall on hot surfaces they melt and ground, resulting in devastating consequences for the on-board computer and all other electronic devices.

# Fuel Selector Switch and Gauge

The installation of the fuel selector switch and gauge is a straightforward operation. However, there are certain points which should be emphasized.
These points are:

- Ask where the customer prefers the fuel switch and gauge.
- Place the switch where the driver can reach it comfortably without being distracted from driving.
- Place the fuel gauge where it can be easily read even in full light.
- Place both units out of the way of other controls, and of the driver's knees while entering the vehicle.

Mogas offers a variety of switch and gauge configurations to suit customer operation. Consult our main catalog or better yet, ask our staff for assistance.

**Appendix B** contains a fair representation of most frequently used Switches and Gauges.

# Injector Disconnect Relay Kit

Fuel injected vehicles are fitted with an injector disconnect relay kit. Each kit is supplied with the appropriate relay kit or harness as is best for simplicity and reliability. All injector control systems are designed to fail-safe into gasoline mode, but can be easily modified to achieve the opposite function. Please consult our technical staff for a particular vehicle requirement.

**Appendix C** contains a fair representation of injector control wiring diagram. Each kit is supplied with its relative wiring instructions.

# Gasoline Fuel Lock-off Solenoid

Carburetted vehicles are fitted with a gasoline lock-off solenoid valve, to stop the flow of gasoline while operating on natural gas. When installing this valve, we recommend that:

- The valve be installed away from the fuel pump, as close as possible to the carburetor. This will allow the gasoline line downstream of the lock-off valve to drain completely and thus prevent the gasoline from sitting in a vertical column, slowly evaporating because of engine heat. The fumes from this evaporation mix with the natural gas - air mixture and affect the vehicle's idle stability and emissions. The closer the gasoline lock-off is to the carburetor, the shorter is the Gasoline to Natural Gas switch-over time.
- The valve be installed well clear of the engine or any other source of intense heat. Excess heat will cause deterioration of the valve internal components.
- Metal tubing be used downstream from the valve to the carburetor. Neoprene hose when empty will dry, deteriorate, and cause hazardous gasoline leaks.
- Good electrical ground be established, along with solid wiring connections. Like most lock-off solenoids this valve is normally closed; failure to open will not allow the engine to operate on gasoline.

# Timing Advance Processors

Most computer controlled vehicles do not need a timing advance processor.

Occasionally, a particular vehicle may require the installation of such a device to enhance its performance. Our experience suggests that the reason for poor performance lies elsewhere.

However, if you need a timing advance processor consult our our main catalog, making sure the addition of a spark advance device is not in violation of emission certification. Our technical staff will be happy to assist as to which unit to install or NOT to install.

Each unit is supplied with ample documentation on installation, wiring diagrams and set-up procedures.

# Leak Testing Procedures

**Carburetted Engines Only**

Before checking the system for natural gas leaks, it is necessary to ensure that there are no leaks in the gasoline delivery system. Disable the ignition by disconnecting the power wire to the coil, and crank the engine long enough to bring the fuel pressure up to working pressure. The use of a pressure gauge at this time will confirm fuel pump efficiency.
Check the whole gasoline fuel system for leaks, especially at the gasoline solenoid valve and at all areas where work was done.

**The entire natural gas system must be thoroughly tested for leaks, before the first fill-up.** The vent kit on internally mounted cylinders is not supposed to be completely fitted until after the system has been tested and found to be well sealed (leak free).
Before filling the cylinders, double check every connection on the vehicle system, then:

- **Close the cylinder valve(s) completely** and pressurize, with caution, the high pressure system tubing. Input the pressure test gas from the refuelling receptacle. This test will take very little gas and will not pose a hazard. Depending on local ruling an inert gas like nitrogen may have to be used instead.
  - Make use of a good gas leak detector and a good leak testing fluid. At times the fluid is more helpful in spotting the exact leak location.
  - If a compression joint leaks: discharge the pressure out of the system, tighten the fitting nut by 1/8 of a turn, repressurize the system and retest for leaks. Repeat this operation if needed. If the leak persists after tightening the fitting a 1/4 turn past the original correct installation procedure, discharge the pressure from the system and replace that fitting. Tightening the fitting further may stress it beyond safe acceptability. Check the tubing portion near the joint sealing surfaces for scratches. It may be a good idea at this time to cut the tube tail end off and to install new fitting nut and ferrules.

  - **Note:**The built-in compression fittings on the vented valve(s) and Pressure Regulator, identified by their male nut, require 2 turns to seal as opposed to 1 1/4 turn required for fittings with a female nut. Nut and ferrules need to be replaced after 3/4 turn over-torque.
  - If an NPT connection is leaking: discharge the pressure from the system, loosen the compression fitting side of that fitting or joint to allow rotation, tighten the fitting NPT joint, and retighten the compression fitting no more than 1/4 turn past the snug point.
  - After correcting all leaks in the system, pressurize it to the full 3600 PSI. If the system is leak-free open one cylinder valve at a time and proceed to refuelling, one cylinder at a time, with caution. Check cylinder-to-valve threaded connection for leaks; STOP if a leak comes to your attention. Keep the cylinder(s) that are leak-free shut, empty the cylinder that has a leak in compliance with safety rules /regulations, repair the leak and repeat the procedure until leak-free.

# Set-Up Procedures

The set-up of a natural gas system is the key to optimum performance and customer satisfaction. This section covers set-up procedures for the following systems:

| | |
|---|---|
| 1. Carburetted Engines | Open Loop & Closed Loop Systems |
| 2. Fuel Injected Engines | Open Loop & Closed Loop Systems |

# Carburetted Engines
# Regulator and Fuel Set-Up

1) Start the engine on gasoline. Position the fuel selector switch to the "empty carburetor" function, making sure to pump the accelerator pedal when the carburetor bowl is nearly empty to completely drain the accelerator pump of fuel.
Turn the engine OFF, set the fuel selector to Natural Gas and fully **OPEN** the Nat Gas cylinder(s) and Master Shut-Offs.

**Note:** Each and every Regulator is tested and tuned at the plant before being released for sale. Do not tamper with it unless there is a strong possibility that it may not be set correctly. To reset the pressure regulator to base setting, proceed from point 2) and there after. If the regulator is believed to be in good order proceed from point 6) and there after.

2) **CLOSE** gently and completely the Positive idle screw (8mm hex) & the Sensitivity screw (10mm hex) on the side of the pressure regulator.
Disconnect the Gas vapor hose and the regulator run / shut-off solenoid power wire.

3) Energize the regulator's run / shut off solenoid with a jumper wire (constant battery power). There should be NO gas output from the regulator / vapor hose or **very little**.

4) OPEN the sensitivity screw (10 mm hex) gently until Gas starts or increases flowing from the regulator / vapor hose. Leave it at this setting if the screw is equipped with a stay spring. Lock the lock nut when provided.

5) Remove the jumper wire and reconnect all systems to running condition.

6) While cranking to start the engine, OPEN the Positive idle screw. Continue opening and adjusting it, until the engine fires well, starts and idles well.

7) Wire-in a **HIGH IMPEDENCE** milli-volt-meter to the exhaust's $O_2$ sensor.
Start and run the engine until the operating temperature is stable.
Bring engine RPM to 3,000 and hold steady.
Adjust the Gas Flow control valve for the best air / Gas mixture. The Volt meter should read $O_2$ sensor output of 0.950 volts +/- 0.025 volts.
Return the engine to Idle. While monitoring the milli-volt meter, set the positive Idle screw to read toggling 0.400 to 0.700 volts.

**Note:** Be aware of the fuel tank fumes purging canister; it may be saturated and need servicing.

8) ONLY IF NEEDED, fine tune the Sensitivity screw for best idle and exhaust emission; it should read toggling 0.400 to 0.700 volts with the transmission in Drive and the air conditioning ON. Also check for engine stalling while operating the power steering.

**Proceed to Set-Up Instructions on page 36 & 37**

# Computerized Engines
# Regulator and Fuel Set-Up

1) Set the fuel selector to Gasoline, start the engine and bring it to operating temperature. Set the curb idle speed to the higher limit of the manufacturer's specifications. Turn the engine OFF, set the fuel selector to Natural Gas and fully **OPEN** the Nat Gas cylinder(s) and Master Shut-Off(s).

**Note:** Each and every Regulator is tested and tuned at the plant before being released for sale. Do not tamper with it unless there is a strong possibility that it may not be set correctly. To reset the pressure regulator to base setting, proceed from point 2) and there after. If the regulator is believed to be in good order proceed from point 6) and there after.

2) CLOSE gently and completely the positive idle screw (8mm hex) & the Sensitivity screw (10 mm hex) on the side of the pressure regulator. Disconnect the Gas vapor hose and the regulator run / shut off solenoid power wire.

3) Energize the regulator's run / shut-off solenoid with a jumper wire (constant battery power). There should be NO gas output from the regulator / vapor hose or **very little**.

4) OPEN the sensitivity screw (10 mm Hex) gently until Gas starts or increases flowing from the regulator / vapor hose. Leave it at this setting if the screw is equipped with a stay spring or lock the lock nut when provided.

5) Remove the jumper wire and reconnect all systems to running condition.

6) Open the Idle screw ( 8mm Hex ) one half a turn for initial setting.

7) Wire-in a **HIGH IMPEDENCE** milli-volt-meter to the exhaust's $O_2$ sensor. Start and run the engine until the operating temperature is stable. Bring engine RPM to 3,000 and hold steady. Adjust the Gas Flow control valve for the best air / Gas mixture. The Volt meter should read $O_2$ sensor output of 0.950 volts +/- 0.025 volts. Return the engine to Idle. While monitoring the milli-volt meter, set the positive Idle screw to read toggling 0.400 to 0.700 volts.

**Note:** Be aware of the fuel tank fumes purging canister; it may be saturated and need servicing.

8) ONLY IF NEEDED, fine tune the Sensitivity screw for best idle and exhaust emission; it should read ɔggling 0.400 to 0.700 volts with the transmission in Drive and the air conditioning ON. Also check for engine stalling while operating the power steering.

**Proceed to Set-Up Instructions on page 36 & 37**

# Closed Loop Fuel System
# Set-Up Instructions

## Before conversion:

Set and connect a good quality High impedence digital Millivolt meter to the $O_2$ sensor-signal wire. Take the vehicle for a test run.

### On the Dynamometer:

If a dynamometer is available drive the vehicle ON Gasoline fuel selection and take notice of the general $O_2$ sensor volt pattern; record it if necessary. Pay particular attention to the toggling voltages when at part load (cruising speeds) and the maximum voltage when loaded and at full throttle acceleration. A second person to read and record the voltmeter readings may be helpful. Make sure that the engine is running as well as expected and that there are no trouble codes recorded in the diagnostic system.

### On the Road:

Find a road where you are familiar with the traffic pattern and paying attention to the traffic signals and the traffic around you, drive the vehicle ON Gasoline fuel selection; take notice of the general $O_2$ sensor volt pattern and record it. Pay particular attention to the toggling voltages when at part load ( cruising speeds) and the maximum voltage when loaded and at full throttle acceleration. A second person to read and record the voltmeter readings is a must. Make sure that the engine is running as well as expected and that there are no trouble codes recorded in the diagnostic system.

## After conversion:

Once the MOGAS Fuel System installation has been completed, as per this manual suggestions and within its guidelines, start the engine ON Gasoline and bring it to working temperature.

- Switch the fuel selector to Nat Gas operation.
- Remove the vacuum line from the fuel flow control valve bellow; plug it to avoid air leaking into the intake manifold; bring the engine to 3500 RPM and hold steady.
- Adjust the fuel control screw to read the full throttle voltage recorded earlier, when test running the vehicle ON Gasoline fuel on the Dyno or the Road, or 0.950 volts +/- 0.025 volts.
- Reconnect the vacuum line to the fuel flow control valve bellow.

**The vehicle is now ready for the final test drive and fine tuning.**

Continued. . . .

**On the Dynamometer:**

- Bring the engine under full load at 3500 RPM and look for the highest voltage; it should be near the value recorded during gasoline testing. This may very well be .900 to .950 volts. If too far from the above:
- Remove the vacuum line from the Fuel control bellow; plug it to avoid air leaking into the intake manifold; bring the engine to 3500 RPM and hold steady.
- Adjust the fuel control screw to read the full throttle voltage recorded earlier, when test running the vehicle ON Gasoline fuel on the Dyno or the Road, or 0.950 volts +/- 0.025 volts.
- Reconnect the vacuum line to the fuel flow control valve bellow.
- Relieve the load; reconnect the vacuum line to the fuel flow control valve; bring the engine to part load and simulate a cruising condition, 2000 to 2500 RPM. The voltmeter will now toggle in or near the range noted during the Gasoline part load condition test run.
- Increase the load until you are at full throttle; the voltmeter now should read the full voltage as per the earlier pass. You are ready for the final road test.

**On the Road:**

If a dynamometer is not available use caution in tuning the system on the road; find a road where you are familiar with the traffic pattern and pay attention to the traffic around you. A second person to read the voltmeter is a must.

- Bring the engine under full load at 2500 RPM and look for the highest voltage; it should be near the value recorded during gasoline testing. This may very well be .900 to .950 volts. If too far from the above:
- Adjust the fuel control screw in quarter turn increments in the desired direction, anti-clockwise for richer mixture, clockwise for leaner mixture.
- Repeat the full load test until the correct voltage is obtained; once the reading is near the desired value the adjustments can be moderated to one eighth of a turn or even less.
- Now, bring the engine to part load, cruising condition, 2000 to 2500 RPM. The voltmeter will now toggle in or near the range noted during the Gasoline part load condition test run.
- Increase the load for acceleration; the voltmeter now should read high in the .800 volt region.
- Slow down, then accelerate fully for a fast departure. Maximum voltage should reappear as per the earlier set-up test. The vehicle is ready for delivery.

# APPENDIX B

# FTP TEST DATA

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH
FTP - VEHICLE EMISSIONS RESULTS -
PROJECT 08-5343-001

| | | |
|---|---|---|
| TEST NO. L1-00-EEE1 RUN | VEHICLE NO.CRC-6 | TEST WEIGHT 1758. KG( 3875. LBS) |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 11/ 6/92 | ACTUAL ROAD LOAD 3.8 KW( 5.1 HP) |
| ENGINE 3.1 L(192. CID) V-6 | BAG CART NO. 2 | GASOLINE EM-1540-F |
| TRANSMISSION A4 | DYNO NO. 2 | ODOMETER 66991. KM( 41626. MILES) |
| | CVS NO. 8 | C = .866 H = .134 O = .000 |
| BAROMETER 747.01 MM HG(29.41 IN HG) | DRY BULB TEMP. 23.3 DEG C(74.0 DEG F) | FUEL DENSITY = 6.16 |
| RELATIVE HUMIDITY 24. PCT | ABS. HUMIDITY 4.3 GM/KG | NOX HUMIDITY CORRECTION FACTOR .83 |

BAG RESULTS

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| BLOWER DIF P MM. H2O(IN. H2O) | 1270.0 (50.0) | 1270.0 (50.0) | 1270.0 (50.0) |
| BLOWER INLET P MM. H2O(IN. H2O) | 939.8 (37.0) | 939.8 (37.0) | 939.8 (37.0) |
| BLOWER INLET TEMP. DEG. C(DEG. F) | 43.3 (110.0) | 41.7 (107.0) | 42.2 (108.0) |
| BLOWER REVOLUTIONS | 19145. | 32870. | 19145. |
| TOT FLOW STD. CU. METRES(SCF) | 133.8 ( 4725.) | 230.7 ( 8147.) | 134.2 ( 4738.) |
| THC SAMPLE METER/RANGE/PPM | 58.6/ 2/ 59. | 9.8/ 2/ 10. | 19.8/ 2/ 20. |
| THC BCKGRD METER/RANGE/PPM | 5.7/ 2/ 6. | 6.6/ 2/ 7. | 7.0/ 2/ 7. |
| CO SAMPLE METER/RANGE/PPM | 76.3/ 13/ 184. | 34.5/ 12/ 33. | 47.4/ 13/ 111. |
| CO BCKGRD METER/RANGE/PPM | .7/ 13/ 2. | .9/ 12/ 1. | .3/ 13/ 1. |
| CO2 SAMPLE METER/RANGE/PCT | 81.2/ 14/ .6809 | 69.0/ 14/ .4856 | 76.7/ 14/ .6018 |
| CO2 BCKGRD METER/RANGE/PCT | 13.0/ 14/ .0438 | 13.2/ 14/ .0446 | 13.1/ 14/ .0442 |
| NOX SAMPLE METER/RANGE/PPM | 60.3/ 1/ 15.0 | 21.2/ 1/ 5.3 | 30.3/ 1/ 7.6 |
| NOX BCKGRD METER/RANGE/PPM | .8/ 1/ .2 | 1.0/ 1/ .3 | .9/ 1/ .2 |
| DILUTION FACTOR | 19.01 | 27.36 | 21.80 |
| THC CONCENTRATION PPM | 53. | 3. | 13. |
| CO CONCENTRATION PPM | 179. | 32. | 108. |
| CO2 CONCENTRATION PCT | .6394 | .4426 | .5596 |
| NOX CONCENTRATION PPM | 14.8 | 5.1 | 7.4 |
| THC MASS GRAMS | 4.102 | .458 | 1.015 |
| CO MASS GRAMS | 27.882 | 8.621 | 16.838 |
| CO2 MASS GRAMS | 1566.4 | 1869.6 | 1374.7 |
| NOX MASS GRAMS | 3.132 | 1.851 | 1.563 |
| THC GRAMS/MI | 1.150 | .119 | .280 |
| CO GRAMS/MI | 7.815 | 2.238 | 4.654 |
| CO2 GRAMS/MI | 439.0 | 485.4 | 380.0 |
| NOX GRAMS/MI | .878 | .481 | .432 |
| FUEL ECONOMY IN MPG | 19.492 | 18.125 | 22.845 |
| RUN TIME SECONDS | 505. | 868. | 506. |
| MEASURED DISTANCE MI | 3.57 | 3.85 | 3.62 |
| SCF, DRY | .986 | .988 | .987 |

COMPOSITE RESULTS

| | | |
|---|---|---|
| TEST NUMBER | | L1-00-EEE1 |
| BAROMETER | MM HG | 747.0 |
| HUMIDITY | G/KG | 4.3 |
| TEMPERATURE | DEG C | 23.3 |

| | | 3-BAG | (4-BAG) |
|---|---|---|---|
| CARBON DIOXIDE | G/MI | 446.7 | ( .0) |
| FUEL ECONOMY | MPG | 19.522 | ( .00) |
| HYDROCARBONS (THC) | G/MI | .377 | ( .00) |
| CARBON MONOXIDE | G/MI | 4.058 | ( .00) |
| OXIDES OF NITROGEN | G/MI | .549 | ( .00) |

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Ait
Veh / Fuel

| | | |
|---|---|---|
| TEST NO. L1-00-EEE2 RUN | VEHICLE NO.CRC-6 | TEST WEIGHT 1758. KG( 3875. LBS) |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 11/23/92 | ACTUAL ROAD LOAD 3.8 KW( 5.1 HP) |
| ENGINE 3.1 L(192. CID) V-6 | BAG CART NO. 2 | GASOLINE EM-1540-F |
| TRANSMISSION A4 | DYNO NO. 2 | ODOMETER 67031. KM( 41651. MILES) |
| | CVS NO. 8 | C = .866 H = .134 O = .000 |
| BAROMETER 738.12 MM HG(29.06 IN HG) | DRY BULB TEMP. 22.8 DEG C(73.0 DEG F) | FUEL DENSITY = 6.16 |
| RELATIVE HUMIDITY 33. PCT | ABS. HUMIDITY 5.8 GM/KG | NOX HUMIDITY CORRECTION FACTOR .86 |

BAG RESULTS

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| BLOWER DIF P MM. H20(IN. H20) | 1270.0 (50.0) | 1270.0 (50.0) | 1270.0 (50.0) |
| BLOWER INLET P MM. H20(IN. H20) | 965.2 (38.0) | 965.2 (38.0) | 965.2 (38.0) |
| BLOWER INLET TEMP. DEG. C(DEG. F) | 43.3 (110.0) | 43.3 (110.0) | 43.3 (110.0) |
| BLOWER REVOLUTIONS | 19176. | 32890. | 19151. |
| TOT FLOW STD. CU. METRES(SCF) | 131.7 ( 4651.) | 225.9 ( 7977.) | 131.5 ( 4645.) |
| THC SAMPLE METER/RANGE/PPM | 53.6/ 2/ 54. | 11.9/ 2/ 12. | 21.5/ 2/ 21. |
| THC BCKGRD METER/RANGE/PPM | 7.7/ 2/ 8. | 8.3/ 2/ 8. | 7.9/ 2/ 8. |
| CO SAMPLE METER/RANGE/PPM | 65.1/ 13/ 155. | 56.9/ 12/ 56. | 68.3/ 13/ 163. |
| CO BCKGRD METER/RANGE/PPM | 1.1/ 13/ 3. | 2.2/ 12/ 2. | 1.0/ 13/ 2. |
| CO2 SAMPLE METER/RANGE/PCT | 82.8/ 14/ .7114 | 69.7/ 14/ .4953 | 77.6/ 14/ .6169 |
| CO2 BCKGRD METER/RANGE/PCT | 14.9/ 14/ .0515 | 14.9/ 14/ .0515 | 14.9/ 14/ .0515 |
| NOX SAMPLE METER/RANGE/PPM | 47.9/ 1/ 11.9 | 14.0/ 1/ 3.5 | 28.3/ 1/ 7.1 |
| NOX BCKGRD METER/RANGE/PPM | .6/ 1/ .2 | .8/ 1/ .2 | .8/ 1/ .2 |
| DILUTION FACTOR | 18.31 | 26.70 | 21.10 |
| THC CONCENTRATION PPM | 46. | 4. | 14. |
| CO CONCENTRATION PPM | 149. | 53. | 157. |
| CO2 CONCENTRATION PCT | .6627 | .4457 | .5679 |
| NOX CONCENTRATION PPM | 11.8 | 3.3 | 6.9 |
| THC MASS GRAMS | 3.516 | .509 | 1.059 |
| CO MASS GRAMS | 22.834 | 13.809 | 24.115 |
| CO2 MASS GRAMS | 1598.3 | 1843.6 | 1367.6 |
| NOX MASS GRAMS | 2.562 | 1.237 | 1.495 |
| THC GRAMS/MI | .984 | .133 | .296 |
| CO GRAMS/MI | 6.390 | 3.616 | 6.743 |
| CO2 GRAMS/MI | 447.3 | 482.8 | 382.4 |
| NOX GRAMS/MI | .717 | .324 | .418 |
| FUEL ECONOMY IN MPG | 19.261 | 18.138 | 22.509 |
| RUN TIME SECONDS | 506. | 868. | 506. |
| MEASURED DISTANCE MI | 3.57 | 3.82 | 3.58 |
| SCF, DRY | .983 | .985 | .984 |

COMPOSITE RESULTS

| | | |
|---|---|---|
| TEST NUMBER | | L1-00-EEE2 |
| BAROMETER | MM HG | 738.1 |
| HUMIDITY | G/KG | 5.8 |
| TEMPERATURE | DEG C | 22.8 |

| | | 3-BAG | (4-BAG) |
|---|---|---|---|
| CARBON DIOXIDE | G/MI | 447.8 | ( .0) |
| FUEL ECONOMY | MPG | 19.412 | ( .00) |
| HYDROCARBONS (THC) | G/MI | .355 | ( .00) |
| CARBON MONOXIDE | G/MI | 5.055 | ( .00) |
| OXIDES OF NITROGEN | G/MI | .432 | ( .00) |

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| | | |
|---|---|---|
| TEST NO. L2-00-EEE1 RUN | VEHICLE NO.92P | TEST WEIGHT 1758. KG( 3875. LBS) |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 12/11/92 | ACTUAL ROAD LOAD 3.8 KW( 5.1 HP) |
| ENGINE 3.1 L(192. CID) V-6 | BAG CART NO. 2 | GASOLINE EM-1540-F |
| TRANSMISSION A3 | DYNO NO. 3 | ODOMETER 28680. KM( 17821. MILES) |
| | CVS NO. 2 | C = .866 H = .134 O = .000 |
| BAROMETER 746.76 MM HG(29.40 IN HG) | DRY BULB TEMP. 22.2 DEG C(72.0 DEG F) | FUEL DENSITY = 6.16 |
| RELATIVE HUMIDITY 22. PCT | ABS. HUMIDITY 3.7 GM/KG | NOX HUMIDITY CORRECTION FACTOR .81 |

BAG RESULTS

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| BLOWER DIF P MM. H2O(IN. H2O) | 711.2 (28.0) | 711.2 (28.0) | 711.2 (28.0) |
| BLOWER INLET P MM. H2O(IN. H2O) | 762.0 (30.0) | 762.0 (30.0) | 762.0 (30.0) |
| BLOWER INLET TEMP. DEG. C(DEG. F) | 42.8 (109.0) | 40.6 (105.0) | 43.3 (110.0) |
| BLOWER REVOLUTIONS | 40419. | 69441. | 40439. |
| TOT FLOW STD. CU. METRES(SCF) | 76.0 ( 2682.) | 131.0 ( 4627.) | 75.9 ( 2681.) |
| THC SAMPLE METER/RANGE/PPM | 59.2/ 2/ 59. | 11.1/ 2/ 11. | 22.7/ 2/ 23. |
| THC BCKGRD METER/RANGE/PPM | 4.6/ 2/ 5. | 4.8/ 2/ 5. | 4.8/ 2/ 5. |
| CO SAMPLE METER/RANGE/PPM | 83.7/ 13/ 204. | 63.3/ 12/ 62. | 58.9/ 13/ 139. |
| CO BCKGRD METER/RANGE/PPM | .3/ 13/ 1. | .4/ 12/ 0. | .0/ 13/ 0. |
| CO2 SAMPLE METER/RANGE/PCT | 62.0/ 1/1.1478 | 85.9/ 14/ .7744 | 54.8/ 1/1.0157 |
| CO2 BCKGRD METER/RANGE/PCT | 2.5/ 1/ .0437 | 12.8/ 14/ .0430 | 2.6/ 1/ .0455 |
| NOX SAMPLE METER/RANGE/PPM | 27.8/ 2/ 27.9 | 22.1/ 1/ 5.5 | 33.8/ 1/ 8.5 |
| NOX BCKGRD METER/RANGE/PPM | .2/ 2/ .2 | .3/ 1/ .1 | .4/ 1/ .1 |
| DILUTION FACTOR | 11.42 | 17.14 | 12.99 |
| THC CONCENTRATION PPM | 55. | 7. | 18. |
| CO CONCENTRATION PPM | 198. | 60. | 135. |
| CO2 CONCENTRATION PCT | 1.1079 | .7339 | .9737 |
| NOX CONCENTRATION PPM | 27.7 | 5.5 | 8.4 |
| THC MASS GRAMS | 2.408 | .497 | .799 |
| CO MASS GRAMS | 17.470 | 9.203 | 11.977 |
| CO2 MASS GRAMS | 1540.8 | 1760.7 | 1353.6 |
| NOX MASS GRAMS | 3.265 | 1.114 | .987 |
| THC GRAMS/MI | .670 | .128 | .222 |
| CO GRAMS/MI | 4.861 | 2.372 | 3.328 |
| CO2 GRAMS/MI | 428.8 | 453.9 | 376.1 |
| NOX GRAMS/MI | .909 | .287 | .274 |
| FUEL ECONOMY IN MPG | 20.222 | 19.361 | 23.211 |
| RUN TIME SECONDS | 505. | 868. | 505. |
| MEASURED DISTANCE MI | 3.59 | 3.88 | 3.60 |
| SCF, DRY | .982 | .986 | .984 |

COMPOSITE RESULTS

| | | |
|---|---|---|
| TEST NUMBER | | L2-00-EEE1 |
| BAROMETER | MM HG | 746.8 |
| HUMIDITY | G/KG | 3.7 |
| TEMPERATURE | DEG C | 22.2 |

| | | 3-BAG | (4-BAG) |
|---|---|---|---|
| CARBON DIOXIDE | G/MI | 427.4 | ( .0) |
| FUEL ECONOMY | MPG | 20.473 | ( .00) |
| HYDROCARBONS (THC) | G/MI | .266 | ( .00) |
| CARBON MONOXIDE | G/MI | 3.149 | ( .00) |
| OXIDES OF NITROGEN | G/MI | .412 | ( .00) |

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| | | |
|---|---|---|
| TEST NO. 12-00-EEE2 RUN | VEHICLE NO.92P | TEST WEIGHT 1758. KG( 3875. LBS) |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 12/29/92 | ACTUAL ROAD LOAD 3.8 KW( 5.1 HP) |
| ENGINE 3.1 L(192. CID) V-6 | BAG CART NO. 2 | GASOLINE EM-1540-F |
| TRANSMISSION A3 | DYNO NO. 2 | ODOMETER 28712. KM( 17841. MILES) |
| | CVS NO. 8 | C = .866 H = .134 O = .000 |
| BAROMETER 745.74 MM HG(29.36 IN HG) | DRY BULB TEMP. 26.1 DEG C(79.0 DEG F) | FUEL DENSITY = 6.16 |
| RELATIVE HUMIDITY 64. PCT | ABS. HUMIDITY 13.9 GM/KG | NOX HUMIDITY CORRECTION FACTOR 1.12 |

BAG RESULTS

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| BLOWER DIF P MM. H20(IN. H20) | 1244.6 (49.0) | 1244.6 (49.0) | 1244.6 (49.0) |
| BLOWER INLET P MM. H20(IN. H20) | 939.8 (37.0) | 939.8 (37.0) | 939.8 (37.0) |
| BLOWER INLET TEMP. DEG. C(DEG. F) | 43.3 (110.0) | 43.3 (110.0) | 43.3 (110.0) |
| BLOWER REVOLUTIONS | 19154. | 32866. | 19151. |
| TOT FLOW STD. CU. METRES(SCF) | 133.8 ( 4725.) | 229.6 ( 8106.) | 133.8 ( 4723.) |
| THC SAMPLE METER/RANGE/PPM | 57.1/ 2/ 57. | 17.5/ 2/ 17. | 23.0/ 2/ 23. |
| THC BCKGRD METER/RANGE/PPM | 9.7/ 2/ 10. | 12.7/ 2/ 13. | 12.4/ 2/ 12. |
| CO SAMPLE METER/RANGE/PPM | 57.1/ 14/ 259. | 57.2/ 12/ 56. | 43.0/ 13/ 100. |
| CO BCKGRD METER/RANGE/PPM | .2/ 14/ 1. | .5/ 12/ 0. | .0/ 13/ 0. |
| CO2 SAMPLE METER/RANGE/PCT | 83.6/ 14/ .7271 | 71.2/ 14/ .5166 | 79.9/ 14/ .6571 |
| CO2 BCKGRD METER/RANGE/PCT | 12.5/ 14/ .0418 | 12.8/ 14/ .0430 | 13.2/ 14/ .0446 |
| NOX SAMPLE METER/RANGE/PPM | 55.4/ 1/ 13.8 | 6.8/ 1/ 1.7 | 14.1/ 1/ 3.5 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .0 | .0/ 1/ .0 | .0/ 1/ .0 |
| DILUTION FACTOR | 17.68 | 25.58 | 20.03 |
| THC CONCENTRATION PPM | 48. | 5. | 11. |
| CO CONCENTRATION PPM | 249. | 54. | 97. |
| CO2 CONCENTRATION PCT | .6876 | .4753 | .6147 |
| NOX CONCENTRATION PPM | 13.8 | 1.7 | 3.5 |
| THC MASS GRAMS | 3.697 | .701 | .865 |
| CO MASS GRAMS | 38.810 | 14.366 | 15.038 |
| CO2 MASS GRAMS | 1684.5 | 1997.5 | 1505.4 |
| NOX MASS GRAMS | 3.947 | .839 | 1.013 |
| THC GRAMS/MI | 1.017 | .179 | .240 |
| CO GRAMS/MI | 10.678 | 3.674 | 4.179 |
| CO2 GRAMS/MI | 463.5 | 510.8 | 418.4 |
| NOX GRAMS/MI | 1.086 | .214 | .282 |
| FUEL ECONOMY IN MPG | 18.343 | 17.147 | 20.831 |
| RUN TIME SECONDS | 505. | 868. | 506. |
| MEASURED DISTANCE MI | 3.63 | 3.91 | 3.60 |
| SCF, DRY | .973 | .975 | .973 |

COMPOSITE RESULTS

| | | |
|---|---|---|
| TEST NUMBER | | 12-00-EEE2 |
| BAROMETER | MM HG | 745.7 |
| HUMIDITY | G/KG | 13.9 |
| TEMPERATURE | DEG C | 26.1 |

| | | 3-BAG | (4-BAG) |
|---|---|---|---|
| CARBON DIOXIDE | G/MI | 475.8 | ( .0) |
| FUEL ECONOMY | MPG | 18.277 | ( .00) |
| HYDROCARBONS (THC) | G/MI | .369 | ( .00) |
| CARBON MONOXIDE | G/MI | 5.263 | ( .00) |
| OXIDES OF NITROGEN | G/MI | .413 | ( .00) |

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| | | |
|---|---|---|
| TEST NO. L2-00-EEE3 RUN | VEHICLE NO.92P | TEST WEIGHT 1758. KG( 3875. LBS) |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 12/30/92 | ACTUAL ROAD LOAD 3.8 KW( 5.1 HP) |
| ENGINE 3.1 L(192. CID) V-6 | BAG CART NO. 2 | GASOLINE EM-1540-F |
| TRANSMISSION A3 | DYNO NO. 2 | ODOMETER 28730. KM( 17852. MILES) |
| | CVS NO. 8 | C = .866 H = .134 0 = .000 |
| BAROMETER 744.98 MM HG(29.33 IN HG) | DRY BULB TEMP. 23.9 DEG C(75.0 DEG F) | FUEL DENSITY = 6.16 |
| RELATIVE HUMIDITY 62. PCT | ABS. HUMIDITY 11.8 GM/KG | NOX HUMIDITY CORRECTION FACTOR 1.04 |

BAG RESULTS

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| BLOWER DIF P MM. H20(IN. H20) | 1244.6 (49.0) | 1244.6 (49.0) | 1244.6 (49.0) |
| BLOWER INLET P MM. H20(IN. H20) | 939.8 (37.0) | 939.8 (37.0) | 939.8 (37.0) |
| BLOWER INLET TEMP. DEG. C(DEG. F) | 43.3 (110.0) | 43.3 (110.0) | 43.3 (110.0) |
| BLOWER REVOLUTIONS | 19165. | 32872. | 19151. |
| TOT FLOW STD. CU. METRES(SCF) | 133.7 ( 4722.) | 229.3 ( 8098.) | 133.6 ( 4717.) |
| THC SAMPLE METER/RANGE/PPM | 52.9/ 2/ 53. | 13.8/ 2/ 14. | 25.6/ 2/ 26. |
| THC BCKGRD METER/RANGE/PPM | 11.2/ 2/ 11. | 11.1/ 2/ 11. | 11.4/ 2/ 11. |
| CO SAMPLE METER/RANGE/PPM | 79.3/ 13/ 192. | 42.7/ 12/ 42. | 45.4/ 13/ 106. |
| CO BCKGRD METER/RANGE/PPM | .2/ 13/ 0. | .4/ 12/ 0. | .2/ 13/ 0. |
| CO2 SAMPLE METER/RANGE/PCT | 82.7/ 14/ .7094 | 70.5/ 14/ .5066 | 79.4/ 14/ .6481 |
| CO2 BCKGRD METER/RANGE/PCT | 13.6/ 14/ .0462 | 13.8/ 14/ .0470 | 14.0/ 14/ .0478 |
| NOX SAMPLE METER/RANGE/PPM | 52.5/ 1/ 13.1 | 7.3/ 1/ 1.8 | 12.0/ 1/ 3.0 |
| NOX BCKGRD METER/RANGE/PPM | 1.2/ 1/ .3 | .5/ 1/ .1 | .2/ 1/ .1 |
| DILUTION FACTOR | 18.27 | 26.17 | 20.27 |
| THC CONCENTRATION PPM | 42. | 3. | 15. |
| CO CONCENTRATION PPM | 185. | 40. | 102. |
| CO2 CONCENTRATION PCT | .6658 | .4614 | .6027 |
| NOX CONCENTRATION PPM | 12.8 | 1.7 | 3.0 |
| THC MASS GRAMS | 3.261 | .413 | 1.137 |
| CO MASS GRAMS | 28.864 | 10.666 | 15.839 |
| CO2 MASS GRAMS | 1630.0 | 1937.2 | 1474.2 |
| NOX MASS GRAMS | 3.398 | .780 | .787 |
| THC GRAMS/MI | .912 | .108 | .316 |
| CO GRAMS/MI | 8.072 | 2.783 | 4.407 |
| CO2 GRAMS/MI | 455.9 | 505.6 | 410.2 |
| NOX GRAMS/MI | .950 | .204 | .219 |
| FUEL ECONOMY IN MPG | 18.810 | 17.378 | 21.207 |
| RUN TIME SECONDS | 505. | 867. | 506. |
| MEASURED DISTANCE MI | 3.58 | 3.83 | 3.59 |
| SCF, DRY | .973 | .975 | .974 |

COMPOSITE RESULTS

| | | |
|---|---|---|
| TEST NUMBER | | L2-00-EEE3 |
| BAROMETER | MM HG | 745.0 |
| HUMIDITY | G/KG | 11.8 |
| TEMPERATURE | DEG C | 23.9 |

| | | 3-BAG | (4-BAG) |
|---|---|---|---|
| CARBON DIOXIDE | G/MI | 469.0 | ( .0) |
| FUEL ECONOMY | MPG | 18.598 | ( .00) |
| HYDROCARBONS (THC) | G/MI | .332 | ( .00) |
| CARBON MONOXIDE | G/MI | 4.329 | ( .00) |
| OXIDES OF NITROGEN | G/MI | .363 | ( .00) |

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| | | |
|---|---|---|
| TEST NO. L2-00-RFA1 RUN | VEHICLE NO.92P | TEST WEIGHT 1758. KG( 3875. LBS) |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 12/31/92 | ACTUAL ROAD LOAD 3.8 KW( 5.1 HP) |
| ENGINE 3.1 L(192. CID) V-6 | BAG CART NO. 2 | GASOLINE EM-1215-F |
| TRANSMISSION A3 | DYNO NO. 2 | ODOMETER 28759. KM( 17870. MILES) |
| | CVS NO. 8 | C = .866 H = .134 O = .000 |
| BAROMETER 744.73 MM HG(29.32 IN HG) | DRY BULB TEMP. 25.0 DEG C(77.0 DEG F) | FUEL DENSITY = 6.16 |
| RELATIVE HUMIDITY 49. PCT | ABS. HUMIDITY 9.9 GM/KG | NOX HUMIDITY CORRECTION FACTOR .97 |

BAG RESULTS

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| BLOWER DIF P MM. H2O(IN. H2O) | 1270.0 (50.0) | 1270.0 (50.0) | 1270.0 (50.0) |
| BLOWER INLET P MM. H2O(IN. H2O) | 965.2 (38.0) | 965.2 (38.0) | 965.2 (38.0) |
| BLOWER INLET TEMP. DEG. C(DEG. F) | 43.3 (110.0) | 43.3 (110.0) | 43.3 (110.0) |
| BLOWER REVOLUTIONS | 19168. | 32880. | 19158. |
| TOT FLOW STD. CU. METRES(SCF) | 133.1 ( 4699.) | 228.3 ( 8060.) | 133.0 ( 4696.) |
| THC SAMPLE METER/RANGE/PPM | 52.6/ 2/ 53. | 16.0/ 2/ 16. | 25.1/ 2/ 25. |
| THC BCKGRD METER/RANGE/PPM | 11.3/ 2/ 11. | 11.1/ 2/ 11. | 10.4/ 2/ 10. |
| CO SAMPLE METER/RANGE/PPM | 72.2/ 13/ 174. | 67.0/ 12/ 66. | 57.0/ 14/ 258. |
| CO BCKGRD METER/RANGE/PPM | .0/ 13/ 0. | .7/ 12/ 1. | .1/ 14/ 0. |
| CO2 SAMPLE METER/RANGE/PCT | 82.5/ 14/ .7055 | 69.5/ 14/ .4925 | 78.6/ 14/ .6341 |
| CO2 BCKGRD METER/RANGE/PCT | 13.6/ 14/ .0462 | 14.0/ 14/ .0478 | 14.1/ 14/ .0482 |
| NOX SAMPLE METER/RANGE/PPM | 60.9/ 1/ 15.2 | 9.5/ 1/ 2.4 | 22.2/ 1/ 5.6 |
| NOX BCKGRD METER/RANGE/PPM | .4/ 1/ .1 | .1/ 1/ .0 | .2/ 1/ .1 |
| DILUTION FACTOR | 18.42 | 26.77 | 20.25 |
| THC CONCENTRATION PPM | 42. | 5. | 15. |
| CO CONCENTRATION PPM | 168. | 63. | 251. |
| CO2 CONCENTRATION PCT | .6619 | .4465 | .5883 |
| NOX CONCENTRATION PPM | 15.1 | 2.4 | 5.5 |
| THC MASS GRAMS | 3.215 | .699 | 1.166 |
| CO MASS GRAMS | 26.094 | 16.874 | 38.816 |
| CO2 MASS GRAMS | 1612.7 | 1865.8 | 1432.2 |
| NOX MASS GRAMS | 3.736 | 1.005 | 1.369 |
| THC GRAMS/MI | .900 | .182 | .323 |
| CO GRAMS/MI | 7.304 | 4.399 | 10.754 |
| CO2 GRAMS/MI | 451.4 | 486.4 | 396.8 |
| NOX GRAMS/MI | 1.046 | .262 | .379 |
| FUEL ECONOMY IN MPG | 19.040 | 17.953 | 21.382 |
| RUN TIME SECONDS | 505. | 868. | 506. |
| MEASURED DISTANCE MI | 3.57 | 3.84 | 3.61 |
| SCF, DRY | .978 | .980 | .978 |

COMPOSITE RESULTS

| | | |
|---|---|---|
| TEST NUMBER | | L2-00-RFA1 |
| BAROMETER | MM HG | 744.7 |
| HUMIDITY | G/KG | 9.9 |
| TEMPERATURE | DEG C | 25.0 |

| | | 3-BAG | (4-BAG) |
|---|---|---|---|
| CARBON DIOXIDE | G/MI | 454.4 | ( .0) |
| FUEL ECONOMY | MPG | 19.022 | ( .00) |
| HYDROCARBONS (THC) | G/MI | .370 | ( .00) |
| CARBON MONOXIDE | G/MI | 6.758 | ( .00) |
| OXIDES OF NITROGEN | G/MI | .457 | ( .00) |

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH
FTP - VEHICLE EMISSIONS RESULTS -
PROJECT 08-4125-001

| | | |
|---|---|---|
| TEST NO. L2-00-RFA2 RUN | VEHICLE NO.92P | TEST WEIGHT 1758. KG( 3875. LBS) |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 1/ 6/93 | ACTUAL ROAD LOAD 3.8 KW( 5.1 HP) |
| ENGINE 3.1 L(192. CID) V-6 | BAG CART NO. 2 | GASOLINE EM-1215-F |
| TRANSMISSION A3 | DYNO NO. 3 | ODOMETER 28794. KM( 17892. MILES) |
| | CVS NO. 2 | C = .867 H = .132 O = .000 |
| BAROMETER 746.76 MM HG(29.40 IN HG) | DRY BULB TEMP. 22.2 DEG C(72.0 DEG F) | FUEL DENSITY = 6.24 |
| RELATIVE HUMIDITY 25. PCT | ABS. HUMIDITY 4.2 GM/KG | NOX HUMIDITY CORRECTION FACTOR .82 |

BAG RESULTS

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| BLOWER DIF P MM. H20(IN. H20) | 711.2 (28.0) | 711.2 (28.0) | 711.2 (28.0) |
| BLOWER INLET P MM. H20(IN. H20) | 762.0 (30.0) | 762.0 (30.0) | 762.0 (30.0) |
| BLOWER INLET TEMP. DEG. C(DEG. F) | 45.0 (113.0) | 37.8 (100.0) | 41.7 (107.0) |
| BLOWER REVOLUTIONS | 40608. | 69688. | 40622. |
| TOT FLOW STD. CU. METRES(SCF) | 76.2 ( 2689.) | 132.3 ( 4670.) | 76.5 ( 2702.) |
| THC SAMPLE METER/RANGE/PPM | 86.9/ 2/ 87. | 16.4/ 2/ 16. | 31.7/ 2/ 32. |
| THC BCKGRD METER/RANGE/PPM | 4.9/ 2/ 5. | 4.9/ 2/ 5. | 5.2/ 2/ 5. |
| CO SAMPLE METER/RANGE/PPM | 66.9/ 14/ 312. | 52.2/ 13/ 122. | 59.2/ 14/ 270. |
| CO BCKGRD METER/RANGE/PPM | .6/ 14/ 2. | .4/ 13/ 1. | .5/ 14/ 2. |
| CO2 SAMPLE METER/RANGE/PCT | 62.5/ 1/1.1569 | 86.2/ 14/ .7808 | 55.8/ 1/1.0341 |
| CO2 BCKGRD METER/RANGE/PCT | 2.9/ 1/ .0508 | 13.7/ 14/ .0466 | 2.7/ 1/ .0473 |
| NOX SAMPLE METER/RANGE/PPM | 24.6/ 2/ 24.7 | 20.4/ 1/ 5.1 | 51.2/ 1/ 12.8 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 2/ .0 | .0/ 1/ .0 | .3/ 1/ .1 |
| DILUTION FACTOR | 11.27 | 16.96 | 12.67 |
| THC CONCENTRATION PPM | 82. | 12. | 27. |
| CO CONCENTRATION PPM | 300. | 119. | 261. |
| CO2 CONCENTRATION PCT | 1.1106 | .7370 | .9905 |
| NOX CONCENTRATION PPM | 24.7 | 5.1 | 12.7 |
| THC MASS GRAMS | 3.612 | .897 | 1.185 |
| CO MASS GRAMS | 26.643 | 18.281 | 23.220 |
| CO2 MASS GRAMS | 1548.7 | 1784.5 | 1387.6 |
| NOX MASS GRAMS | 2.961 | 1.067 | 1.531 |
| THC GRAMS/MI | .998 | .230 | .327 |
| CO GRAMS/MI | 7.358 | 4.680 | 6.401 |
| CO2 GRAMS/MI | 427.7 | 456.8 | 382.5 |
| NOX GRAMS/MI | .818 | .273 | .422 |
| FUEL ECONOMY IN MPG | 20.313 | 19.332 | 22.835 |
| RUN TIME SECONDS | 505. | 868. | 506. |
| MEASURED DISTANCE MI | 3.62 | 3.91 | 3.63 |
| SCF, DRY | .981 | .985 | .982 |

COMPOSITE RESULTS

| | | |
|---|---|---|
| TEST NUMBER | | L2-00-RFA2 |
| BAROMETER | MM HG | 746.8 |
| HUMIDITY | G/KG | 4.2 |
| TEMPERATURE | DEG C | 22.2 |

| | | 3-BAG | (4-BAG) |
|---|---|---|---|
| CARBON DIOXIDE | G/MI | 430.4 | ( .0) |
| FUEL ECONOMY | MPG | 20.394 | ( .00) |
| HYDROCARBONS (THC) | G/MI | .415 | ( .00) |
| CARBON MONOXIDE | G/MI | 5.706 | ( .00) |
| OXIDES OF NITROGEN | G/MI | .427 | ( .00) |

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH
FTP - VEHICLE EMISSIONS RESULTS -
PROJECT 08-4125-001

| | | |
|---|---|---|
| TEST NO. L2-00-RFA3 RUN | VEHICLE NO.92P | TEST WEIGHT 1758. KG( 3875. LBS) |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 1/ 7/93 | ACTUAL ROAD LOAD 3.8 KW( 5.1 HP) |
| ENGINE 3.1 L(192. CID) V-6 | BAG CART NO. 2 | GASOLINE EM-1215-F |
| TRANSMISSION A3 | DYNO NO. 3 | ODOMETER 28815. KM( 17905. MILES) |
| | CVS NO. 2 | C = .867 H = .132 O = .000 |
| BAROMETER 740.41 MM HG(29.15 IN HG) | DRY BULB TEMP. 23.9 DEG C(75.0 DEG F) | FUEL DENSITY = 6.24 |
| RELATIVE HUMIDITY 38. PCT | ABS. HUMIDITY 7.2 GM/KG | NOX HUMIDITY CORRECTION FACTOR .90 |

BAG RESULTS

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| BLOWER DIF P MM. H2O(IN. H2O) | 711.2 (28.0) | 711.2 (28.0) | 711.2 (28.0) |
| BLOWER INLET P MM. H2O(IN. H2O) | 762.0 (30.0) | 762.0 (30.0) | 762.0 (30.0) |
| BLOWER INLET TEMP. DEG. C(DEG. F) | 41.7 (107.0) | 40.0 (104.0) | 43.3 (110.0) |
| BLOWER REVOLUTIONS | 40595. | 69675. | 40617. |
| TOT FLOW STD. CU. METRES(SCF) | 75.7 ( 2674.) | 130.4 ( 4605.) | 75.6 ( 2668.) |
| THC SAMPLE METER/RANGE/PPM | 93.0/ 2/ 93. | 20.7/ 2/ 21. | 34.6/ 2/ 35. |
| THC BCKGRD METER/RANGE/PPM | 6.2/ 2/ 6. | 7.4/ 2/ 7. | 7.5/ 2/ 7. |
| CO SAMPLE METER/RANGE/PPM | 67.7/ 14/ 317. | 55.8/ 13/ 131. | 73.3/ 14/ 348. |
| CO BCKGRD METER/RANGE/PPM | .2/ 14/ 1. | .4/ 13/ 1. | .6/ 14/ 2. |
| CO2 SAMPLE METER/RANGE/PCT | 63.5/ 1/1.1752 | 86.7/ 14/ .7916 | 56.7/ 1/1.0506 |
| CO2 BCKGRD METER/RANGE/PCT | 2.6/ 1/ .0455 | 14.0/ 14/ .0478 | 2.9/ 1/ .0508 |
| NOX SAMPLE METER/RANGE/PPM | 27.2/ 2/ 27.3 | 18.2/ 1/ 4.6 | 43.5/ 1/ 10.9 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 2/ .0 | .0/ 1/ .0 | .0/ 1/ .0 |
| DILUTION FACTOR | 11.09 | 16.71 | 12.39 |
| THC CONCENTRATION PPM | 87. | 14. | 28. |
| CO CONCENTRATION PPM | 305. | 127. | 335. |
| CO2 CONCENTRATION PCT | 1.1338 | .7467 | 1.0039 |
| NOX CONCENTRATION PPM | 27.3 | 4.6 | 10.9 |
| THC MASS GRAMS | 3.807 | 1.031 | 1.204 |
| CO MASS GRAMS | 26.882 | 19.271 | 29.443 |
| CO2 MASS GRAMS | 1572.3 | 1782.6 | 1388.6 |
| NOX MASS GRAMS | 3.534 | 1.020 | 1.405 |
| THC GRAMS/MI | 1.050 | .264 | .332 |
| CO GRAMS/MI | 7.412 | 4.926 | 8.120 |
| CO2 GRAMS/MI | 433.5 | 455.7 | 383.0 |
| NOX GRAMS/MI | .974 | .261 | .387 |
| FUEL ECONOMY IN MPG | 20.040 | 19.359 | 22.651 |
| RUN TIME SECONDS | 505. | 868. | 506. |
| MEASURED DISTANCE MI | 3.63 | 3.91 | 3.63 |
| SCF, DRY | .977 | .981 | .978 |

COMPOSITE RESULTS

| | | |
|---|---|---|
| TEST NUMBER | | L2-00-RFA3 |
| BAROMETER | MM HG | 740.4 |
| HUMIDITY | G/KG | 7.2 |
| TEMPERATURE | DEG C | 23.9 |

| | | 3-BAG | (4-BAG) |
|---|---|---|---|
| CARBON DIOXIDE | G/MI | 431 | ( .0) |
| FUEL ECONOMY | MPG | 20.311 | ( .00) |
| HYDROCARBONS (THC) | G/MI | .445 | ( .00) |
| CARBON MONOXIDE | G/MI | 6.316 | ( .00) |
| OXIDES OF NITROGEN | G/MI | .443 | ( .00) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-01-P85 | LPG |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 1/20/93 RUN 1 | FUEL DENSITY 4.195 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .180 C .820 O .000 X .000 |
| TRANSMISSION A4 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 28862 KM ( 17938 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 745.2 MM HG ( 29.34 IN HG)    DRY BULB TEMPERATURE 25.6°C ( 78.0°F)    NOX HUMIDITY C.F. .891

RELATIVE HUMIDITY 33.6 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.4 | 867.4 | 505.5 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .981/.989 | .983/.989 | .982/.989 |
| MEASURED DISTANCE KM (MILES) | 5.76 ( 3.58) | 6.18 ( 3.84) | 5.77 ( 3.59) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.79 ( 557.4) | 15.77 ( 556.9) | 15.76 ( 556.6) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 133.0 ( 4695.) | 228.0 ( 8051.) | 132.8 ( 4689.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 33.0/ 2/ 32.98 | 13.2/ 2/ 13.19 | 24.5/ 2/ 24.49 |
| HC BCKGRD METER/RANGE/PPM | 7.4/ 2/ 7.40 | 8.3/ 2/ 8.30 | 8.0/ 2/ 8.00 |
| CO SAMPLE METER/RANGE/PPM | 50.5/ 13/118.20 | 11.5/ 12/ 11.03 | 85.9/ 12/ 85.72 |
| CO BCKGRD METER/RANGE/PPM | .8/ 13/ 1.85 | 1.4/ 12/ 1.33 | 1.3/ 12/ 1.23 |
| CO2 SAMPLE METER/RANGE/PCT | 77.7/ 14/ .6186 | 64.8/ 14/ .4305 | 74.0/ 14/ .5586 |
| CO2 BCKGRD METER/RANGE/PCT | 15.3/ 14/ .0531 | 15.3/ 14/ .0531 | 15.4/ 14/ .0535 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 26.5/ 2/ 26.56 | 54.6/ 1/ 13.60 | 27.0/ 2/ 27.05 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 2/ .00 | .3/ 1/ .08 | .0/ 2/ .00 |
| DILUTION FACTOR | 18.52 | 27.09 | 20.60 |
| HC CONCENTRATION PPM | 25.98 | 5.20 | 16.88 |
| CO CONCENTRATION PPM | 113.50 | 9.53 | 82.52 |
| CO2 CONCENTRATION PCT | .5683 | .3794 | .5076 |
| NOX CONCENTRATION PPM | 26.56 | 13.53 | 27.05 |
| HC MASS GRAMS | 2.103 | .722 | 1.365 |
| CO MASS GRAMS | 17.571 | 2.530 | 12.758 |
| CO2 MASS GRAMS | 1383.68 | 1583.49 | 1234.21 |
| NOX MASS GRAMS | 6.018 | 5.256 | 6.123 |
| FUEL MASS KG | .472 | .529 | .419 |
| FUEL ECONOMY L/100KM (MPG) | 16.29 ( 14.44) | 17.03 ( 13.82) | 14.44 ( 16.29) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .201 ( .324) ( .32) |
| CO G/KM (G/MI) | 1.453 ( 2.337) ( 2.34) |
| NOX G/KM (G/MI) | .949 ( 1.526) ( 1.53) |
| FUEL ECONOMY L/100KM (MPG) | 16.15 ( 14.56) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R | 3-BAG EPA FTP VEHICLE EMISSION RESULTS | PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-01-P85 | LPG |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 1/21/93 RUN 2 | FUEL DENSITY 4.195 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .180 C .820 O .000 X .000 |
| TRANSMISSION A4 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 28878 KM ( 17948 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 745.5 MM HG ( 29.35 IN HG) DRY BULB TEMPERATURE 22.2°C ( 72.0°F) NOX HUMIDITY C.F. .865
RELATIVE HUMIDITY 35.1 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 504.9 | 867.9 | 505.5 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .982/.990 | .985/.990 | .983/.990 |
| MEASURED DISTANCE KM (MILES) | 5.75 ( 3.57) | 6.18 ( 3.84) | 5.75 ( 3.58) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.82 ( 558.5) | 15.81 ( 558.1) | 15.79 ( 557.5) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 133.1 ( 4700.) | 228.6 ( 8073.) | 133.0 ( 4697.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 31.3/ 2/ 31.28 | 12.2/ 2/ 12.19 | 23.5/ 2/ 23.49 |
| HC BCKGRD METER/RANGE/PPM | 6.2/ 2/ 6.20 | 6.8/ 2/ 6.80 | 6.7/ 2/ 6.70 |
| CO SAMPLE METER/RANGE/PPM | 93.7/ 12/ 94.51 | 17.7/ 12/ 17.05 | 79.0/ 12/ 78.26 |
| CO BCKGRD METER/RANGE/PPM | 2.7/ 12/ 2.57 | 3.0/ 12/ 2.85 | 3.4/ 12/ 3.24 |
| CO2 SAMPLE METER/RANGE/PCT | 77.6/ 14/ .6169 | 64.5/ 14/ .4268 | 73.8/ 14/ .5555 |
| CO2 BCKGRD METER/RANGE/PCT | 13.7/ 14/ .0466 | 13.9/ 14/ .0474 | 14.4/ 14/ .0494 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 32.1/ 2/ 32.14 | 62.4/ 1/ 15.52 | 31.4/ 2/ 31.44 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 2/ .00 | .0/ 1/ .00 | .0/ 2/ .00 |
| DILUTION FACTOR | 18.64 | 27.30 | 20.74 |
| HC CONCENTRATION PPM | 25.42 | 5.65 | 17.11 |
| CO CONCENTRATION PPM | 89.69 | 13.97 | 73.32 |
| CO2 CONCENTRATION PCT | .5728 | .3811 | .5084 |
| NOX CONCENTRATION PPM | 32.14 | 15.52 | 31.44 |
| HC MASS GRAMS | 2.059 | .786 | 1.386 |
| CO MASS GRAMS | 13.897 | 3.718 | 11.355 |
| CO2 MASS GRAMS | 1395.85 | 1595.39 | 1238.27 |
| NOX MASS GRAMS | 7.075 | 5.870 | 6.918 |
| FUEL MASS KG | .474 | .534 | .420 |
| FUEL ECONOMY L/100KM (MPG) | 16.40 ( 14.35) | 17.19 ( 13.68) | 14.50 ( 16.22) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .206 ( .332) ( .33) |
| CO G/KM (G/MI) | 1.355 ( 2.181) ( 2.18) |
| NOX G/KM (G/MI) | 1.078 ( 1.734) ( 1.73) |
| FUEL ECONOMY L/100KM (MPG) | 16.28 ( 14.45) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-01-P92 | LPG |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 1/22/93 RUN 1 | FUEL DENSITY 4.178 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .182 C .818 O .000 X .000 |
| TRANSMISSION A4 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 28908 KM ( 17967 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 746.8 MM HG ( 29.40 IN HG)    DRY BULB TEMPERATURE 23.3°C ( 74.0°F)    NOX HUMIDITY C.F. .867

RELATIVE HUMIDITY 33.4 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| | ( 0-505 SEC.) | (506-1372 SEC.) | ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.3 | 867.6 | 505.4 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .982/.990 | .985/.990 | .983/.990 |
| MEASURED DISTANCE KM (MILES) | 5.77 ( 3.59) | 6.21 ( 3.86) | 5.78 ( 3.59) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.85 ( 559.6) | 15.84 ( 559.1) | 15.82 ( 558.7) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 133.5 ( 4713.) | 229.0 ( 8085.) | 133.3 ( 4706.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 33.0/ 2/ 32.98 | 13.5/ 2/ 13.49 | 24.1/ 2/ 24.09 |
| HC BCKGRD METER/RANGE/PPM | 6.6/ 2/ 6.60 | 6.5/ 2/ 6.50 | 6.4/ 2/ 6.40 |
| CO SAMPLE METER/RANGE/PPM | 50.1/ 13/117.22 | 23.6/ 12/ 22.81 | 49.4/ 13/115.49 |
| CO BCKGRD METER/RANGE/PPM | .7/ 13/ 1.62 | 2.2/ 12/ 2.09 | .8/ 13/ 1.85 |
| CO2 SAMPLE METER/RANGE/PCT | 77.4/ 14/ .6135 | 64.5/ 14/ .4268 | 73.4/ 14/ .5493 |
| CO2 BCKGRD METER/RANGE/PCT | 14.7/ 14/ .0506 | 14.5/ 14/ .0498 | 14.6/ 14/ .0502 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 27.4/ 2/ 27.45 | 53.9/ 1/ 13.43 | 25.4/ 2/ 25.46 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 2/ .00 | .1/ 1/ .03 | .0/ 2/ .00 |
| DILUTION FACTOR | 18.56 | 27.09 | 20.71 |
| HC CONCENTRATION PPM | 26.74 | 7.24 | 18.00 |
| CO CONCENTRATION PPM | 112.77 | 20.34 | 111.03 |
| CO2 CONCENTRATION PCT | .5656 | .3788 | .5015 |
| NOX CONCENTRATION PPM | 27.45 | 13.40 | 25.46 |
| HC MASS GRAMS | 2.178 | 1.011 | 1.464 |
| CO MASS GRAMS | 17.522 | 5.422 | 17.227 |
| CO2 MASS GRAMS | 1382.17 | 1587.99 | 1223.74 |
| NOX MASS GRAMS | 6.079 | 5.091 | 5.628 |
| FUEL MASS KG | .473 | .534 | .419 |
| FUEL ECONOMY L/100KM (MPG) | 16.36 ( 14.38) | 17.17 ( 13.70) | 14.48 ( 16.24) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .232 ( .373) ( .37) |
| CO G/KM (G/MI) | 1.900 ( 3.058) ( 3.06) |
| NOX G/KM (G/MI) | .911 ( 1.465) ( 1.47) |
| FUEL ECONOMY L/100KM (MPG) | 16.25 ( 14.48) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-01-P92 | LPG |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 1/26/93 RUN 2 | FUEL DENSITY 4.178 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .182 C .818 O .000 X .000 |
| TRANSMISSION A4 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 28937 KM ( 17985 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 750.1 MM HG ( 29.53 IN HG)    DRY BULB TEMPERATURE 22.2°C ( 72.0°F)    NOX HUMIDITY C.F. .800

RELATIVE HUMIDITY 18.6 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.6 | 868.0 | 507.1 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .987/.995 | .989/.995 | .988/.995 |
| MEASURED DISTANCE KM (MILES) | 5.82 ( 3.62) | 6.23 ( 3.87) | 5.79 ( 3.60) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.94 ( 562.8) | 15.93 ( 562.5) | 15.91 ( 561.8) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 134.3 ( 4742.) | 230.5 ( 8138.) | 134.5 ( 4748.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 32.0/ 2/ 31.98 | 11.6/ 2/ 11.59 | 20.5/ 2/ 20.49 |
| HC BCKGRD METER/RANGE/PPM | 5.3/ 2/ 5.30 | 4.8/ 2/ 4.80 | 5.2/ 2/ 5.20 |
| CO SAMPLE METER/RANGE/PPM | 51.8/ 13/121.42 | 16.0/ 12/ 15.40 | 61.4/ 12/ 60.13 |
| CO BCKGRD METER/RANGE/PPM | .8/ 13/ 1.85 | 1.7/ 12/ 1.62 | 1.5/ 12/ 1.43 |
| CO2 SAMPLE METER/RANGE/PCT | 77.9/ 14/ .6220 | 64.4/ 14/ .4255 | 73.2/ 14/ .5463 |
| CO2 BCKGRD METER/RANGE/PCT | 13.8/ 14/ .0470 | 13.6/ 14/ .0462 | 13.8/ 14/ .0470 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 33.5/ 2/ 33.54 | 66.8/ 1/ 16.61 | 33.7/ 2/ 33.74 |
| NOX BCKGRD METER/RANGE/PPM | .1/ 2/ .10 | 1.2/ 1/ .30 | .3/ 2/ .30 |
| DILUTION FACTOR | 18.30 | 27.23 | 21.03 |
| HC CONCENTRATION PPM | 26.97 | 6.97 | 15.54 |
| CO CONCENTRATION PPM | 117.20 | 13.60 | 57.65 |
| CO2 CONCENTRATION PCT | .5776 | .3811 | .5015 |
| NOX CONCENTRATION PPM | 33.44 | 16.32 | 33.45 |
| HC MASS GRAMS | 2.211 | .981 | 1.275 |
| CO MASS GRAMS | 18.324 | 3.650 | 9.024 |
| CO2 MASS GRAMS | 1420.21 | 1607.85 | 1234.62 |
| NOX MASS GRAMS | 6.873 | 5.756 | 6.882 |
| FUEL MASS KG | .486 | .539 | .418 |
| FUEL ECONOMY L/100KM (MPG) | 16.68 ( 14.11) | 17.31 ( 13.59) | 14.41 ( 16.32) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .221 ( .355) ( .36) |
| CO G/KM (G/MI) | 1.386 ( 2.229) ( 2.23) |
| NOX G/KM (G/MI) | 1.050 ( 1.690) ( 1.69) |
| FUEL ECONOMY L/100KM (MPG) | 16.36 ( 14.38) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-01-P98 | LPG |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 1/28/93 RUN 1 | FUEL DENSITY 4.139 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .183 C .817 O .000 X .000 |
| TRANSMISSION A4 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 28937 KM ( 17985 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 744.7 MM HG ( 29.32 IN HG)    DRY BULB TEMPERATURE 22.2°C ( 72.0°F)    NOX HUMIDITY C.F. .865

RELATIVE HUMIDITY 35.1 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.4 | 867.2 | 505.3 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .982/.990 | .985/.990 | .983/.990 |
| MEASURED DISTANCE KM (MILES) | 5.74 ( 3.57) | 6.16 ( 3.83) | 5.76 ( 3.58) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.77 ( 556.9) | 15.78 ( 557.1) | 15.77 ( 556.7) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 132.9 ( 4691.) | 228.0 ( 8051.) | 132.8 ( 4689.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 30.6/ 2/ 30.58 | 12.2/ 2/ 12.19 | 20.5/ 2/ 20.49 |
| HC BCKGRD METER/RANGE/PPM | 7.5/ 2/ 7.50 | 7.0/ 2/ 7.00 | 7.3/ 2/ 7.30 |
| CO SAMPLE METER/RANGE/PPM | 65.6/ 12/ 64.37 | 2.4/ 12/ 2.28 | 22.0/ 12/ 21.24 |
| CO BCKGRD METER/RANGE/PPM | 1.6/ 12/ 1.52 | 1.1/ 12/ 1.04 | 1.3/ 12/ 1.23 |
| CO2 SAMPLE METER/RANGE/PCT | 77.9/ 14/ .6220 | 64.5/ 14/ .4268 | 73.3/ 14/ .5478 |
| CO2 BCKGRD METER/RANGE/PCT | 13.1/ 14/ .0442 | 12.8/ 14/ .0430 | 12.6/ 14/ .0422 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 35.2/ 2/ 35.23 | 56.8/ 1/ 14.14 | 32.6/ 2/ 32.64 |
| NOX BCKGRD METER/RANGE/PPM | .1/ 2/ .10 | .1/ 1/ .03 | .1/ 2/ .10 |
| DILUTION FACTOR | 18.41 | 27.14 | 21.06 |
| HC CONCENTRATION PPM | 23.49 | 5.45 | 13.54 |
| CO CONCENTRATION PPM | 61.28 | 1.24 | 19.57 |
| CO2 CONCENTRATION PCT | .5802 | .3853 | .5076 |
| NOX CONCENTRATION PPM | 35.14 | 14.12 | 32.54 |
| HC MASS GRAMS | 1.907 | .760 | 1.098 |
| CO MASS GRAMS | 9.479 | .329 | 3.025 |
| CO2 MASS GRAMS | 1411.32 | 1608.68 | 1233.92 |
| NOX MASS GRAMS | 7.723 | 5.326 | 7.149 |
| FUEL MASS KG | .478 | .538 | .415 |
| FUEL ECONOMY L/100KM (MPG) | 16.80 ( 14.00) | 17.61 ( 13.36) | 14.51 ( 16.21) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .185 ( .298) ( .30) |
| CO G/KM (G/MI) | .514 ( .828) ( .83) |
| NOX G/KM (G/MI) | 1.067 ( 1.717) ( 1.72) |
| FUEL ECONOMY L/100KM (MPG) | 16.57 ( 14.19) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R 3-BAG EPA FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-01-P98 | LPG |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 1/29/93 RUN 2 | FUEL DENSITY 4.139 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .183 C .817 O .000 X .000 |
| TRANSMISSION A4 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 29000 KM ( 18024 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 744.7 MM HG ( 29.32 IN HG) DRY BULB TEMPERATURE 22.2°C ( 72.0°F) NOX HUMIDITY C.F. .880

RELATIVE HUMIDITY 38.6 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.1 | 867.5 | 505.7 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .981/.990 | .984/.990 | .982/.990 |
| MEASURED DISTANCE KM (MILES) | 5.79 ( 3.60) | 6.24 ( 3.88) | 5.76 ( 3.58) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.80 ( 558.0) | 15.79 ( 557.4) | 15.78 ( 557.0) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 133.0 ( 4697.) | 228.2 ( 8059.) | 133.0 ( 4695.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 25.5/ 2/ 25.49 | 10.3/ 2/ 10.29 | 18.6/ 2/ 18.59 |
| HC BCKGRD METER/RANGE/PPM | 5.6/ 2/ 5.60 | 5.3/ 2/ 5.30 | 5.3/ 2/ 5.30 |
| CO SAMPLE METER/RANGE/PPM | 49.7/ 12/ 48.46 | 2.1/ 12/ 2.00 | 26.8/ 12/ 25.94 |
| CO BCKGRD METER/RANGE/PPM | .0/ 12/ .00 | .0/ 12/ .00 | .0/ 12/ .00 |
| CO2 SAMPLE METER/RANGE/PCT | 76.7/ 14/ .6018 | 64.6/ 14/ .4280 | 72.5/ 14/ .5357 |
| CO2 BCKGRD METER/RANGE/PCT | 12.5/ 14/ .0418 | 12.5/ 14/ .0418 | 12.9/ 14/ .0434 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 32.0/ 2/ 32.04 | 49.8/ 1/ 12.42 | 30.5/ 2/ 30.55 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 2/ .00 | .0/ 1/ .00 | .0/ 2/ .00 |
| DILUTION FACTOR | 19.08 | 27.08 | 21.52 |
| HC CONCENTRATION PPM | 20.18 | 5.19 | 13.54 |
| CO CONCENTRATION PPM | 47.17 | 1.95 | 25.29 |
| CO2 CONCENTRATION PCT | .5622 | .3877 | .4943 |
| NOX CONCENTRATION PPM | 32.04 | 12.42 | 30.55 |
| HC MASS GRAMS | 1.640 | .724 | 1.100 |
| CO MASS GRAMS | 7.306 | .519 | 3.914 |
| CO2 MASS GRAMS | 1369.21 | 1620.22 | 1203.35 |
| NOX MASS GRAMS | 7.174 | 4.769 | 6.835 |
| FUEL MASS KG | .463 | .542 | .405 |
| FUEL ECONOMY L/100KM (MPG) | 16.12 ( 14.59) | 17.53 ( 13.42) | 14.20 ( 16.57) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .171 ( .276) ( .28) |
| CO G/KM (G/MI) | .490 ( .789) ( .79) |
| NOX G/KM (G/MI) | .979 ( 1.574) ( 1.57) |
| FUEL ECONOMY L/100KM (MPG) | 16.31 ( 14.42) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-01-HD5 | LPG |
| VEHICLE MODEL 91 CHEVY LUMINA | DATE 2/.2/93 RUN | FUEL DENSITY 4.053 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .184 C .816 O .000 X .000 |
| TRANSMISSION A4 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 29000 KM ( 18024 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 744.5 MM HG ( 29.31 IN HG)    DRY BULB TEMPERATURE 24.4°C ( 76.0°F)    NOX HUMIDITY C.F. .887

RELATIVE HUMIDITY 35.2 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT | STABILIZED | HOT TRANSIENT |
| | ( 0-505 SEC.) | (506-1372 SEC.) | ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.2 | 867.4 | 505.3 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .981/.989 | .983/.989 | .982/.989 |
| MEASURED DISTANCE KM (MILES) | 5.79 ( 3.60) | 6.24 ( 3.88) | 5.75 ( 3.57) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.78 ( 557.2) | 15.77 ( 556.9) | 15.80 ( 557.9) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 132.9 ( 4692.) | 228.0 ( 8051.) | 133.1 ( 4699.) |
| | | | |
| HC SAMPLE METER/RANGE/PPM (BAG) | 31.3/ 2/ 31.28 | 13.4/ 2/ 13.39 | 26.1/ 2/ 26.08 |
| HC BCKGRD METER/RANGE/PPM | 8.9/ 2/ 8.89 | 9.6/ 2/ 9.59 | 13.7/ 2/ 13.69 |
| CO SAMPLE METER/RANGE/PPM | 62.4/ 12/ 61.13 | 2.5/ 12/ 2.38 | 22.7/ 12/ 21.93 |
| CO BCKGRD METER/RANGE/PPM | 2.3/ 12/ 2.19 | 1.7/ 12/ 1.62 | 1.5/ 12/ 1.43 |
| CO2 SAMPLE METER/RANGE/PCT | 77.5/ 14/ .6152 | 65.0/ 14/ .4330 | 73.7/ 14/ .5539 |
| CO2 BCKGRD METER/RANGE/PCT | 14.7/ 14/ .0506 | 14.9/ 14/ .0515 | 15.0/ 14/ .0519 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 34.6/ 2/ 34.63 | 54.4/ 1/ 13.55 | 32.8/ 2/ 32.84 |
| NOX BCKGRD METER/RANGE/PPM | .1/ 2/ .10 | .2/ 1/ .05 | .1/ 2/ .10 |
| | | | |
| DILUTION FACTOR | 18.56 | 26.67 | 20.74 |
| HC CONCENTRATION PPM | 22.87 | 4.16 | 13.05 |
| CO CONCENTRATION PPM | 57.51 | .79 | 20.05 |
| CO2 CONCENTRATION PCT | .5673 | .3835 | .5045 |
| NOX CONCENTRATION PPM | 34.54 | 13.50 | 32.74 |
| | | | |
| HC MASS GRAMS | 1.859 | .580 | 1.063 |
| CO MASS GRAMS | 8.896 | .210 | 3.106 |
| CO2 MASS GRAMS | 1380.02 | 1600.76 | 1229.24 |
| NOX MASS GRAMS | 7.788 | 5.224 | 7.394 |
| FUEL MASS KG | .468 | .536 | .414 |
| FUEL ECONOMY L/100KM (MPG) | 16.65 ( 14.12) | 17.70 ( 13.29) | 14.83 ( 15.86) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .165 ( .266) ( .27) |
| CO G/KM (G/MI) | .483 ( .778) ( .78) |
| NOX G/KM (G/MI) | 1.065 ( 1.714) ( 1.71) |
| FUEL ECONOMY L/100KM (MPG) | 16.69 ( 14.10) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

VEHICLE NUMBER 92P    TEST L2-02-P92    LPG
VEHICLE MODEL 92 CHEVY LUMINA    DATE 2/13/93 RUN    FUEL DENSITY 4.178 LB/GAL
ENGINE 3.1 L (192 CID)-V-6    DYNO 2 BAG CART 2    H .182 C .818 O .000 X .000
TRANSMISSION A3    ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP)
ODOMETER 29105 KM ( 18089 MILES)    TEST WEIGHT 1757 KG ( 3875 LBS)

BAROMETER 743.0 MM HG ( 29.25 IN HG)    DRY BULB TEMPERATURE 24.4°C ( 76.0°F)    NOX HUMIDITY C.F. .872
RELATIVE HUMIDITY 32.1 PCT.

| | | | |
|---|---|---|---|
| BAG NUMBER | 1 | 2 | 3 |
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.2 | 867.6 | 505.5 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .982/.990 | .984/.990 | .983/.990 |
| MEASURED DISTANCE KM (MILES) | 5.75 ( 3.57) | 6.20 ( 3.86) | 5.77 ( 3.58) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.76 ( 556.3) | 15.77 ( 556.9) | 15.74 ( 555.6) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 132.7 ( 4684.) | 228.0 ( 8052.) | 132.6 ( 4681.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 67.7/ 2/ 67.66 | 11.8/ 2/ 11.79 | 37.3/ 2/ 37.28 |
| HC BCKGRD METER/RANGE/PPM | 7.1/ 2/ 7.10 | 6.7/ 2/ 6.70 | 6.9/ 2/ 6.90 |
| CO SAMPLE METER/RANGE/PPM | 81.2/ 1/799.55 | 19.3/ 12/ 18.61 | 61.7/ 14/283.52 |
| CO BCKGRD METER/RANGE/PPM | .2/ 1/ 1.38 | .8/ 12/ .76 | .3/ 14/ 1.21 |
| CO2 SAMPLE METER/RANGE/PCT | 75.7/ 14/ .5855 | 64.5/ 14/ .4268 | 72.9/ 14/ .5417 |
| CO2 BCKGRD METER/RANGE/PCT | 12.9/ 14/ .0434 | 12.9/ 14/ .0434 | 13.2/ 14/ .0446 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 31.4/ 1/ 7.86 | 27.4/ 1/ 6.87 | 13.6/ 1/ 3.42 |
| NOX BCKGRD METER/RANGE/PPM | .2/ 1/ .05 | .1/ 1/ .03 | .0/ 1/ .00 |
| DILUTION FACTOR | 17.39 | 27.13 | 20.34 |
| HC CONCENTRATION PPM | 60.97 | 5.34 | 30.72 |
| CO CONCENTRATION PPM | 779.10 | 17.51 | 275.87 |
| CO2 CONCENTRATION PCT | .5445 | .3850 | .4993 |
| NOX CONCENTRATION PPM | 7.82 | 6.84 | 3.42 |
| HC MASS GRAMS | 4.936 | .744 | 2.485 |
| CO MASS GRAMS | 120.328 | 4.648 | 42.578 |
| CO2 MASS GRAMS | 1322.63 | 1607.31 | 1211.98 |
| NOX MASS GRAMS | 1.729 | 2.603 | .755 |
| FUEL MASS KG | .509 | .540 | .429 |
| FUEL ECONOMY L/100KM (MPG) | 17.69 ( 13.30) | 17.37 ( 13.54) | 14.87 ( 15.82) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .358 ( .576) ( .58) |
| CO G/KM (G/MI) | 6.743 (10.850) (10.85) |
| NOX G/KM (G/MI) | .316 ( .508) ( .51) |
| FUEL ECONOMY L/100KM (MPG) | 16.72 ( 14.07) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R　　3-BAG EPA FTP VEHICLE EMISSION RESULTS　　PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-02-P98 | LPG |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 2/14/93 RUN | FUEL DENSITY 4.139 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .183 C .817 O .000 X .000 |
| TRANSMISSION A3 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 29000 KM ( 18024 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 743.0 MM HG ( 29.25 IN HG)　DRY BULB TEMPERATURE 23.3°C ( 74.0°F)　NOX HUMIDITY C.F. .956

RELATIVE HUMIDITY 50.7 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.3 | 867.8 | 505.4 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .977/.985 | .979/.985 | .978/.985 |
| MEASURED DISTANCE KM (MILES) | 5.77 ( 3.59) | 6.19 ( 3.85) | 5.77 ( 3.59) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.76 ( 556.6) | 15.79 ( 557.7) | 15.73 ( 555.6) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 132.8 ( 4687.) | 228.4 ( 8066.) | 132.5 ( 4680.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 58.6/ 2/ 58.57 | 8.7/ 2/ 8.69 | 25.2/ 2/ 25.19 |
| HC BCKGRD METER/RANGE/PPM | 6.1/ 2/ 6.10 | 5.9/ 2/ 5.90 | 5.9/ 2/ 5.90 |
| CO SAMPLE METER/RANGE/PPM | 63.6/ 1/575.34 | 3.2/ 12/ 3.05 | 59.1/ 13/139.71 |
| CO BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .1/ 12/ .09 | .2/ 13/ .46 |
| CO2 SAMPLE METER/RANGE/PCT | 76.3/ 14/ .5952 | 64.6/ 14/ .4280 | 73.5/ 14/ .5509 |
| CO2 BCKGRD METER/RANGE/PCT | 12.7/ 14/ .0426 | 12.8/ 14/ .0430 | 13.1/ 14/ .0442 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 34.2/ 1/ 8.56 | 43.9/ 1/ 10.96 | 32.9/ 1/ 8.24 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .2/ 1/ .05 | .5/ 1/ .13 |
| DILUTION FACTOR | 17.70 | 27.08 | 20.50 |
| HC CONCENTRATION PPM | 52.81 | 3.02 | 19.58 |
| CO CONCENTRATION PPM | 557.92 | 2.88 | 135.19 |
| CO2 CONCENTRATION PCT | .5550 | .3866 | .5088 |
| NOX CONCENTRATION PPM | 8.56 | 10.91 | 8.12 |
| HC MASS GRAMS | 4.284 | .421 | 1.585 |
| CO MASS GRAMS | 86.224 | .765 | 20.859 |
| CO2 MASS GRAMS | 1348.90 | 1616.85 | 1234.65 |
| NOX MASS GRAMS | 2.076 | 4.555 | 1.966 |
| FUEL MASS KG | .500 | .541 | .425 |
| FUEL ECONOMY L/100KM (MPG) | 17.48 ( 13.46) | 17.62 ( 13.35) | 14.85 ( 15.84) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .265 ( .426) ( .43) |
| CO G/KM (G/MI) | 4.157 ( 6.689) ( 6.69) |
| NOX G/KM (G/MI) | .549 ( .884) ( .88) |
| FUEL ECONOMY L/100KM (MPG) | 16.81 ( 14.00) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-02-P85 | LPG |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 2/15/93 RUN | FUEL DENSITY 4.195 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .180 C .820 O .000 X .000 |
| TRANSMISSION A3 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 29164 KM ( 18126 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 735.1 MM HG ( 28.94 IN HG)    DRY BULB TEMPERATURE 25.6°C ( 78.0°F)    NOX HUMIDITY C.F. 1.020

RELATIVE HUMIDITY 53.2 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.1 | 867.0 | 505.4 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .974/.982 | .976/.982 | .975/.982 |
| MEASURED DISTANCE KM (MILES) | 5.81 ( 3.61) | 6.24 ( 3.88) | 5.76 ( 3.58) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.55 ( 549.1) | 15.55 ( 549.0) | 15.53 ( 548.3) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 130.9 ( 4623.) | 224.7 ( 7934.) | 130.8 ( 4619.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 76.3/ 2/ 76.26 | 13.7/ 2/ 13.69 | 46.1/ 2/ 46.07 |
| HC BCKGRD METER/RANGE/PPM | 6.4/ 2/ 6.40 | 6.6/ 2/ 6.60 | 7.1/ 2/ 7.10 |
| CO SAMPLE METER/RANGE/PPM | 89.0/ 1/910.46 | 38.3/ 12/ 37.22 | 77.5/ 14/372.32 |
| CO BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .7/ 12/ .66 | .3/ 14/ 1.21 |
| CO2 SAMPLE METER/RANGE/PCT | 76.1/ 14/ .5919 | 65.5/ 14/ .4393 | 73.0/ 14/ .5432 |
| CO2 BCKGRD METER/RANGE/PCT | 13.7/ 14/ .0466 | 13.7/ 14/ .0466 | 13.7/ 14/ .0466 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 26.8/ 1/ 6.72 | 12.7/ 1/ 3.19 | 9.7/ 1/ 2.44 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .0/ 1/ .00 | .0/ 1/ .00 |
| DILUTION FACTOR | 17.05 | 26.40 | 20.08 |
| HC CONCENTRATION PPM | 70.23 | 7.35 | 39.33 |
| CO CONCENTRATION PPM | 882.36 | 35.57 | 360.12 |
| CO2 CONCENTRATION PCT | .5481 | .3945 | .4990 |
| NOX CONCENTRATION PPM | 6.72 | 3.19 | 2.44 |
| HC MASS GRAMS | 5.597 | 1.005 | 3.132 |
| CO MASS GRAMS | 134.477 | 9.304 | 54.839 |
| CO2 MASS GRAMS | 1313.68 | 1622.83 | 1194.97 |
| NOX MASS GRAMS | 1.715 | 1.398 | .622 |
| FUEL MASS KG | .513 | .546 | .430 |
| FUEL ECONOMY L/100KM (MPG) | 17.57 ( 13.39) | 17.42 ( 13.51) | 14.85 ( 15.84) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .432 ( .695) ( .70) |
| CO G/KM (G/MI) | 8.180 (13.162) (13.16) |
| NOX G/KM (G/MI) | .207 ( .333) ( .33) |
| FUEL ECONOMY L/100KM (MPG) | 16.72 ( 14.07) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-03-P85 | LPG |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 2/17/93 RUN | FUEL DENSITY 4.195 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .180 C .820 O .000 X .000 |
| TRANSMISSION A3 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 29195 KM ( 18145 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 751.1 MM HG ( 29.57 IN HG)    DRY BULB TEMPERATURE 22.8°C ( 73.0°F)    NOX HUMIDITY C.F. .818

RELATIVE HUMIDITY 22.7 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.5 | 867.2 | 505.8 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .986/.994 | .988/.994 | .987/.994 |
| MEASURED DISTANCE KM (MILES) | 5.77 ( 3.59) | 6.18 ( 3.84) | 5.78 ( 3.59) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.94 ( 562.7) | 15.95 ( 563.1) | 15.94 ( 562.7) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 134.3 ( 4741.) | 230.5 ( 8139.) | 134.3 ( 4744.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 92.3/ 5/ 46.26 | 31.2/ 5/ 15.64 | 51.3/ 5/ 25.71 |
| HC BCKGRD METER/RANGE/PPM | 11.9/ 5/ 5.96 | 10.8/ 5/ 5.41 | 9.8/ 5/ 4.91 |
| CO SAMPLE METER/RANGE/PPM | 93.1/ 14/463.41 | 58.5/ 13/138.19 | 71.6/ 14/338.51 |
| CO BCKGRD METER/RANGE/PPM | .3/ 14/ 1.21 | .4/ 13/ .92 | .3/ 14/ 1.21 |
| CO2 SAMPLE METER/RANGE/PCT | 77.1/ 14/ .6085 | 64.3/ 14/ .4243 | 72.9/ 14/ .5417 |
| CO2 BCKGRD METER/RANGE/PCT | 13.5/ 14/ .0458 | 13.1/ 14/ .0442 | 12.9/ 14/ .0434 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 29.0/ 1/ 7.27 | 3.8/ 1/ .95 | 4.5/ 1/ 1.13 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .0/ 1/ .00 | .5/ 1/ .13 |
| DILUTION FACTOR | 17.81 | 26.69 | 20.31 |
| HC CONCENTRATION PPM | 40.63 | 10.43 | 21.04 |
| CO CONCENTRATION PPM | 452.37 | 134.94 | 330.64 |
| CO2 CONCENTRATION PCT | .5653 | .3818 | .5005 |
| NOX CONCENTRATION PPM | 7.27 | .95 | 1.01 |
| HC MASS GRAMS | 3.320 | 1.463 | 1.721 |
| CO MASS GRAMS | 70.704 | 36.209 | 51.711 |
| CO2 MASS GRAMS | 1389.42 | 1611.01 | 1230.92 |
| NOX MASS GRAMS | 1.526 | .344 | .212 |
| FUEL MASS KG | .503 | .557 | .439 |
| FUEL ECONOMY L/100KM (MPG) | 17.34 ( 13.57) | 17.92 ( 13.13) | 15.11 ( 15.57) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .324 ( .521) ( .52) |
| CO G/KM (G/MI) | 8.038 (12.933) (12.93) |
| NOX G/KM (G/MI) | .094 ( .151) ( .15) |
| FUEL ECONOMY L/100KM (MPG) | 17.01 ( 13.83) |

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

VEHICLE NUMBER 92P    TEST L2-03-P85    LPG
VEHICLE MODEL 92 CHEVY LUMINA    DATE 2/18/93 RUN 2    FUEL DENSITY 4.195 LB/GAL
ENGINE 3.1 L (192 CID)-V-6    DYNO 2 BAG CART 2    H .180 C .820 O .000 X .000
TRANSMISSION A3    ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP)
ODOMETER 29195 KM ( 18145 MILES)    TEST WEIGHT 1757 KG ( 3875 LBS)

BAROMETER 754.4 MM HG ( 29.70 IN HG)    DRY BULB TEMPERATURE 22.2°C ( 72.0°F)    NOX HUMIDITY C.F. .799
RELATIVE HUMIDITY 18.4 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.0 | 867.6 | 505.3 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .987/.995 | .989/.995 | .988/.995 |
| MEASURED DISTANCE KM (MILES) | 5.75 ( 3.58) | 6.18 ( 3.84) | 5.74 ( 3.57) |
| BLOWER FLOW RATE SCMM (SCFM) | 16.12 ( 569.1) | 16.16 ( 570.7) | 16.13 ( 569.5) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 135.7 ( 4790.) | 233.7 ( 8252.) | 135.8 ( 4796.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 47.1/ 2/ 47.07 | 20.1/ 5/ 10.07 | 37.1/ 5/ 18.59 |
| HC BCKGRD METER/RANGE/PPM | 5.2/ 2/ 5.20 | 10.7/ 5/ 5.36 | 10.8/ 5/ 5.41 |
| CO SAMPLE METER/RANGE/PPM | 65.3/ 1/595.51 | 82.4/ 12/ 81.90 | 94.9/ 13/234.42 |
| CO BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .4/ 12/ .38 | .3/ 13/ .69 |
| CO2 SAMPLE METER/RANGE/PCT | 76.8/ 14/ .6035 | 64.9/ 14/ .4318 | 73.8/ 14/ .5555 |
| CO2 BCKGRD METER/RANGE/PCT | 13.5/ 14/ .0458 | 13.5/ 14/ .0458 | 13.9/ 14/ .0474 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 21.9/ 1/ 5.49 | 1.9/ 1/ .48 | 1.8/ 1/ .45 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .0/ 1/ .00 | .1/ 1/ .03 |
| DILUTION FACTOR | 17.60 | 26.60 | 20.21 |
| HC CONCENTRATION PPM | 42.17 | 4.91 | 13.45 |
| CO CONCENTRATION PPM | 583.68 | 80.24 | 229.37 |
| CO2 CONCENTRATION PCT | .5603 | .3877 | .5104 |
| NOX CONCENTRATION PPM | 5.49 | .48 | .43 |
| HC MASS GRAMS | 3.482 | .699 | 1.112 |
| CO MASS GRAMS | 92.178 | 21.829 | 36.273 |
| CO2 MASS GRAMS | 1391.55 | 1658.75 | 1269.41 |
| NOX MASS GRAMS | 1.139 | .170 | .089 |
| FUEL MASS KG | .515 | .564 | .443 |
| FUEL ECONOMY L/100KM (MPG) | 17.81 ( 13.21) | 18.17 ( 12.95) | 15.34 ( 15.34) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .237 ( .382) ( .38) |
| CO G/KM (G/MI) | 6.886 (11.080) (11.08) |
| NOX G/KM (G/MI) | .060 ( .096) ( .30) |
| FUEL ECONOMY L/100KM (MPG) | 17.29 ( 13.60) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-03-P92 | LPG |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 2/19/93 RUN 1 | FUEL DENSITY 4.178 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .182 C .818 O .000 X .000 |
| TRANSMISSION A3 | ACTUAL ROAD LOAD 3.80 KW ( 5.10 HP) | |
| ODOMETER 29262 KM ( 18187 MILES) | TEST WEIGHT 1757 KG ( 3875 LBS) | |

BAROMETER 746.8 MM HG ( 29.40 IN HG)    DRY BULB TEMPERATURE 22.8°C ( 73.0°F)    NOX HUMIDITY C.F. .819

RELATIVE HUMIDITY 22.9 PCT.

| BAG NUMBER | 1 | 2 | 3 |
|---|---|---|---|
| BAG DESCRIPTION | COLD TRANSIENT ( 0-505 SEC.) | STABILIZED (506-1372 SEC.) | HOT TRANSIENT ( 0- 505 SEC.) |
| RUN TIME SECONDS | 505.4 | 867.5 | 505.5 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .986/.994 | .988/.994 | .986/.994 |
| MEASURED DISTANCE KM (MILES) | 5.78 ( 3.59) | 6.19 ( 3.85) | 5.78 ( 3.59) |
| BLOWER FLOW RATE SCMM (SCFM) | 15.85 ( 559.8) | 15.84 ( 559.4) | 15.85 ( 559.7) |
| GAS METER FLOW RATE SCMM (SCFM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCM (SCF) | 133.6 ( 4716.) | 229.1 ( 8088.) | 133.6 ( 4716.) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 49.5/ 2/ 49.47 | 27.6/ 5/ 13.83 | 48.2/ 1/ 4.84 |
| HC BCKGRD METER/RANGE/PPM | 5.5/ 2/ 5.50 | 11.6/ 5/ 5.81 | 12.0/ 1/ 1.20 |
| CO SAMPLE METER/RANGE/PPM | 55.8/ 1/486.61 | 52.1/ 13/122.16 | 63.3/ 14/292.24 |
| CO BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .0/ 13/ .00 | .1/ 14/ .40 |
| CO2 SAMPLE METER/RANGE/PCT | 77.1/ 14/ .6085 | 65.1/ 14/ .4343 | 73.8/ 14/ .5555 |
| CO2 BCKGRD METER/RANGE/PCT | 13.9/ 14/ .0474 | 14.0/ 14/ .0478 | 14.1/ 14/ .0482 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 26.7/ 1/ 6.69 | 1.1/ 1/ .28 | 1.0/ 1/ .25 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .5/ 1/ .13 | .4/ 1/ .10 |
| DILUTION FACTOR | 17.64 | 26.04 | 19.94 |
| HC CONCENTRATION PPM | 44.29 | 8.24 | 3.69 |
| CO CONCENTRATION PPM | 476.13 | 120.03 | 285.92 |
| CO2 CONCENTRATION PCT | .5638 | .3883 | .5097 |
| NOX CONCENTRATION PPM | 6.69 | .16 | .16 |
| HC MASS GRAMS | 3.609 | 1.152 | .301 |
| CO MASS GRAMS | 74.027 | 32.006 | 44.454 |
| CO2 MASS GRAMS | 1378.48 | 1628.45 | 1246.24 |
| NOX MASS GRAMS | 1.400 | .056 | .033 |
| FUEL MASS KG | .502 | .561 | .440 |
| FUEL ECONOMY L/100KM (MPG) | 17.37 ( 13.54) | 18.12 ( 12.98) | 15.20 ( 15.48) |

3-BAG COMPOSITE RESULTS

| | |
|---|---|
| HC G/KM (G/MI) | .240 ( .387) ( .39) |
| CO G/KM (G/MI) | 7.454 (11.993) (11.99) |
| NOX G/KM (G/MI) | .057 ( .091) ( .09) |
| FUEL ECONOMY L/100KM (MPG) | 17.15 ( 13.72) |

SOUTHWEST RESEARCH INSTITUTE - DEPARTMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-03-P92 | LPG |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 2/22/93 RUN 2 | FUEL DENSITY 4.178 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .182 C .818 O .000 X .000 |
| TRANSMISSION A3 | ACTUAL ROAD LOAD 5.10 HP ( 3.80 KW) | |
| ODOMETER 18211 MILES ( 29301 KM) | TEST WEIGHT 3875 LBS ( 1757 KG) | |

BAROMETER 29.15 IN HG (740.4 MM HG)    DRY BULB TEMPERATURE 77.0°F ( 25.0°C)    NOX HUMIDITY C.F. .852

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 | 505.2 | 867.8 | 505.0 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .983/.991 | .985/.991 | .984/.991 |
| MEASURED DISTANCE MILES (KM) | 3.59 ( 5.77) | 3.86 ( 6.20) | 3.59 ( 5.78) |
| BLOWER FLOW RATE SCFM (SCMM) | 553.9 (15.69) | 553.6 (15.68) | 554.2 (15.69) |
| GAS METER FLOW RATE SCFM (SCMM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCF (SCM) | 4664. ( 132.1) | 8007. ( 226.8) | 4664. ( 132.1) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 32.5/ 2/ 32.48 | 8.9/ 2/ 8.89 | 14.7/ 2/ 14.69 |
| HC BCKGRD METER/RANGE/PPM | 6.1/ 2/ 6.10 | 6.6/ 2/ 6.60 | 7.0/ 2/ 7.00 |
| CO SAMPLE METER/RANGE/PPM | 66.0/ 13/157.36 | 5.5/ 12/ 5.25 | 73.7/ 12/ 72.69 |
| CO BCKGRD METER/RANGE/PPM | .7/ 13/ 1.62 | 1.5/ 12/ 1.43 | 2.1/ 12/ 2.00 |
| CO2 SAMPLE METER/RANGE/PCT | 78.7/ 14/ .6358 | 65.5/ 14/ .4393 | 75.1/ 14/ .5758 |
| CO2 BCKGRD METER/RANGE/PCT | 14.4/ 14/ .0494 | 14.6/ 14/ .0502 | 15.0/ 14/ .0519 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 54.6/ 1/ 13.60 | 26.5/ 1/ 6.64 | 33.9/ 1/ 8.48 |
| NOX BCKGRD METER/RANGE/PPM | .2/ 1/ .05 | .2/ 1/ .05 | .2/ 1/ .05 |
| DILUTION FACTOR | 17.81 | 26.45 | 19.95 |
| HC CONCENTRATION PPM | 26.73 | 2.55 | 8.05 |
| CO CONCENTRATION PPM | 152.15 | 3.79 | 69.20 |
| CO2 CONCENTRATION PCT | .5892 | .3910 | .5266 |
| NOX CONCENTRATION PPM | 13.55 | 6.59 | 8.44 |
| HC MASS GRAMS | 2.154 | .353 | .649 |
| CO MASS GRAMS | 23.395 | 1.000 | 10.642 |
| CO2 MASS GRAMS | 1424.69 | 1623.30 | 1273.42 |
| NOX MASS GRAMS | 2.917 | 2.438 | 1.816 |
| FUEL MASS KG | .490 | .543 | .431 |
| FUEL ECONOMY MPG (L/100KM) | 13.88 ( 16.95) | 13.46 ( 17.47) | 15.80 ( 14.89) |

3-BAG COMPOSITE RESULTS

| | | |
|---|---|---|
| HC | G/MI | .22 |
| CO | G/MI | 2.30 |
| NOX | G/MI | .63 |
| FUEL ECONOMY MPG (L/100KM) | | 14.14 (16.64) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-03-P98 | LPG |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 2/23/93 RUN | FUEL DENSITY 4.139 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .183 C .817 O .000 X .000 |
| TRANSMISSION A3 | ACTUAL ROAD LOAD 5.10 HP ( 3.80 KW) | |
| ODOMETER 18211 MILES ( 29301 KM) | TEST WEIGHT 3875 LBS ( 1757 KG) | |

BAROMETER 29.28 IN HG (743.7 MM HG)    DRY BULB TEMPERATURE 75.0°F ( 23.9°C)    NOX HUMIDITY C.F. .822

RELATIVE HUMIDITY 22.0 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 | 505.3 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .985/.993 | .988/.993 | .986/.993 |
| MEASURED DISTANCE MILES (KM) | 3.59 ( 5.77) | 3.87 ( 6.23) | 3.59 ( 5.78) |
| BLOWER FLOW RATE SCFM (SCMM) | 557.2 (15.78) | 556.5 (15.76) | 556.1 (15.75) |
| GAS METER FLOW RATE SCFM (SCMM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCF (SCM) | 4693. ( 132.9) | 8044. ( 227.8) | 4684. ( 132.6) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 60.6/ 5/ 30.37 | 22.5/ 5/ 11.28 | 34.2/ 5/ 17.14 |
| HC BCKGRD METER/RANGE/PPM | 15.5/ 5/ 7.77 | 18.6/ 5/ 9.32 | 19.8/ 5/ 9.92 |
| CO SAMPLE METER/RANGE/PPM | 60.7/ 13/143.77 | 3.1/ 12/ 2.95 | 59.0/ 12/ 57.72 |
| CO BCKGRD METER/RANGE/PPM | .7/ 13/ 1.62 | .7/ 12/ .66 | 1.2/ 12/ 1.14 |
| CO2 SAMPLE METER/RANGE/PCT | 78.7/ 14/ .6358 | 64.9/ 14/ .4318 | 74.7/ 14/ .5695 |
| CO2 BCKGRD METER/RANGE/PCT | 14.7/ 14/ .0506 | 14.6/ 14/ .0502 | 14.9/ 14/ .0515 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 61.7/ 1/ 15.35 | 32.1/ 1/ 8.04 | 50.6/ 1/ 12.61 |
| NOX BCKGRD METER/RANGE/PPM | .8/ 1/ .20 | .6/ 1/ .15 | .5/ 1/ .13 |
| DILUTION FACTOR | 17.80 | 26.83 | 20.15 |
| HC CONCENTRATION PPM | 23.04 | 2.30 | 7.71 |
| CO CONCENTRATION PPM | 139.10 | 2.26 | 55.46 |
| CO2 CONCENTRATION PCT | .5880 | .3834 | .5206 |
| NOX CONCENTRATION PPM | 15.16 | 7.89 | 12.49 |
| HC MASS GRAMS | 1.871 | .320 | .625 |
| CO MASS GRAMS | 21.522 | .601 | 8.564 |
| CO2 MASS GRAMS | 1430.81 | 1599.18 | 1264.19 |
| NOX MASS GRAMS | 3.167 | 2.826 | 2.605 |
| FUEL MASS KG | .491 | .535 | .428 |
| FUEL ECONOMY MPG (L/100KM) | 13.71 ( 17.16) | 13.58 ( 17.33) | 15.78 ( 14.91) |

3-BAG COMPOSITE RESULTS

| | | |
|---|---|---|
| HC | G/MI | .20 |
| CO | G/MI | 1.98 |
| NOX | G/MI | .76 |
| FUEL ECONOMY MPG (L/100KM) | | 14.16 (16.61) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | | |
|---|---|---|---|
| VEHICLE NUMBER | 92P | TEST L2-03-P98 | LPG |
| VEHICLE MODEL | 92 CHEVY LUMINA | DATE 2/24/93 RUN 2 | FUEL DENSITY 4.139 LB/GAL |
| ENGINE | 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .183 C .817 O .000 X .000 |
| TRANSMISSION | A3 | ACTUAL ROAD LOAD 5.10 HP ( 3.80 KW) | |
| ODOMETER | 18240 MILES ( 29348 KM) | TEST WEIGHT 3875 LBS ( 1757 KG) | |

BAROMETER 29.19 IN HG (741.4 MM HG)    DRY BULB TEMPERATURE 76.0°F ( 24.4°C)    NOX HUMIDITY C.F. .942

RELATIVE HUMIDITY 45.1 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 | 505.3 | 867.4 | 505.3 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .977/.986 | .980/.986 | .978/.986 |
| MEASURED DISTANCE MILES (KM) | 3.60 ( 5.80) | 3.87 ( 6.23) | 3.87 ( 6.23) |
| BLOWER FLOW RATE SCFM (SCMM) | 554.8 (15.71) | 554.2 (15.70) | 554.0 (15.69) |
| GAS METER FLOW RATE SCFM (SCMM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCF (SCM) | 4672. ( 132.3) | 8012. ( 226.9) | 4665. ( 132.1) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 58.0/ 5/ 29.07 | 19.2/ 5/ 9.62 | 30.2/ 5/ 15.14 |
| HC BCKGRD METER/RANGE/PPM | 13.5/ 5/ 6.77 | 14.0/ 5/ 7.02 | 14.1/ 5/ 7.07 |
| CO SAMPLE METER/RANGE/PPM | 91.7/ 13/225.74 | 3.1/ 12/ 2.95 | 54.7/ 12/ 53.42 |
| CO BCKGRD METER/RANGE/PPM | .2/ 13/ .46 | .2/ 12/ .19 | .4/ 12/ .38 |
| CO2 SAMPLE METER/RANGE/PCT | 78.8/ 14/ .6376 | 65.4/ 14/ .4381 | 74.8/ 14/ .5711 |
| CO2 BCKGRD METER/RANGE/PCT | 13.9/ 14/ .0474 | 14.1/ 14/ .0482 | 14.3/ 14/ .0490 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 45.0/ 1/ 11.23 | 26.4/ 1/ 6.62 | 40.8/ 1/ 10.19 |
| NOX BCKGRD METER/RANGE/PPM | .1/ 1/ .03 | .2/ 1/ .05 | .0/ 1/ .00 |
| DILUTION FACTOR | 17.55 | 26.46 | 20.12 |
| HC CONCENTRATION PPM | 22.69 | 2.87 | 8.42 |
| CO CONCENTRATION PPM | 218.66 | 2.70 | 51.58 |
| CO2 CONCENTRATION PCT | .5929 | .3917 | .5245 |
| NOX CONCENTRATION PPM | 11.21 | 6.57 | 10.19 |
| HC MASS GRAMS | 1.834 | .398 | .680 |
| CO MASS GRAMS | 33.682 | .713 | 7.934 |
| CO2 MASS GRAMS | 1436.20 | 1627.23 | 1268.80 |
| NOX MASS GRAMS | 2.672 | 2.686 | 2.427 |
| FUEL MASS KG | .499 | .545 | .429 |
| FUEL ECONOMY MPG (L/100KM) | 13.55 ( 17.36) | 13.36 ( 17.61) | 16.96 ( 13.87) |

3-BAG COMPOSITE RESULTS

| | | |
|---|---|---|
| HC | G/MI | .21 |
| CO | G/MI | 2.61 |
| NOX | G/MI | .68 |
| FUEL ECONOMY MPG (L/100KM) | | 14.30 (16.45) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

| | | |
|---|---|---|
| VEHICLE NUMBER 92P | TEST L2-03-P85 | LPG |
| VEHICLE MODEL 92 CHEVY LUMINA | DATE 2/25/93 RUN 3 | FUEL DENSITY 4.195 LB/GAL |
| ENGINE 3.1 L (192 CID)-V-6 | DYNO 2 BAG CART 2 | H .180 C .820 O .000 X .000 |
| TRANSMISSION A3 | ACTUAL ROAD LOAD 5.10 HP ( 3.80 KW) | |
| ODOMETER 18259 MILES ( 29378 KM) | TEST WEIGHT 3875 LBS ( 1757 KG) | |

BAROMETER 29.04 IN HG (737.6 MM HG)    DRY BULB TEMPERATURE 76.0°F ( 24.4°C)    NOX HUMIDITY C.F. 1.062

RELATIVE HUMIDITY 62.9 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 | 867.4 | 505.6 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .972/.980 | .974/.980 | .973/.980 |
| MEASURED DISTANCE MILES (KM) | 3.59 ( 5.78) | 3.85 ( 6.20) | 3.57 ( 5.74) |
| BLOWER FLOW RATE SCFM (SCMM) | 551.3 (15.61) | 550.9 (15.60) | 550.3 (15.59) |
| GAS METER FLOW RATE SCFM (SCMM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCF (SCM) | 4642. ( 131.5) | 7964. ( 225.6) | 4638. ( 131.3) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 68.0/ 5/ 34.08 | 19.6/ 5/ 9.82 | 29.6/ 5/ 14.83 |
| HC BCKGRD METER/RANGE/PPM | 15.1/ 5/ 7.57 | 15.5/ 5/ 7.77 | 14.8/ 5/ 7.42 |
| CO SAMPLE METER/RANGE/PPM | 59.6/ 14/272.20 | 4.2/ 12/ 4.00 | 78.6/ 12/ 77.84 |
| CO BCKGRD METER/RANGE/PPM | .1/ 14/ .40 | .5/ 12/ .47 | .8/ 12/ .76 |
| CO2 SAMPLE METER/RANGE/PCT | 78.7/ 14/ .6358 | 65.8/ 14/ .4431 | 74.8/ 14/ .5711 |
| CO2 BCKGRD METER/RANGE/PCT | 13.6/ 14/ .0462 | 13.5/ 14/ .0458 | 13.8/ 14/ .0470 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 34.5/ 1/ 8.63 | 19.9/ 1/ 4.99 | 30.3/ 1/ 7.59 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .0/ 1/ .00 | .1/ 1/ .03 |
| DILUTION FACTOR | 17.62 | 26.38 | 20.22 |
| HC CONCENTRATION PPM | 26.94 | 2.35 | 7.78 |
| CO CONCENTRATION PPM | 262.30 | 3.43 | 74.52 |
| CO2 CONCENTRATION PCT | .5923 | .3991 | .5264 |
| NOX CONCENTRATION PPM | 8.63 | 4.99 | 7.57 |
| HC MASS GRAMS | 2.156 | .323 | .622 |
| CO MASS GRAMS | 40.144 | .901 | 11.394 |
| CO2 MASS GRAMS | 1425.50 | 1648.08 | 1265.79 |
| NOX MASS GRAMS | 2.305 | 2.288 | 2.018 |
| FUEL MASS KG | .498 | .549 | .428 |
| FUEL ECONOMY MPG (L/100KM) | 13.72 ( 17.14) | 13.34 ( 17.63) | 15.87 ( 14.82) |

3-BAG COMPOSITE RESULTS

| | | |
|---|---|---|
| HC | G/MI | .22 |
| CO | G/MI | 3.32 |
| NOX | G/MI | .60 |
| FUEL ECONOMY MPG (L/100KM) | | 14.05 (16.74) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

VEHICLE NUMBER 92P    TEST L2-03-HD5    LPG
VEHICLE MODEL 92 CHEVY LUMINA    DATE 2/26/93 RUN 1    FUEL DENSITY 4.053 LB/GAL
ENGINE 3.1 L (192 CID)-V-6    DYNO 2 BAG CART 2    H .184 C .816 O .000 X .000
TRANSMISSION A3    ACTUAL ROAD LOAD 5.10 HP ( 3.80 KW)
ODOMETER 18277 MILES ( 29407 KM)    TEST WEIGHT 3875 LBS ( 1757 KG)

BAROMETER 29.42 IN HG (747.3 MM HG)    DRY BULB TEMPERATURE 70.0°F ( 21.1°C)    NOX HUMIDITY C.F. .811
RELATIVE HUMIDITY 22.9 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 | 867.4 | 505.3 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .986/.994 | .989/.994 | .987/.994 |
| MEASURED DISTANCE MILES (KM) | 3.58 ( 5.76) | 3.85 ( 6.20) | 3.58 ( 5.77) |
| BLOWER FLOW RATE SCFM (SCMM) | 560.3 (15.87) | 559.8 (15.85) | 559.2 (15.84) |
| GAS METER FLOW RATE SCFM (SCMM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCF (SCM) | 4717. ( 133.6) | 8093. ( 229.2) | 4710. ( 133.4) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 58.5/ 5/ 29.32 | 18.4/ 5/ 9.22 | 28.2/ 5/ 14.13 |
| HC BCKGRD METER/RANGE/PPM | 12.6/ 5/ 6.31 | 13.3/ 5/ 6.67 | 12.7/ 5/ 6.36 |
| CO SAMPLE METER/RANGE/PPM | 91.7/ 13/225.74 | .9/ 12/ .85 | 34.4/ 12/ 33.39 |
| CO BCKGRD METER/RANGE/PPM | .1/ 13/ .23 | .0/ 12/ .00 | .0/ 12/ .00 |
| CO2 SAMPLE METER/RANGE/PCT | 77.3/ 14/ .6118 | 63.9/ 14/ .4194 | 73.9/ 14/ .5570 |
| CO2 BCKGRD METER/RANGE/PCT | 13.1/ 14/ .0442 | 13.2/ 14/ .0446 | 13.3/ 14/ .0450 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 55.4/ 1/ 13.80 | 39.0/ 1/ 9.75 | 67.9/ 1/ 16.88 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .0/ 1/ .00 | .0/ 1/ .00 |
| DILUTION FACTOR | 18.20 | 27.57 | 20.63 |
| HC CONCENTRATION PPM | 23.35 | 2.80 | 8.08 |
| CO CONCENTRATION PPM | 220.61 | .84 | 32.70 |
| CO2 CONCENTRATION PCT | .5701 | .3764 | .5142 |
| NOX CONCENTRATION PPM | 13.80 | 9.75 | 16.88 |
| HC MASS GRAMS | 1.908 | .392 | .659 |
| CO MASS GRAMS | 34.308 | .224 | 5.078 |
| CO2 MASS GRAMS | 1394.19 | 1579.44 | 1255.65 |
| NOX MASS GRAMS | 2.857 | 3.464 | 3.491 |
| FUEL MASS KG | .486 | .529 | .423 |
| FUEL ECONOMY MPG (L/100KM) | 13.54 ( 17.37) | 13.39 ( 17.57) | 15.56 ( 15.12) |

3-BAG COMPOSITE RESULTS

| | | |
|---|---|---|
| HC | G/MI | .21 |
| CO | G/MI | 2.40 |
| NOX | G/MI | .90 |
| FUEL ECONOMY MPG (L/100KM) | | 13.97 (16.84) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R 3-BAG EPA FTP VEHICLE EMISSION RESULTS PROJECT NO. 08-5343-001

VEHICLE NUMBER 92P
VEHICLE MODEL 92 CHEVY LUMINA
ENGINE 3.1 L (192 CID)-V-6
TRANSMISSION A3
ODOMETER 18277 MILES ( 29407 KM)

TEST L2-00-EEE4
DATE 3/ 3/93 RUN
DYNO 2 BAG CART 2
ACTUAL ROAD LOAD 5.10 HP ( 3.80 KW)
TEST WEIGHT 3875 LBS ( 1757 KG)

GASOLINE EM-1540-F
FUEL DENSITY 6.160 LB/GAL
H .134 C .866 O .000 X .000

BAROMETER 29.05 IN HG (737.9 MM HG) DRY BULB TEMPERATURE 74.0°F ( 23.3°C) NOX HUMIDITY C.F. .842
RELATIVE HUMIDITY 27.3 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 | 505.2 | 867.6 | 505.4 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .986/.992 | .987/.992 | .986/.992 |
| MEASURED DISTANCE MILES (KM) | 3.63 ( 5.84) | 3.90 ( 6.28) | 3.61 ( 5.81) |
| BLOWER FLOW RATE SCFM (SCMM) | 551.4 (15.62) | 551.5 (15.62) | 550.9 (15.60) |
| GAS METER FLOW RATE SCFM (SCMM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCF (SCM) | 4643. ( 131.5) | 7975. ( 225.9) | 4640. ( 131.4) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 64.3/ 2/ 64.26 | 18.2/ 5/ 9.12 | 36.2/ 5/ 18.14 |
| HC BCKGRD METER/RANGE/PPM | 5.7/ 2/ 5.70 | 11.4/ 5/ 5.71 | 12.4/ 5/ 6.21 |
| CO SAMPLE METER/RANGE/PPM | 93.8/ 14/467.49 | 36.9/ 12/ 35.84 | 54.2/ 13/127.39 |
| CO BCKGRD METER/RANGE/PPM | .0/ 14/ .00 | .0/ 12/ .00 | .0/ 13/ .00 |
| CO2 SAMPLE METER/RANGE/PCT | 82.3/ 14/ .7017 | 69.9/ 14/ .4981 | 79.0/ 14/ .6411 |
| CO2 BCKGRD METER/RANGE/PCT | 13.6/ 14/ .0462 | 13.6/ 14/ .0462 | 13.8/ 14/ .0470 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 52.2/ 1/ 13.01 | 19.6/ 1/ 4.92 | 33.1/ 1/ 8.29 |
| NOX BCKGRD METER/RANGE/PPM | .0/ 1/ .00 | .0/ 1/ .00 | .0/ 1/ .00 |
| DILUTION FACTOR | 17.89 | 26.84 | 20.58 |
| HC CONCENTRATION PPM | 58.88 | 3.62 | 12.23 |
| CO CONCENTRATION PPM | 457.06 | 35.18 | 124.69 |
| CO2 CONCENTRATION PCT | .6581 | .4536 | .5964 |
| NOX CONCENTRATION PPM | 13.01 | 4.92 | 8.29 |
| HC MASS GRAMS | 4.463 | .471 | .926 |
| CO MASS GRAMS | 69.960 | 9.251 | 19.076 |
| CO2 MASS GRAMS | 1584.13 | 1875.75 | 1434.78 |
| NOX MASS GRAMS | 2.754 | 1.789 | 1.753 |
| FUEL MASS KG | .539 | .596 | .463 |
| FUEL ECONOMY MPG (L/100KM) | 18.84 ( 12.49) | 18.29 ( 12.86) | 21.80 ( 10.79) |

3-BAG COMPOSITE RESULTS

| | | |
|---|---|---|
| HC | G/MI | .39 |
| CO | G/MI | 6.67 |
| NOX | G/MI | .53 |
| FUEL ECONOMY MPG (L/100KM) | | 19.27 (12.20) |

SOUTHWEST RESEARCH INSTITUTE - DEPARMENT OF EMISSIONS RESEARCH

COMPUTER PROGRAM LDT 1.0-R    3-BAG EPA FTP VEHICLE EMISSION RESULTS    PROJECT NO. 08-5343-001

VEHICLE NUMBER 92P    TEST L2-00-EEE5    GASOLINE EM-1540-F
VEHICLE MODEL 92 CHEVY LUMINA    DATE 3/ 5/93 RUN    FUEL DENSITY 6.160 LB/GAL
ENGINE 3.1 L (192 CID)-V-6    DYNO 2 BAG CART 2    H .134 C .866 O .000 X .000
TRANSMISSION A3    ACTUAL ROAD LOAD 5.10 HP ( 3.80 KW)
ODOMETER 18319 MILES ( 29475 KM)    TEST WEIGHT 3875 LBS ( 1757 KG)

BAROMETER 29.45 IN HG (748.0 MM HG)    DRY BULB TEMPERATURE 72.0°F ( 22.2°C)    NOX HUMIDITY C.F. .837
RELATIVE HUMIDITY 28.3 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 | 505.2 | 867.4 | 505.8 |
| DRY/WET CORRECTION FACTOR, SAMP/BACK | .985/.992 | .988/.992 | .986/.992 |
| MEASURED DISTANCE MILES (KM) | 3.63 ( 5.84) | 3.92 ( 6.30) | 3.63 ( 5.83) |
| BLOWER FLOW RATE SCFM (SCMM) | 560.8 (15.88) | 560.0 (15.86) | 559.8 (15.85) |
| GAS METER FLOW RATE SCFM (SCMM) | .00 ( .00) | .00 ( .00) | .00 ( .00) |
| TOTAL FLOW SCF (SCM) | 4722. ( 133.7) | 8096. ( 229.3) | 4719. ( 133.6) |
| HC SAMPLE METER/RANGE/PPM (BAG) | 88.5/ 5/ 44.35 | 91.4/ 1/ 9.17 | 31.6/ 5/ 15.84 |
| HC BCKGRD METER/RANGE/PPM | 12.0/ 5/ 6.01 | 62.6/ 1/ 6.28 | 11.8/ 5/ 5.91 |
| CO SAMPLE METER/RANGE/PPM | 59.1/ 13/139.71 | 33.5/ 12/ 32.50 | 72.9/ 12/ 71.86 |
| CO BCKGRD METER/RANGE/PPM | .4/ 13/ .92 | .1/ 12/ .09 | .5/ 12/ .47 |
| CO2 SAMPLE METER/RANGE/PCT | 84.7/ 14/ .7493 | 70.1/ 14/ .5009 | 80.7/ 14/ .6716 |
| CO2 BCKGRD METER/RANGE/PCT | 13.8/ 14/ .0470 | 13.7/ 14/ .0466 | 13.7/ 14/ .0466 |
| NOX SAMPLE METER/RANGE/PPM (BAG) (D) | 73.9/ 1/ 18.38 | 11.1/ 1/ 2.79 | 17.3/ 1/ 4.34 |
| NOX BCKGRD METER/RANGE/PPM | .1/ 1/ .03 | .2/ 1/ .05 | .2/ 1/ .05 |
| DILUTION FACTOR | 17.57 | 26.71 | 19.83 |
| HC CONCENTRATION PPM | 38.68 | 3.12 | 10.22 |
| CO CONCENTRATION PPM | 135.56 | 31.80 | 69.83 |
| CO2 CONCENTRATION PCT | .7050 | .4560 | .6274 |
| NOX CONCENTRATION PPM | 18.35 | 2.74 | 4.30 |
| HC MASS GRAMS | 2.982 | .413 | .787 |
| CO MASS GRAMS | 21.103 | 8.488 | 10.864 |
| CO2 MASS GRAMS | 1726.08 | 1914.30 | 1535.10 |
| NOX MASS GRAMS | 3.927 | 1.005 | .919 |
| FUEL MASS KG | .558 | .608 | .490 |
| FUEL ECONOMY MPG (L/100KM) | 18.17 ( 12.94) | 18.00 ( 13.07) | 20.67 ( 11.38) |

3-BAG COMPOSITE RESULTS

| | | |
|---|---|---|
| HC | G/MI | .28 |
| CO | G/MI | 3.15 |
| NOX | G/MI | .43 |

FUEL ECONOMY MPG (L/100KM) 18.71 (12.57)

# APPENDIX C

# EXHAUST HYDROCARBON SPECIATION DATA

## TABLE C-1. 1992 CHEVROLET LUMINA, EM1540 BASELINE, TEST NO. L2-00-EEE2, 12/29/92

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| METHANE | 217 | 59.8 | 6.17 | 166 | 42.5 | 28.27 | 134 | 37.3 | 17.63 | 44.7 | 13.27 | 0.661 |
| ETHYLENE | 208 | 57.2 | 5.91 | 0 | 0.0 | 0.00 | 28 | 7.9 | 3.73 | 14.0 | 4.16 | 102.068 |
| ETHANE | 60 | 16.4 | 1.70 | 20 | 5.2 | 3.47 | 29 | 7.9 | 3.75 | 8.3 | 2.46 | 2.069 |
| ACETYLENE | 62 | 17.0 | 1.76 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 3.5 | 1.05 | 1.761 |
| PROPANE | 161 | 44.5 | 4.59 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 9.2 | 2.74 | 4.420 |
| PROPYLENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 2 | 0.5 | 0.24 | 0.1 | 0.04 | 1.280 |
| 1,3-BUTADIENE | 22 | 6.0 | 0.62 | 0 | 0.0 | 0.00 | 6 | 1.7 | 0.79 | 1.7 | 0.51 | 18.531 |
| ISOBUTANE | 35 | 9.5 | 0.98 | 15 | 3.9 | 2.57 | 20 | 5.5 | 2.59 | 5.5 | 1.63 | 6.620 |
| BUTANE | 28 | 7.6 | 0.78 | 12 | 3.1 | 2.07 | 13 | 3.6 | 1.70 | 4.2 | 1.24 | 4.257 |
| 1-BUTENE | 16 | 4.5 | 0.47 | 0 | 0.0 | 0.00 | 2 | 0.4 | 0.20 | 1.1 | 0.31 | 9.385 |
| ISOBUTYLENE | 84 | 23.2 | 2.40 | 5 | 1.4 | 0.91 | 13 | 3.7 | 1.74 | 6.5 | 1.94 | 34.655 |
| CIS-2-BUTENE | 10 | 2.8 | 0.29 | 0 | 0.0 | 0.00 | 2 | 0.4 | 0.20 | 0.7 | 0.21 | 6.930 |
| TRANS-2-BUTENE | 10 | 2.8 | 0.29 | 0 | 0.0 | 0.00 | 4 | 1.1 | 0.51 | 0.9 | 0.26 | 8.695 |
| BENZENE | 158 | 43.4 | 4.48 | 31 | 7.9 | 5.29 | 45 | 12.4 | 5.86 | 16.5 | 4.90 | 6.931 |
| TOLUENE | 719 | 198.1 | 20.45 | 161 | 41.1 | 27.36 | 135 | 37.4 | 17.68 | 72.6 | 21.58 | 198.205 |
| ISOPENTANE | 163 | 44.9 | 4.64 | 0 | 0.0 | 0.00 | 103 | 28.6 | 13.51 | 17.1 | 5.08 | 23.601 |
| 1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PENTANE | 48 | 13.3 | 1.38 | 0 | 0.0 | 0.00 | 17 | 4.8 | 2.26 | 4.1 | 1.21 | 4.231 |
| 2-METHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPRENE(2-METHYL-1,3-BUTADIENE) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CIS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2-DIMETHYLBUTANE | 10 | 2.6 | 0.27 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.16 | 0.448 |
| CYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTANE | 4 | 1.1 | 0.12 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.07 | 0.562 |
| 3-METHYL-1-PENTENE | 4 | 1.1 | 0.12 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.07 | 1.043 |
| 4-METHYL-1-PENTENE | 4 | 1.1 | 0.12 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.07 | 1.043 |
| 2,3-DIMETHYLBUTANE | 16 | 4.5 | 0.47 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.9 | 0.28 | 1.001 |
| 2,3-DIMETHYL-1-BUTEN | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLPENTANE | 26 | 7.3 | 0.75 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.5 | 0.45 | 2.309 |
| 4-METHYL-2-PENTENE | 26 | 7.1 | 0.73 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.5 | 0.44 | 9.859 |
| MTBE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLPENTANE | 30 | 8.2 | 0.84 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.7 | 0.50 | 2.572 |
| 2-METHYL-1-PENTENE/1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANE | 24 | 6.7 | 0.69 | 0 | 0.0 | 0.00 | 8 | 2.2 | 1.05 | 2.0 | 0.59 | 1.952 |
| C6 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

## TABLE C-1 (CONT'D). 1992 CHEVROLET LUMINA, EM1540 BASELINE, TEST NO. L2-00-EEE2, 12/29/92

| COMPOUND | BAG 1 MG | BAG 1 MG/MI | BAG 1 WGT. % | BAG 2 MG | BAG 2 MG/MI | BAG 2 WGT. % | BAG 3 MG | BAG 3 MG/MI | BAG 3 WGT. % | FTP TOTAL MG/MI | FTP TOTAL WGT. % | FTP TOTAL OZONE MG/MI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,4-DIMETHYLPENTANE | 14 | 3.8 | 0.39 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.8 | 0.23 | 1.385 |
| METHYLCYCLOPENTANE | 22 | 6.2 | 0.64 | 0 | 0.0 | 0.00 | 5 | 1.5 | 0.71 | 1.7 | 0.50 | 0.000 |
| CYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1,3-PENTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLPENTANE/2-METHYLHEXANE | 54 | 15.0 | 1.55 | 0 | 0.0 | 0.00 | 18 | 5.0 | 2.37 | 4.5 | 1.33 | 5.812 |
| CYCLOHEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 5-METHYL-2-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEXANE | 43 | 11.8 | 1.21 | 0 | 0.0 | 0.00 | 8 | 2.2 | 1.02 | 3.0 | 0.90 | 4.235 |
| 2,2,4-TRIMETHYLPENTANE | 312 | 85.9 | 8.87 | 89 | 22.8 | 15.20 | 77 | 21.4 | 10.14 | 35.5 | 10.56 | 33.035 |
| N-HEPTANE | 6 | 1.7 | 0.18 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.4 | 0.11 | 0.291 |
| 2,4,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4/2-5-DIMETHYLHEXANE | 64 | 17.6 | 1.81 | 0 | 0.0 | 0.00 | 11 | 3.0 | 1.40 | 4.4 | 1.32 | 6.956 |
| 2,3,4-TRIMETHYLPENTANE | 36 | 9.8 | 1.02 | 10 | 2.5 | 1.67 | 10 | 2.7 | 1.27 | 4.1 | 1.21 | 6.516 |
| 2,3,3-TRIMETHYLPENTANE | 61 | 16.9 | 1.74 | 10 | 2.5 | 1.67 | 10 | 2.7 | 1.27 | 5.5 | 1.64 | 6.631 |
| 2-METHYL-3-HEPTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3,5,5-TRIMETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-/4-METHYLHEPTANE | 35 | 9.7 | 1.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 2.0 | 0.60 | 2.167 |
| 3-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5-DIMETHYL-1,5-HEXADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,5-TRIMETHYLHEXANE | 10 | 2.7 | 0.28 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.17 | 0.543 |
| 2-ETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-CIS-4-DIMETHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| OCTANE | 15 | 4.3 | 0.44 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.9 | 0.26 | 0.539 |
| 2,3,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5/3,5-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ETHYLBENZENE | 43 | 11.9 | 1.22 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 2.5 | 0.73 | 6.632 |
| 2,3-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-XYLENE/M-XYLENE | 72 | 19.9 | 2.05 | 12 | 3.1 | 2.05 | 14 | 3.9 | 1.83 | 6.8 | 2.01 | 49.919 |
| 2-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-XYLENE | 32 | 8.8 | 0.91 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.8 | 0.54 | 11.768 |

## TABLE C-1 (CONT'D). 1992 CHEVROLET LUMINA, EM1540 BASELINE, TEST NO. L2-00-EEE2, 12/29/92

| COMPOUND | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| NONANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-NONENE | 6 | 1.7 | 0.18 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.4 | 0.11 | 1.619 |
| PROPYLBENZENE | 17 | 4.6 | 0.48 | 0 | 0.0 | 0.00 | 10 | 2.9 | 1.36 | 1.7 | 0.52 | 3.813 |
| 2,3-DIMETHYLOCTANE | 101 | 27.9 | 2.88 | 0 | 0.0 | 0.00 | 17 | 4.6 | 2.17 | 7.0 | 2.09 | 7.105 |
| O-ETHYLTOLUENE | 18 | 4.9 | 0.51 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.0 | 0.30 | 7.308 |
| 1,2,4-TRIMETHYLBENZENE | 86 | 23.6 | 2.44 | 13 | 3.4 | 2.24 | 9 | 2.6 | 1.21 | 7.3 | 2.18 | 64.848 |
| ISOBUTYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| DECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-CYMENE | 39 | 10.6 | 1.10 | 15 | 3.9 | 2.57 | 8 | 2.1 | 0.99 | 4.8 | 1.42 | 30.793 |
| INDAN(E) | 6 | 1.5 | 0.16 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.10 | 0.340 |
| 4-PHENYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| M-DIETHYLBENZENE | 8 | 2.3 | 0.24 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.14 | 3.081 |
| 1-METHYL-3-PROPYLBENZENE | 10 | 2.8 | 0.29 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.17 | 3.722 |
| N-BUTYLBENZENE/P-DIETHYLBENZENE | 8 | 2.1 | 0.22 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.4 | 0.13 | 1.843 |
| O-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLDECANE | 12 | 3.2 | 0.33 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.7 | 0.20 | 0.781 |
| BICYCLOPENTYL | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| UNDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,3,5-TRIMETHYLBENZENE | 25 | 6.8 | 0.71 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.4 | 0.42 | 14.320 |
| C7 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C8-C9 OLEFINS | 79 | 21.9 | 2.26 | 26 | 6.6 | 4.39 | 0 | 0.0 | 0.00 | 8.0 | 2.36 | 27.054 |
| C9-C11 PARAFFINS, OLEFINS, AROMATICS | 45 | 12.5 | 1.29 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 2.6 | 0.77 | 9.827 |
| FORMALDEHYDE | 43 | 11.8 | 1.21 | 0 | 0.0 | 0.01 | 0 | 0.0 | 0.02 | 2.5 | 0.73 | 17.533 |
| ACETALDEHYDE | 14 | 3.8 | 0.39 | 1 | 0.2 | 0.12 | 1 | 0.2 | 0.07 | 0.9 | 0.27 | 5.098 |
| ACROLEIN | 4 | 1.0 | 0.10 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.06 | 1.409 |
| ACETONE | 9 | 2.5 | 0.25 | 1 | 0.1 | 0.09 | 2 | 0.6 | 0.28 | 0.7 | 0.22 | 0.419 |
| PROPIONALDEHYDE | 1 | 0.4 | 0.04 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.02 | 0.533 |
| CROTONALDEHYDE | 0 | 0.1 | 0.01 | 0 | 0.0 | 0.00 | 2 | 0.5 | 0.24 | 0.2 | 0.05 | 0.843 |
| ISOBUTYRALDEHYDE | 1 | 0.2 | 0.02 | 0 | 0.0 | 0.00 | 0 | 0.1 | 0.04 | 0.1 | 0.02 | 0.355 |
| METHYL ETHYL KETONE | 1 | 0.2 | 0.02 | 0 | 0.0 | 0.00 | 0 | 0.1 | 0.04 | 0.1 | 0.02 | 0.080 |
| BENZALDEHYDE | 17 | 4.7 | 0.48 | 0 | 0.0 | 0.00 | 0 | 0.1 | 0.05 | 1.0 | 0.30 | -0.551 |
| HEXANALDEHYDE | 3 | 0.8 | 0.08 | 0 | 0.1 | 0.08 | 1 | 0.1 | 0.07 | 0.3 | 0.08 | 0.997 |

## TABLE C-2. 1992 CHEVROLET LUMINA, EM1540 BASELINE, TEST NO. L2-00-EEE3, 12/30/92

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| METHANE | 176 | 49.3 | 6.50 | 153 | 40.1 | 28.94 | 125 | 35.0 | 14.10 | 40.6 | 13.65 | 0.600 |
| ETHYLENE | 160 | 44.7 | 5.90 | 15 | 3.9 | 2.82 | 50 | 14.0 | 5.67 | 15.2 | 5.11 | 110.680 |
| ETHANE | 27 | 7.5 | 0.99 | 21 | 5.5 | 3.99 | 33 | 9.1 | 3.66 | 6.9 | 2.32 | 1.727 |
| ACETYLENE | 53 | 14.8 | 1.95 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 3.1 | 1.03 | 1.539 |
| PROPANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PROPYLENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 29 | 8.2 | 3.30 | 2.3 | 0.76 | 21.214 |
| 1,3-BUTADIENE | 28 | 7.8 | 1.03 | 0 | 0.0 | 0.00 | 5 | 1.3 | 0.51 | 2.0 | 0.66 | 21.474 |
| ISOBUTANE | 28 | 7.7 | 1.02 | 9 | 2.4 | 1.77 | 20 | 5.6 | 2.27 | 4.4 | 1.48 | 5.338 |
| BUTANE | 21 | 5.8 | 0.76 | 6 | 1.6 | 1.16 | 13 | 3.7 | 1.50 | 3.1 | 1.03 | 3.126 |
| 1-BUTENE | 14 | 3.9 | 0.52 | 0 | 0.0 | 0.00 | 3 | 0.9 | 0.35 | 1.1 | 0.35 | 9.393 |
| ISOBUTYLENE | 75 | 20.9 | 2.76 | 3 | 0.7 | 0.50 | 19 | 5.2 | 2.10 | 6.1 | 2.07 | 32.620 |
| CIS-2-BUTENE | 3 | 0.9 | 0.12 | 0 | 0.0 | 0.00 | 2 | 0.7 | 0.26 | 0.4 | 0.12 | 3.585 |
| TRANS-2-BUTENE | 9 | 2.6 | 0.35 | 0 | 0.0 | 0.02 | 2 | 0.5 | 0.18 | 0.7 | 0.23 | 6.835 |
| BENZENE | 89 | 25.0 | 3.29 | 33 | 8.7 | 6.28 | 46 | 12.9 | 5.22 | 13.2 | 4.45 | 5.561 |
| TOLUENE | 645 | 180.0 | 23.75 | 63 | 16.4 | 11.86 | 148 | 41.1 | 16.60 | 57.2 | 19.25 | 156.229 |
| ISOPENTANE | 53 | 14.9 | 1.97 | 50 | 13.0 | 9.38 | 19 | 5.3 | 2.13 | 11.3 | 3.79 | 15.544 |
| 1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PENTANE | 30 | 8.5 | 1.12 | 10 | 2.7 | 1.97 | 6 | 1.6 | 0.66 | 3.6 | 1.22 | 3.763 |
| 2-METHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPRENE(2-METHYL-1,3-BUTADIENE) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CIS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTANE | 9 | 2.6 | 0.35 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.18 | 1.297 |
| 3-METHYL-1-PENTENE | 9 | 2.6 | 0.35 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.18 | 2.409 |
| 4-METHYL-1-PENTENE | 9 | 2.6 | 0.35 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.18 | 2.409 |
| 2,3-DIMETHYLBUTANE | 19 | 5.2 | 0.68 | 0 | 0.0 | 0.00 | 10 | 2.7 | 1.09 | 1.8 | 0.61 | 1.947 |
| 2,3-DIMETHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLPENTANE | 25 | 6.9 | 0.91 | 5 | 1.2 | 0.88 | 19 | 5.2 | 2.11 | 3.5 | 1.18 | 5.363 |
| 4-METHYL-2-PENTENE | 24 | 6.7 | 0.89 | 5 | 1.2 | 0.86 | 18 | 5.1 | 2.06 | 3.4 | 1.15 | 22.895 |
| MTBE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLPENTANE | 19 | 5.3 | 0.70 | 0 | 0.0 | 0.00 | 12 | 3.5 | 1.40 | 2.1 | 0.69 | 3.136 |
| 2-METHYL-1-PENTENE/1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANE | 17 | 4.7 | 0.62 | 0 | 0.0 | 0.00 | 6 | 1.7 | 0.70 | 1.4 | 0.49 | 1.420 |
| C6 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

TABLE C-2 (CONT'D). 1992 CHEVROLET LUMINA, EM1540 BASELINE, TEST NO. L2-00-EEE3, 12/30/92

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| 2,4-DIMETHYLPENTANE | 14 | 4.0 | 0.53 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.8 | 0.28 | 1.473 |
| METHYLCYCLOPENTANE | 15 | 4.2 | 0.55 | 0 | 0.0 | 0.00 | 6 | 1.6 | 0.64 | 1.3 | 0.44 | 0.000 |
| CYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1,3-PENTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLPENTANE/2-METHYLHEXANE | 37 | 10.4 | 1.37 | 0 | 0.0 | 0.00 | 16 | 4.3 | 1.75 | 3.4 | 1.13 | 4.362 |
| CYCLOHEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 5-METHYL-2-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEXANE | 25 | 6.9 | 0.91 | 0 | 0.0 | 0.00 | 10 | 2.9 | 1.15 | 2.2 | 0.74 | 3.096 |
| 2,2,4-TRIMETHYLPENTANE | 249 | 69.5 | 9.17 | 34 | 8.8 | 6.38 | 101 | 28.2 | 11.38 | 26.8 | 9.01 | 24.901 |
| N-HEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOHEXANE | 5 | 1.5 | 0.20 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.10 | 0.575 |
| 2,4,4-TRIMETHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4/2-5-DIMETHYLHEXANE | 52 | 14.6 | 1.92 | 0 | 0.0 | 0.00 | 14 | 3.9 | 1.56 | 4.1 | 1.38 | 6.401 |
| 2,3,4-TRIMETHYLPENTANE | 33 | 9.2 | 1.21 | 0 | 0.0 | 0.00 | 11 | 3.1 | 1.24 | 2.8 | 0.93 | 4.411 |
| 2,3,3-TRIMETHYLPENTANE | 48 | 13.4 | 1.77 | 0 | 0.0 | 0.00 | 11 | 3.1 | 1.24 | 3.6 | 1.22 | 4.355 |
| 2-METHYL-3-HEPTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3,5,5-TRIMETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-/4-METHYLHEPTANE | 17 | 4.8 | 0.63 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.0 | 0.34 | 1.079 |
| 3-METHYLHEPTANE | 6 | 1.6 | 0.21 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.11 | 0.322 |
| 2,5-DIMETHYL-1,5-HEXADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,5-TRIMETHYLHEXANE | 14 | 3.9 | 0.51 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.8 | 0.27 | 0.785 |
| 2-ETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-CIS-4-DIMETHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| OCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5/3,5-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ETHYLBENZENE | 36 | 10.0 | 1.32 | 0 | 0.0 | 0.00 | 10 | 2.7 | 1.08 | 2.8 | 0.95 | 7.602 |
| 2,3-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-XYLENE/M-XYLENE | 60 | 16.8 | 2.22 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 3.5 | 1.18 | 25.805 |
| 2-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-XYLENE | 22 | 6.1 | 0.81 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.3 | 0.43 | 8.189 |

## TABLE C-2 (CONT'D). 1992 CHEVROLET LUMINA, EM1540 BASELINE, TEST NO. L2-00-EEE3, 12/30/92

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| NONANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-NONENE | 7 | 1.9 | 0.25 | 0 | 0.0 | 0.00 | 6 | 1.7 | 0.69 | 0.9 | 0.29 | 3.964 |
| PROPYLBENZENE | 13 | 3.7 | 0.48 | 11 | 2.7 | 1.98 | 0 | 0.0 | 0.00 | 2.2 | 0.73 | 4.745 |
| 2,3-DIMETHYLOCTANE | 111 | 31.0 | 4.09 | 66 | 17.2 | 12.41 | 20 | 5.4 | 2.20 | 16.8 | 5.65 | 16.975 |
| O-ETHYLTOLUENE | 21 | 5.8 | 0.76 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.2 | 0.40 | 8.642 |
| 1,2,4-TRIMETHYLBENZENE | 100 | 28.0 | 3.69 | 26 | 6.8 | 4.91 | 50 | 14.0 | 5.64 | 13.2 | 4.43 | 116.428 |
| ISOBUTYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| DECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-CYMENE | 47 | 13.0 | 1.72 | 13 | 3.5 | 2.50 | 5 | 1.3 | 0.51 | 4.8 | 1.63 | 31.190 |
| INDAN(E) | 8 | 2.3 | 0.30 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.16 | 0.507 |
| 4-PHENYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| M-DIETHYLBENZENE | 9 | 2.6 | 0.34 | 0 | 0.0 | 0.00 | 5 | 1.3 | 0.53 | 0.9 | 0.30 | 5.822 |
| 1-METHYL-3-PROPYLBENZENE | 10 | 2.8 | 0.37 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.20 | 3.792 |
| N-BUTYLBENZENE/P-DIETHYLBENZENE | 8 | 2.2 | 0.29 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.15 | 1.899 |
| O-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLDECANE | 12 | 3.3 | 0.43 | 0 | 0.0 | 0.00 | 11 | 3.2 | 1.28 | 1.6 | 0.52 | 1.825 |
| BICYCLOPENTYL | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| UNDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,3,5-TRIMETHYLBENZENE | 28 | 7.7 | 1.01 | 0 | 0.0 | 0.00 | 17 | 4.6 | 1.87 | 2.9 | 0.97 | 29.089 |
| C7 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C8-C9 OLEFINS | 13 | 3.7 | 0.49 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.8 | 0.26 | 2.632 |
| C9-C11 PARAFFINS, OLEFINS, AROMATICS | 54 | 15.2 | 2.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 3.1 | 1.06 | 11.996 |
| FORMALDEHYDE | 39 | 10.8 | 1.43 | 0 | 0.0 | 0.01 | 0 | 0.0 | 0.00 | 2.3 | 0.76 | 16.128 |
| ACETALDEHYDE | 12 | 3.4 | 0.45 | 0 | 0.1 | 0.05 | 0 | 0.1 | 0.05 | 0.8 | 0.26 | 4.250 |
| ACROLEIN | 4 | 1.1 | 0.15 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.08 | 1.583 |
| ACETONE | 11 | 3.2 | 0.42 | 1 | 0.3 | 0.23 | 3 | 0.8 | 0.32 | 1.0 | 0.35 | 0.582 |
| PROPIONALDEHYDE | 2 | 0.4 | 0.06 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.03 | 0.591 |
| CROTONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.041 |
| ISOBUTYRALDEHYDE | 1 | 0.2 | 0.03 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.02 | 0.1 | 0.02 | 0.326 |
| METHYL ETHYL KETONE | 1 | 0.2 | 0.03 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.02 | 0.1 | 0.02 | 0.073 |
| BENZALDEHYDE | 18 | 5.0 | 0.66 | 1 | 0.2 | 0.13 | 1 | 0.3 | 0.13 | 1.2 | 0.41 | -0.669 |
| HEXANALDEHYDE | 9 | 2.6 | 0.34 | 5 | 1.4 | 0.98 | 8 | 2.1 | 0.86 | 1.8 | 0.62 | 6.933 |

## TABLE C-3. 1992 CHEVROLET LUMINA, EM1215 TRC BASE, TEST NO. L2-00-RFA1, 12/31/92

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| METHANE | 181 | 50.8 | 6.37 | 154 | 40.0 | 29.25 | 159 | 44.1 | 15.21 | 43.4 | 13.72 | 0.642 |
| ETHYLENE | 263 | 73.6 | 9.23 | 37 | 9.6 | 6.99 | 85 | 23.7 | 8.16 | 26.7 | 8.46 | 194.910 |
| ETHANE | 52 | 14.6 | 1.83 | 28 | 7.2 | 5.29 | 27 | 7.6 | 2.61 | 8.9 | 2.80 | 2.215 |
| ACETYLENE | 38 | 10.6 | 1.32 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 2.2 | 0.69 | 1.094 |
| PROPANE | 12 | 3.3 | 0.42 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.7 | 0.22 | 0.333 |
| PROPYLENE | 151 | 42.2 | 5.28 | 0 | 0.0 | 0.00 | 32 | 8.8 | 3.02 | 11.2 | 3.53 | 104.869 |
| 1,3-BUTADIENE | 37 | 10.3 | 1.29 | 0 | 0.0 | 0.00 | 4 | 1.2 | 0.43 | 2.5 | 0.78 | 26.919 |
| ISOBUTANE | 6 | 1.6 | 0.20 | 2 | 0.6 | 0.45 | 2 | 0.4 | 0.15 | 0.8 | 0.24 | 0.925 |
| BUTANE | 71 | 20.0 | 2.50 | 39 | 10.2 | 7.47 | 46 | 12.8 | 4.42 | 13.0 | 4.10 | 13.214 |
| 1-BUTENE | 24 | 6.7 | 0.84 | 0 | 0.0 | 0.00 | 4 | 1.1 | 0.37 | 1.7 | 0.54 | 15.087 |
| ISOBUTYLENE | 41 | 11.5 | 1.44 | 4 | 1.0 | 0.76 | 10 | 2.8 | 0.96 | 3.7 | 1.17 | 19.629 |
| CIS-2-BUTENE | 7 | 2.0 | 0.25 | 0 | 0.0 | 0.00 | 3 | 0.9 | 0.30 | 0.6 | 0.20 | 6.390 |
| TRANS-2-BUTENE | 8 | 2.2 | 0.28 | 1 | 0.4 | 0.27 | 1 | 0.2 | 0.08 | 0.7 | 0.23 | 7.088 |
| BENZENE | 104 | 29.0 | 3.63 | 42 | 11.0 | 8.04 | 66 | 18.3 | 6.31 | 16.7 | 5.30 | 7.034 |
| TOLUENE | 267 | 74.7 | 9.36 | 25 | 6.5 | 4.76 | 98 | 27.2 | 9.37 | 26.3 | 8.33 | 71.925 |
| ISOPENTANE | 32 | 9.0 | 1.13 | 0 | 0.0 | 0.00 | 16 | 4.4 | 1.53 | 3.1 | 0.98 | 4.259 |
| 1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PENTANE | 17 | 4.8 | 0.60 | 0 | 0.0 | 0.00 | 17 | 4.7 | 1.60 | 2.3 | 0.72 | 2.362 |
| 2-METHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPRENE(2-METHYL-1,3-BUTADIENE) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CIS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLBUTANE | 29 | 8.0 | 1.01 | 11 | 2.8 | 2.05 | 22 | 6.2 | 2.13 | 4.8 | 1.52 | 5.155 |
| 2,3-DIMETHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLPENTANE | 49 | 13.8 | 1.73 | 12 | 3.2 | 2.32 | 57 | 15.8 | 5.43 | 8.8 | 2.80 | 13.540 |
| 4-METHYL-2-PENTENE | 48 | 13.5 | 1.69 | 12 | 3.1 | 2.26 | 56 | 15.4 | 5.30 | 8.6 | 2.73 | 57.807 |
| MTBE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLPENTANE | 50 | 13.9 | 1.74 | 9 | 2.4 | 1.76 | 35 | 9.6 | 3.30 | 6.8 | 2.14 | 10.281 |
| 2-METHYL-1-PENTENE/1-HEXENE | 6 | 1.6 | 0.20 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.11 | 1.478 |
| HEXANE | 31 | 8.8 | 1.10 | 10 | 2.5 | 1.83 | 21 | 5.7 | 1.97 | 4.7 | 1.48 | 4.597 |
| C6 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

## TABLE C-3 (CONT'D). 1992 CHEVROLET LUMINA, EM1215 TRC BASE, TEST NO. L2-00-RFA1, 12/31/92

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| 2,4-DIMETHYLPENTANE | 5 | 1.5 | 0.18 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.10 | 0.541 |
| METHYLCYCLOPENTANE | 16 | 4.5 | 0.56 | 0 | 0.0 | 0.00 | 13 | 3.5 | 1.22 | 1.9 | 0.60 | 0.000 |
| CYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1,3-PENTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLPENTANE/2-METHYLHEXANE | 53 | 14.9 | 1.87 | 15 | 4.0 | 2.91 | 23 | 6.3 | 2.16 | 6.9 | 2.18 | 8.947 |
| CYCLOHEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 5-METHYL-2-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEXANE | 24 | 6.7 | 0.84 | 0 | 0.0 | 0.00 | 14 | 4.0 | 1.37 | 2.5 | 0.78 | 3.469 |
| 2,2,4-TRIMETHYLPENTANE | 52 | 14.6 | 1.82 | 24 | 6.4 | 4.65 | 20 | 5.6 | 1.94 | 7.9 | 2.48 | 7.304 |
| N-HEPTANE | 16 | 4.6 | 0.57 | 0 | 0.0 | 0.00 | 8 | 2.1 | 0.73 | 1.5 | 0.48 | 1.240 |
| 2,4,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOHEXANE | 10 | 2.7 | 0.34 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.18 | 1.041 |
| 2,4,4-TRIMETHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4/2-5-DIMETHYLHEXANE | 16 | 4.6 | 0.57 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.9 | 0.30 | 1.485 |
| 2,3,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 6 | 1.7 | 0.57 | 0.5 | 0.15 | 0.735 |
| 2,3,3-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 6 | 1.7 | 0.57 | 0.5 | 0.15 | 0.551 |
| 2-METHYL-3-HEPTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3,5,5-TRIMETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-/4-METHYLHEPTANE | 33 | 9.1 | 1.15 | 0 | 0.0 | 0.00 | 15 | 4.2 | 1.44 | 3.0 | 0.96 | 3.287 |
| 3-METHYLHEPTANE | 20 | 5.5 | 0.69 | 0 | 0.0 | 0.00 | 9 | 2.4 | 0.84 | 1.8 | 0.57 | 1.795 |
| 2,5-DIMETHYL-1,5-HEXADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,5-TRIMETHYLHEXANE | 9 | 2.4 | 0.30 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.16 | 0.488 |
| 2-ETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-CIS-4-DIMETHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| OCTANE | 10 | 2.9 | 0.36 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.19 | 0.362 |
| 2,3,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5/3,5-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ETHYLBENZENE | 108 | 30.4 | 3.81 | 8 | 2.1 | 1.55 | 21 | 5.7 | 1.98 | 9.0 | 2.84 | 24.234 |
| 2,3-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-XYLENE/M-XYLENE | 257 | 71.9 | 9.00 | 21 | 5.5 | 4.05 | 53 | 14.6 | 5.05 | 21.8 | 6.89 | 160.840 |
| 2-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-XYLENE | 97 | 27.0 | 3.39 | 8 | 2.2 | 1.59 | 15 | 4.3 | 1.48 | 7.9 | 2.50 | 51.095 |

## TABLE C-3 (CONT'D). 1992 CHEVROLET LUMINA, EM1215 TRC BASE, TEST NO. L2-00-RFA1, 12/31/92

| COMPOUND | BAG 1 MG | BAG 1 MG/MI | BAG 1 WGT. % | BAG 2 MG | BAG 2 MG/MI | BAG 2 WGT. % | BAG 3 MG | BAG 3 MG/MI | BAG 3 WGT. % | FTP TOTAL MG/MI | FTP TOTAL WGT. % | FTP TOTAL OZONE MG/MI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NONANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-NONENE | 6 | 1.8 | 0.22 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.4 | 0.12 | 1.689 |
| PROPYLBENZENE | 16 | 4.6 | 0.58 | 0 | 0.0 | 0.00 | 12 | 3.3 | 1.14 | 1.9 | 0.59 | 4.060 |
| 2,3-DIMETHYLOCTANE | 125 | 35.1 | 4.39 | 48 | 12.4 | 9.05 | 20 | 5.6 | 1.95 | 15.2 | 4.82 | 15.376 |
| O-ETHYLTOLUENE | 26 | 7.2 | 0.91 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.5 | 0.47 | 10.798 |
| 1,2,4-TRIMETHYLBENZENE | 118 | 32.9 | 4.13 | 10 | 2.6 | 1.89 | 23 | 6.4 | 2.21 | 9.9 | 3.14 | 87.671 |
| ISOBUTYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| DECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-CYMENE | 42 | 11.9 | 1.49 | 0 | 0.0 | 0.00 | 11 | 3.0 | 1.05 | 3.3 | 1.04 | 21.258 |
| INDAN(E) | 10 | 2.7 | 0.34 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.18 | 0.603 |
| 4-PHENYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| M-DIETHYLBENZENE | 13 | 3.5 | 0.44 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.7 | 0.23 | 4.688 |
| 1-METHYL-3-PROPYLBENZENE | 14 | 3.8 | 0.47 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.8 | 0.25 | 5.056 |
| N-BUTYLBENZENE/P-DIETHYLBENZENE | 11 | 3.0 | 0.37 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.20 | 2.575 |
| O-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLDECANE | 17 | 4.6 | 0.58 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.0 | 0.30 | 1.121 |
| BICYCLOPENTYL | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| UNDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,3,5-TRIMETHYLBENZENE | 25 | 7.0 | 0.87 | 0 | 0.0 | 0.00 | 6 | 1.7 | 0.59 | 1.9 | 0.61 | 19.364 |
| C7 OLEFINS | 13 | 3.5 | 0.44 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.7 | 0.23 | 3.275 |
| C8-C9 OLEFINS | 47 | 13.2 | 1.66 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 2.7 | 0.87 | 9.310 |
| C9-C11 PARAFFINS, OLEFINS, AROMATICS | 14 | 3.9 | 0.49 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.8 | 0.26 | 3.086 |
| FORMALDEHYDE | 53 | 14.7 | 1.84 | 0 | 0.0 | 0.01 | 1 | 0.3 | 0.09 | 3.1 | 0.99 | 22.336 |
| ACETALDEHYDE | 18 | 5.0 | 0.63 | 2 | 0.5 | 0.34 | 3 | 0.7 | 0.25 | 1.5 | 0.47 | 8.210 |
| ACROLEIN | 5 | 1.5 | 0.19 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.10 | 2.098 |
| ACETONE | 10 | 2.8 | 0.35 | 1 | 0.4 | 0.28 | 4 | 1.1 | 0.38 | 1.1 | 0.34 | 0.606 |
| PROPIONALDEHYDE | 3 | 0.7 | 0.09 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.05 | 0.985 |
| CROTONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTYRALDEHYDE | 1 | 0.3 | 0.04 | 0 | 0.0 | 0.00 | 1 | 0.2 | 0.06 | 0.1 | 0.04 | 0.629 |
| METHYL ETHYL KETONE | 1 | 0.3 | 0.04 | 0 | 0.0 | 0.00 | 1 | 0.2 | 0.06 | 0.1 | 0.04 | 0.141 |
| BENZALDEHYDE | 15 | 4.2 | 0.52 | 1 | 0.2 | 0.13 | 2 | 0.6 | 0.21 | 1.1 | 0.35 | -0.616 |
| HEXANALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.1 | 0.05 | 0 | 0.0 | 0.01 | 0.0 | 0.01 | 0.163 |

## TABLE C-4. 1992 CHEVROLET LUMINA, 98% PROPANE, TEST NO. L2-01-P98, 1/28/93

| COMPOUND | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| METHANE | 173 | 48.5 | 9.23 | 194 | 50.7 | 27.56 | 117 | 32.8 | 11.83 | 45.3 | 16.16 | 0.670 |
| ETHYLENE | 129 | 36.1 | 6.88 | 48 | 12.6 | 6.86 | 40 | 11.3 | 4.07 | 17.1 | 6.11 | 124.739 |
| ETHANE | 47 | 13.2 | 2.51 | 0 | 0.0 | 0.00 | 44 | 12.3 | 4.44 | 6.1 | 2.18 | 1.529 |
| ACETYLENE | 21 | 5.8 | 1.10 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.2 | 0.43 | 0.597 |
| PROPANE | 1269 | 355.5 | 67.69 | 453 | 118.2 | 64.32 | 740 | 206.6 | 74.63 | 191.8 | 68.44 | 92.050 |
| PROPYLENE | 63 | 17.7 | 3.36 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 3.7 | 1.31 | 34.456 |
| 1,3-BUTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTANE | 5 | 1.4 | 0.27 | 0 | 0.1 | 0.04 | 5 | 1.4 | 0.51 | 0.7 | 0.26 | 0.876 |
| BUTANE | 49 | 13.8 | 2.63 | 3 | 0.7 | 0.40 | 21 | 5.9 | 2.13 | 4.9 | 1.74 | 4.970 |
| 1-BUTENE | 3 | 0.9 | 0.17 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.06 | 1.605 |
| ISOBUTYLENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CIS-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1 | 0.2 | 0.08 | 0.1 | 0.02 | 0.592 |
| BENZENE | 18 | 5.1 | 0.97 | 0 | 0.0 | 0.00 | 14 | 4.0 | 1.45 | 2.2 | 0.77 | 0.907 |
| TOLUENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPRENE(2-METHYL-1,3-BUTADIENE) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CIS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| MTBE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-1-PENTENE/1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C6 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

## TABLE C-4 (CONT'D). 1992 CHEVROLET LUMINA, 98% PROPANE, TEST NO. L2-01-P98, 1/28/93

| COMPOUND | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| 2,4-DIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1,3-PENTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLPENTANE/2-METHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOHEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 5-METHYL-2-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| N-HEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4/2-5-DIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,3-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-3-HEPTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3,5,5-TRIMETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-/4-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5-DIMETHYL-1,5-HEXADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-ETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-CIS-4-DIMETHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| OCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5/3,5-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-XYLENE/M-XYLENE | 14 | 3.8 | 0.72 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.8 | 0.28 | 5.827 |
| 2-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-XYLENE | 6 | 1.7 | 0.32 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.12 | 2.230 |

## TABLE C-4 (CONT'D). 1992 CHEVROLET LUMINA, 98% PROPANE, TEST NO. L2-01-P98, 1/28/93

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| NONANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-NONENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PROPYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLOCTANE | 11 | 3.0 | 0.57 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.22 | 0.623 |
| O-ETHYLTOLUENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,2,4-TRIMETHYLBENZENE | 23 | 6.5 | 1.24 | 0 | 0.0 | 0.00 | 5 | 1.3 | 0.48 | 1.7 | 0.61 | 15.151 |
| ISOBUTYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| DECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-CYMENE | 5 | 1.3 | 0.25 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.10 | 1.763 |
| INDAN(E) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-PHENYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| M-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-METHYL-3-PROPYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| N-BUTYLBENZENE/P-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| BICYCLOPENTYL | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| UNDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,3,5-TRIMETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C7 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C8-C9 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C9-C11 PARAFFINS, OLEFINS, AROMATICS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| FORMALDEHYDE | 26 | 7.3 | 1.39 | 0 | 0.1 | 0.04 | 0 | 0.0 | 0.00 | 1.5 | 0.55 | 11.067 |
| ACETALDEHYDE | 8 | 2.3 | 0.43 | 1 | 0.2 | 0.10 | 1 | 0.3 | 0.09 | 0.6 | 0.23 | 3.525 |
| ACROLEIN | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ACETONE | 5 | 1.4 | 0.26 | 4 | 1.1 | 0.58 | 2 | 0.6 | 0.23 | 1.0 | 0.36 | 0.565 |
| PROPIONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CROTONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTYRALDEHYDE | 0 | 0.0 | 0.01 | 0 | 0.1 | 0.05 | 0 | 0.1 | 0.03 | 0.1 | 0.03 | 0.404 |
| METHYL ETHYL KETONE | 0 | 0.0 | 0.01 | 0 | 0.1 | 0.05 | 0 | 0.1 | 0.03 | 0.1 | 0.03 | 0.090 |
| BENZALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

# TABLE C-5. 1992 CHEVROLET LUMINA, MARKET HD5, TEST NO. L2-01-HD5, 2/2/93

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| METHANE | 130 | 36.2 | 7.51 | 161 | 41.6 | 24.30 | 128 | 35.8 | 9.48 | 38.9 | 13.32 | 0.576 |
| ETHYLENE | 144 | 39.9 | 8.27 | 96 | 24.8 | 14.48 | 21 | 5.9 | 1.56 | 22.8 | 7.79 | 165.902 |
| ETHANE | 86 | 23.8 | 4.93 | 0 | 0.0 | 0.00 | 79 | 22.2 | 5.88 | 11.0 | 3.77 | 2.750 |
| ACETYLENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PROPANE | 1251 | 347.6 | 72.06 | 399 | 102.9 | 60.11 | 1073 | 300.5 | 79.49 | 207.5 | 71.05 | 99.602 |
| PROPYLENE | 59 | 16.4 | 3.39 | 0 | 0.0 | 0.00 | 9 | 2.6 | 0.70 | 4.1 | 1.41 | 38.585 |
| 1,3-BUTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTANE | 10 | 2.8 | 0.57 | 0 | 0.1 | 0.06 | 8 | 2.1 | 0.56 | 1.2 | 0.41 | 1.460 |
| BUTANE | 13 | 3.7 | 0.76 | 0 | 0.0 | 0.01 | 6 | 1.7 | 0.44 | 1.2 | 0.42 | 1.248 |
| 1-BUTENE | 3 | 0.9 | 0.18 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.06 | 1.588 |
| ISOBUTYLENE | 2 | 0.4 | 0.09 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.03 | 0.473 |
| CIS-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| BENZENE | 2 | 0.7 | 0.14 | 4 | 0.9 | 0.55 | 0 | 0.0 | 0.00 | 0.6 | 0.22 | 0.267 |
| TOLUENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPENTANE | 19 | 5.2 | 1.09 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.1 | 0.37 | 1.498 |
| 1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PENTANE | 15 | 4.1 | 0.86 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.9 | 0.29 | 0.890 |
| 2-METHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPRENE(2-METHYL-1,3-BUTADIENE) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CIS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| MTBE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-1-PENTENE/1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C6 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

# TABLE C-5 (CONT'D). 1992 CHEVROLET LUMINA, MARKET HD5, TEST NO. L2-01-HD5, 2/2/93

| COMPOUND | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| 2,4-DIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1,3-PENTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLPENTANE/2-METHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOHEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 5-METHYL-2-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| N-HEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4/2-5-DIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,3-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-3-HEPTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3,5,5-TRIMETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-/4-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5-DIMETHYL-1,5-HEXADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-ETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-CIS-4-DIMETHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| OCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5/3,5-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-XYLENE/M-XYLENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.8 | 0.28 | 0.000 |
| 2-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-XYLENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.12 | 0.000 |

## TABLE C-5 (CONT'D). 1992 CHEVROLET LUMINA, MARKET HD5, TEST NO. L2-01-HD5, 2/2/93

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| NONANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-NONENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PROPYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-ETHYLTOLUENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,2,4-TRIMETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| DECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-CYMENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| INDAN(E) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-PHENYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| M-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-METHYL-3-PROPYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| N-BUTYLBENZENE/P-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| BICYCLOPENTYL | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| UNDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,3,5-TRIMETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C7 OLEFINS | 0 | 0.0 | 0.00 | 2 | 0.5 | 0.26 | 23 | 6.3 | 1.67 | 2.0 | 0.67 | 8.841 |
| C8-C9 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C9-C11 PARAFFINS, OLEFINS, AROMATICS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| FORMALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.1 | 0.04 | 1 | 0.2 | 0.04 | 0.1 | 0.03 | 0.581 |
| ACETALDEHYDE | 0 | 0.0 | 0.01 | 1 | 0.3 | 0.18 | 1 | 0.2 | 0.06 | 0.2 | 0.08 | 1.266 |
| ACROLEIN | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ACETONE | 2 | 0.5 | 0.10 | 0 | 0.0 | 0.00 | 1 | 0.4 | 0.11 | 0.2 | 0.07 | 0.119 |
| PROPIONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CROTONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTYRALDEHYDE | 0 | 0.1 | 0.02 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.01 | 0.099 |
| METHYL ETHYL KETONE | 0 | 0.1 | 0.02 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.01 | 0.022 |
| BENZALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

## TABLE C-6. 1992 CHEVROLET LUMINA, 98% PROPANE, TEST NO. L2-03-P98, 2/23/93

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| METHANE | 181 | 50.5 | 10.32 | 130 | 33.7 | 40.26 | 130 | 36.2 | 21.40 | 37.9 | 19.82 | 0.560 |
| ETHYLENE | 131 | 36.4 | 7.45 | 0 | 0.0 | 0.00 | 2 | 0.5 | 0.31 | 7.7 | 4.02 | 55.980 |
| ETHANE | 27 | 7.6 | 1.55 | 24 | 6.2 | 7.42 | 24 | 6.6 | 3.93 | 6.6 | 3.46 | 1.654 |
| ACETYLENE | 4 | 1.2 | 0.25 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.13 | 0.125 |
| PROPANE | 1145 | 319.0 | 65.22 | 159 | 41.2 | 49.16 | 428 | 119.2 | 70.46 | 120.1 | 62.84 | 57.625 |
| PROPYLENE | 73 | 20.3 | 4.15 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 4.2 | 2.20 | 39.444 |
| 1,3-BUTADIENE | 2 | 0.6 | 0.13 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.07 | 1.408 |
| ISOBUTANE | 3 | 1.0 | 0.20 | 0 | 0.1 | 0.08 | 1 | 0.3 | 0.17 | 0.3 | 0.16 | 0.374 |
| BUTANE | 42 | 11.6 | 2.37 | 1 | 0.2 | 0.26 | 7 | 2.0 | 1.16 | 3.1 | 1.60 | 3.113 |
| 1-BUTENE | 4 | 1.1 | 0.22 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.12 | 1.991 |
| ISOBUTYLENE | 2 | 0.4 | 0.09 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.05 | 0.475 |
| CIS-2-BUTENE | 0 | 0.0 | 0.01 | 0 | 0.1 | 0.06 | 1 | 0.3 | 0.15 | 0.1 | 0.06 | 1.072 |
| TRANS-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| BENZENE | 13 | 3.5 | 0.72 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.7 | 0.38 | 0.305 |
| TOLUENE | 10 | 2.9 | 0.60 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.32 | 1.652 |
| ISOPENTANE | 5 | 1.5 | 0.30 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.16 | 0.421 |
| 1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPRENE(2-METHYL-1,3-BUTADIENE) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CIS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLPENTANE | 4 | 1.2 | 0.25 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.13 | 0.382 |
| 4-METHYL-2-PENTENE | 4 | 1.2 | 0.24 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.2 | 0.13 | 1.630 |
| MTBE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLPENTANE | 5 | 1.5 | 0.31 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.16 | 0.471 |
| 2-METHYL-1-PENTENE/1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C6 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

## TABLE C-6 (CONT'D). 1992 CHEVROLET LUMINA, 98% PROPANE, TEST NO. L2-03-P98, 2/23/93

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| 2,4-DIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1,3-PENTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLPENTANE/2-METHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOHEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 5-METHYL-2-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| N-HEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4/2-5-DIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,3-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-3-HEPTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3,5,5-TRIMETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-/4-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5-DIMETHYL-1,5-HEXADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-ETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-CIS-4-DIMETHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| OCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5/3,5-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ETHYLBENZENE | 5 | 1.4 | 0.28 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.15 | 0.756 |
| 2,3-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-XYLENE/M-XYLENE | 12 | 3.4 | 0.70 | 0 | 0.0 | 0.00 | 5 | 1.5 | 0.90 | 1.1 | 0.59 | 8.310 |
| 2-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-XYLENE | 5 | 1.3 | 0.27 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.14 | 1.745 |

## TABLE C-6 (CONT'D). 1992 CHEVROLET LUMINA, 98% PROPANE, TEST NO. L2-03-P98, 2/23/93

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| NONANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-NONENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PROPYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLOCTANE | 7 | 2.0 | 0.41 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.4 | 0.22 | 0.416 |
| O-ETHYLTOLUENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,2,4-TRIMETHYLBENZENE | 17 | 4.8 | 0.99 | 7 | 1.7 | 2.07 | 6 | 1.6 | 0.97 | 2.3 | 1.23 | 20.715 |
| ISOBUTYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| DECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-CYMENE | 7 | 1.9 | 0.40 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.4 | 0.21 | 2.583 |
| INDAN(E) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-PHENYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| M-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-METHYL-3-PROPYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| N-BUTYLBENZENE/P-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| BICYCLOPENTYL | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| UNDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,3,5-TRIMETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C7 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C8-C9 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C9-C11 PARAFFINS, OLEFINS, AROMATICS | 5 | 1.4 | 0.28 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.3 | 0.15 | 1.067 |
| FORMALDEHYDE | 26 | 7.4 | 1.50 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.5 | 0.80 | 10.889 |
| ACETALDEHYDE | 8 | 2.2 | 0.46 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.24 | 2.549 |
| ACROLEIN | 2 | 0.7 | 0.13 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.07 | 0.917 |
| ACETONE | 4 | 1.0 | 0.21 | 2 | 0.5 | 0.61 | 3 | 0.8 | 0.50 | 0.7 | 0.37 | 0.396 |
| PROPIONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CROTONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTYRALDEHYDE | 0 | 0.1 | 0.02 | 0 | 0.0 | 0.04 | 0 | 0.1 | 0.03 | 0.0 | 0.03 | 0.261 |
| METHYL ETHYL KETONE | 0 | 0.1 | 0.02 | 0 | 0.0 | 0.04 | 0 | 0.1 | 0.03 | 0.0 | 0.03 | 0.059 |
| BENZALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

## TABLE C-7. 1992 CHEVROLET LUMINA, MARKET HD5, TEST NO. L2-03-HD5, 2/26/93

| COMPOUND | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| METHANE | 210 | 58.7 | 12.36 | 132 | 34.4 | 41.57 | 107 | 30.0 | 19.07 | 38.2 | 20.71 | 0.566 |
| ETHYLENE | 128 | 35.8 | 7.53 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 7.4 | 4.02 | 54.049 |
| ETHANE | 43 | 11.9 | 2.51 | 51 | 13.3 | 16.10 | 33 | 9.1 | 5.77 | 11.9 | 6.43 | 2.965 |
| ACETYLENE | 27 | 7.5 | 1.58 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 1.6 | 0.84 | 0.778 |
| PROPANE | 1133 | 316.5 | 66.61 | 132 | 34.2 | 41.33 | 412 | 115.0 | 73.15 | 114.9 | 62.27 | 55.143 |
| PROPYLENE | 67 | 18.7 | 3.93 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 3.9 | 2.10 | 36.415 |
| 1,3-BUTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTANE | 11 | 3.0 | 0.62 | 0 | 0.0 | 0.05 | 2 | 0.5 | 0.31 | 0.8 | 0.42 | 0.929 |
| BUTANE | 5 | 1.4 | 0.30 | 0 | 0.1 | 0.11 | 2 | 0.5 | 0.33 | 0.5 | 0.27 | 0.500 |
| 1-BUTENE | 2 | 0.7 | 0.14 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.07 | 1.205 |
| ISOBUTYLENE | 1 | 0.2 | 0.05 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.02 | 0.239 |
| CIS-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| BENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TOLUENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOPRENE(2-METHYL-1,3-BUTADIENE) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CIS-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-2-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLBUTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| MTBE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-1-PENTENE/1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C6 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

TABLE C-7 (CONT'D). 1992 CHEVROLET LUMINA, MARKET HD5, TEST NO. L2-01-HD5, 2/26/93

| COMPOUND | BAG 1 MG | BAG 1 MG/MI | BAG 1 WGT. % | BAG 2 MG | BAG 2 MG/MI | BAG 2 WGT. % | BAG 3 MG | BAG 3 MG/MI | BAG 3 WGT. % | FTP TOTAL MG/MI | FTP TOTAL WGT. % | FTP TOTAL OZONE MG/MI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,4-DIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOPENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYL-1,3-PENTADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLPENTANE/2-METHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| CYCLOHEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 5-METHYL-2-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| N-HEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,4-TRIMETHYL-1-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| METHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4,4-TRIMETHYL-2-PENTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4/2-5-DIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,4-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,3-TRIMETHYLPENTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYL-3-HEPTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3,5,5-TRIMETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-/4-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5-DIMETHYL-1,5-HEXADIENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,2,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-ETHYL-1-HEXENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-CIS-4-DIMETHYLCYCLOHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| OCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3,5-TRIMETHYLHEXANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,4-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,5/3,5-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLHEPTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-XYLENE/M-XYLENE | 8 | 2.4 | 0.50 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.5 | 0.27 | 3.611 |
| 2-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 3-METHYLOCTANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-XYLENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

## TABLE C-7 (CONT'D). 1992 CHEVROLET LUMINA, MARKET HD5, TEST NO. L2-03-HD5, 2/26/93

| | BAG 1 | | | BAG 2 | | | BAG 3 | | | FTP TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMPOUND | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG | MG/MI | WGT. % | MG/MI | WGT. % | OZONE MG/MI |
| NONANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| TRANS-2-NONENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| PROPYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2,3-DIMETHYLOCTANE | 10 | 2.7 | 0.57 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.6 | 0.31 | 0.571 |
| O-ETHYLTOLUENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,2,4-TRIMETHYLBENZENE | 18 | 5.0 | 1.06 | 0 | 0.0 | 0.00 | 5 | 1.4 | 0.87 | 1.4 | 0.77 | 12.517 |
| ISOBUTYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| DECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| P-CYMENE | 6 | 1.7 | 0.36 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.4 | 0.19 | 2.260 |
| INDAN(E) | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 4-PHENYL-1-BUTENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| M-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1-METHYL-3-PROPYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| N-BUTYLBENZENE/P-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| O-DIETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 2-METHYLDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| BICYCLOPENTYL | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| UNDECANE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| 1,3,5-TRIMETHYLBENZENE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C7 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C8-C9 OLEFINS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| C9-C11 PARAFFINS, OLEFINS, AROMATICS | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| FORMALDEHYDE | 20 | 5.7 | 1.19 | 0 | 0.1 | 0.15 | 0 | 0.0 | 0.00 | 1.2 | 0.67 | 8.858 |
| ACETALDEHYDE | 5 | 1.5 | 0.31 | 0 | 0.0 | 0.01 | 0 | 0.0 | 0.03 | 0.3 | 0.17 | 1.768 |
| ACROLEIN | 1 | 0.4 | 0.09 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.05 | 0.568 |
| ACETONE | 3 | 0.9 | 0.19 | 2 | 0.6 | 0.69 | 3 | 0.7 | 0.47 | 0.7 | 0.37 | 0.385 |
| PROPIONALDEHYDE | 1 | 0.3 | 0.06 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.1 | 0.03 | 0.397 |
| CROTONALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| ISOBUTYRALDEHYDE | 0 | 0.1 | 0.02 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.01 | 0.113 |
| METHYL ETHYL KETONE | 0 | 0.1 | 0.02 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.01 | 0.025 |
| BENZALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |
| HEXANALDEHYDE | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0 | 0.0 | 0.00 | 0.0 | 0.00 | 0.000 |

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**15. Supplementary Notes**

**16. Abstract** (Limit: 200 words)
Three liquefied propane gas (LPG) conversion kits were evaluated on a Chevrolet Lumina. The objective of the project was to measure the Federal Test Procedure emissions and the fuel economy of these kits, and compare their performance to the vehicle's operation on gasoline. The three kits were also compared to each other. Study conclusions and recommendations are included.

**17. Document Analysis**
**a. Descriptors**
alternative fuels, liquefied propane gas, conversion kits

**b. Identifiers/Open-Ended Terms**

**c. UC Categories** 335

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