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I am submitting herewith a thesis written by Charles Scott Sluder entitled "Development of a Method for Determining Exhaust Emissions and Fuel Consumption of Vehicles in On-Road Operation." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Mechanical Engineering.

Dr. J.W. Hodgson, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor and
Dean of The Graduate School

# Development of a Method for Determining Exhaust Emissions and Fuel Consumption Of Vehicles In On-Road Operation

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Charles Scott Sluder

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This thesis is dedicated to my parents

Jerry and Dianne Sluder

who always been supportive

and encouraged me in

my pursuits, whatever they

happened to be.

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# ABSTRACT

Interest in the contribution of automobiles to air pollution has caused review of the current emissions testing procedures in use in the United States and elsewhere. Specifically, concern has arisen that current mobile source inventory tools do not adequately model actual driving behavior and therefore do not accurately predict the fuel consumption and emissions from vehicles. By including the actual driving conditions vehicles experience during operation, a database of emissions and fuel consumption values can be constructed using data from actual driving conditions.

A method is described for measuring the tailpipe emissions and fuel consumption of vehicles operating in realistic on-road conditions. The method, which focuses on the calibration of a chassis dynamometer for use in modeling on-road driving conditions, is demonstrated on a 1988 Chevrolet Corsica and the results are presented for this vehicle.

The results support the conclusion that this method is suitable for measuring the emissions and fuel consumption of vehicles in on-road operation for the purposes of developing emission factors for atmospheric models.

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# LIST OF SYMBOLS

| | |
|---|---|
| AAMA | American Automobile Manufacturer's Association |
| ALDL | Assembly Line Diagnostic Link |
| AOM | Analog Output Module |
| C3H8 | Propane |
| CARB | California Air Resources Board |
| CLD | Photochemiluminescence Detector |
| CO | Carbon Monoxide |
| CO2 | Carbon Dioxide |
| DAS | Data Acquisition System |
| ECM | Engine Control Module |
| EPA | Environmental Protection Agency |
| FID | Flame Ionization Detector |
| FTP | Federal Test Procedure |
| MPH | Miles Per Hour |
| NDIR | Non-dispersive Infrared analyzer |
| NOx | Oxides of Nitrogen |
| O2 | Oxygen |
| PMD | Paramagnetic Detector |
| RPM | Revolutions Per Minute |
| THC | Total Hydrocarbons |

# CHAPTER I
# INTRODUCTION

In an effort to lessen the environmental repercussions from the operation of modern vehicles, the automotive industry is working to decrease fuel consumption and vehicle exhaust emissions. One important step in this process is the ability to measure tailpipe emissions and fuel consumption in transient on-road conditions.

There are several reasons why the testing of fuel consumption and tailpipe emissions in on-road operation in important. First of all, improvements in vehicle emissions control technology are driven by air quality legislation. Air quality models depend upon emission factors to quantify emissions from mobile sources. As air quality standards continue to become more stringent, the significance of these factors is increasing. Efforts at improving the models which predict these emissions factors demand a more in depth understanding of the relationships between vehicle operating parameters and tailpipe emissions and fuel consumption. This can be accomplished by testing these parameters in on-road operation (1,2). Secondly, as emissions and fuel consumption standards for automobiles become more demanding, testing adequate to certify vehicles to the tougher standards must be developed. Current emissions testing cycles fail to duplicate the on-road behavior of drivers (1,2). Improvements to testing such as the inclusion of a much wider range of vehicle operation will enable emissions test cycles to more accurately model on-road behavior. Information about the on-road behavior of automobile exhaust emissions and fuel consumption is therefore essential to the

development of better test methods (1-3). Thirdly, one of the most important variables in the tailpipe emissions and fuel consumption equation is the cycle over which a given vehicle is operated. With improved modeling of emissions and fuel consumption the construction of new roadways can be planned in such a way as to reduce exhaust emissions and fuel consumption. Accurate modeling requires knowledge of the transient behavior of emissions and fuel consumption in a multitude of operating modes (1-4).

# CHAPTER II
# BACKGROUND

## The Environmental Imperative

It is a documented fact that each of the major pollutants emitted from automobiles has an adverse effect upon the environment, but how serious are these effects? They range from acid rain to acute toxic effects and can even be fatal in high concentrations. Carbon monoxide is known to cause dizziness at levels as low as approximately 100 parts per million. Nitrogen oxides can cause acid rain. Exposure to unburned hydrocarbons can cause problems as mild as sneezing to increased risk of cancer (5). In addition, the combination of unburned hydrocarbons and oxides of nitrogen in the presence of sunlight can form ground level ozone. Although ozone is desirable in the stratosphere, it causes several problems, such as respiratory problems and stunted vegetation, when it occurs at ground level (6).

## Air Quality: The Continuing Challenge

According to legislated emissions standards, hydrocarbon and carbon monoxide emissions from automotive exhaust have been reduced to 4% of their late 1960's grams per mile levels. (See Table 1.) Although information about motor vehicle in use emissions is incomplete, it is good enough to estimate that the actual levels of these pollutants are 5 to 10 times higher than current standards. This suggests that the reduction since the late

1960's has been at best 50%, rather than the 96% target of the law (7). A recent study by the California Air Resource Board (CARB) indicates that as much as 77% of the carbon monoxide present in the atmosphere in urban areas is due to the emissions from motor vehicles (6).

Table 1: Passenger Car Exhaust Emission Reduction Progress
Federal 49 State Standards (Grams per Mile)

| Model Year | Hydrocarbons | Carbon Monoxide | Nitrogen Oxides |
|---|---|---|---|
| PreControl* | 10.60 | 84.00 | 4.10 |
| 1968-1971** | 4.10 | 34.00 | NR |
| 1972-1974** | 3.00 | 28.00 | 3.10 |
| 1975-1976 | 1.50 | 15.00 | 3.10 |
| 1977-1979 | 1.50 | 15.00 | 2.00 |
| 1980 | 0.40 | 7.00 | 2.00 |
| 1981-1982 | 0.40 | 3.4(1) | 1.00 |
| 1983-1993 | 0.40 | 3.40 | 1.0(2) |
| 1994 | 0.25 | 3.40 | 0.40 |
| 2004 | 0.13 | 1.70 | 0.20 |

* AAMA 1960 baseline data

** Pre-1975 standards have been adjusted according to current test procedure. EPA data.

(1) Waivers allowed manufacturers to use 7.0 grams per mile CO for 1981-82 model years.

(2) Waivers allowed 1.5 grams per mile $NO_x$ for light-duty diesel engines only through the 1984 model year.

Source: "Facts and Figures '93", American Automobile Manufacturers Association.

How is this possible? The current emissions test procedure in use in the United States is the 1975 Federal Test Procedure, a statistical average driving cycle which is traceable to the Los Angeles urban area. The test is broken into three phases: a cold transient phase, a stabilized phase, and a hot transient phase. The hot transient phase is performed after the car has cooled with the engine off for ten minutes, and is simply a repeat of the cold transient phase driving pattern. Figure 1 shows the cold transient and stabilized driving pattern of the FTP. Driving conditions which are not a part of the FTP are therefore not regulated (1,8). Since the FTP has a relatively mild acceleration pattern, wide open throttle is not used except for very low performance vehicles. To make matters worse, the trend to smaller engines has resulted in higher throttle positions during acceleration events. From a single instrumented vehicle it was found that a high-power acceleration on a freeway entrance ramp produced more carbon monoxide than for a moderate two hour drive in that same vehicle (7). Frequent starting of a vehicle in cold weather also brings on enrichment, and is similarly off-cycle because the FTP is conducted with the vehicle initially soaked at between 68 and 86 °F.

This fact has led the United States Environmental Protection Agency (EPA), the agency responsible for automobile emissions certification, to consider changing the current emissions testing procedure. The EPA is investigating the current in-use operation of modern vehicles in an effort to characterize the events which fall outside the rules established by the FTP. Principally, these events are expected to include cold starts, high rates of acceleration, and grade effects. Since no one cycle can accurately represent all possible modes of vehicle operation, EPA expects to derive one or more

new cycles in addition to modifying the FTP, should studies show that changes will benefit air quality and lead to better automobile emissions control systems (9).

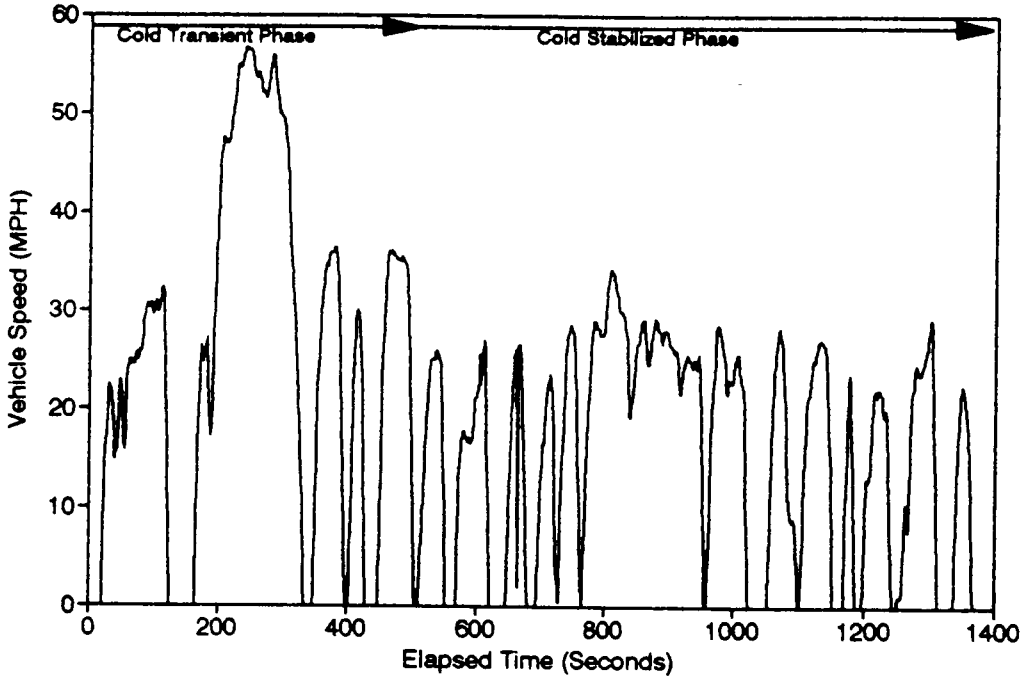



Figure 1: The Federal Test Procedure Cold Transient and Stabilized Phases.

## Real Time Emissions Testing

Current emissions testing protocol requires that the vehicle be exercised on a chassis dynamometer according to a specific speed-time trace (10). The exhaust of the vehicle is then diluted and representative samples are collected. The emissions are measured from the collected exhaust of the vehicle and represent a mass average over the distance "travelled" while the exhaust was collected. Real-time emissions measurements in contrast measure the concentrations of the regulated pollutants as they are emitted. Real-time measurements of emissions could, in theory, allow correlation of the measured

emissions to the vehicle instantaneous operating parameters (such as speed, acceleration, throttle position, and others) at the time of the emission. This is not done in the current EPA emissions testing protocols.

## On-Road Testing

There are at least two ways of testing the exhaust emissions of vehicles in on-road operation. Much effort has been spent on the development of remote sensing systems capable of reliably testing the emissions from vehicles as they pass a sensor on a stretch of road. This form of testing represents a cost-effective method for testing large numbers of cars in large numbers of operating conditions in on-road operation and preliminary studies using a specially configured test vehicle which could both vary and monitor its own emissions show a reasonable correlation between the remotely sensed emissions levels and the actual levels measured by the vehicle for carbon monoxide. Unfortunately, the correlation of these two measurements for hydrocarbon emissions was unacceptable due to low hydrocarbon emission rates and the inability of the remote sensor to measure low concentrations of hydrocarbons (11). Oxides of nitrogen were not measured due to the lack of a remote sensor suitable for their measurement. Although these approaches are suitable for identifying high emission vehicles, they are not currently sufficient for generating data to be used in emissions models, however remote sensor technology is advancing rapidly (8). No sensor currently exists for the remote measurement of fuel consumption.

This leaves the use of instrumented vehicles as the best near-term method for measuring the on-road emissions and fuel consumption of modern vehicles. By creating a reasonable cost technology for measurement of tailpipe emissions in driving, followed by a series of experiments on samples of vehicles, data could be generated which would suggest the direction for more reliable systems of regulation and testing (7). In fact, it has been demonstrated that driving behavior can be characterized by measuring variables such as vehicle speed, manifold absolute pressure, and engine speed in instrumented vehicles (3). By including other variables which influence tailpipe emissions such as coolant temperature, intake air temperature, instantaneous acceleration, throttle position, and fuel consumption a description of the vehicle's operating parameters can be made at any operating point. Given these measurements, the point could then be duplicated on a chassis dynamometer and the vehicle's emissions determined in real-time. This method of matching on-road data to dynamometer simulation has been shown to be successful in the past (12). This data would then lead to better understanding of the cause-effect relationships between vehicle activity and tailpipe emissions. This understanding could in turn lead to improved methods of traffic metering and control and improved air quality regulation.

# CHAPTER III
# THE PROBLEM

## Theoretical Framework

The operating point of an engine can be defined by noting the values of several operational parameters. Most often these parameters consist simply of the engine speed and a variable indicative of engine load, such as manifold absolute pressure. Other variables which are important in defining the operating point of an engine are coolant temperature, air consumption, fuel consumption, and throttle position (1,2,13). If vehicle speed and vehicle acceleration are added to this list, the operating point of a vehicle can also be defined (2-4,12).

Unfortunately, equipping a vehicle with exhaust analysis equipment is not currently feasible for several reasons. Most models of the gas analysis equipment required are bulky and could not easily be incorporated into average sized vehicles. Further, these instruments require a power supply which is not currently available in vehicles. Even if the instruments could be placed in a vehicle their added weight and electrical requirements would place an uncharacteristic demand upon the engine, thereby changing the characteristic operating points of the vehicle. Although some smaller models have been developed, many of them use infrared detection of hydrocarbons. This method of measuring hydrocarbons is not as accurate as flame ionization detection. In either case, the response time of the measurement system is likely to be long enough to preclude good

measurements because the vehicle cannot be driven at steady conditions long enough to reach a steady measurement. Therefore, emissions testing should be undertaken on a chassis dynamometer by duplicating the on-road operation of a vehicle on the dynamometer.

The resulting emissions measurements will only be of value if the dynamometer simulation of on-road driving is accurate. Calibration of chassis dynamometers has been performed in the past according to several methods. Perhaps the best means of calibrating a dynamometer is the measurement of wheel torque under both steady speeds and with the vehicle accelerating. Calibration is then completed by reproducing these points on the dynamometer (14). For a given engine, the torque output at a given speed is a function of the amount of air and of fuel consumed (13,15). If the intake system, exhaust system, and control scheme of the engine are unchanged, then the closed-loop air fuel ratio and volumetric efficiency of the engine at a given speed are constant. Hence, measurement of the fuel consumption of a vehicle at a given steady speed will be indicative of the wheel torque of the vehicle at that speed, provided that the engine is warmed up and in closed-loop mode. Thus, measurement of the fuel consumption of the vehicle can also be used to calibrate the resistance of a chassis dynamometer. Similarly, the air consumption of a vehicle might also be used to calibrate a chassis dynamometer.

Transient analysis of the exhaust emissions and fuel consumption of a vehicle operating in a realistic on-road manner require that the time response of the measurement systems be characterized (16, 17). The response time of the fuel flow measurement system is simply a function of the design of the instrument being used. However, the

response time of an emissions measurement system can be broken into two parts. The first, transport time, is the amount of time needed for a sample of gas to travel from the vehicle exhaust to the emissions analyzers. The second, response time, is the amount of time required for the instrument to change from the current reading to the new reading. Both of these parts are a function of the flow system which moves exhaust gas from the vehicle exhaust to the analyzers.

For example, a non-dispersive infrared analyzer measuring carbon monoxide works on the principle that carbon monoxide absorbs infrared light in a certain wavelength band. The analyzer sample cell has a gas inlet at one end and an exit at the other. An infrared light of the appropriate frequency shines from one end to the other. The concentration of the carbon monoxide is measured by the amount of absorbed infrared light. The amount of time required for the analyzer to change from one steady reading to another is related to the amount of time necessary to fill the sample cell with the gas containing the new concentration of carbon monoxide. This in turn is related to the flow rate of exhaust gas to the analyzer and the volume of the sample cell. The gas transport time is also related to the flow rate of exhaust gas. The higher the flow rate, the lower the gas transport time and the lower the instrument response time. By taking steps to improve the flow rate of exhaust gas to the emissions analyzers, their total response time can be improved. By providing a step change in gas concentration and noting the output of a given analyzer, its total response time can be characterized.

## Statement of the Problem

The purpose of this study is to develop a method for determining the on-road emissions and fuel consumption of modern vehicles. The strategy used to accomplish this task was to define the vehicle's on-road operating envelope, followed by dynamometer measurement of emissions at specific operating points.

The speed of a vehicle over level road is a function of the engine speed and gear ratio. Similarly, the acceleration of a vehicle is a function of the engine speed, engine load, and gear ratio. Tailpipe emissions and fuel consumption are both functions of the engine speed and engine load. Therefore, the emissions and fuel consumption of a vehicle can be related to the vehicle's speed and acceleration, since these two quantities are in turn related to the engine speed and engine load for a given gear ratio.

Characterization of the vehicle's operating envelope requires extensive testing of the vehicle on-road. If the vehicle has a manual transmission, several fixed throttle position acceleration tests must be completed in each gear. Similarly, several fixed throttle deceleration tests must also be completed. Lastly, steady speed tests at several speeds for each gear must be accomplished. The result of this testing is an envelope of accelerations which are possible at each vehicle speed. The vehicle actual acceleration at any speed, and hence the fuel consumption and tailpipe emissions, is then dependent upon the throttle position and gear ratio. Hence, by completely defining the vehicle as described followed by measurement of the tailpipe emissions and fuel consumption during identical tests

performed on a chassis dynamometer, a database can be assembled which relates speed and acceleration to tailpipe emissions and fuel consumption (18).

Analysis of fuel consumption and emissions in real time implies that the response time of each of these measurement systems must be known. Since any mechanical measurement system cannot respond instantaneously, the time necessary for it to respond must be determined, and taken into account in any attempt to correlate its measurement in a cause-effect relationship (16, 17). Consider, for example, the response of the simplest of systems, a first order system. The time response of such a system to a step input is shown in figure 2. Note that if a reading were taken before the instrument output had settled, significant error would have been induced.

Thus, with a calibrated dynamometer, a properly instrumented vehicle, and emissions and fuel consumption measurement equipment with known measurement characteristics, on-road measurement of tailpipe emissions and fuel consumption should be possible.

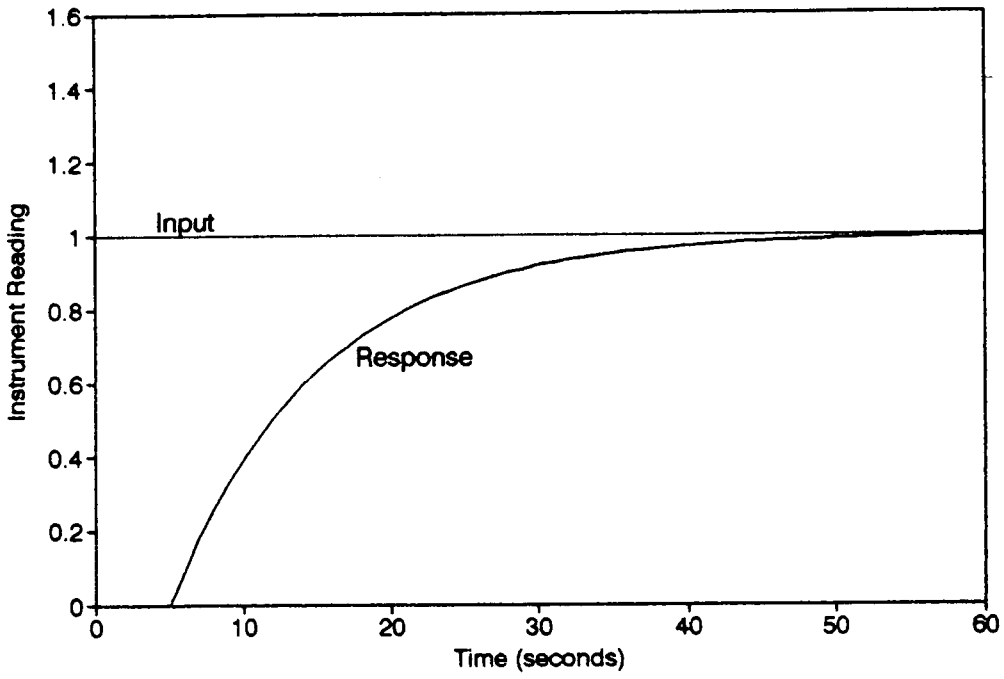



Figure 2: Time response of a first order system with a time constant of 10 seconds and a time delay of 5 seconds.

# CHAPTER IV
# EQUIPMENT

## Test Vehicle

As the nature of this study is to better understand the problem of emissions and fuel consumption of vehicles in normally occurring modes of operation, the vehicle selected should be of a common type. The vehicle chosen for this study was a production 1988 Chevrolet Corsica sedan, which is a typical midsize modern vehicle. The vehicle is powered by the stock 2.8 liter, port fuel injected V-6 engine, which is controlled by a mass air flow type control scheme. In this scheme, the engine control module (ECM) measures the amount of air being inducted at a given time and injects the amount of fuel appropriate to the measured air flow. The ECM operated in closed loop mode by utilizing feedback from an exhaust gas oxygen sensor mounted in the exhaust stream upstream of the catalytic converter. By sensing the oxygen present in the exhaust, the engine controller can adjust the amount of fuel injected to produce a stoichiometric air fuel ratio during closed loop operation.

Several modifications were made to the test vehicle in order to accommodate the instrumentation. First of all, exhaust sampling ports were installed upstream and downstream of the catalyst to enable the sampling of exhaust gas at these points by a sampling system separate from the vehicle. The sample ports were designed in such a way as to draw gas from a cross section of the exhaust pipe, rather than merely drawing gas

from a point on its circumference. These ports were plugged when the exhaust sampling equipment was not in use. Figure 3 shows a typical sampling tube.

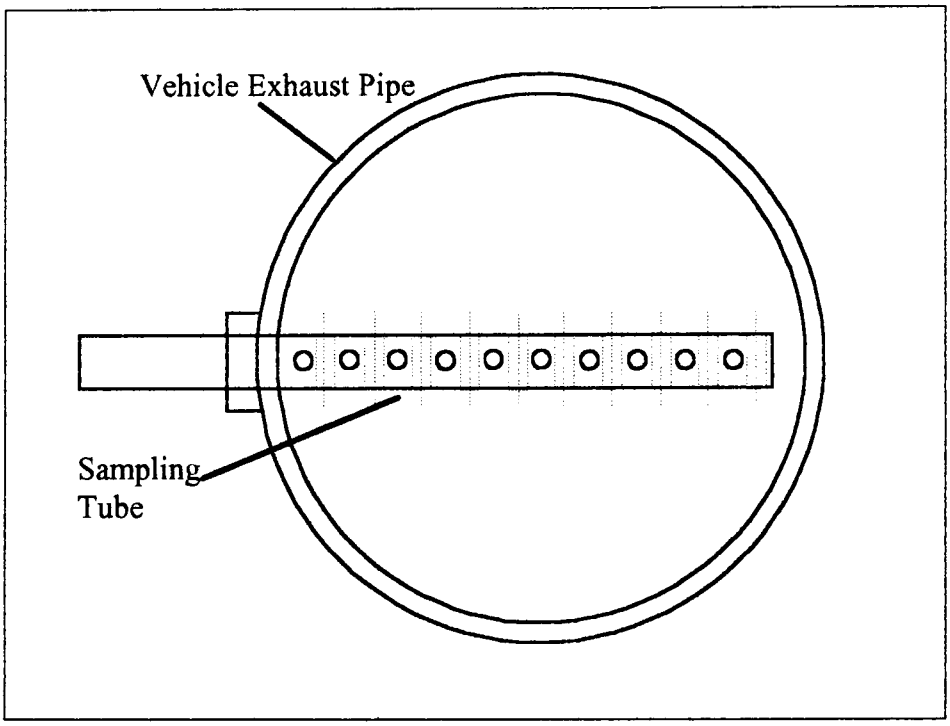



Figure 3: Sketch of a typical sampling tube and installation.

Secondly, the fuel delivery system on the vehicle was modified to permit the installation of a fuel flow measurement system. Since the engine is fuel injected, the fuel rail pressure is regulated so that the fuel injectors experience a constant pressure difference between the fuel rail and the intake manifold. Fuel is also circulated through the fuel rail to keep the fuel in the rail cool. Thus fuel flows into and out of the fuel rail as depicted in figure 4. The net flow rate of fuel to the engine is the difference between the supply flow and the return flow. Thus, the fuel flow measurement system required that

both fuel streams be interrupted and the flow meter inserted. This is discussed in more detail in the next section.

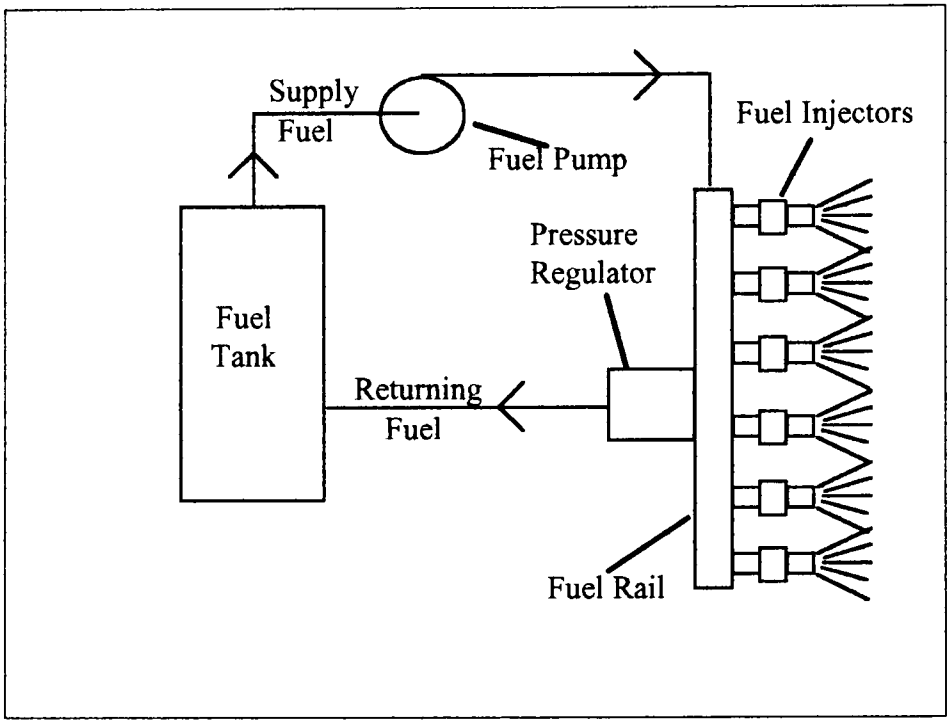



Figure 4: A typical fuel flow configuration for a fuel injected engine.

Thirdly, since operation of a vehicle on a chassis dynamometer does not generate significant amounts of airflow past the vehicle the engine oil temperatures can become excessive when a vehicle is tested in this manner. To alleviate this problem the vehicle was fitted with an external oil cooler that used ordinary tap water to cool the engine oil. The flow of water was controlled manually in such a way as to maintain the engine oil temperature in the range typically encountered in normal driving situations. The oil

temperature was monitored by using a type K thermocouple and a microprocessor thermocouple readout.

Lastly, the engine's electrical wiring was modified such that the fuel injector driving frequency, the fuel injector pulsewidth, and the mass airflow sensor output could be measured and recorded independently of the engine control unit. These connections were made in such a way as to not interfere with normal operation.

## Fuel Flow Measurement System

The fuel flow measurement system was used to measure the net fuel flow from the fuel tank. Since the returning stream is in general, at a higher temperature than the supply stream, density effects must also be measured. Further, this elevated temperature can lead to vaporization of the fuel in the fuel lines and gases dissolved in the fuel can also be released. The vapor and released gases must be removed in order to facilitate an accurate flow measurement. The flow measurement system chosen for this study was the Max Machinery model 710 Fuel Flow Measurement System. This system features a heat exchanger which uses a stream of fuel leaving the tank to cool the return stream. This unit also features a vapor eliminator. The unit operates by pumping fuel from the tank through a vapor eliminator, a piston flow meter, and into a level control unit. The return stream is also directed into this level control unit after being cooled by an integral heat exchanger. Fuel is then pumped from the level control unit to the engine. By controlling the level of the fuel in the level control unit, the amount of fuel being pumped from the tank can be

controlled. Since fuel is returned to this unit from the engine, the net fuel being pumped from the tank must then be the amount of fuel actually consumed by the engine at a given time. By using this scheme, it is possible to measure the amount of fuel being pumped from the tank. The flowmeter is a piston flowmeter, which is a positive displacement type flowmeter (see figure 5). The flow of fuel through the flowmeter acts against pistons which are placed radially around a central shaft and causes the pistons to move, which, in turn, causes the shaft to rotate. The rotational speed of the shaft is then indicative of the volumetric flow rate of fuel through the flowmeter. The fuel flow measurement system setup is depicted schematically in figure 6.

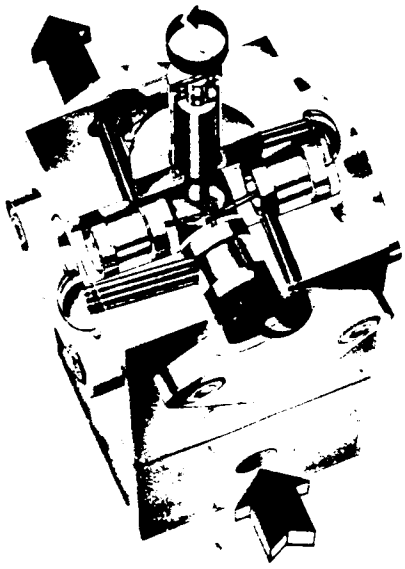


Illustration courtesy of Max Machinery, Incorporated.

Figure 5: Max 213-310 piston flowmeter.

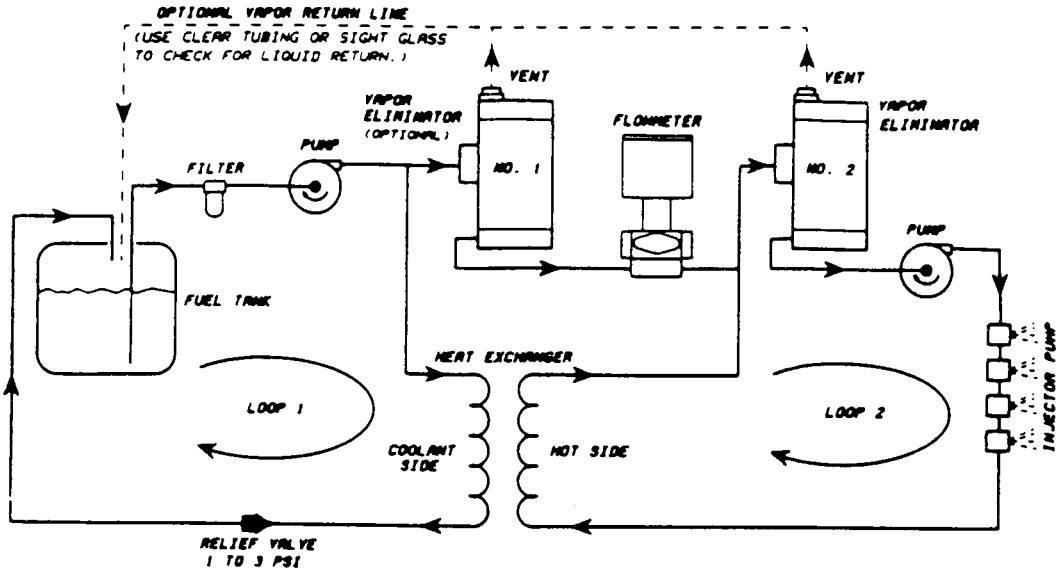



Illustration courtesy of Max Machinery, Incorporated.

Figure 6: Max 710 fuel flow measurement system configuration.

The Max 710 system also provides a computer controlled interface to the flow meter itself. The interface acquires a signal from the piston flow meter which is then corrected using a manufacturer provided calibration curve unique to the flow meter. The output can be displayed using a lap top computer or acquired via a calibrated analog output. The output could in either case be the volumetric flow rate or gravimetric flow rate. Since gravimetric output requires knowledge of the fuel density, the fuel density is calculated and applied by the computer interface. Fuel density is computed from the measured fuel temperature by interpolation from two user provided reference points.

A check of the calibration of the Max 710 was performed by installing the system in a vehicle, then simulating engine fuel consumption by bleeding fuel from the fuel rail through a factory installed valve in the fuel rail. The flow rate of the fuel being bled from the fuel rail was measured by noting the time necessary to fill a graduated cylinder with a convenient volume of fuel. The fuel was allowed to run into a gasoline tank after the measurement so that the Max 710 could continue running until it reached a steady measurement. The Max 710 flow measurement was then recorded and the two measurements compared. The fuel flow rate was checked at nine points from zero to approximately 18 cc/second. In each case, the flow rate as measured with a graduated cylinder and stopwatch was within estimated measurement uncertainty of 0.6 cc/sec of the Max 710 measurement. The Max machinery calibration of the fuel flow measurement system was therefore accepted as accurate within this range.

The Max 710 system later became the standard for calibrating the vehicle fuel injection system as a means of measuring fuel consumption. This is discussed in more detail in the next chapter. Figure 7 shows the Max 710 system installed in the Chevrolet Corsica test vehicle.

## Emissions Measurement Systems

Exhaust gas analysis equipment has used much the same technology for several years. The non-dispersive infrared analyzer (NDIR) has become the mainstay in the industry for measuring both carbon monoxide and carbon dioxide. Similarly, the flame

ionization detector (FID) has become the standard hydrocarbon analyzer and the photochemiluminescence (CLD) analyzer the standard for measuring nitrogen oxides. A paramagnetic analyzer (PMD) is used to measure oxygen content. Only recently have the time and frequency response characteristics of these analyzers become important. In the past, it was not terribly important to have fast response analyzers because the emissions testing protocol in use did not demand them.

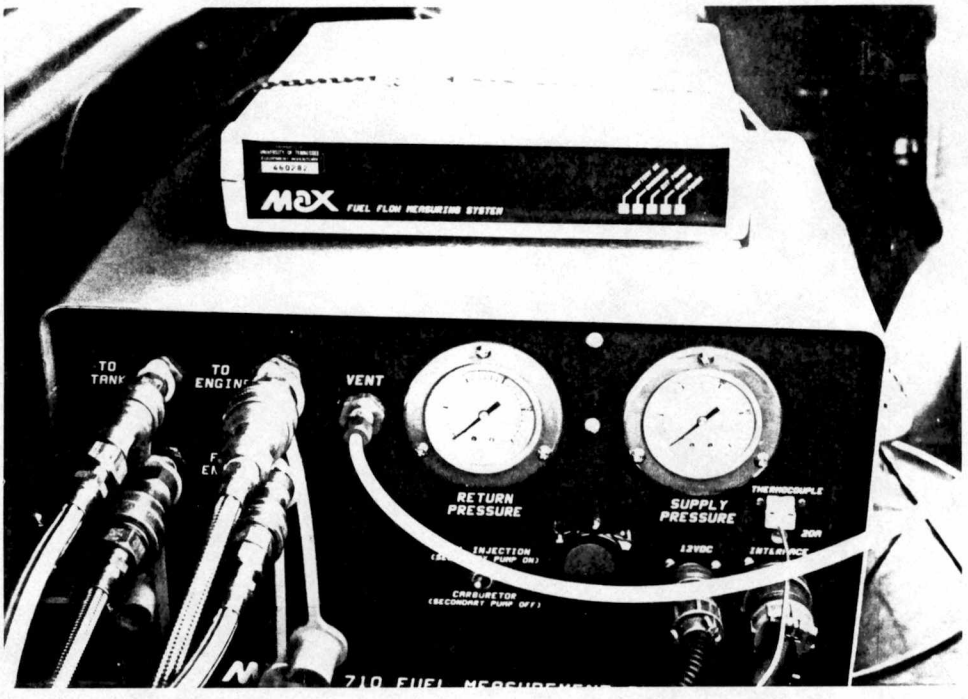



Figure 7: The Max 710 fuel flow measurement system installed in the 1988 Chevrolet Corsica.

The analyzers chosen for this study were Fisher-Rosemount NGA 2000 series analyzers. Although this system uses standard technology for measuring exhaust gas constituent concentrations, this system incorporates many useful features. The analyzers are modular in construction and feature an integrated control system which displays the

analyzer outputs. In addition, each analyzer module is assigned an analog output channel which delivers a calibrated voltage or current output to be used for data acquisition and display independent of the control unit. Each analyzer module has four ranges in order to more accurately measure a wide range of gas concentrations. The analyzers can independently be assigned a range from the control panel or autorange with changing gas concentration. Range output is accomplished through switch closures on the analog output module. For the purposes of this study, 6 non-dispersive infrared analyzers, 2 flame ionization analyzers, 2 paramagnetic analyzers, and 2 photochemiluminescence analyzers were used. These measured high range carbon monoxide, low range carbon monoxide, total hydrocarbon content, oxygen content, and nitrogen oxides content, respectively. One complete set of analyzers was used to measure these concentrations before the exhaust gas passed through the vehicle's catalytic converter and one complete set after the gas passed through the catalytic converter.

In order to facilitate data collection, each analog output module was set to provide voltage output and was calibrated such that the maximum 5 volt output occurred at the maximum gas concentration in each range. To prevent electrical noise, shielded cables were used to carry this voltage to a data acquisition system. Since the analyzers were used in autoranging mode, a method of determining range from the switch closure provided by the analyzer system was required. To this end, a resistive divider network was devised which would translate the switch closures into an analog voltage output requiring only one channel per analyzer. Figure 8 shows the analog output module, resistive divider, and data acquisition connections. The divider provided a 1 volt output

for range 1, 2 volts for range 2, etc. Therefore, two analog channels were required for each analyzer module; one each for concentration and range. This brought the total analog channel requirement for the emissions analysis system to 12 channels per complete set of analyzers.

Calibration of each of the 12 analyzers was undertaken by flowing both a "zero" concentration gas and a "span" gas for each range through each analyzer. Adjustments to the zero and span output concentrations were accomplished electronically by the Rosemount system. The zero gas which was used was nitrogen, since none of the analyzers in use detected nitrogen. The span gases were provided by a gas divider and several bottles of gas of known composition. For example, a 184 ppm span gas for the low CO analyzer was generated by selecting 10% of an 1840 ppm CO bottle of gas. A check of the gas divider was accomplished by spanning an instrument with a bottled gas, then flowing various percentages of the bottled gas through the gas divider and noting the instrument reading. The gas divider was found to be accurate to at least the level measurable by the Rosemount instruments. The dilution gas for the gas divider was the nitrogen which was also used as a zero gas. The gases which were used for this study were provided by either the Liquid Air company or the Specialty Gas Division of Holston Gases. Each company certified the compositions of the gas mixtures which they provided.

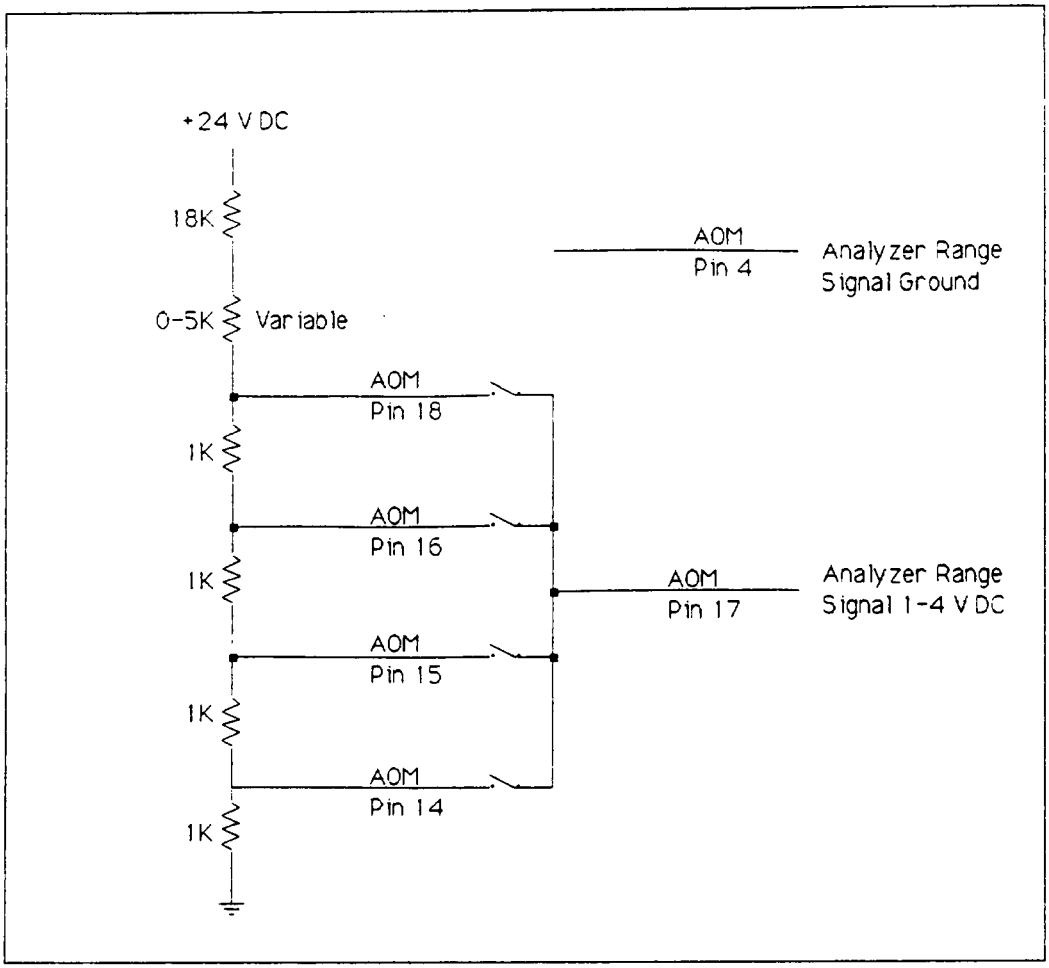



Figure 8: Electrical schematic of the resistive divider network and connections to a Rosemount analog output module (AOM).

## ECM Interface

The engine control module (ECM) in the vehicle continuously monitors onboard sensors such as the mass airflow sensor, exhaust gas oxygen sensor, coolant temperature sensor, and others. If this module could be utilized to provide information about the engine operating conditions, invasive modifications to the engine wiring harness could be minimized. Since all domestic automobiles have an assembly line diagnostic link (ALDL) to the engine control module to facilitate inspection and maintenance, there are tools available which can interface with the ECM. For this study, a tool manufactured by GM Expertec called the TECH1a was chosen. This unit interfaces with the ECM through the assembly line diagnostic link and provides a standard serial communications interface for passing the ECM data to a computer. For the purposes of this study, the TECH1a was used only as a device to translate the ECM output into data which could be acquired with a computer. Figure 9 shows the TECH1a diagnostic tool.

## Speed Sensor

The standard instrument in the past for measuring the speed, distance traveled, and acceleration of a vehicle was the fifth wheel. This was essentially a wheel of known diameter which attached to the car and contacted the road. A sensor on the hub of the wheel detected the rotational speed of the wheel. For this study, a more modern version was selected. A Davit Lightspeed non-contact speed, distance, and acceleration sensor

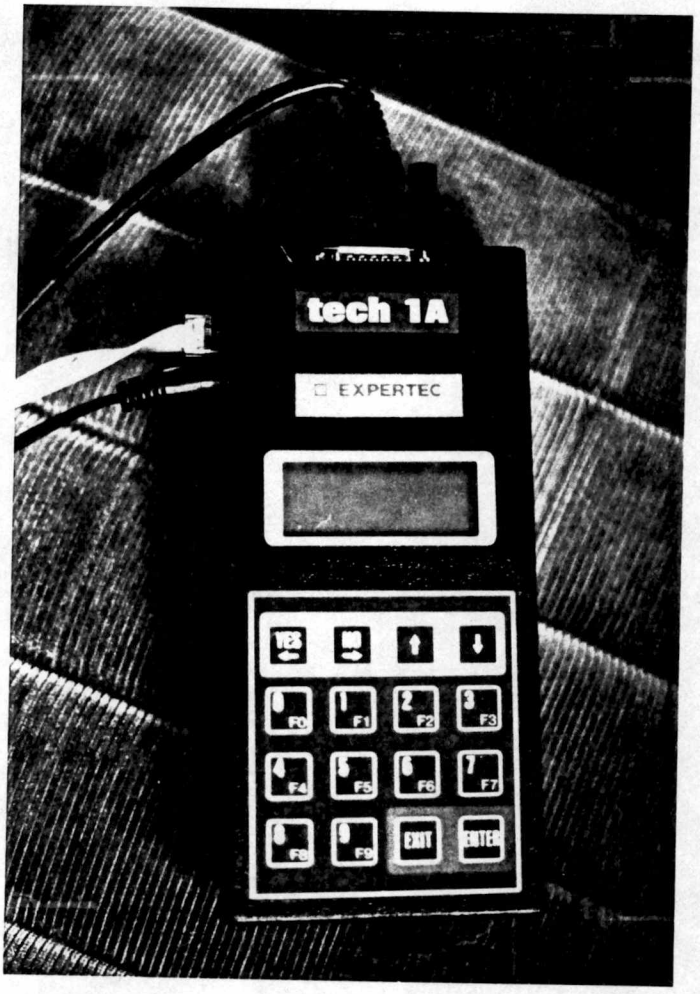



Figure 9: The TECH1A diagnostic tool.

was chosen. This device attaches to the vehicle but does not contact the road. Rather, speed is deduced optically. Irregularities in the road are projected onto a measured surface by a lens system. The measured surface irregularities are then projected onto a prismatic lens. The relative motion of the irregularities to the measured surface then is measured as light/dark pulses by two photodetectors. The resulting sinusoidal signal is transformed by subsequent filter electronics into frequency signals proportional to the

speed of the vehicle. The output of this device was configured to be an analog voltage proportional to speed. The maximum output was set at 10 volts equal 100 miles per hour, or 1 mile per hour equals 0.1 volts. The signal from the sensor could then be integrated over time to determine distance traveled, or differentiated to determine acceleration. The noncontact nature of the sensor is preferable to a fifth wheel because of error introduced by the travel of a fifth wheel across abnormalities such as potholes and speed bumps. Figure 10 shows the Lightspeed sensor attached to the Chevrolet Corsica test vehicle.



Figure 10: The Davit Lightspeed Sensor attached to the Chevrolet Corsica.

## Data Acquisition System

The data acquisition system for this study had to be capable of measuring voltages, frequencies, pulsewidths, and acquiring serial communications data from the TECH1a. The Flight Recorder system manufactured by Advanced Electronic Diagnostics Incorporated met these needs. It provided voltage/current inputs adequate for measuring the Rosemount instrument signals, the fuel flow measurement system signal, and the speed sensor signal. Timer/counter inputs allowed measurements of fuel injector pulsewidth and frequency and mass airflow sensor frequency. Lastly, a serial logging port allowed data to be logged from the TECH1a device which provided ECM data.

Each of the analog channels allowed independent logging rates and independent scale and offset settings. In addition, nonlinear signals could be conditioned by the use of a lookup table to interpret the raw signal. Data acquisition software was included with the unit which allowed several different data acquisition configurations. The system was based upon a 486 DX2 50 megahertz portable computer. The system was ruggedized and designed for use in a vehicle. Data files acquired using this system could be readily translated into a variety of formats for reduction using other software.

The signals from each of the sensors to be measured was appropriately connected to the data acquisition system. The serial communications link to the ECM through the TECH1a tool provided data at a maximum rate of 2 hertz due to the slow communications speed of the ECM. The data logging rate was therefore set to 2 hertz for all signals so that the data files would be uniform. A logging speed of 2 hertz allowed acceptable

accuracy to be achieved while maintaining data file sizes within reasonable limits. Figure 11 shows an example of the data logging software screen. Figure 12 shows the data logger module to which the actual instrument signals were connected.

## Chassis Dynamometer

In order to duplicate the loads experienced by a vehicle in normal operation, a chassis dynamometer was used. For this study, a Sun Road-A-Matic model RAM-937-1 chassis dynamometer was available. This dynamometer has several features including both a constant wheel speed mode and a mode in which the load is proportional to speed and acceleration. This dynamometer used discreet settings for vehicle weight and air resistance. For this study, the dynamometer was used in both of its operating modes to absorb the power generated by the vehicle drivetrain. The dynamometer was of dual roll design, in which each of the two vehicle drive wheels is in contact with two dynamometer rolls which are 24 inches in diameter. The dynamometer was an eddy-current design, meaning that it used an electromagnetic braking system to apply a load to the drive wheels. The load which the dynamometer can provide increases as the roll speed is allowed to increase.

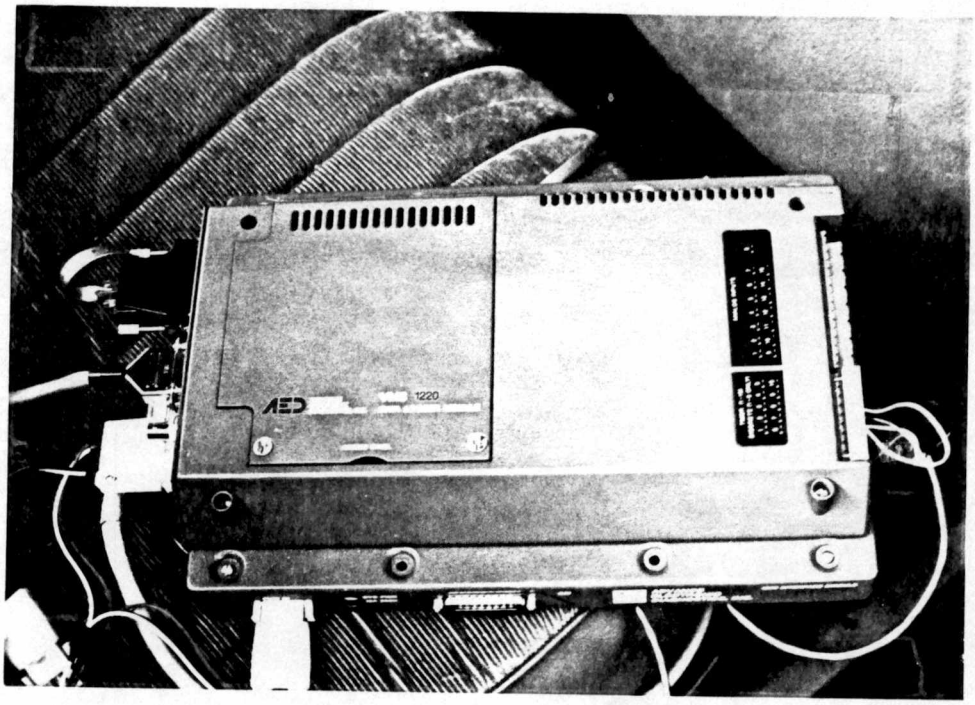


Figure 11: The AED data logger computer displaying data logging software.

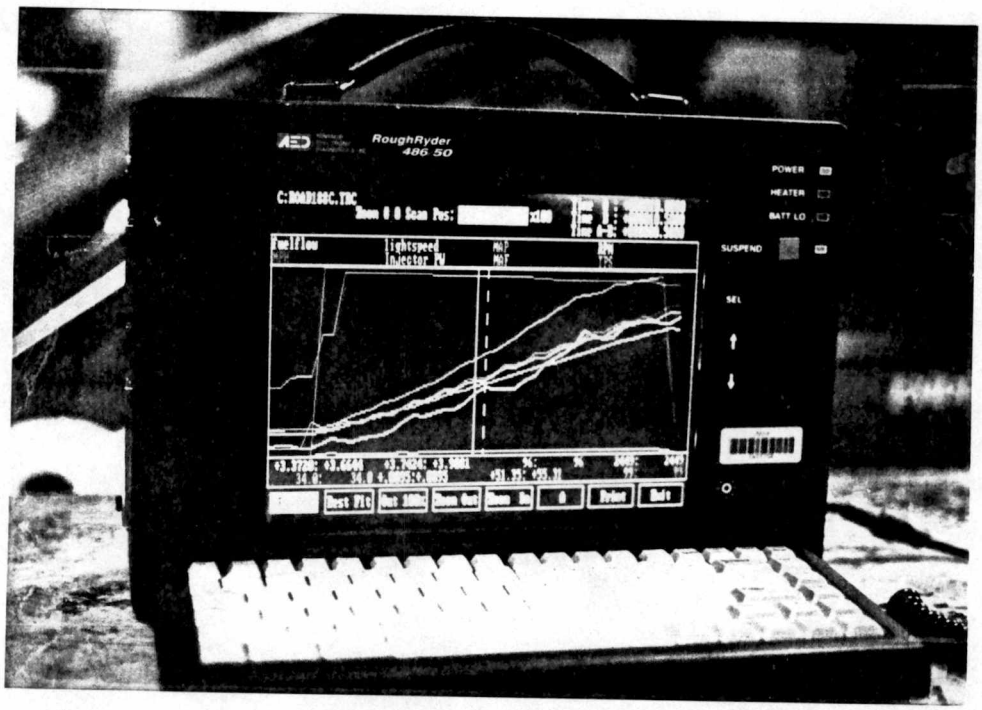



Figure 12: The AED Data Logger Module.

# CHAPTER V

# THE PROCEDURE

## Step 1: Instrumenting the Vehicle

Before any other task could be accomplished, proper instrumentation had to be installed in the vehicle. First, a Max 710 fuel flow measurement system was installed to allow measurement of the vehicle fuel consumption. This system mounted in the trunk of the test vehicle and connections to the fuel system were made in close proximity to the fuel tank using existing connections. Second, an interface to the vehicle ECM was installed in order to allow the measurement of the manifold absolute pressure, manifold air temperature, engine speed, coolant temperature, throttle position, and vehicle speed. In this fashion, it was possible to utilize existing onboard sensors in such way as to minimize changes to the vehicle wiring. Third, a noncontact speed, acceleration, and distance sensor had to be attached to the vehicle to provide acceleration data and to augment the vehicle speed measurement by the vehicle ECM. An inertial sensor was mounted on the same mount as the speed sensor in order to determine road grade. Sample ports and K-type thermocouples were installed in the vehicle exhaust stream both upstream and downstream of the catalytic converter in order to allow sampling of the vehicle exhaust gas concentrations and temperatures. Lastly, a data acquisition system had to be placed in the vehicle and each of the sensors connected to it appropriately.

## Step 2: Fuel Flow Measurement Time Response

In order to determine the time response of the Max 710 system, a step change in the fuel consumption of the vehicle had to be created. This was accomplished by performing a constant vehicle speed test. With the vehicle speed and gear ratio, and hence the engine speed, held constant a step change in the throttle position created a step change in fuel consumption.

Measurement of time response of the Max 710 fuel flow measurement system was attempted using the chassis dynamometer. The vehicle was first centered on the dynamometer rolls and chained down. The dynamometer was then allowed to warm up for one hour and a large fan placed in front of the vehicle. The vehicle hood was raised. The dynamometer was operated in constant speed mode. In this mode the dynamometer held the vehicle speed at a constant value so long as the vehicle did not exceed the power absorption capabilities of the dynamometer. The vehicle was then driven at a convenient speed and the dynamometer speed adjusted. The data acquisition system was then configured to measure the throttle position, engine speed, vehicle speed, fuel flow system output, fuel injector pulsewidth, and fuel injector frequency. The car was then allowed to idle for several minutes. The vehicle was then driven at the minimum throttle position necessary to maintain 30 miles per hour in third gear. Data collection is initiated. After ten seconds, the throttle position was suddenly increased. Data collection continued until the output from the fuel flow measurement system assumed a new average value. The amount of time between the step change in throttle position throttle position and the

attainment of the new average value of fuel consumption was then deemed to be the settling time of the measurement system.

## Step 3: Chassis Dynamometer Calibration

For the chassis dynamometer to adequately model the engine loads typically experienced by a vehicle on the road, it had to be calibrated. In other words, the loads which result from aerodynamic drag, tire friction, and acceleration of the vehicle must be determined in on-road operation and duplicated by the dynamometer. This can be accomplished by locating a very nearly level stretch of roadway on which steady speed testing can be undertaken. In this case, a section of Neyland Drive near the University of Tennessee at Knoxville was used. The vehicle was first be driven until the coolant temperature reached its operating range and the control system began to operate in closed loop mode. Data was then taken along the roadway at steady speeds beginning at 30 miles per hour and in 10 mile per hour increments up to 50 miles per hour. Sixty and 70 mile per hour tests were performed on a level stretch of interstate 40 as it passed the Strawberry Plains exit, just east of Knoxville. During these tests, fuel consumption, throttle position, air consumption, manifold absolute pressure, engine speed, and vehicle speed were recorded. Care was taken to avoid driving in the wake of other vehicles in order to prevent underestimation of the fuel and air consumption at any given speed. Data was taken for approximately 30 seconds during each test. The 30, 40, and 50 mile per

hour tests were performed with the transmission in third gear, while the 60 and 70 mile per hour tests were performed with the transmission in fifth gear.

The dynamometer duplication of these tests was then undertaken. The chassis dynamometer was first turned on and allowed to warm up for one hour prior to any testing in order to stabilize the operating temperature of the various electrical components in the dynamometer controller. The vehicle drive wheels were then placed on the dynamometer rolls and allowed to center by driving slowly in first gear. The car was then chained in position to prevent the wheels from shifting on or leaving the rolls. Since the test vehicle was a front wheel drive vehicle, the emergency brake was engaged to further stabilize the vehicle. A large fan was placed in front of the vehicle and the hood raised. Any foreign objects were then cleared from the area and the vehicle was driven until closed loop control was established and the coolant temperature rose to its operating range.

Since the chassis dynamometer in use for this study had only discrete settings for vehicle air resistance, the task was to determine the optimum setting for this control for the test vehicle. The steady speed tests at 30, 40, 50, 60, and 70 miles per hour were again performed on the dynamometer. These steady tests were used to select the appropriate air resistance of the vehicle. The optimum match was determined by matching the dynamometer test fuel consumption with the on-road test fuel consumption for each steady speed.

Since only steady speed testing was to be performed as a part of this study the air resistance parameter was the only dynamometer parameter which had to be calibrated for

the test vehicle. For a study in which transients are of interest, the vehicle mass parameter must also be calibrated. Once the proper air resistance parameter has been found, the mass parameter can be calibrated by performing accelerations on the road and duplicating them on the dynamometer. The proper match could then be determined by matching the amount of time necessary for the vehicle to accelerate between two engine speeds in a given gear

## Step 4: Emissions Measurement Time Response

The time response of each analyzer was determined by causing a step change in the concentration of the gas stream which was flowing through each analyzer. By measuring the amount of time between the step change in concentration and the attainment of a new steady reading on each instrument, the settling time of that instrument could be determined.

The flow rate of the gas sampling system in this implementation was limited by the sample pump which provided a sample flow of approximately 15 liters per minute through the flow system. The sample manifold which fed gas to each of the individual analyzers was maintained at 7 psig by a backpressure regulator. The individual analyzer flow rates were set at the maximum allowable flow rate as specified by the manufacturer. For the non-dispersive infrared analyzers, this was 2.0 liters per minute. The flow rate to the paramagnetic detectors was set at 1.5 liters per minute. The flow rates to the flame ionization detectors and chemiluminescence detectors was determined by setting the

sample pressure regulator on each of these instruments. The sample pressure regulator for the flame ionization detectors was set at 4.9 psig, which allowed a flow rate of 0.95 liters per minute to these instruments. The sample pressure regulators on the chemiluminescence detectors were set at 5.0 psig, which allowed a flow rate of 1.0 liters per minute to these instruments.

Each instrument was then calibrated by flowing gases of known concentration through the analyzers. A tube equal to the length of the exhaust sampling tube was then connected to the sample inlet of each of the 2 sets of analyzers. These tubes were in turn connected to one end of a device which allowed flow from either of two sources. This device consisted of two solenoid valves, which were connected electrically such that when a voltage was applied one valve opened while the other closed. The inlet of the normally open valve was left open to the atmosphere, so that when no voltage was applied room air was being supplied to the analyzers. This device is depicted in figure 13. A tedlar bag was then filled with a combination of several span gases in such a manner that the analyzers would be nearly full scale in given ranges. This bag was then connected to the inlet of the remaining solenoid valve. The power supply to the solenoid valves was connected to the data acquisition system so that the time that the valves were switched could be recorded. The analog outputs of each of the analyzers along with the range outputs from each of the analyzers were then connected to the data acquisition system. The DAS was configured to record each of the analyzer concentration signals, the range signals, the valve switching signal, and time. Data collection was then triggered. After several seconds had passed, a voltage was applied to the solenoid valves, causing the

room air source to be shut off and the bag of mixed gas to flow into the analyzers. The valves were held in this position for several seconds and then the valves were again reversed. After several more seconds, data collection was terminated.

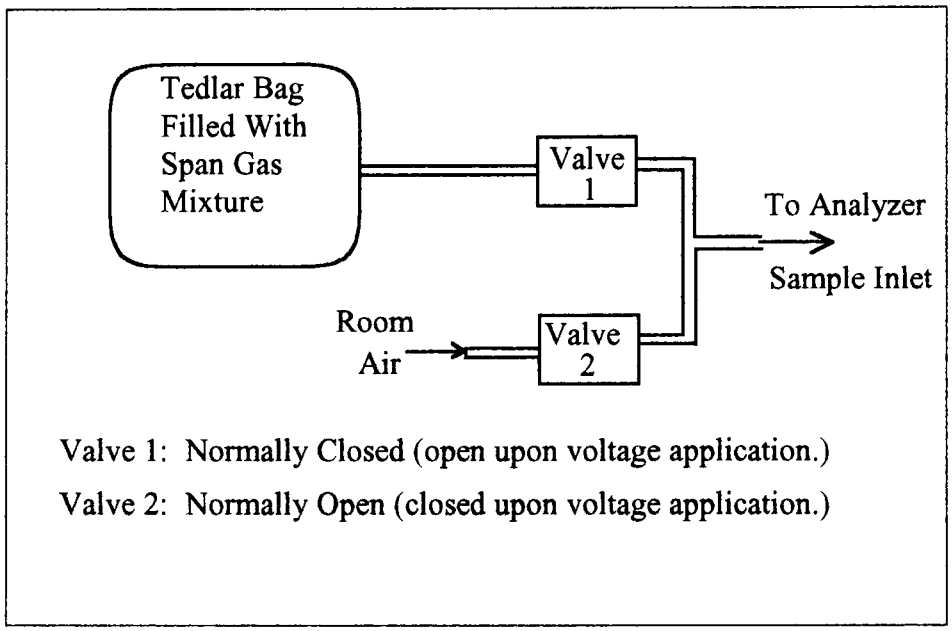



Figure 13: Schematic of the solenoid valve device.

## Step 5: Vehicle Dynamometer Testing

At this point, the vehicle emissions were measured by testing the operating points of interest on the dynamometer. The vehicle was again placed on the dynamometer, centered, and chained into position. A large fan was placed in front of the vehicle to provide some air flow over the engine. The dynamometer was allowed to warm up for

one hour. The exhaust gas analyzers were calibrated and connected to the exhaust sampling ports on the vehicle. The exhaust gas analyzer analog outputs were then acquired by the data acquisition system. The vehicle was then driven at varying speeds until the coolant temperature rose to the normal operating range and the catalytic converter had achieved light-off temperature. Light-off of the catalytic converter was verified by monitoring the precatalyst and postcatalyst carbon monoxide levels. At the point that the post catalyst carbon monoxide concentration dropped off rapidly from the precatalyst concentration the catalyst was judged to be functioning. After double checking settings on the dynamometer and instruments, testing began.

The vehicle was driven at constant speed and throttle position for several seconds prior to the initiation of data acquisition in order to allow each instrument reading to stabilize. The amount of time required for each reading to stabilize was determined earlier during the time response characterization of the instrumentation. The maximum settling time was taken as the amount of time necessary between attainment of steady operation and the initiation of data acquisition. At this point, driving continued and data acquisition was initiated. Data was collected for thirty seconds. The car was then allowed to idle until the next test. Care was taken to avoid overheating the engine or the catalytic converter. In the event that either of these temperatures became excessive, the vehicle was allowed to idle until the temperatures are again inside the normal operating range of the vehicle. The temperatures at which coolant and catalyst were deemed to be excessive was determined by examining the range of these two measurements during on-road operation. Care was also taken to avoid idling the car for excessive periods of time between tests. In this

event, the catalytic converter was warmed up to the operating temperature by driving the vehicle for several minutes prior to the resumption of testing.

This procedure can be followed for both steady speed and acceleration events. Acceleration events can be modeled as a series of steady speeds at the appropriate load levels on the dynamometer. This can be accomplished by placing the dynamometer in constant speed mode and driving the desired speed at the desired throttle position. By testing in this fashion, it is possible to avoid the need for instrumentation which can respond quickly enough to measure events lasting only a few seconds or less.

## Step 6: Data Correlation

In order to allow better correlation of the emissions and fuel consumption data to the vehicle events which caused them, the individual streams of data were offset in order to reduce or eliminate the difference in time between the various streams of data. This was accomplished with the use of a computer and spreadsheet package.

The trace files from the data acquisition system were first converted to spreadsheet format using a conversion software package provided by the data acquisition system manufacturer. The data was then post-processed as necessary to convert the gas analyzer outputs and fuel flow measurement system outputs to engineering units. The data streams were then offset from each other by delaying the faster responding systems to match the measurements from the slowest responding system. The time delays necessary to accomplish this task were defined in the previous characterization of each of the

instruments. At this point other calculations were made using the spreadsheet, such as instantaneous air/fuel ratio, average fuel consumption, and average emissions concentrations.

# CHAPTER VI
# RESULTS AND DISCUSSION

## Fuel Consumption Time Response

To cause a step change in the fuel consumption rate of the test vehicle, it was necessary to fix the engine speed and then increase the throttle position suddenly. Since the fuel consumption rate of an engine is a function of both engine speed and throttle position, fixing the engine speed then allows a step change in the throttle position to cause an increase in the fuel consumption rate of the engine. Therefore, the chassis dynamometer was placed in the constant speed mode of operation, and the vehicle speed was adjusted to a convenient point. The vehicle was then driven at this speed at a steady throttle position until the fuel flow measurement became steady. At this point, the throttle position was suddenly changed and the resulting fuel flow measurement output noted. When the reading again reached a steady value, the test was terminated.

Examination of the resulting time response curve of the fuel flow measurement system depicted in figure 14 showed that the instrument required some 7 seconds after the step change to reach steady state. Since on-road testing involves driving on limited lengths of roadway which are acceptably level and since the testing was performed under normal traffic conditions, this settling time was deemed to be too long. Therefore, a new method for determining fuel consumption in on-road operation was sought.

In light of the ability of the data acquisition system to measure frequency and pulsewidth signals, an attempt was made to correlate the vehicle instantaneous fuel consumption to the fuel injector driving frequency and pulsewidth. By using these measurements, fuel consumption could be determined without such an excessive settling time.

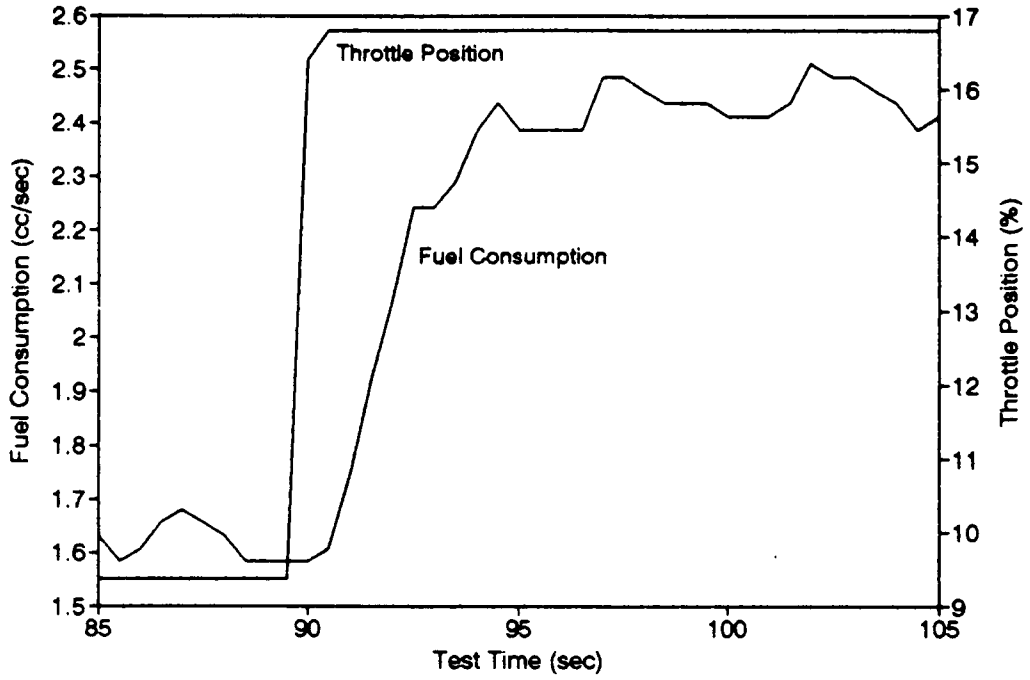



Figure 14: Max fuel flow measurement system time response to a step input.

The Corsica was once again placed on the dynamometer and driven at several steady speeds. After allowing time for the fuel flow measurement system to reach a steady value, the fuel injector pulsewidth and frequency were measured along with the output

from the fuel flow measurement system. By dividing the fuel flow measurement signal by the fuel injector driving frequency, the fuel consumption was described in terms of the amount of fuel injected per pulse of the fuel injectors. This data was then plotted against the fuel injectors pulsewidth data, and a second order curve fit applied. The resulting fuel injector calibration curve agreed very well with the experimental data, producing a correlation coefficient of .9995. Figure 15 shows the fuel consumption data and the second order curve fit. The fuel injectors for a 1988 Corsica were known to fire once per engine revolution. The measured injector frequency agreed well with this known phenomenon when compared with the measured engine speed. Furthermore, the maximum observed fuel injector pulsewidth was just under 11 ms, which agreed with the maximum allowable pulsewidth of 11 ms at the maximum engine speed of 5500 rpm.

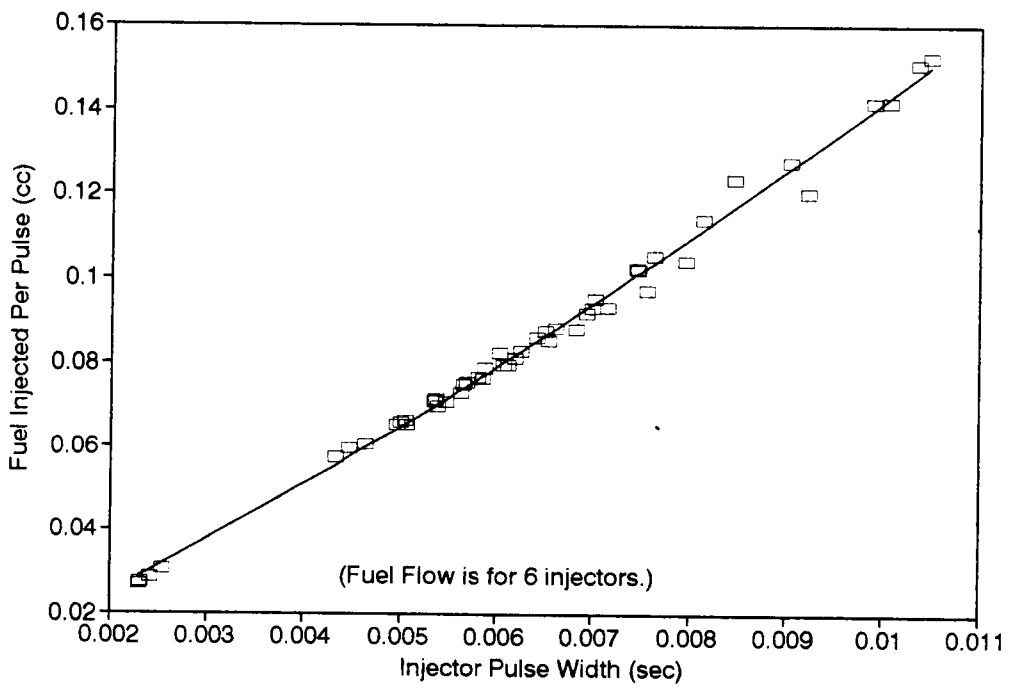



Figure 15: Fuel injector calibration curve.

As a test of the new fuel consumption measurement technique, a transient event was selected in which the fuel flow measurement system appeared to have kept up with the changing vehicle operating conditions. The event chosen was a 12% throttle acceleration test which was performed in second gear. The low throttle nature of the test ensured that the engine speed and hence the fuel consumption changed slowly. The fuel consumption was then predicted from the measured fuel injector frequency and pulsewidth and compared with the fuel consumption as measured by the fuel flow measurement system. As seen in figure 16, the instantaneous fuel consumption rates measured by both methods agreed well once the fuel flow measurement system had time to settle. In addition, the new method exhibited much less signal noise than the fuel flow measurement system output. Figure 17 shows the totalized fuel consumption as measured by both methods as the event progressed. This figure shows that the new method for measuring fuel consumption did respond to the change more quickly, exhibiting a higher totalized fuel consumption early in the acceleration event. The difference in the measurements then stabilized and was nearly constant across the remainder of the event, indicating that the fuel flow measurement system had indeed kept up with changing engine conditions after the initial step change. This test further demonstrated the dramatic error which might have been introduced had the reading from the fuel flow measurement system been taken during the first few seconds of the acceleration event. The results from the acceleration transient support the use of fuel injector pulsewidth and driving frequency for measuring the fuel consumption of the vehicle.

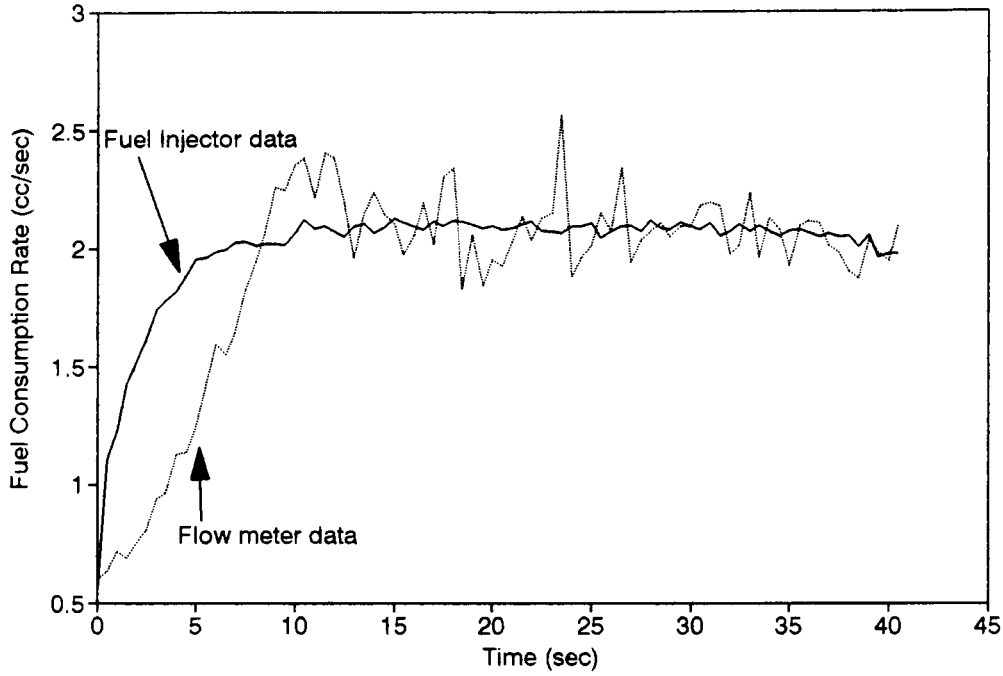



Figure 16: Instantaneous fuel consumption comparison for an acceleration event.

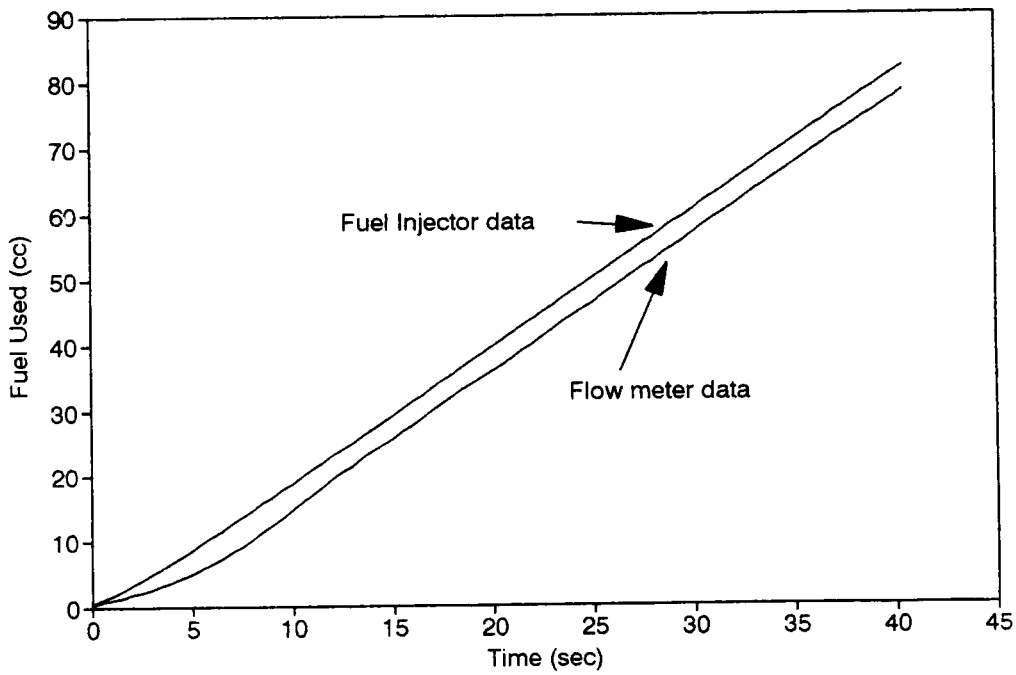



Figure 17: Totalized fuel consumption comparison for an acceleration event.

It was also discovered at this point that the digital data from the ECM for engine air consumption was experiencing a relatively large problem with discretization error. Since the factory calibration curve was available for this particular mass airflow sensor, the air flow measurement was moved to an analog channel on the DAS. The factory calibration curve was then converted to a lookup table for the DAS and utilized. Although the same calibration curve was used for this measurement as for the ECM measurement, the DAS interpolated between points to give a more accurate answer. Although the discretization error was eliminated, a bias was introduced into the measurement. The new mass air flow measurement had a bias of approximately 1 gram per second to the low side of the ECM measurement.

**Dynamometer Calibration**

Fuel consumption was used as a parameter to match the loads experienced on the road to the loads applied by the dynamometer. After testing several air resistance settings at each of the test speeds, it was determined that setting the dynamometer air resistance parameter to seven provided the best possible steady speed loading for the Corsica. This setting resulted in a maximum error in fuel consumption of 4.6% at a speed of 50 miles per hour. Each of the other steady speed tests using this setting also exhibited an error in fuel consumption of less than 5%. The resulting fuel consumption versus speed data are tabulated in table 2, and the data is shown graphically in figure 18.

Table 2: Dynamometer air resistance parameter calibration results.

| Vehicle Speed (MPH) | On-Road Fuel Consumption (cc/sec) | Dynamometer 7 Fuel Consumption (cc/sec) | Percent Error in Fuel Consumption for Dynamometer 7 |
|---|---|---|---|
| 30 | 1.2 | 1.18 | -1.96 |
| 40 | 1.62 | 1.67 | 3.02 |
| 50 | 2.17 | 2.27 | 4.61 |
| 60 | 1.91 | 2 | 4.53 |
| 70 | 2.83 | 2.8 | 1.31 |

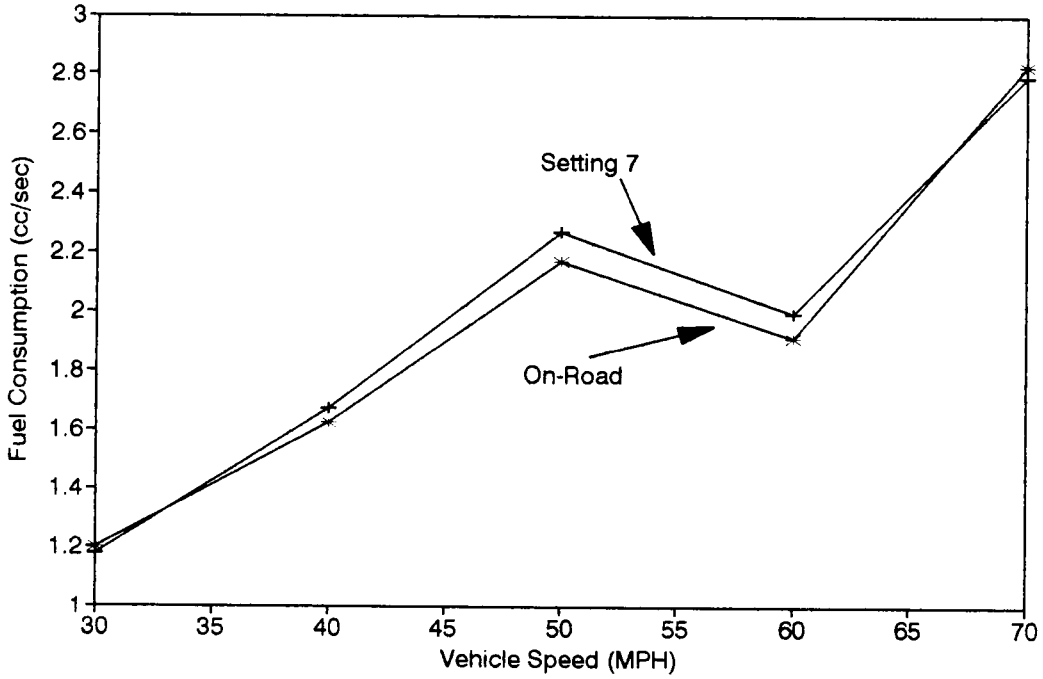



Figure 18: Dynamometer air resistance parameter calibration results.

## Emissions Measurement Time Response

The objective of this step was to determine the amount of time necessary for the precatalyst and postcatalyst emissions measurement systems to reach a stable measurement when subjected to a step change in the relevant gas concentrations.

To produce a step change in gas concentration to each of the individual analyzers, a tedlar bag was filled with a gas mixture. The concentrations of each component gas in the mixture were such that each analyzer would measure nearly full scale in a given range. The step change was produced by allowing room air to flow into the emissions analysis equipment, then rapidly changing from room air to the gas mixture. This was accomplished by using two solenoid valves connected in such a way that a switch could be used to open one valve while closing the other. The switch for the valves was also connected to the data acquisition system, along with the gas analyzer analog outputs. This allowed the time response of all of the analyzers to be measured simultaneously. A pulse of the gas mixture of approximately 5 s in duration was introduced into the analyzers.

The resulting time response curves for each of the analyzers showed the amount of time necessary for each instrument reading to stabilize. The five second duration of the gas pulse was determined to just allow each analyzer to reach its peak reading. Figure 19 shows the time response curves for each of the precatalyst emissions analyzers and figure 20 shows the curves for the six postcatalyst instruments. Both of these figures demonstrate that each instrument had reached its steady reading by an elapsed time of twenty seconds after the gas mixture was introduced.

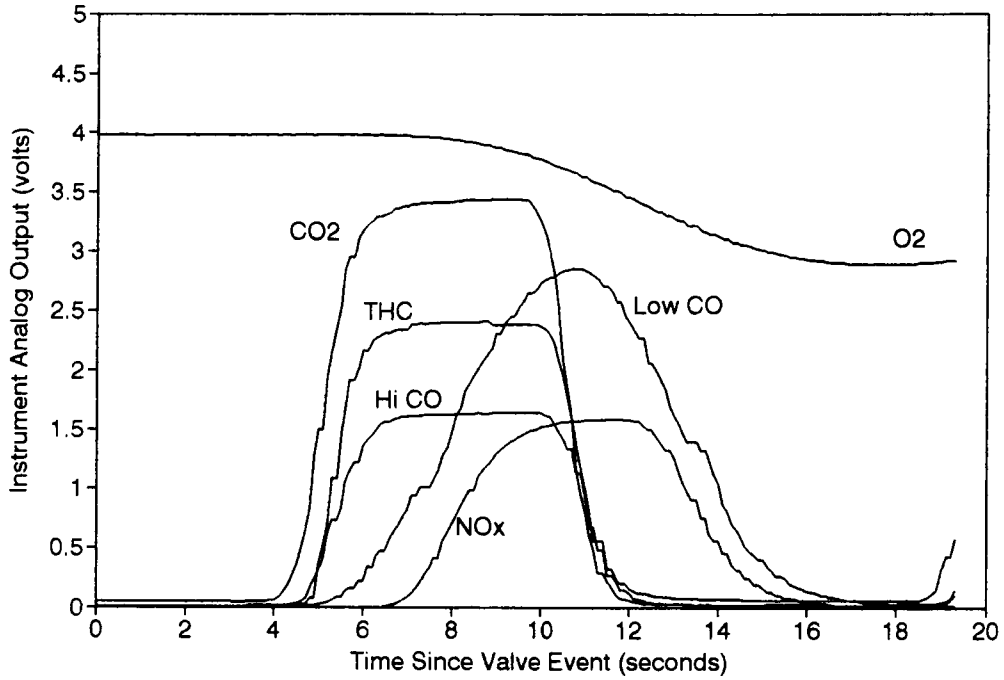



Figure 19: Precatalyst exhaust analyzer time response curves.

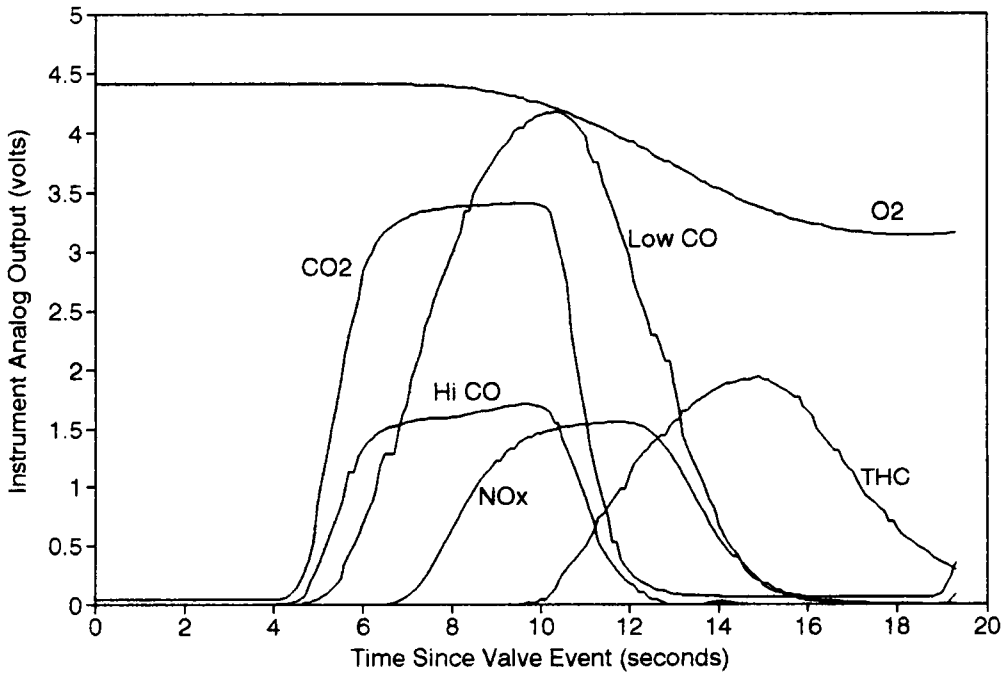



Figure 20: Postcatalyst exhaust analyzer time response curves.

Also shown by these two curves is that the two sets of analyzers agree well for the unknown gas mixture which was sampled. Of particular note were three potential problems: the two low range carbon monoxide analyzers did not have similar output for the same input, the two oxygen analyzers did not have similar output for the same input, and the postcatalyst flame ionization detector responded much more slowly than the precatalyst unit. Upon further inspection the precatalyst low range carbon monoxide analyzer had an incorrect gain factor set for its analog output. Correcting this factor solved this potential problem. The same problem was found for the precatalyst oxygen analyzer. The postcatalyst flame ionization detector was determined to have a partially clogged sample capillary tube. The tube was later replaced, but was deemed to not be a problem for the purposes of this study, since only steady readings were gathered.

## Dynamometer Testing

The purpose of dynamometer testing the vehicle was to characterize the tailpipe emissions and fuel consumption of typical on-road operating conditions. Since the dynamometer was calibrated for the Corsica, several operating points could be examined. It was decided that for the purposes of verifying the procedure outlined in this study, several steady speed operating points would be sufficient.

The Corsica was tested at steady vehicle speeds in each of five gears. The speeds were chosen to span the range of engine speeds possible in each gear. Table 3 shows the specific speeds which were tested in each gear. Each speed in a given gear represents the

natural on-road load for the vehicle at that particular steady speed; no accelerations were simulated.

Table 3: Steady speed operating points which were tested in each gear.

| Gear Position | Steady Speeds which were tested. (MPH) |
|---|---|
| First | 10, 15 |
| Second | 10, 15, 20, 25, 30, 35 |
| Third | 15, 20, 25, 30, 35, 40, 45, 50 |
| Fourth | 25, 30, 35, 40, 45, 50, 55 |
| Fifth | 25, 30, 35, 40, 45, 50, 55 |

The resulting data files included thirty seconds of data taken at a rate of 2 Hz for several operating characteristics of the vehicle. These particular characteristics are shown in table 4.

The resulting emissions and fuel consumption data for each operating point were then averaged and their relationships to vehicle speed and manifold pressure examined. Points which exhibited changes in vehicle speed in excess of ±1 mph over the test period were repeated, as were tests which exhibited changes in throttle position of over ±1 %.

The Corsica exhibited fuel consumption rates from a low of 0.439 gallons/hr to a high of 2.119 gallons/hr over a speed range of 0 to 55 miles/hr. A typical highway cruise at 55 miles/hr in fifth gear showed a 1.503 gallons/hr flow rate, or 36.6 miles/gallon. This result was deemed reasonable, due the ideal nature of the test: no accelerations were

Table 4: Measured vehicle operating parameters.

| Number | Measurement | Type, Source |
|---|---|---|
| 1 | Precatalyst Emissions | Analog, 0-5 V |
| 2 | Postcatalyst Emissions | Analog, 0-5 V |
| 3 | Fuel Consumption Rate | Analog, 0-10 V |
| 4 | Vehicle Speed | Digital, ECM |
| 5 | Vehicle Acceleration | Analog, 0-10 V |
| 6 | Manifold Pressure | Digital, ECM |
| 7 | Coolant Temperature | Digital, ECM |
| 8 | Manifold Air Temperature | Digital, ECM |
| 9 | Engine Speed | Digital, ECM |
| 10 | Air Consumption Rate | Analog, Freq. |
| 11 | Throttle Position | Digital, ECM |
| 12 | Exhaust Gas Recirculation | Digital, ECM |
| 13 | Ambient Temperature | Analog, K-Type |
| 14 | Precatalyst Temperature | Analog, K-Type |
| 15 | Postcatalyst Temperature | Analog, K-Type |
| 16 | Fuel Injector Pulsewidth | Analog, Pulse |
| 17 | Fuel Injector Frequency | Analog, Freq. |

performed, the simulated road was flat, and there was no headwind to overcome. The fuel consumption pattern that was exhibited by the Corsica was one which was expected: the fuel consumption rate increased with speed in a given gear, and decreased with increasing gear position at a given speed. The fuel consumption versus speed and gear position for the Corsica is shown in figure 21 and the data is tabulated in table 5. Without exception, the data demonstrates that for a given vehicle speed the best fuel economy is achieved by selecting the highest gear practical. This was expected and reasonable, since engines operate most efficiently at low speed and high manifold pressure (13, 15). The maximum fuel economy of 46 miles/gallon was found to occur at 25 miles/hr in fifth gear. The fuel economy was not maximized by minimizing vehicle speed. Rather, the fuel economy showed a tendency to decrease from a maximum if the vehicle speed was increased or decreased from the point where the maximum fuel economy was found. Figure 22 and table 6 show the dependence of fuel economy on vehicle speed and gear position.

Although measurement of the precatalyst emissions from the test vehicle was not specifically a goal of this study, the measurement of precatalyst emissions can be a useful tool for analyzing the postcatalyst emissions measurements. Therefore, the precatalyst emissions were also measured.

The concentrations of carbon monoxide, total hydrocarbons, and oxides of nitrogen were measured and recorded. Since the exhaust gas mass flow rate was not constant for all tests due to varying throttle position and engine speed the concentrations

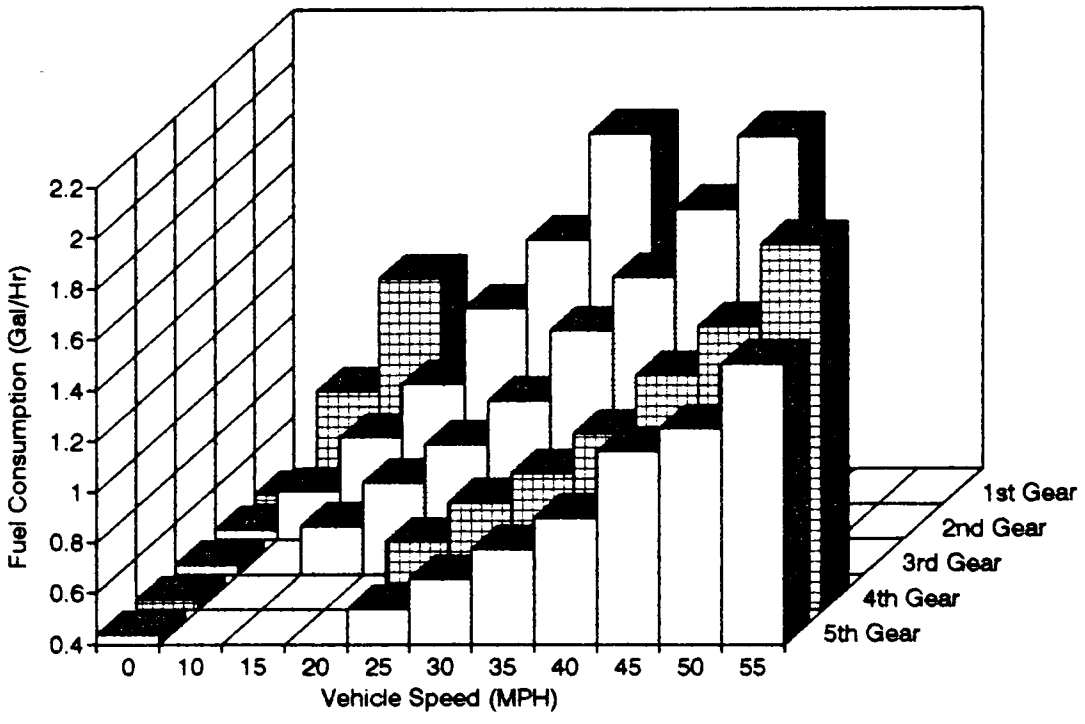



Figure 21: Fuel consumption rates for the 1988 Corsica.

Table 5: Fuel consumption rates for the 1988 Corsica.

| Fuel Consumption Rates in Gallons per Hour | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 0.439 | 0.439 | 0.439 | 0.439 | 0.439 |
| 10 | 0.84 | 0.588 | | | |
| 15 | 1.287 | 0.803 | 0.59 | | |
| 20 | | 1.007 | 0.759 | | |
| 25 | | 1.308 | 0.911 | 0.668 | 0.541 |
| 30 | | 1.576 | 1.081 | 0.82 | 0.658 |
| 35 | | 1.993 | 1.353 | 0.935 | 0.777 |
| 40 | | | 1.568 | 1.09 | 0.897 |
| 45 | | | 1.834 | 1.319 | 1.158 |
| 50 | | | 2.119 | 1.509 | 1.25 |
| 55 | | | | 1.831 | 1.503 |

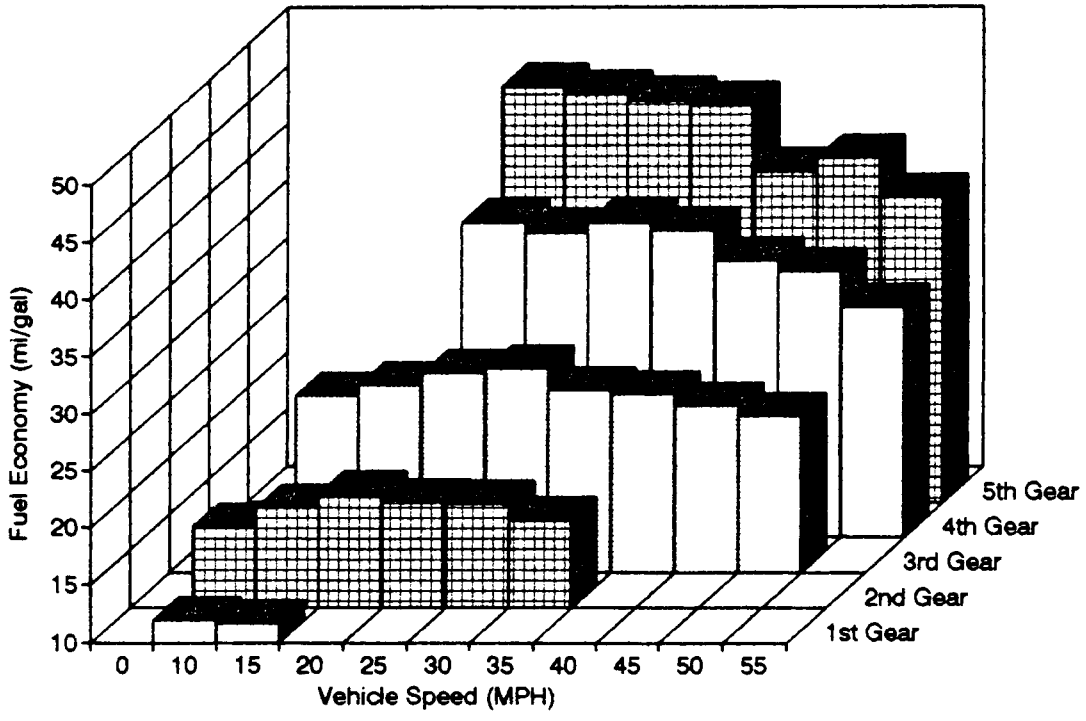



Figure 22: Fuel economies for the 1988 Corsica.

Table 6: Fuel Economies for the 1988 Corsica.

| Fuel economies in miles per gallon. | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | | | | | |
| 10 | 11.9 | 17.01 | | | |
| 15 | 11.66 | 18.68 | 25.42 | | |
| 20 | | 19.86 | 26.35 | | |
| 25 | | 19.11 | 27.44 | 37.43 | 46.21 |
| 30 | | 19.04 | 27.75 | 36.59 | 45.59 |
| 35 | | 17.56 | 25.87 | 37.43 | 45.05 |
| 40 | | | 25.51 | 36.7 | 44.59 |
| 45 | | | 24.54 | 34.12 | 38.86 |
| 50 | | | 23.6 | 33.13 | 40 |
| 55 | | | | 30.04 | 36.59 |

were then used along with intake air mass flow rate and fuel mass flow rates to calculate the emissions of these pollutants as mass flows. For this purpose the exhaust hydrocarbons were measured as propane. Similarly, the oxides of nitrogen were assumed to be $NO_2$. By examining the emissions data in this form, any changes in exhaust flow rate would be included in the analysis. Unfortunately, this meant that any error associated with the air flow and fuel flow measurements would be compounded when the exhaust mass flow rate was calculated. Another useful measure of pollutant emissions is the number of grams of pollutant that are emitted by the vehicle per mile of travel. The emissions data was also put into this form. Equations relating exhaust concentrations to mass flow rates can be found in the appendix.

The precatalyst pollutant concentrations did not seem to follow any specific pattern with respect to speed and gear, except for the concentration of nitrogen oxides. The NOx concentration in general increased with vehicle speed and decreased with increasing gear position. The precatalyst CO concentration does indicate that the engine was operating with a slightly rich mixture. The precatalyst hydrocarbon concentrations were not excessively high, however. Since the vehicle was operated in closed-loop control, it is likely that there was some cylinder to cylinder variation in the fuel/air mixture. The precatalyst concentrations of carbon monoxide, hydrocarbons, and oxides of nitrogen are shown in figures 23 through 25 and tabulated in tables 7 through 9, respectively. The precatalyst carbon monoxide and oxides of nitrogen mass flow rates behaved similar to the fuel consumption of the vehicle: they increased with speed and for

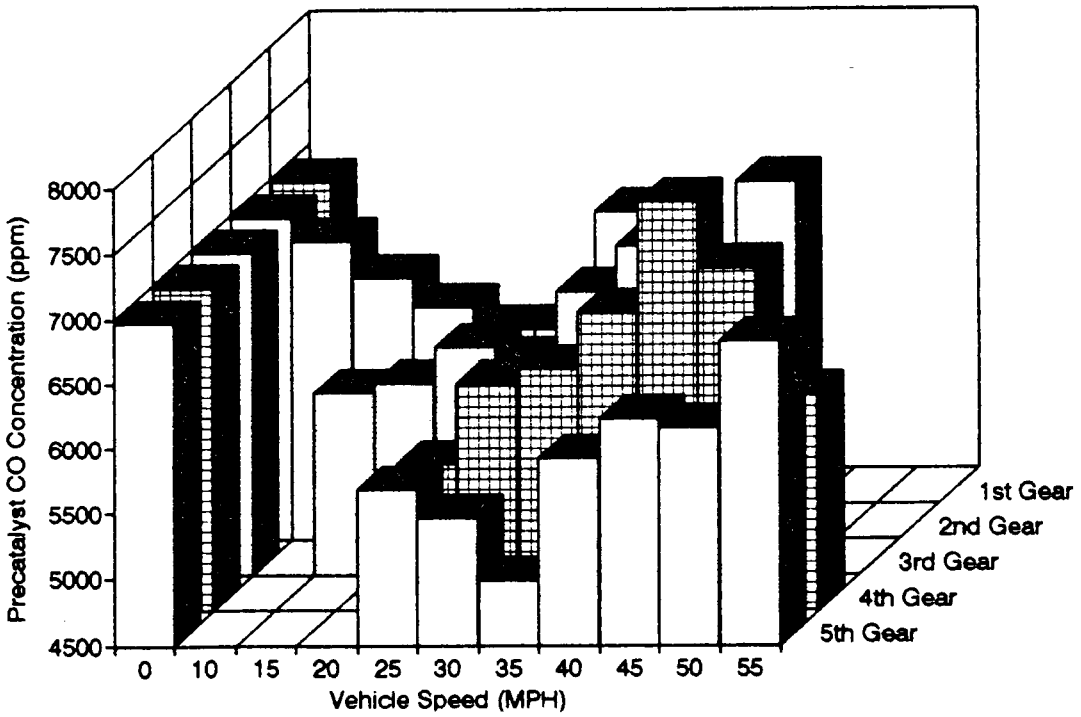



Figure 23: Precatalyst carbon monoxide concentrations for the 1988 Corsica.

Table 7: Precatalyst carbon monoxide concentrations for the 1988 Corsica.

| Carbon monoxide concentrations in parts per million (ppm) | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 6,967 | 6,967 | 6,967 | 6,967 | 6,967 |
| 10 | 6,083 | 6,782 | | | |
| 15 | 5,927 | 6,498 | 5,892 | | |
| 20 | | 6,277 | 5,964 | | |
| 25 | | 6,111 | 6,242 | 5,615 | 5,682 |
| 30 | | 6,104 | 6,135 | 6,229 | 5,471 |
| 35 | | 7,003 | 6,662 | 6,341 | 4,996 |
| 40 | | | 7,015 | 6,779 | 5,927 |
| 45 | | | 6,585 | 7,614 | 6,229 |
| 50 | | | 7,497 | 7,108 | 6,160 |
| 55 | | | | 6,141 | 6,817 |

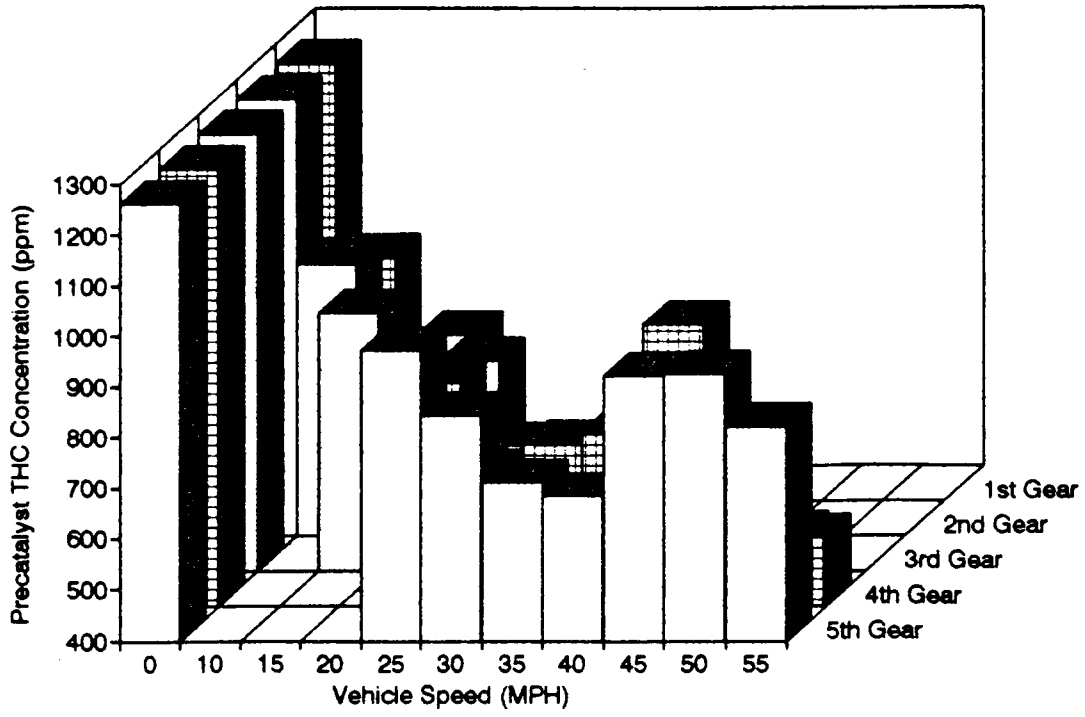



Figure 24: Precatalyst hydrocarbon concentrations for the 1988 Corsica.

Table 8: Precatalyst hydrocarbon concentrations for the 1988 Corsica.

| Hydrocarbon concentrations in parts per million (ppm) | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 1,260 | 1,260 | 1,260 | 1,260 | 1,260 |
| 10 | 878 | 935 | | | |
| 15 | 531 | 730 | 909 | | |
| 20 | | 796 | 689 | | |
| 25 | | 453 | 814 | 843 | 973 |
| 30 | | 420 | 647 | 661 | 844 |
| 35 | | 409 | 563 | 721 | 713 |
| 40 | | | 589 | 744 | 686 |
| 45 | | | 516 | 954 | 922 |
| 50 | | | 472 | 660 | 927 |
| 55 | | | | 535 | 822 |

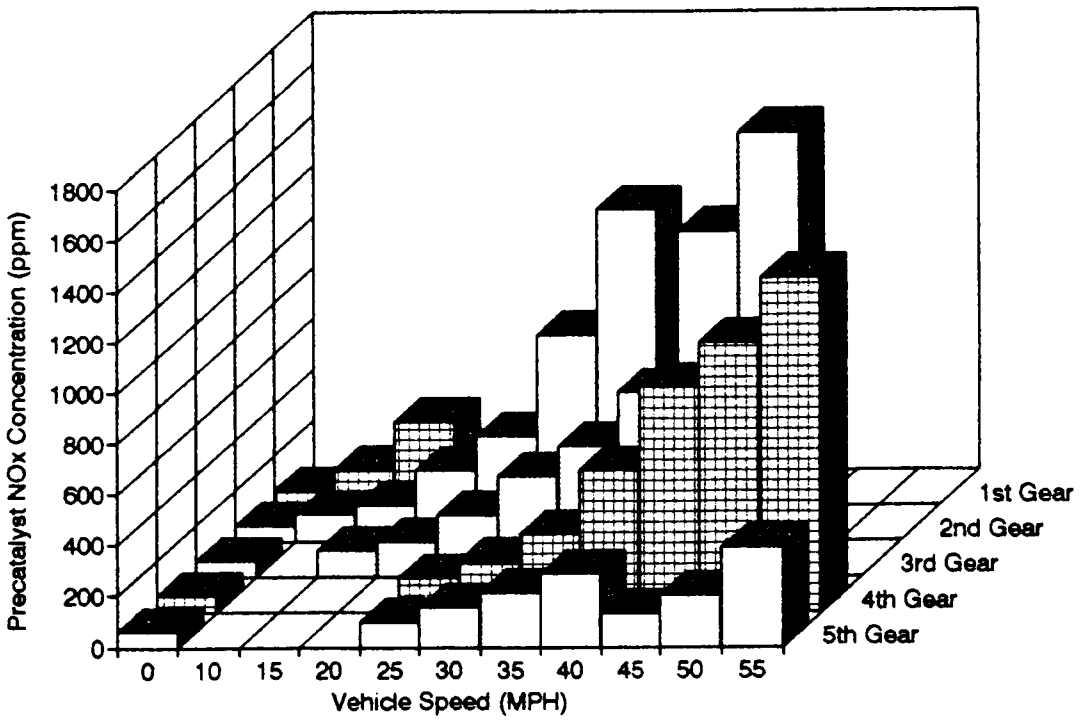



Figure 25: Precatalyst NOx concentrations for the 1988 Corsica.

Table 9: Precatalyst NOx concentrations for the 1988 Corsica.

| Nitrogen Oxides concentrations in parts per million (ppm) | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 62 | 62 | 62 | 62 | 62 |
| 10 | 143 | 106 | | | |
| 15 | 330 | 142 | 103 | | |
| 20 | | 279 | 136 | | |
| 25 | | 413 | 242 | 133 | 99 |
| 30 | | 810 | 392 | 198 | 155 |
| 35 | | 1,300 | 513 | 304 | 214 |
| 40 | | | 722 | 552 | 288 |
| 45 | | | 1,356 | 881 | 134 |
| 50 | | | 1,741 | 1,058 | 202 |
| 55 | | | | 1,308 | 389 |

a given speed decreased with increasing gear position. Precatalyst carbon monoxide mass flow rates are shown in figure 26 and tabulated in table 10. Precatalyst nitrogen oxides mass flow rate are shown in figure 27 and tabulated in table 11. Precatalyst hydrocarbon mass flow did not follow the same trend. The data as shown indicated that in general the THC emissions were not always reduced at a given speed by increasing the gear position, nor did they always increase with increasing speed. The THC emissions at 20 miles/hr in second gear and at 45 miles/hr in gear four appear to be grossly exaggerated when compared to the points around them. The data around these points does not support the conclusion that manifold pressure controlled enrichment caused the mixture at these point to be rich. Further examination of the conditions during each of these tests showed that in each case where the THC emissions did not follow the pattern of the other precatalyst pollutant streams there was a significant change in precatalyst exhaust temperature from the neighboring points. Specifically, at some points the exhaust temperature was high, which indicated that a higher amount of oxidation of hydrocarbons was occurring prior to the catalytic converter. Since in on-road operation the exhaust temperature can vary significantly at any given speed, this behavior was not deemed to be unusual. The precatalyst total hydrocarbon mass flow data is shown in figure 28 and tabulated in table 12. The precatalyst pollutants were also calculated in terms of gram of pollution per mile driven. Figures 29 through 31 and tables 13 through 15 show the grams per mile emission rates of carbon monoxide, hydrocarbons, and nitrogen oxides, respectively.

The postcatalyst concentration of carbon monoxide showed a virtual independence from vehicle speed and gear. This is shown by figure 32 and tabulated in table 16.

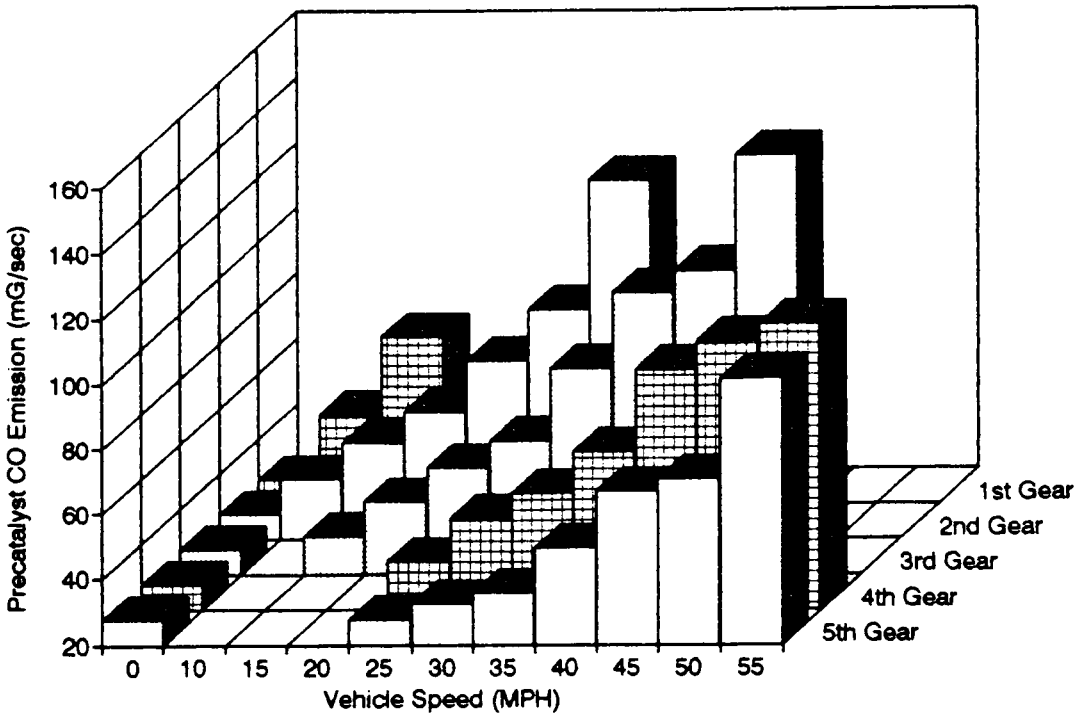



Figure 26: Precatalyst carbon monoxide mass flow rates for the 1988 Corsica.

Table 10: Precatalyst carbon monoxide mass flow rates for the 1988 Corsica.

| Carbon monoxide mass flow rates in milligrams per second. | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 27.74 | 27.74 | 27.74 | 27.74 | 27.74 |
| 10 | 47.39 | 38.49 | | | |
| 15 | 71.03 | 49.69 | 31.62 | | |
| 20 | | 59.07 | 42.39 | | |
| 25 | | 74.56 | 52.89 | 34.82 | 27.86 |
| 30 | | 90.13 | 61.04 | 48.12 | 32.55 |
| 35 | | 129.55 | 82.77 | 55.54 | 35.87 |
| 40 | | | 106.04 | 68.28 | 49.52 |
| 45 | | | 112.79 | 93.31 | 66.97 |
| 50 | | | 147.67 | 101.94 | 70.8 |
| 55 | | | | 106.84 | 101.39 |

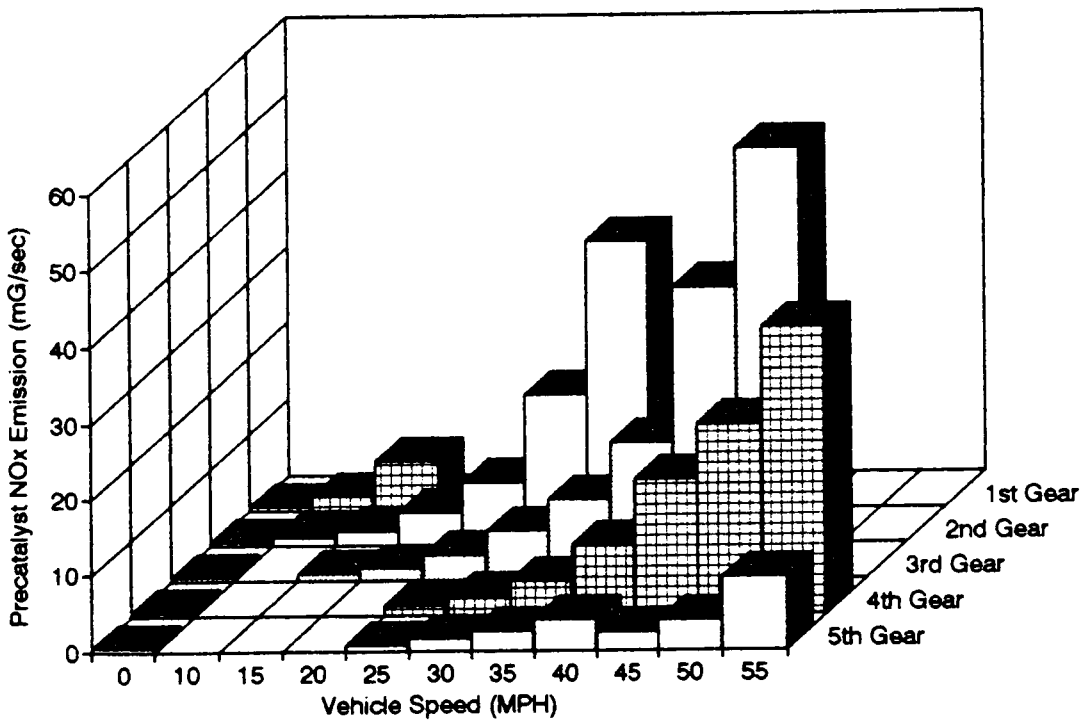



Figure 27: Precatalyst nitrogen oxides mass flow rates for the 1988 Corsica.

Table 11: Precatalyst nitrogen oxides mass flow rates for the 1988 Corsica.

| Nitrogen oxides mass flow rates in milligrams per second | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 |
| 10 | 1.83 | 0.99 | | | |
| 15 | 6.5 | 1.79 | 0.91 | | |
| 20 | | 4.32 | 1.59 | | |
| 25 | | 8.28 | 3.37 | 1.35 | 0.8 |
| 30 | | 19.65 | 6.41 | 2.52 | 1.51 |
| 35 | | 39.52 | 10.48 | 4.37 | 2.53 |
| 40 | | | 17.94 | 9.13 | 3.95 |
| 45 | | | 38.14 | 17.74 | 2.37 |
| 50 | | | 56.33 | 24.93 | 3.81 |
| 55 | | | | 37.38 | 9.5 |

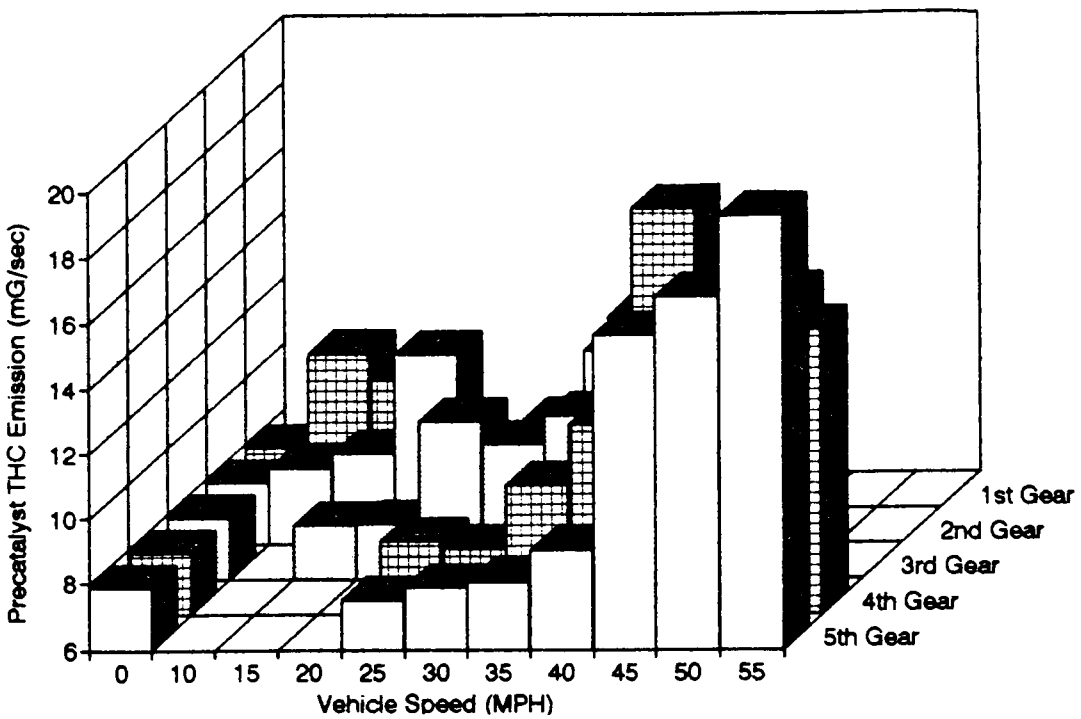



Figure 28: Precatalyst hydrocarbon mass flow rates for the 1988 Corsica.

Table 12: Precatalyst hydrocarbon mass flow rates for the 1988 Corsica.

| Hydrocarbon mass flow rates in milligrams per second | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 7.88 | 7.88 | 7.88 | 7.88 | 7.88 |
| 10 | 10.74 | 8.34 | | | |
| 15 | 10 | 8.78 | 7.66 | | |
| 20 | | 11.78 | 7.7 | | |
| 25 | | 8.68 | 10.84 | 8.22 | 7.5 |
| 30 | | 9.75 | 10.12 | 8.02 | 7.89 |
| 35 | | 11.89 | 11 | 9.93 | 8.04 |
| 40 | | | 13.99 | 11.77 | 9.01 |
| 45 | | | 13.89 | 18.38 | 15.58 |
| 50 | | | 14.6 | 14.88 | 16.74 |
| 55 | | | | 14.62 | 19.2 |

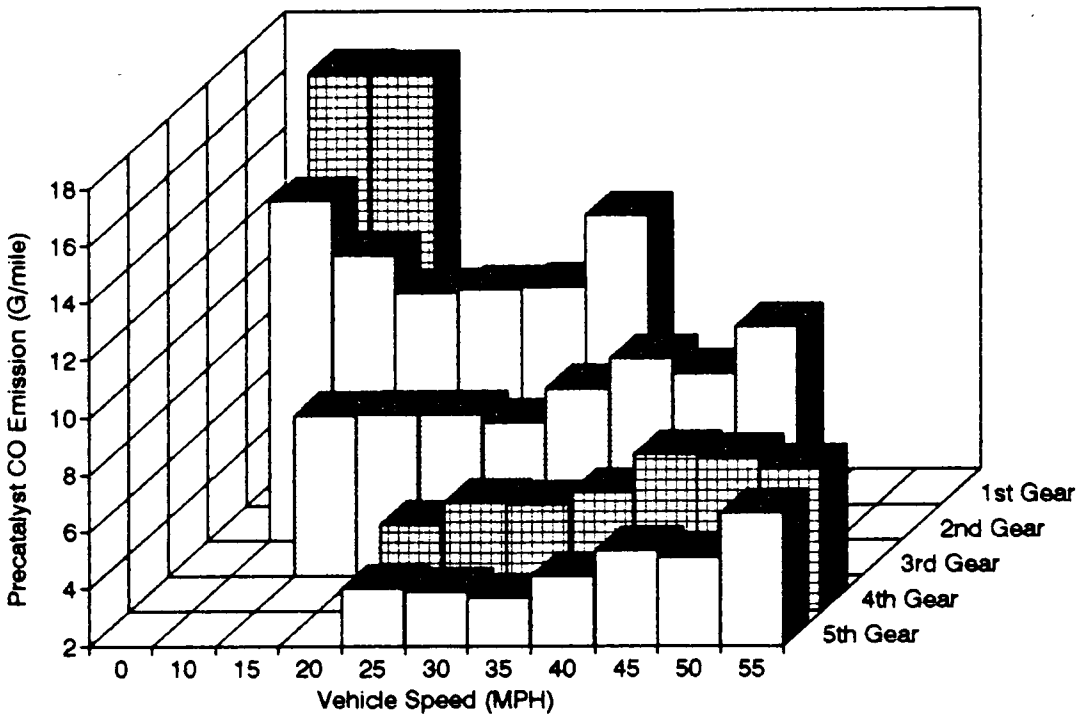



Figure 29: Precatalyst carbon monoxide emission rates for the 1988 Corsica.

Table 13: Precatalyst carbon monoxide emission rates for the 1988 Corsica.

| Carbon monoxide emission rates in grams per mile | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | | | | | |
| 10 | 17.06 | 13.86 | | | |
| 15 | 17.05 | 11.93 | 7.59 | | |
| 20 | | 10.63 | 7.63 | | |
| 25 | | 10.74 | 7.62 | 5.01 | 4.01 |
| 30 | | 10.82 | 7.32 | 5.77 | 3.91 |
| 35 | | 13.33 | 8.51 | 5.71 | 3.69 |
| 40 | | | 9.54 | 6.15 | 4.46 |
| 45 | | | 9.02 | 7.46 | 5.36 |
| 50 | | | 10.63 | 7.34 | 5.1 |
| 55 | | | | 6.99 | 6.64 |

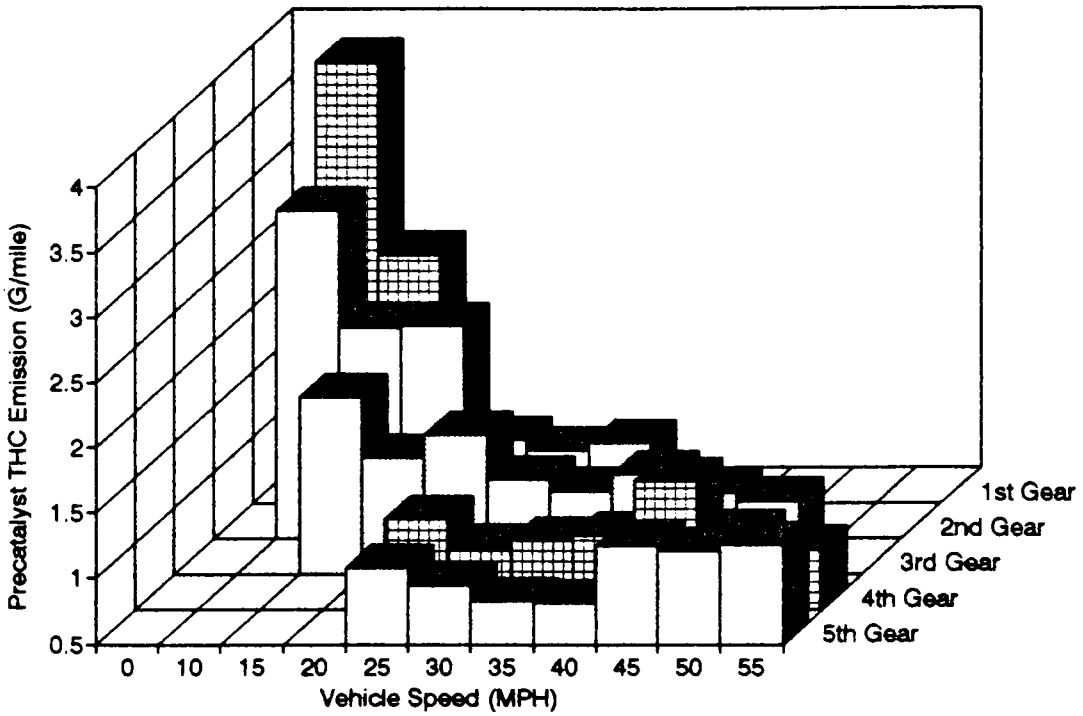



Figure 30: Precatalyst hydrocarbon emission rates for the 1988 Corsica.

Table 14: Precatalyst hydrocarbon emission rates for the 1988 Corsica.

| Hydrocarbon emission rates in grams per mile | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | | | | | |
| 10 | 3.87 | 3 | 1.84 | | |
| 15 | 2.4 | 2.11 | 1.39 | | |
| 20 | | 2.12 | 1.56 | | |
| 25 | | 1.25 | 1.21 | 1.18 | 1.08 |
| 30 | | 1.17 | 1.13 | 0.96 | 0.95 |
| 35 | | 1.22 | 1.26 | 1.02 | 0.83 |
| 40 | | | 1.11 | 1.06 | 0.81 |
| 45 | | | 1.05 | 1.47 | 1.25 |
| 50 | | | | 1.07 | 1.21 |
| 55 | | | | 0.96 | 1.26 |

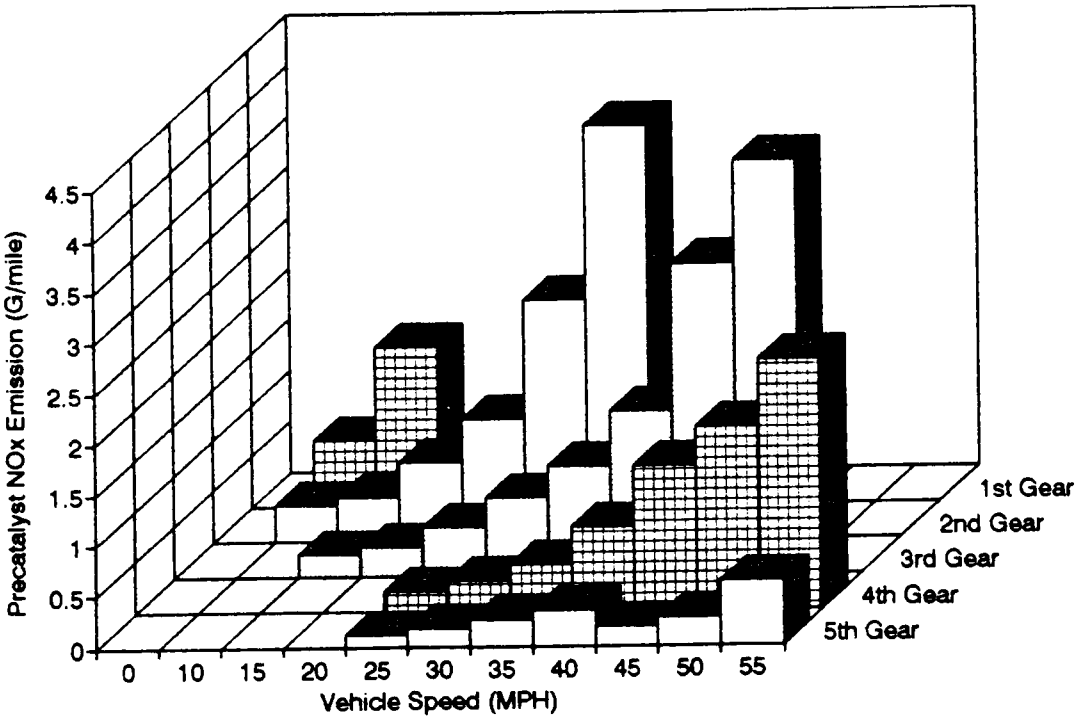



Figure 31: Precatalyst NOx emission rates for the 1988 Corsica.

Table 15: Precatalyst NOx emission rates for the 1988 Corsica.

| Nitrogen oxides emission rates in grams per mile | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | | | | | |
| 10 | 0.66 | 0.36 | | | |
| 15 | 1.56 | 0.43 | 0.22 | | |
| 20 | | 0.78 | 0.29 | | |
| 25 | | 1.19 | 0.49 | 0.19 | 0.12 |
| 30 | | 2.36 | 0.77 | 0.3 | 0.18 |
| 35 | | 4.06 | 1.08 | 0.45 | 0.26 |
| 40 | | | 1.61 | 0.82 | 0.36 |
| 45 | | | 3.05 | 1.42 | 0.19 |
| 50 | | | 4.06 | 1.79 | 0.27 |
| 55 | | | | 2.45 | 0.62 |

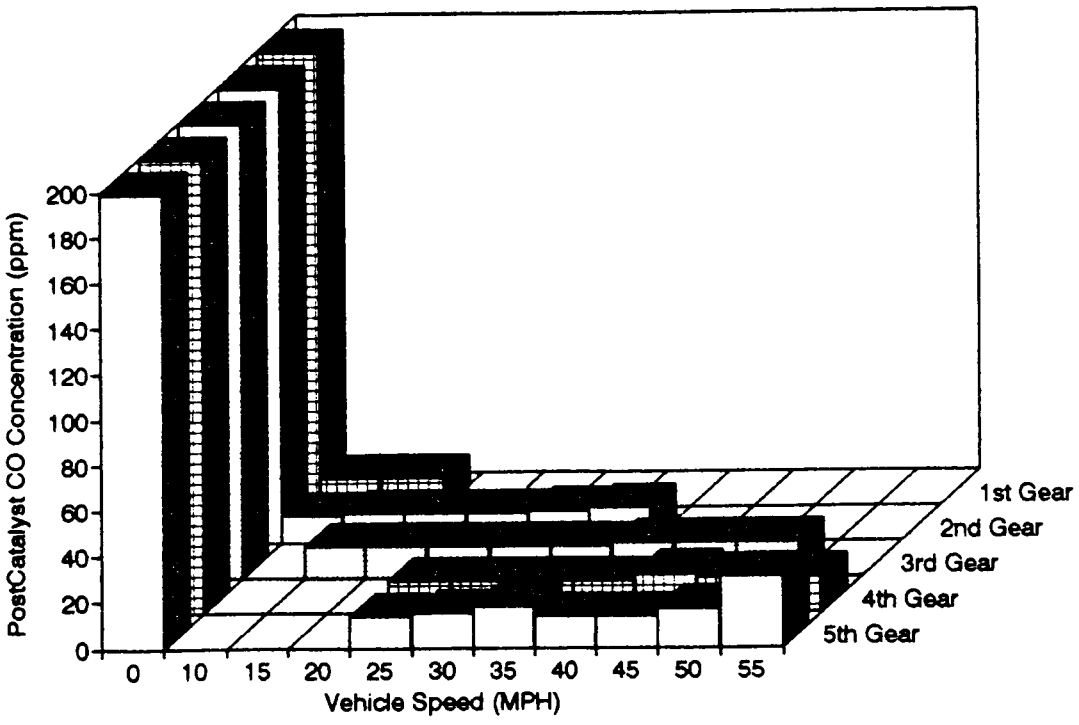



Figure 32: Postcatalyst carbon monoxide concentrations for the 1988 Corsica.

Table 16: Postcatalyst carbon monoxide concentrations for the 1988 Corsica

| Carbon monoxide concentrations in parts per million (ppm) | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 199 | 199 | 199 | 199 | 199 |
| 10 | 13 | 12 | | | |
| 15 | 12 | 13 | 14 | | |
| 20 | | 13 | 14 | | |
| 25 | | 13 | 14 | 14 | 14 |
| 30 | | 14 | 14 | 14 | 15 |
| 35 | | 15 | 14 | 14 | 18 |
| 40 | | | 15 | 14 | 14 |
| 45 | | | 15 | 17 | 14 |
| 50 | | | 15 | 15 | 17 |
| 55 | | | | 15 | 31 |

However, the concentrations of both CO and hydrocarbons under idle conditions are much higher than those when the vehicle was in motion. Figure 33 and table 17 show the postcatalyst concentrations for hydrocarbons. The postcatalyst NOx concentrations show again a tendency to increase as the vehicle speed increased in a given gear, but to decrease with increasing gear position. This is shown in figure 34 and table 18.

The postcatalyst pollutant mass flow rates did not show the same trend as the precatalyst flow rates. The postcatalyst carbon monoxide mass flow rates show that the highest mass flow of carbon monoxide occurred at idle. Aside from the idle data, the carbon monoxide flow tended to increase with speed and with few exceptions to decrease with increasing gear position. Given the nearly invariant nature of the carbon monoxide concentration, this trend is likely due to changing exhaust flow rates. This trend is shown in figure 35 and tabulated in table 19. Postcatalyst hydrocarbon emissions do not show a readily visible trend. Hydrocarbon emissions also showed their maximum value at idle. Hydrocarbon emissions are shown in figure 36 and table 20. Postcatalyst nitrogen oxides showed a minimum value at idle and tended to increase with speed and to decrease with increasing gear position, although there were several exceptions. Nitrogen oxides emissions data is shown in figure 37 and table 21. The emissions of each of the pollutants in terms of grams per mile showed that in general the pollutant emissions were minimized by selecting the highest gear practical for a given vehicle speed. These emission rates are shown in figures 38 through 40 and tables 22 through 24.

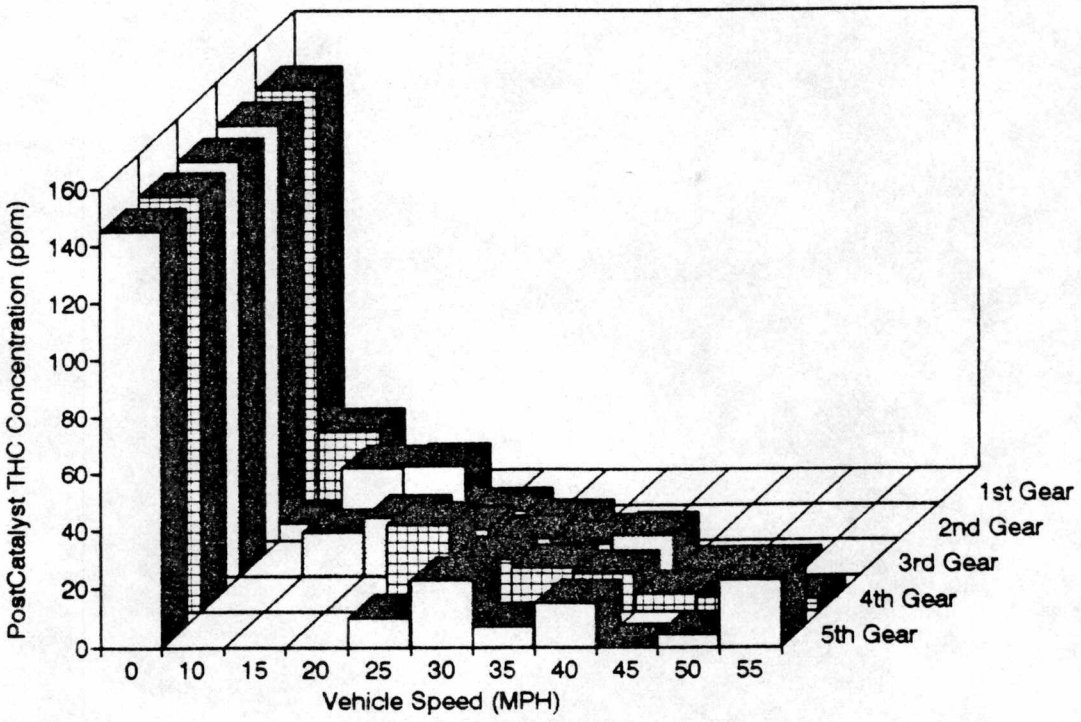



Figure 33: Postcatalyst hydrocarbon concentrations for the 1988 Corsica.

Table 17: Postcatalyst hydrocarbon concentrations for the 1988 Corsica.

| Hydrocarbon concentrations in parts per million (ppm) | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 145 | 145 | 145 | 145 | 145 |
| 10 | 26 | 6 | | | |
| 15 | 12 | 25 | 15 | | |
| 20 | | 26 | 20 | | |
| 25 | | 10 | 16 | 30 | 10 |
| 30 | | 6 | 13 | 18 | 23 |
| 35 | | 1 | 11 | 15 | 7 |
| 40 | | | 14 | 13 | 15 |
| 45 | | | 2 | 6 | 0 |
| 50 | | | 2 | 5 | 4 |
| 55 | | | | 4 | 23 |

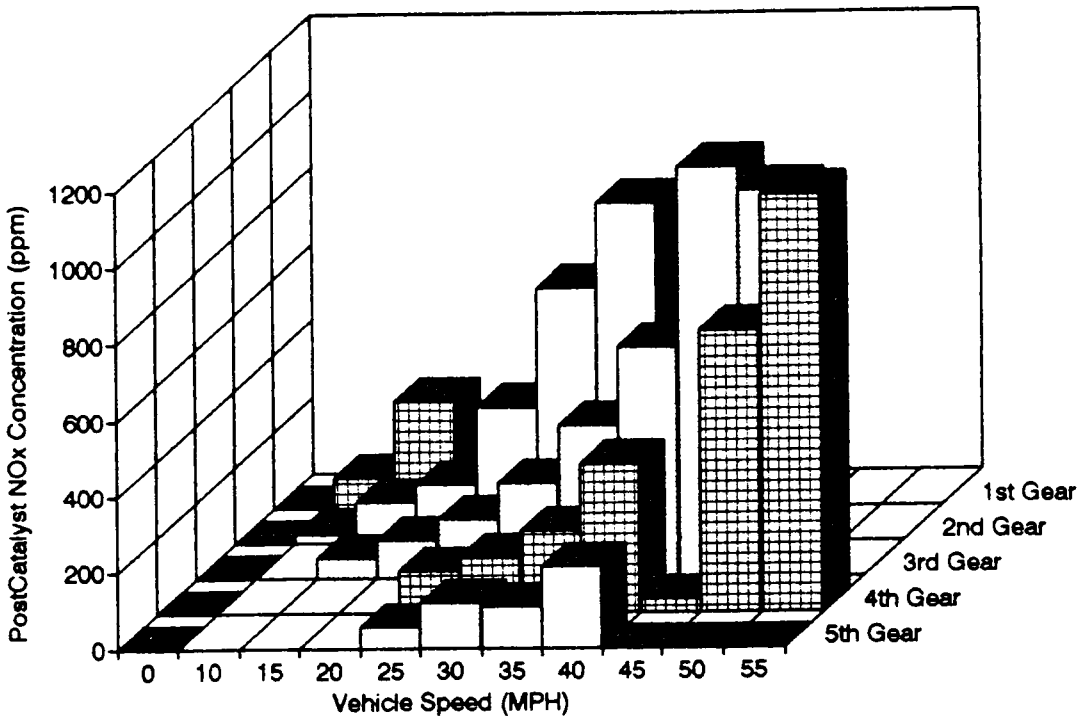



Figure 34: Postcatalyst NOx concentrations for the 1988 Corsica.

Table 18: Postcatalyst NOx concentrations for the 1988 Corsica.

| Nitrogen oxides concentrations in parts per million (ppm) | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 79 | 24 | | | |
| 15 | 278 | 107 | 53 | | |
| 20 | | 154 | 98 | | |
| 25 | | 355 | 153 | 111 | 57 |
| 30 | | 663 | 249 | 144 | 118 |
| 35 | | 886 | 397 | 215 | 107 |
| 40 | | | 601 | 390 | 213 |
| 45 | | | 1,071 | 33 | 0 |
| 50 | | | 1,008 | 736 | 0 |
| 55 | | | | 1,090 | 0 |

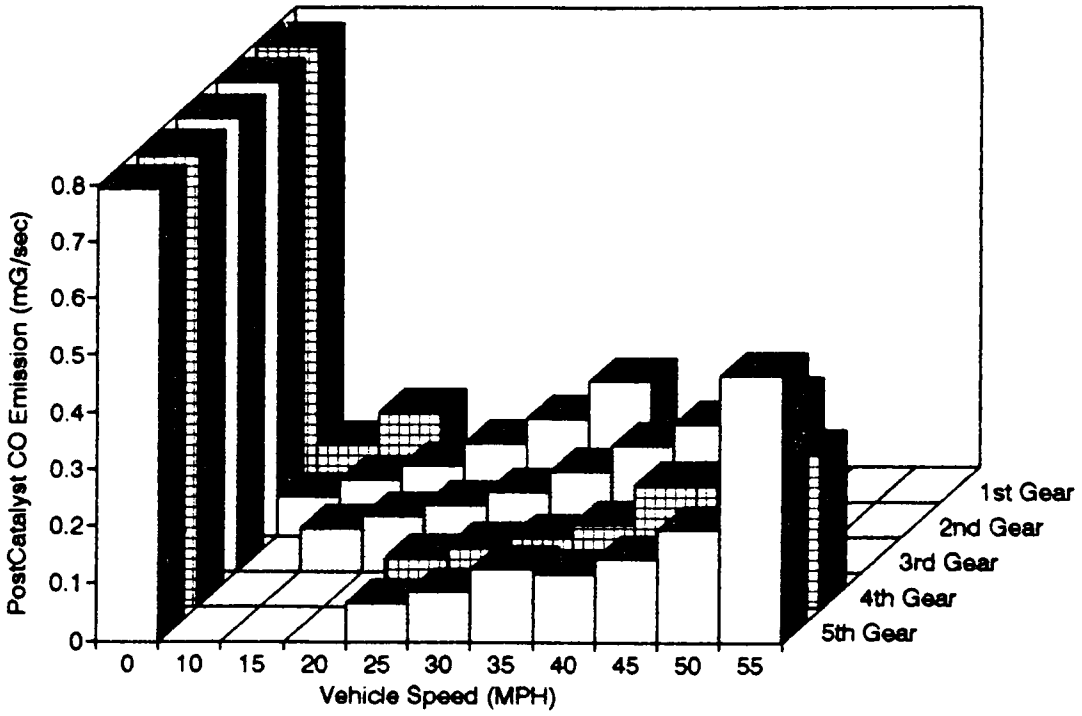



Figure 35: Postcatalyst carbon monoxide mass flow rates for the 1988 Corsica.

Table 19: Postcatalyst carbon monoxide mass flow rates for the 1988 Corsica.

| Carbon monoxide mass flow rates in milligrams per second | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 |
| 10 | 0.1 | 0.07 | | | |
| 15 | 0.15 | 0.1 | 0.08 | | |
| 20 | | 0.12 | 0.1 | | |
| 25 | | 0.16 | 0.12 | 0.09 | 0.07 |
| 30 | | 0.21 | 0.14 | 0.11 | 0.09 |
| 35 | | 0.27 | 0.17 | 0.12 | 0.13 |
| 40 | | | 0.22 | 0.14 | 0.12 |
| 45 | | | 0.26 | 0.21 | 0.15 |
| 50 | | | 0.3 | 0.21 | 0.2 |
| 55 | | | | 0.26 | 0.46 |

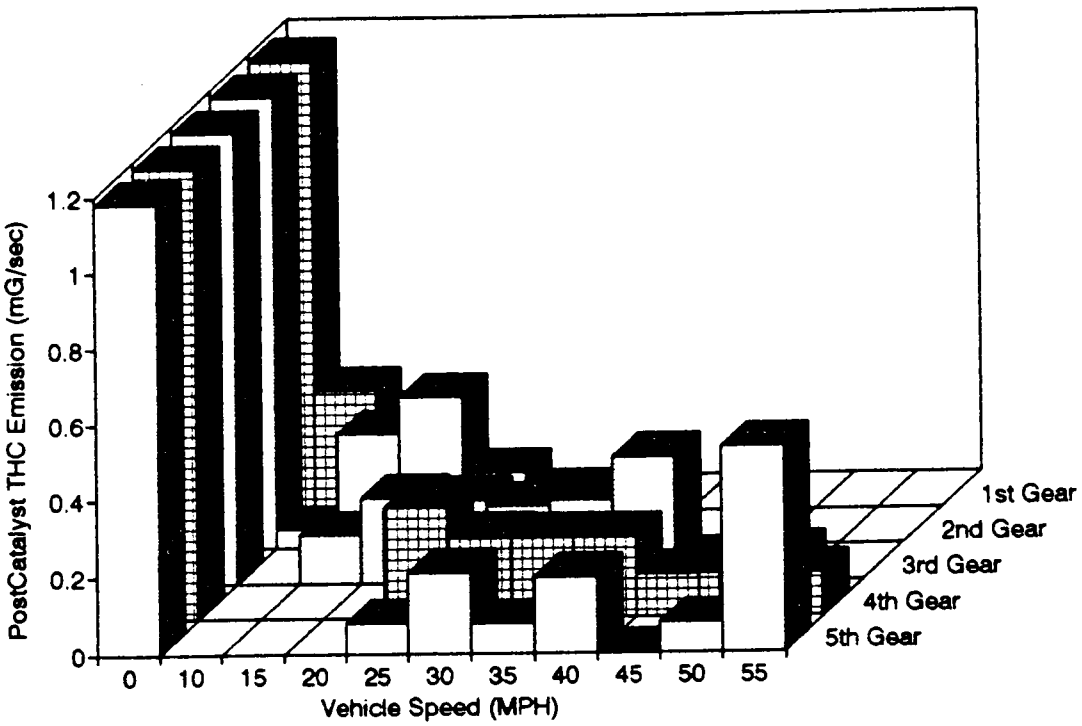



Figure 36: Postcatalyst hydrocarbon mass flow rates for the 1988 Corsica.

Table 20: Postcatalyst hydrocarbon mass flow rates for the 1988 Corsica.

| Hydrocarbon mass flow rates in milligrams per second | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 |
| 10 | 0.32 | 0.05 | | | |
| 15 | 0.22 | 0.3 | 0.13 | | |
| 20 | | 0.39 | 0.22 | | |
| 25 | | 0.19 | 0.22 | 0.29 | 0.08 |
| 30 | | 0.14 | 0.2 | 0.21 | 0.21 |
| 35 | | 0.03 | 0.21 | 0.21 | 0.08 |
| 40 | | | 0.32 | 0.21 | 0.2 |
| 45 | | | 0.05 | 0.11 | 0.002 |
| 50 | | | 0.07 | 0.11 | 0.08 |
| 55 | | | | 0.11 | 0.53 |

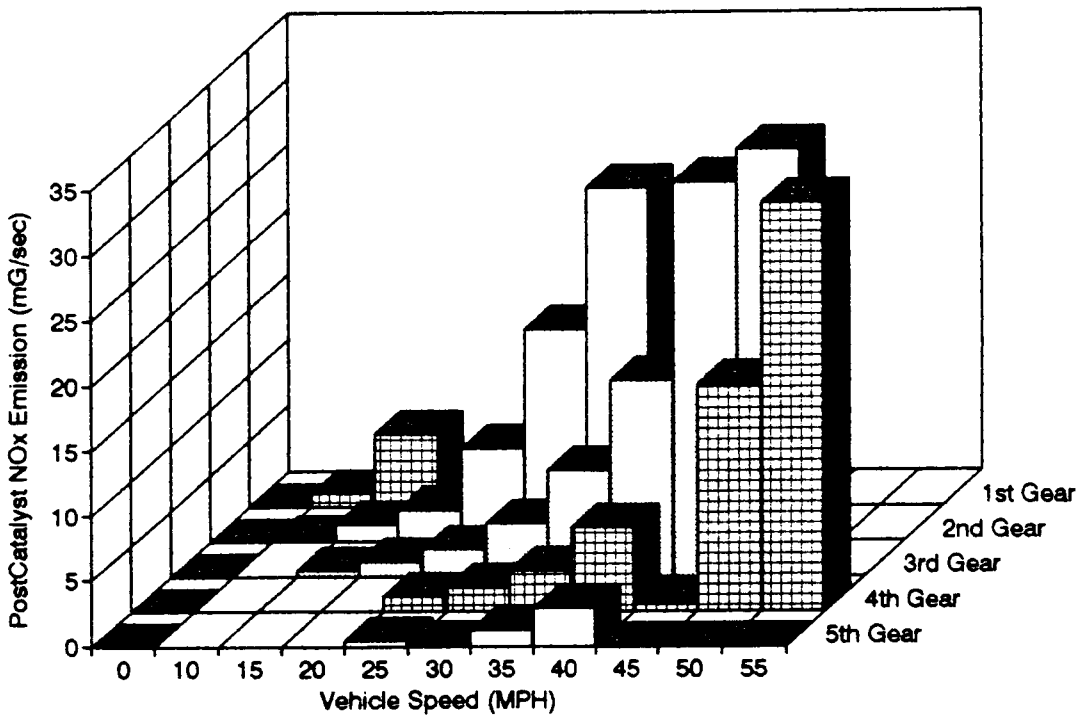



Figure 37: Postcatalyst NOx mass flow rates for the 1988 Corsica.

Table 21: Postcatalyst NOx mass flow rates for the 1988 Corsica.

| Nitrogen oxides mass flow rates in milligrams per second | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 1.01 | 0.22 | | | |
| 15 | 5.47 | 1.34 | 0.46 | | |
| 20 | | 2.38 | 1.14 | | |
| 25 | | 7.12 | 2.12 | 1.13 | 0.46 |
| 30 | | 16.09 | 4.07 | 1.83 | 0.12 |
| 35 | | 26.94 | 8.11 | 3.1 | 1.26 |
| 40 | | | 14.93 | 6.45 | 2.93 |
| 45 | | | 30.13 | 0.67 | 0.005 |
| 50 | | | 32.62 | 17.34 | 0.008 |
| 55 | | | | 31.16 | 0.007 |

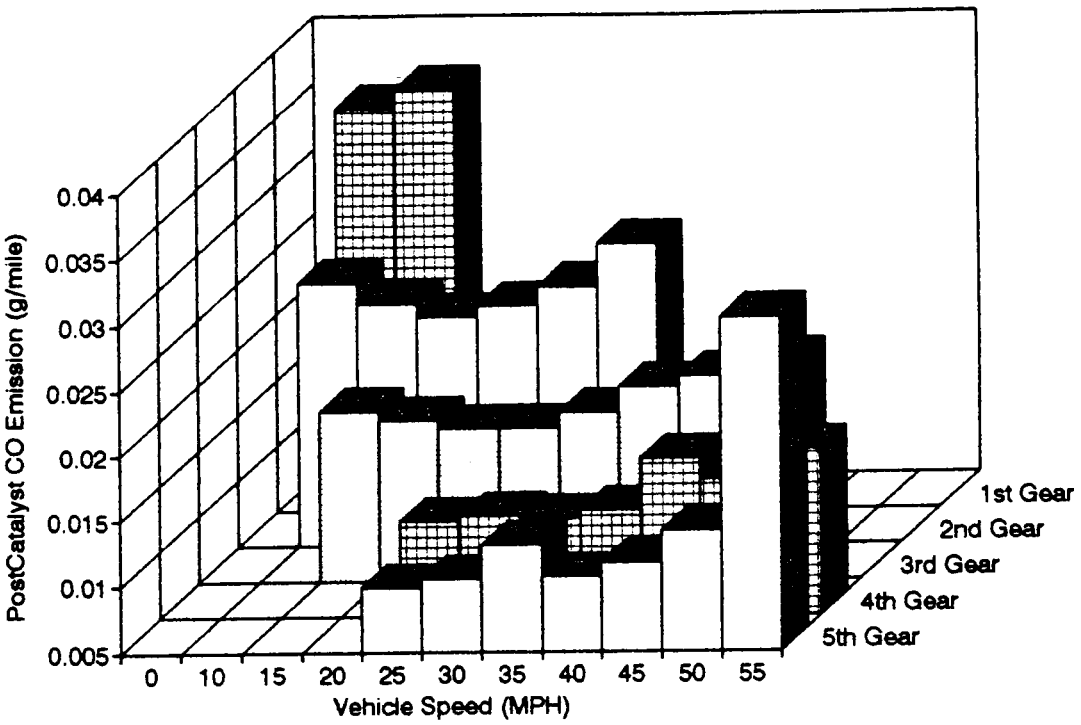



Figure 38: Postcatalyst carbon monoxide emission rates for the 1988 Corsica.

Table 22: Postcatalyst carbon monoxide emission rates for the 1988 Corsica.

| Carbon monoxide emission rates in grams per mile | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | | | | | |
| 10 | 0.04 | 0.03 | | | |
| 15 | 0.04 | 0.02 | 0.02 | | |
| 20 | | 0.02 | 0.02 | | |
| 25 | | 0.02 | 0.02 | 0.01 | 0.01 |
| 30 | | 0.02 | 0.02 | 0.01 | 0.01 |
| 35 | | 0.03 | 0.02 | 0.01 | 0.01 |
| 40 | | | 0.02 | 0.01 | 0.01 |
| 45 | | | 0.02 | 0.02 | 0.01 |
| 50 | | | 0.02 | 0.02 | 0.01 |
| 55 | | | | 0.02 | 0.03 |

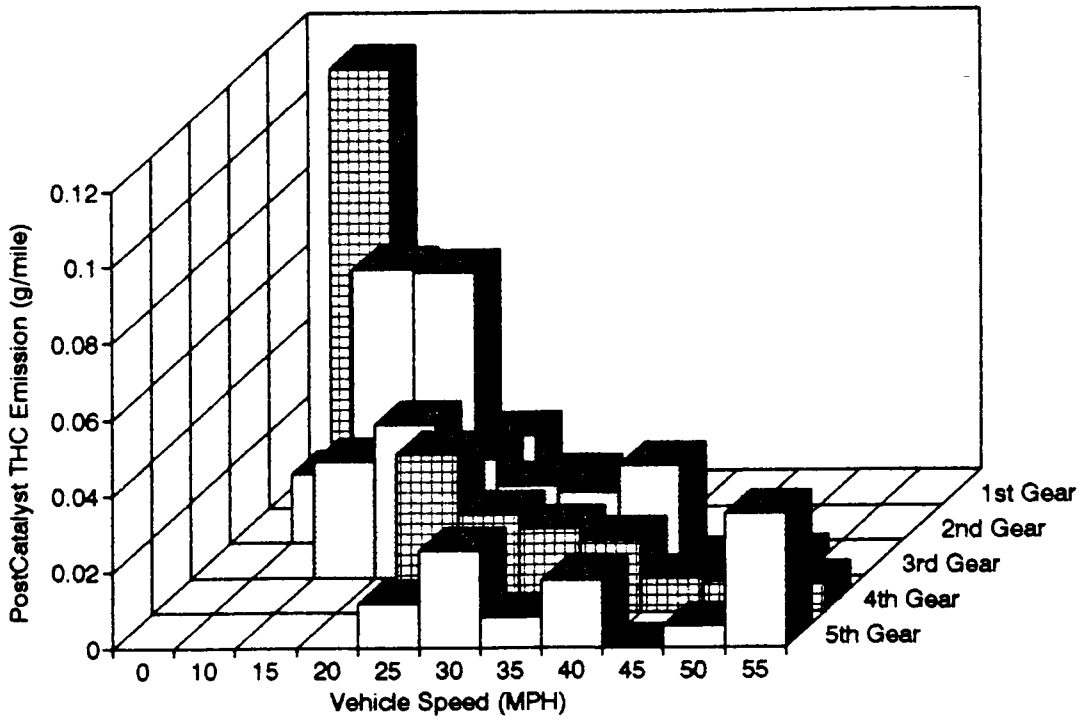



Figure 39: Postcatalyst hydrocarbon emission rates for the 1988 Corsica.

Table 23: Postcatalyst hydrocarbon emission rates for the 1988 Corsica.

| Hydrocarbon emission rates in grams per mile | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | | | | | |
| 10 | 0.11 | 0.02 | 0.03 | | |
| 15 | 0.05 | 0.07 | 0.04 | | |
| 20 | | 0.07 | 0.03 | | |
| 25 | | 0.03 | 0.02 | 0.04 | 0.01 |
| 30 | | 0.02 | 0.02 | 0.03 | 0.03 |
| 35 | | 0.003 | 0.03 | 0.02 | 0.01 |
| 40 | | | 0.004 | 0.02 | 0.02 |
| 45 | | | 0.004 | 0.01 | 0 |
| 50 | | | 0.005 | 0.01 | 0.01 |
| 55 | | | | 0.01 | 0.04 |

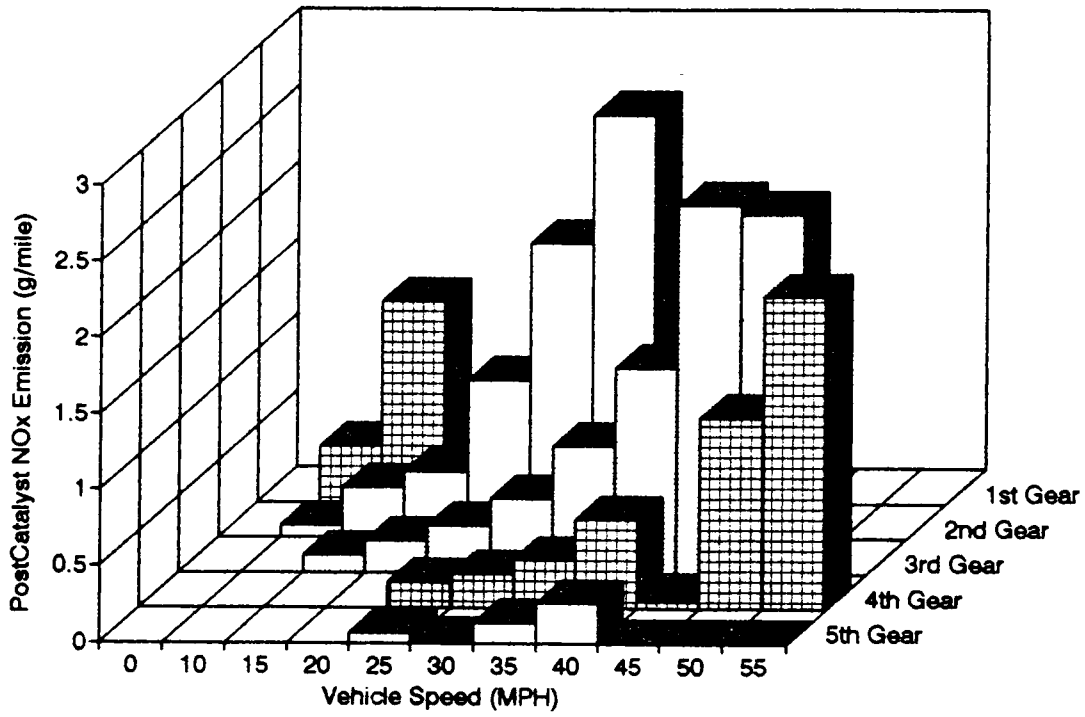



Figure 40: Postcatalyst NOx emission rates for the 1988 Corsica.

Table 24: Postcatalyst NOx emission rates for the 1988 Corsica.

| Nitrogen oxides emission rates in grams per mile | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | | | | | |
| 10 | 0.36 | 0.08 | | | |
| 15 | 1.31 | 0.32 | 0.11 | | |
| 20 | | 0.43 | 0.21 | | |
| 25 | | 1.03 | 0.31 | 0.16 | 0.07 |
| 30 | | 1.93 | 0.49 | 0.22 | 0.01 |
| 35 | | 2.77 | 0.83 | 0.32 | 0.13 |
| 40 | | | 1.34 | 0.58 | 0.26 |
| 45 | | | 2.41 | 0.05 | 0 |
| 50 | | | 2.34 | 1.25 | 0.001 |
| 55 | | | | 2.04 | 0.001 |

The postcatalyst emissions data is somewhat more scattered than the precatalyst data. This is due in large part to the effects of the catalyst temperature on its conversion efficiency. The individual pollutant concentrations, and hence the other measures of pollutant emission, were highly sensitive to conversion efficiency. At an average conversion efficiency of 97%, a change of 1% in conversion efficiency can result in a change in postcatalyst pollutant concentration of 33% for the same precatalyst concentration. The conversion efficiency for hydrocarbons varied from a low of 85% to a high of virtually 100%. The carbon monoxide conversion efficiency was much better, dipping below 99% only at idle and then was 97%. The nitrogen oxides conversion efficiency was by far the most variable, ranging from 14% to virtually 100%. Tables 25 through 27 show the conversion efficiencies for each of the three principle pollutants. In each case the converter temperature was judged to be within acceptable limits. That is to say that it was at least 300 °C and not more than 500 °C. Catalytic conversion efficiency is not only a function of temperature however. It also depends upon the relative precatalyst concentrations of the pollutants and upon the exhaust space velocity, among other things (13).

The operating conditions of the vehicle during dynamometer testing were of particular interest. Particularly of interest is the manifold air temperature, the coolant temperature, and the catalytic converter temperature. Each of these temperatures had the potential to influence the dynamometer data by causing the vehicle to operate in an abnormal or undesirable way. However, with care each of these temperatures was

Table 25: Carbon monoxide conversion efficiencies for the 1988 Corsica.

| Conversion efficiencies in percent | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 97.12 | 97.12 | 97.12 | 97.12 | 97.12 |
| 10 | 99.79 | 99.82 | | | |
| 15 | 99.78 | 99.8 | 99.76 | | |
| 20 | | 99.79 | 99.77 | | |
| 25 | | 99.78 | 99.78 | 99.75 | 99.75 |
| 30 | | 99.77 | 99.77 | 99.78 | 99.73 |
| 35 | | 99.79 | 99.79 | 99.78 | 99.65 |
| 40 | | | 99.79 | 99.79 | 99.76 |
| 45 | | | 99.77 | 99.77 | 99.78 |
| 50 | | | 99.8 | 99.79 | 99.72 |
| 55 | | | | 99.75 | 99.55 |

Table 26: Hydrocarbon conversion efficiencies for the 1988 Corsica.

| Conversion efficiencies in percent | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 85.05 | 85.05 | 85.05 | 85.05 | 85.05 |
| 10 | 97.03 | 99.4 | | | |
| 15 | 97.81 | 96.62 | 98.35 | | |
| 20 | | 96.68 | 97.12 | | |
| 25 | | 97.77 | 98.02 | 96.49 | 98.94 |
| 30 | | 98.57 | 98.02 | 97.34 | 97.32 |
| 35 | | 99.74 | 98.05 | 97.87 | 99.02 |
| 40 | | | 97.67 | 98.21 | 97.83 |
| 45 | | | 99.6 | 99.39 | 99.99 |
| 50 | | | 99.54 | 99.24 | 99.53 |
| 55 | | | | 99.25 | 97.22 |

Table 27: NOx conversion efficiencies for the 1988 Corsica.

| Conversion efficiencies in percent | | | | | |
|---|---|---|---|---|---|
| Speed (MPH) | Gear 1 | Gear 2 | Gear 3 | Gear 4 | Gear 5 |
| 0 | 100 | 100 | 100 | 100 | 100 |
| 10 | 44.92 | 77.24 | | | |
| 15 | 15.92 | 24.96 | 48.85 | | |
| 20 | | 45.01 | 28.22 | | |
| 25 | | 14.03 | 37 | 15.84 | 42.96 |
| 30 | | 18.14 | 36.51 | 27.49 | 23.34 |
| 35 | | 31.86 | 22.53 | 29.13 | 50.14 |
| 40 | | | 16.73 | 29.29 | 25.85 |
| 45 | | | 21.09 | 96.21 | 99.79 |
| 50 | | | 42.2 | 30.41 | 99.8 |
| 55 | | | | 17.54 | 99.93 |

successfully kept within its normal range. The engine coolant, for example, was found to normally operate at about 97 °C. The post catalyst temperature normally fell between 300 and 550 °C, and the manifold air temperature normally operated between 38 and 66 °C. The coolant temperature and the catalyst temperature were successfully managed by idling the car as necessary to allow cooling. The manifold air temperature was not as easily controlled. Fortunately, although the manifold air temperature frequently operated high in the normal range of operation, it did not become excessive.

# CHAPTER VII
# CONCLUSIONS

Based upon the results of this study two conclusions can be drawn. The procedure proposed by this study was to measure the exhaust emissions and fuel consumption of vehicles in on-road operation by calibrating a chassis dynamometer followed by dynamometer testing of the on-road points of interest. This procedure has been shown to produce results acceptable for use in determining emissions factors to be used in atmospheric modeling.

Installing analyzers in the vehicle and actually driving the vehicle on the road would be preferable to using a chassis dynamometer if the analyzers could respond quickly enough to make good measurements in a transient environment. However, given the long response times of the analyzers used for this study placing analyzers in a vehicle and driving the vehicle is not likely to produce emissions and fuel consumption data of significantly improved accuracy.

# CHAPTER VIII
# RECOMMENDATIONS

Based upon the results of this study the following recommendations are made:

1. Investigate signal reconstruction techniques to improve exhaust gas analysis equipment response characteristics.

2. Use a more up to date chassis dynamometer or modify the controls on the existing machine in order to further reduce on-road load modeling error.

3. Perform additional testing at each point to better quantify characteristic catalyst efficiencies and temperatures.

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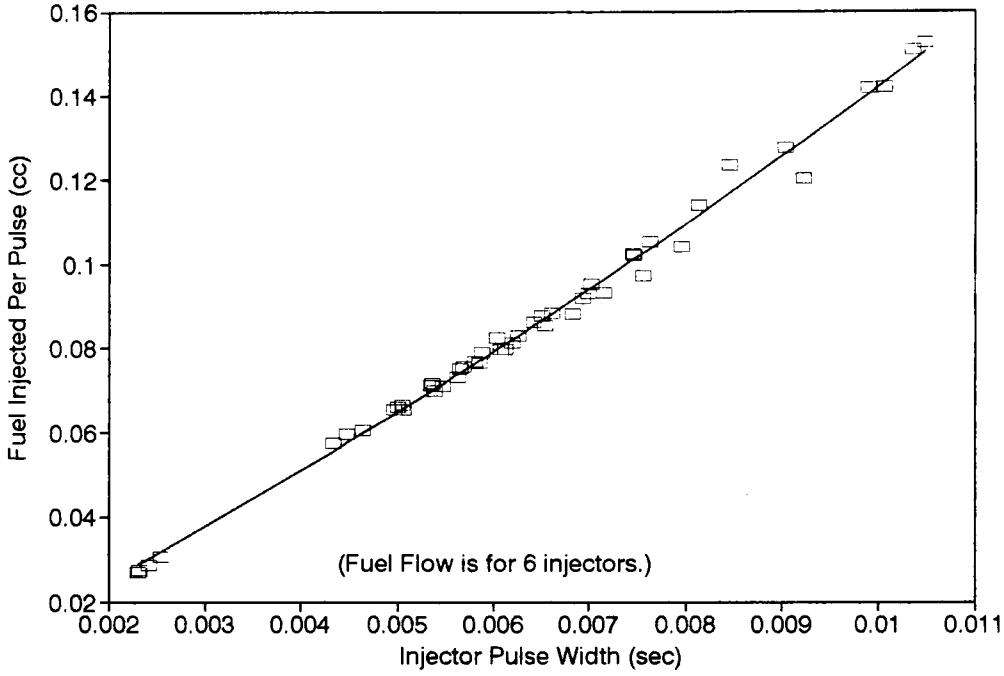
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# APPENDIX

# FUEL INJECTOR CALIBRATION




Fuel Injected per Pulse = A + B(pw) + C(pw)^2
where:

A = 1.3136225 * 10^-3
B = 1.1334156 * 10^1
C = 2.7352564 * 10^2
pw = measured injector pulsewidth in seconds
Fuel injected per pulse is in units of cc/pulse.

In order to get fuel consumption in units of cc/sec, multiply the fuel injected per pulse by the injector frequency in pulses/second.

This curve is valid only for the tested 1988 Chevrolet Corsica using gasoline fuel injectors and fuel rail.

## Non-Dispersive Infrared Analyzer
## Theory of Operation

A non-dispersive infrared analyzer operates on the principle that a gas absorbs infrared light in a specific range of wavelengths. An infrared analyzer typically has two parallel cells through which shines an infrared light of the appropriate frequency range for the gas which is of interest, such as carbon monoxide. If one cell is filled with a reference gas, such as air, and the other cell is filled with the gas mixture to be measured, the two cells will absorb different amounts of the infrared radiation which is incident upon them. The amount of radiation which is absorbed by the two cells is dependent upon the concentration of the gas of interest in the sample cell relative to the concentration of that same gas in the reference cell. The difference in absorbed radiation between the two cells causes a pressure difference between the two cells. This pressure difference is then measured by the distention of a thin metal membrane which is exposed on one side to the sample cell and on the other side to the reference cell. The distention of the membrane is typically measured by measuring the change in the capacitance of the membrane device. This signal is then proportional to the concentration of the gas of interest.

Because the concentration measurement is made by utilizing a pressure change, non-dispersive infrared analyzers are particularly sensitive to changes in the pressure of the sample flow to the sample cell. The reference cell can also be filled with a gas which absorbs in the same wavelength range as the gas of interest, in order to account for gases which can distort the measurement of the gas of interest. This is sometimes the case with carbon monoxide and carbon dioxide measurements.

## Chemiluminescence Analyzer

## Theory of Operation

A chemiluminescence analyzer operates on the principle that when NO reacts with $O_3$ to form $NO_2$ and $O_2$, red light is given off. The sample stream is first directed through a catalysis chamber where the $NO_x$ which is present is converted to NO. This stream is then directed to the sample cell. A stream of $O_3$ is also directed to the sample cell. When the two gases react, red light is given off. The intensity of the red light which is given off is proportional to the concentration of NO in the sample stream. The intensity of the red light is typically measured with a photodiode.

If only measurements of NO, and not NOx are of interest, the catalytic conversion of the sample stream is skipped. Chemiluminescence analyzers are typically pressure regulated so that the sample chamber pressure is constant. This eliminates measurement bias due to pressure changes in the chamber.

## Paramagnetic Analyzer
## Theory of Operation

Oxygen is strongly paramagnetic. That is, it is capable of becoming a temporary magnet when exposed to a magnetic field. Most other gases tend to be strongly nonmagnetic. A paramagnetic analyzer operates on this principle by measuring the magnetic force being exerted by the gas sample.

A test body consisting of a dumbell shaped, nitrogen filled, hollow glass test body is suspended on a platinum/nickel allow ribbon in a non-uniform magnetic field. The spheres of the test body are subjected to displacement forces which are in proportion to the magnetic susceptibility of the gas surrounding the test body. By measuring the force necessary to counteract the forces exerted by the gas, the concentration of the gas can be deduced. The restoring force is exerted by the analyzer, and is kept at the appropriate level by a feedback system typically utilizing a beam of light which is reflected from the body onto a photocell. By measuring the current which provides the restoring force, the force being exerted by the gas is measured. This force is then in proportion to the concentration of the gas.

## Flame Ionization Detector

## Theory of Operation

Hydrocarbons, when burned, produce positive ions (carbon atoms). A flame ionization detector measures the hydrocarbon content of a sample stream by taking advantage of this fact. A flame which is sustained by hydrogen has no positive ions. By introducing a sample into this flame, ions will be produced. The ions are measured by inducing an electrical potential across the flame. The positive ions will then be attracted to the negative collector. The amount of current which is detected at the collector is then proportional to the number of ions which were generated by the flame. This number of ions is in turn proportional to the hydrocarbon content of the sample gas.

A flame ionization detector actually detects the carbon content of the sample stream. Typically, the hydrocarbon values are reported as propane ($C_3H_8$), although it is not possible to speciate the hydrocarbon measurements without additional equipment. The analyzer can also be calibrated such that it reports the hydrocarbon values as methane ($CH_4$), or whatever hydrocarbon is desired, provided that a calibration gas containing that hydrocarbon is available.

# Fuel Analysis

Fuel Analysis Performed By:

Galbraith Laboratories, Inc.
2323 Sycamore Drive
Knoxville, TN 37921-1750
(423) 546-1335

Sample Number 1: UT Pump Gasoline Aged in the Vehicle

Sample Date: 9/19/95
Lab ID M-7449

| | |
|---|---|
| Carbon: | 86.47 % |
| Hydrogen: | 13.50 % |
| Oxygen: | < 0.5 % |

Which yields: $CH_{1.87}$

Sample Number 2: UT Motor Pool Pump Gasoline

Sample Date: 9/19/95
Lab ID M-7450

| | |
|---|---|
| Carbon: | 86.72 % |
| Hydrogen: | 13.78 % |
| Oxygen: | < 0.5 % |

Which yields: $CH_{1.91}$

## Equations used in Data Reduction

Stoichiometric Combustion Equation:

$$CH_{1.87} + 1.4675(O_2 + 3.76N_2) \rightarrow CO_2 + 0.935H_2O + 5.5178N_2$$

from the combustion equation, the stoichiometric air/fuel ratio is:

$$\frac{A}{F} = \frac{1.4675(32+3.76(28))}{13.87} = 14.52$$

The actual air/fuel ratio is found by dividing the mass air flow sensor reading (in grams per second) by the fuel consumption rate (in grams per second.) The fuel consumption rate is found by using the fuel injector pulsewidth and frequency readings. This was covered previously.

If all of the hydrogen in the fuel is assumed to make water in the exhaust, then the mass flow rate of water in the exhaust stream can be related to the mass flow of fuel to the engine. This assumption is reasonable in the neighborhood of stoichiometry, since the resulting concentrations of hydrogen and unburned hydrocarbons in the exhaust are small in this region. So, from the stoichiometric combustion equation:

$$\frac{W}{F} = \frac{0.935(18)}{13.87} = 1.2134$$

Where W is the mass flow rate of water in the exhaust and F is the mass flow rate of fuel to the engine. Since pollutant concentrations are normally measured after the steam contained in the exhaust stream is condensed out and removed, it is useful to know the "dry exhaust" mass flow rate, which can now be found.

$$M = A + F - 1.2134F = A - 0.2134F$$

Where A is the mass flow rate of air given by the mass airflow sensor, M is the mass flow rate of dry exhaust gas, and F is the mass flow rate of fuel to the engine.

Since the dry exhaust mass flow rate has been found, it is now possible to calculate the emission rate of a pollutant from its concentration as measured by the exhaust gas analyzers. Since the concentration of a constituent gas is related to the mole ratio of the constituent of interest in a gas mixture, the mass of the gas of interest can be deduced if the total mass of the gas mixture and the molecular weight of the gas mixture are known. The molecular weight of the exhaust stream is simply the weighted average of the molecular weights of the constituents. For a spark ignited engine operating near

stoichiometry, this can be approximated with little error by using the weighted average of the molecular weights of nitrogen, carbon monoxide, and carbon dioxide.

$$M_{CO} = (MW_{CO})(\frac{M}{MW_E})(\frac{PPM_{CO}}{10^6})$$

Where $M_{CO}$ is the mass flow rate of carbon monoxide, $MW_{CO}$ is the molecular weight of carbon monoxide, M is the mass flow rate of dry exhaust, $MW_E$ is the molecular weight of the dry exhaust (30.48 g/mole), and $PPM_{CO}$ is the concentration of carbon monoxide in parts per million. The mass flow rates of other pollutants can be found similarly by substituting the appropriate molecular weights and concentrations. The molecular weight of $NO_2$ (46 g/mole) was used for the molecular weight of $NO_X$ and the molecular weight of propane (44g/mole) was used for the molecular weight of THC.

The mass flow rates of the various pollutants can also be found by dividing the mass flow of the pollutant per unit time by the number of miles travelled per unit time. Similarly, the fuel economy of the vehicle can be found by dividing the vehicle fuel consumption per unit time by the number of miles travelled per unit time, and taking the reciprocal.

1988 Chevrolet Corsica Test Summary
Trace File: DYNO104C.TRC
Time/Date Tue Aug 22 13:13:49 1995

Third Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.7 | 2843 | 32.7 | 8.62 | 206 | 116 |
| St. Dev. | 0.5 | 10 | 0.9 | 0.14 | 2 | 3 |
| Maximum | 40.0 | 2861 | 34.0 | 9.38 | 208 | 120 |
| Minimum | 39.0 | 2824 | 32.0 | 8.59 | 203 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.66 | 1.568 | 14.2 | 16.45 | 0.00 |
| St. Dev. | 0.71 | 0.025 | 0.4 | 0.71 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 106.04 | 13.99 | 17.94 | 3708.64 | 285.27 |
| St. Dev. | 8.96 | 0.67 | 0.47 | 1.38 | 4.17 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.2193 | 0.3247 | 14.9309 | 3705.57 | 236.27 |
| St. Dev. | 0.0020 | 0.0466 | 1.6455 | 11.88 | 1.91 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.79 | 97.67 | 16.73 | 504 | 353 |
| St. Dev. | 0.02 | 0.34 | 9.16 | 6 | 9 |
| Maximum | 99.83 | 98.67 | 39.66 | 514 | 371 |
| Minimum | 99.75 | 97.19 | 1.89 | 493 | 339 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO102C.TRC
Time/Date Tue Aug 22 13:09:29 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 29.5 | 2120 | 33.0 | 5.08 | 205 | 131 |
| St. Dev. | 0.5 | 11 | 0.3 | 0.00 | 0 | 0 |
| Maximum | 30.0 | 2141 | 34.0 | 5.08 | 205 | 131 |
| Minimum | 29.0 | 2103 | 32.0 | 5.08 | 205 | 131 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 10.97 | 1.081 | 13.6 | 10.83 | 6.60 |
| St. Dev. | 0.08 | 0.008 | 0.1 | 0.08 | 0.56 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6135 | 647 | 392 | 156169 | 15632 |
| St. Dev. | 301 | 15 | 10 | 62 | 70 |
| Maximum | 6900 | 678 | 411 | 156342 | 15809 |
| Minimum | 5512 | 616 | 375 | 156050 | 15556 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 13 | 249 | 157031 | 8733 |
| St. Dev. | 0 | 1 | 35 | 234 | 1526 |
| Maximum | 14 | 14 | 312 | 157510 | 12159 |
| Minimum | 14 | 11 | 169 | 156634 | 6435 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 98.02 | 36.51 | 462 | 385 |
| St. Dev. | 0.01 | 0.10 | 8.60 | 1 | 2 |
| Maximum | 99.80 | 98.26 | 57.33 | 464 | 388 |
| Minimum | 99.75 | 97.80 | 21.80 | 461 | 381 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO102C.TRC
Time/Date Tue Aug 22 13:09:29 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 29.5 | 2120 | 33.0 | 5.08 | 205 | 131 |
| St. Dev. | 0.5 | 11 | 0.3 | 0.00 | 0 | 0 |
| Maximum | 30.0 | 2141 | 34.0 | 5.08 | 205 | 131 |
| Minimum | 29.0 | 2103 | 32.0 | 5.08 | 205 | 131 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 10.97 | 1.081 | 13.6 | 10.83 | 6.60 |
| St. Dev. | 0.08 | 0.008 | 0.1 | 0.08 | 0.56 |

| | PreCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 7.46 | 1.24 | 0.78 | 298.46 | 21.73 |
| St. Dev. | 0.37 | 0.03 | 0.02 | 0.12 | 0.10 |

| | PostCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0170 | 0.0245 | 0.0000 | 300.11 | 12.14 |
| St. Dev. | 0.0001 | 0.0014 | 0.0000 | 0.45 | 2.13 |

Catalytic Conversion Efficiencies

| | CO (%) | THC (%) | NOx (%) |
|---|---|---|---|
| Average | 99.77 | 98.02 | 100.00 |
| St. Dev. | 0.01 | 0.10 | 0.00 |
| Maximum | 99.80 | 98.26 | 100.00 |
| Minimum | 99.75 | 97.80 | 100.00 |

Catalyst Temperatures

| Pre- (Deg. C) | Post- (Deg. C) |
|---|---|
| 462 | 385 |
| 1 | 2 |
| 464 | 388 |
| 461 | 381 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO102C.TRC
Time/Date Tue Aug 22 13:09:29 1995

Third Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 29.5 | 2120 | 33.0 | 5.08 | 205 | 131 |
| St. Dev. | 0.5 | 11 | 0.3 | 0.00 | 0 | 0 |
| Maximum | 30.0 | 2141 | 34.0 | 5.08 | 205 | 131 |
| Minimum | 29.0 | 2103 | 32.0 | 5.08 | 205 | 131 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 10.97 | 1.081 | 13.6 | 10.83 | 6.60 |
| St. Dev. | 0.08 | 0.008 | 0.1 | 0.08 | 0.56 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 61.04 | 10.12 | 6.41 | 2441.73 | 177.75 |
| St. Dev. | 3.00 | 0.23 | 0.16 | 0.97 | 0.79 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.1387 | 0.2005 | 4.0720 | 2455.21 | 99.30 |
| St. Dev. | 0.0006 | 0.0115 | 0.5757 | 3.66 | 17.41 |

Catalytic Conversion Efficiencies

| | CO (%) | THC (%) | NOx (%) |
|---|---|---|---|
| Average | 99.77 | 98.02 | 36.51 |
| St. Dev. | 0.01 | 0.10 | 8.60 |
| Maximum | 99.80 | 98.26 | 57.33 |
| Minimum | 99.75 | 97.80 | 21.80 |

Catalyst Temperatures

| Pre- (Deg. C) | Post- (Deg. C) |
|---|---|
| 462 | 385 |
| 1 | 2 |
| 464 | 388 |
| 461 | 381 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO101C.TRC
Time/Date Tue Aug 22 13:06:45 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 25.0 | 1808 | 34.5 | 3.91 | 203 | 127 |
| St. Dev. | 0.0 | 9 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 25.0 | 1822 | 35.0 | 3.91 | 203 | 127 |
| Minimum | 25.0 | 1785 | 34.0 | 3.91 | 203 | 127 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.34 | 0.911 | 13.7 | 9.22 | 7.35 |
| St. Dev. | 0.22 | 0.008 | 0.2 | 0.21 | 0.55 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6242 | 814 | 242 | 156082 | 16638 |
| St. Dev. | 318 | 51 | 4 | 78 | 88 |
| Maximum | 7119 | 899 | 250 | 156244 | 16802 |
| Minimum | 5658 | 694 | 234 | 155952 | 16471 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 16 | 153 | 157804 | 7149 |
| St. Dev. | 0 | 2 | 26 | 354 | 3930 |
| Maximum | 14 | 20 | 202 | 158483 | 13619 |
| Minimum | 14 | 12 | 105 | 157121 | 1635 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.78 | 98.02 | 37.00 | 429 | 351 |
| St. Dev. | 0.01 | 0.14 | 10.25 | 1 | 4 |
| Maximum | 99.81 | 98.28 | 56.12 | 433 | 357 |
| Minimum | 99.76 | 97.66 | 16.33 | 428 | 344 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO101C.TRC
Time/Date Tue Aug 22 13:06:45 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 25.0 | 1808 | 34.5 | 3.91 | 203 | 127 |
| St. Dev. | 0.0 | 9 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 25.0 | 1822 | 35.0 | 3.91 | 203 | 127 |
| Minimum | 25.0 | 1785 | 34.0 | 3.91 | 203 | 127 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.34 | 0.911 | 13.7 | 9.22 | 7.35 |
| St. Dev. | 0.22 | 0.008 | 0.2 | 0.21 | 0.55 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 7.62 | 1.56 | 0.48 | 299.25 | 23.20 |
| St. Dev. | 0.39 | 0.10 | 0.01 | 0.15 | 0.12 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0167 | 0.0310 | 0.0000 | 302.55 | 9.97 |
| St. Dev. | 0.0001 | 0.0038 | 0.0000 | 0.68 | 5.50 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.78 | 98.02 | 100.00 | 429 | 351 |
| St. Dev. | 0.01 | 0.14 | 0.00 | 1 | 4 |
| Maximum | 99.81 | 98.28 | 100.00 | 433 | 357 |
| Minimum | 99.76 | 97.66 | 100.00 | 428 | 344 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO101C.TRC
Time/Date Tue Aug 22 13:06:45 1995

Third Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 25.0 | 1808 | 34.5 | 3.91 | 203 | 127 |
| St. Dev. | 0.0 | 9 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 25.0 | 1822 | 35.0 | 3.91 | 203 | 127 |
| Minimum | 25.0 | 1785 | 34.0 | 3.91 | 203 | 127 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.34 | 0.911 | 13.7 | 9.22 | 7.35 |
| St. Dev. | 0.22 | 0.008 | 0.2 | 0.21 | 0.55 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 52.89 | 10.84 | 3.37 | 2078.14 | 161.11 |
| St. Dev. | 2.70 | 0.68 | 0.05 | 1.04 | 0.85 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.1159 | 0.2152 | 2.1237 | 2101.07 | 69.23 |
| St. Dev. | 0.0007 | 0.0264 | 0.3610 | 4.71 | 38.18 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 98.02 | 37.00 | 429 | 351 |
| St. Dev. | 0.01 | 0.14 | 10.25 | 1 | 4 |
| Maximum | 99.81 | 98.28 | 56.12 | 433 | 357 |
| Minimum | 99.76 | 97.66 | 16.33 | 428 | 344 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO100C.TRC
Time/Date Tue Aug 22 13:02:57 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 20.0 | 1466 | 39.0 | 2.73 | 201 | 122 |
| St. Dev. | 0.0 | 44 | 0.0 | 0.00 | 0 | 0 |
| Maximum | 20.0 | 1700 | 39.0 | 2.73 | 201 | 122 |
| Minimum | 20.0 | 1440 | 39.0 | 2.73 | 201 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 7.84 | 0.759 | 13.9 | 7.74 | 0.00 |
| St. Dev. | 0.13 | 0.008 | 0.2 | 0.13 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 5964 | 689 | 136 | 156187 | 16085 |
| St. Dev. | 423 | 15 | 3 | 64 | 40 |
| Maximum | 7082 | 724 | 143 | 156342 | 16160 |
| Minimum | 5220 | 656 | 131 | 156050 | 16004 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 20 | 98 | 156599 | 13579 |
| St. Dev. | 0 | 1 | 12 | 381 | 131 |
| Maximum | 14 | 22 | 121 | 157510 | 13814 |
| Minimum | 13 | 18 | 66 | 155952 | 13385 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 97.12 | 28.22 | 392 | 336 |
| St. Dev. | 0.02 | 0.09 | 8.27 | 2 | 2 |
| Maximum | 99.81 | 97.36 | 50.72 | 395 | 340 |
| Minimum | 99.74 | 96.91 | 13.99 | 389 | 330 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO100C.TRC
Time/Date Tue Aug 22 13:02:57 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 20.0 | 1466 | 39.0 | 2.73 | 201 | 122 |
| St. Dev. | 0.0 | 44 | 0.0 | 0.00 | 0 | 0 |
| Maximum | 20.0 | 1700 | 39.0 | 2.73 | 201 | 122 |
| Minimum | 20.0 | 1440 | 39.0 | 2.73 | 201 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 7.84 | 0.759 | 13.9 | 7.74 | 0.00 |
| St. Dev. | 0.13 | 0.008 | 0.2 | 0.13 | 0.00 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 7.63 | 1.39 | 0.29 | 314.01 | 23.52 |
| St. Dev. | 0.54 | 0.03 | 0.01 | 0.13 | 0.06 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0173 | 0.0399 | 0.0000 | 314.83 | 19.85 |
| St. Dev. | 0.0001 | 0.0014 | 0.0000 | 0.77 | 0.19 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 97.12 | 100.00 | 392 | 336 |
| St. Dev. | 0.02 | 0.09 | 0.00 | 2 | 2 |
| Maximum | 99.81 | 97.36 | 100.00 | 395 | 340 |
| Minimum | 99.74 | 96.91 | 100.00 | 389 | 330 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO100C.TRC
Time/Date Tue Aug 22 13:02:57 1995

Third Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 20.0 | 1466 | 39.0 | 2.73 | 201 | 122 |
| St. Dev. | 0.0 | 44 | 0.0 | 0.00 | 0 | 0 |
| Maximum | 20.0 | 1700 | 39.0 | 2.73 | 201 | 122 |
| Minimum | 20.0 | 1440 | 39.0 | 2.73 | 201 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 7.84 | 0.759 | 13.9 | 7.74 | 0.00 |
| St. Dev. | 0.13 | 0.008 | 0.2 | 0.13 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 42.39 | 7.70 | 1.59 | 1744.48 | 130.66 |
| St. Dev. | 3.01 | 0.17 | 0.03 | 0.72 | 0.32 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.0962 | 0.2219 | 1.1432 | 1749.08 | 110.30 |
| St. Dev. | 0.0006 | 0.0078 | 0.1352 | 4.26 | 1.07 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.77 | 97.12 | 28.22 | 392 | 336 |
| St. Dev. | 0.02 | 0.09 | 8.27 | 2 | 2 |
| Maximum | 99.81 | 97.36 | 50.72 | 395 | 340 |
| Minimum | 99.74 | 96.91 | 13.99 | 389 | 330 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO099C.TRC
Time/Date Tue Aug 22 13:01:57 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 1099 | 41.0 | 0.39 | 202 | 122 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 1 | 0 |
| Maximum | 15.0 | 1111 | 41.0 | 0.39 | 203 | 122 |
| Minimum | 15.0 | 1083 | 41.0 | 0.39 | 201 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 5.92 | 0.590 | 13.4 | 5.84 | 0.00 |
| St. Dev. | 0.05 | 0.008 | 0.2 | 0.05 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 5892 | 909 | 103 | 155975 | 17523 |
| St. Dev. | 452 | 13 | 2 | 57 | 51 |
| Maximum | 7046 | 941 | 108 | 156050 | 17630 |
| Minimum | 4965 | 883 | 98 | 155855 | 17435 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 15 | 53 | 156592 | 9881 |
| St. Dev. | 0 | 2 | 8 | 306 | 3455 |
| Maximum | 14 | 18 | 74 | 157121 | 13541 |
| Minimum | 14 | 13 | 41 | 156147 | 2872 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.76 | 98.35 | 48.85 | 339 | 400 |
| St. Dev. | 0.02 | 0.15 | 7.94 | 1 | 4 |
| Maximum | 99.80 | 98.59 | 59.62 | 341 | 406 |
| Minimum | 99.72 | 98.06 | 26.92 | 338 | 386 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO099C.TRC
Time/Date Tue Aug 22 13:01:57 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 1099 | 41.0 | 0.39 | 202 | 122 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 1 | 0 |
| Maximum | 15.0 | 1111 | 41.0 | 0.39 | 203 | 122 |
| Minimum | 15.0 | 1083 | 41.0 | 0.39 | 201 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 5.92 | 0.590 | 13.4 | 5.84 | 0.00 |
| St. Dev. | 0.05 | 0.008 | 0.2 | 0.05 | 0.00 |

| | PreCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 7.59 | 1.84 | 0.22 | 315.64 | 25.79 |
| St. Dev. | 0.58 | 0.03 | 0.00 | 0.11 | 0.07 |

| | PostCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0180 | 0.0228 | 0.0000 | 316.89 | 14.54 |
| St. Dev. | 0.0002 | 0.0144 | 0.0000 | 0.62 | 5.10 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.76 | 98.77 | 100.00 | 339 | 400 |
| St. Dev. | 0.02 | 0.78 | 0.00 | 1 | 4 |
| Maximum | 99.80 | 100.00 | 100.00 | 341 | 406 |
| Minimum | 99.72 | 98.06 | 100.00 | 338 | 386 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO099C.TRC
Time/Date Tue Aug 22 13:01:57 1995

Third Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 1099 | 41.0 | 0.39 | 202 | 122 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 1 | 0 |
| Maximum | 15.0 | 1111 | 41.0 | 0.39 | 203 | 122 |
| Minimum | 15.0 | 1083 | 41.0 | 0.39 | 201 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 5.92 | 0.590 | 13.4 | 5.84 | 0.00 |
| St. Dev. | 0.05 | 0.008 | 0.2 | 0.05 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 31.62 | 7.66 | 0.91 | 1315.15 | 107.46 |
| St. Dev. | 2.43 | 0.11 | 0.02 | 0.48 | 0.31 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.0751 | 0.1267 | 0.4647 | 1320.36 | 60.59 |
| St. Dev. | 0.0010 | 0.0129 | 0.0699 | 2.58 | 21.25 |

Catalytic Conversion Efficiencies

| | CO (%) | THC (%) | NOx (%) |
|---|---|---|---|
| Average | 99.76 | 98.35 | 48.85 |
| St. Dev. | 0.02 | 0.15 | 7.94 |
| Maximum | 99.80 | 98.59 | 59.62 |
| Minimum | 99.72 | 98.06 | 26.92 |

Catalyst Temperatures

| Pre- (Deg. C) | Post- (Deg. C) |
|---|---|
| 339 | 400 |
| 1 | 4 |
| 341 | 406 |
| 338 | 386 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO098C.TRC
Time/Date Tue Aug 22 12:51:47 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 35.3 | 3795 | 27.0 | 12.11 | 212 | 135 |
| St. Dev. | 0.5 | 7 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 36.0 | 3810 | 27.0 | 12.11 | 212 | 136 |
| Minimum | 35.0 | 3777 | 27.0 | 12.11 | 210 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 20.40 | 1.993 | 13.7 | 20.14 | 0.00 |
| St. Dev. | 0.20 | 0.017 | 0.2 | 0.20 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 7003 | 409 | 1300 | 156335 | 12831 |
| St. Dev. | 563 | 14 | 17 | 66 | 134 |
| Maximum | 8579 | 434 | 1327 | 156439 | 13035 |
| Minimum | 6133 | 381 | 1254 | 156244 | 12558 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 15 | 1 | 886 | 156773 | 12803 |
| St. Dev. | 0 | 1 | 114 | 576 | 1417 |
| Maximum | 15 | 3 | 996 | 157899 | 13921 |
| Minimum | 15 | -0 | 574 | 155466 | 9511 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 99.74 | 31.86 | 591 | 485 |
| St. Dev. | 0.02 | 0.18 | 8.41 | 5 | 7 |
| Maximum | 99.83 | 100.06 | 54.44 | 601 | 500 |
| Minimum | 99.76 | 99.26 | 21.27 | 581 | 471 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO098C.TRC
Time/Date Tue Aug 22 12:51:47 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 35.3 | 3795 | 27.0 | 12.11 | 212 | 135 |
| St. Dev. | 0.5 | 7 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 36.0 | 3810 | 27.0 | 12.11 | 212 | 136 |
| Minimum | 35.0 | 3777 | 27.0 | 12.11 | 210 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 20.40 | 1.993 | 13.7 | 20.14 | 0.00 |
| St. Dev. | 0.20 | 0.017 | 0.2 | 0.20 | 0.00 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 13.20 | 1.21 | 4.03 | 463.21 | 27.65 |
| St. Dev. | 1.06 | 0.04 | 0.05 | 0.19 | 0.29 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0277 | 0.0017 | 0.0000 | 464.51 | 27.59 |
| St. Dev. | 0.0002 | 0.0017 | 0.0000 | 1.71 | 3.06 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 99.86 | 100.00 | 591 | 485 |
| St. Dev. | 0.02 | 0.14 | 0.00 | 5 | 7 |
| Maximum | 99.83 | 100.06 | 100.00 | 601 | 500 |
| Minimum | 99.76 | 99.59 | 100.00 | 581 | 471 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO098C.TRC
Time/Date Tue Aug 22 12:51:47 1995

Second Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 35.3 | 3795 | 27.0 | 12.11 | 212 | 135 |
| St. Dev. | 0.5 | 7 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 36.0 | 3810 | 27.0 | 12.11 | 212 | 136 |
| Minimum | 35.0 | 3777 | 27.0 | 12.11 | 210 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 20.40 | 1.993 | 13.7 | 20.14 | 0.00 |
| St. Dev. | 0.20 | 0.017 | 0.2 | 0.20 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 129.55 | 11.89 | 39.52 | 4544.97 | 271.29 |
| St. Dev. | 10.41 | 0.41 | 0.52 | 1.91 | 2.83 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.2713 | 0.0311 | 26.9423 | 4557.68 | 270.70 |
| St. Dev. | 0.0015 | 0.0213 | 3.4541 | 16.73 | 30.06 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.79 | 99.74 | 31.86 | 591 | 485 |
| St. Dev. | 0.02 | 0.18 | 8.41 | 5 | 7 |
| Maximum | 99.83 | 100.06 | 54.44 | 601 | 500 |
| Minimum | 99.76 | 99.26 | 21.27 | 581 | 471 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO097C.TRC
Time/Date Tue Aug 22 12:40:52 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 30.0 | 3177 | 27.0 | 9.38 | 207 | 131 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 30.0 | 3189 | 27.0 | 9.38 | 207 | 133 |
| Minimum | 30.0 | 3165 | 27.0 | 9.38 | 207 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.28 | 1.576 | 13.9 | 16.07 | 0.00 |
| St. Dev. | 0.19 | 0.013 | 0.2 | 0.19 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6104 | 420 | 810 | 156350 | 13459 |
| St. Dev. | 349 | 18 | 13 | 67 | 147 |
| Maximum | 7192 | 486 | 837 | 156439 | 13833 |
| Minimum | 5330 | 387 | 784 | 156244 | 13259 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 6 | 663 | 156892 | 13735 |
| St. Dev. | 0 | 1 | 77 | 361 | 159 |
| Maximum | 14 | 7 | 833 | 157607 | 14213 |
| Minimum | 14 | 4 | 468 | 155855 | 13531 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 98.57 | 18.14 | 542 | 444 |
| St. Dev. | 0.01 | 0.20 | 9.09 | 3 | 4 |
| Maximum | 99.81 | 99.11 | 41.12 | 549 | 451 |
| Minimum | 99.74 | 98.17 | (0.94) | 537 | 432 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO097C.TRC
Time/Date Tue Aug 22 12:40:52 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 30.0 | 3177 | 27.0 | 9.38 | 207 | 131 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 30.0 | 3189 | 27.0 | 9.38 | 207 | 133 |
| Minimum | 30.0 | 3165 | 27.0 | 9.38 | 207 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.28 | 1.576 | 13.9 | 16.07 | 0.00 |
| St. Dev. | 0.19 | 0.013 | 0.2 | 0.19 | 0.00 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 10.82 | 1.17 | 2.36 | 435.35 | 27.26 |
| St. Dev. | 0.62 | 0.05 | 0.04 | 0.19 | 0.30 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0247 | 0.0119 | 0.0000 | 436.87 | 27.82 |
| St. Dev. | 0.0001 | 0.0075 | 0.0000 | 1.00 | 0.32 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 98.97 | 100.00 | 542 | 444 |
| St. Dev. | 0.01 | 0.65 | 0.00 | 3 | 4 |
| Maximum | 99.81 | 100.00 | 100.00 | 549 | 451 |
| Minimum | 99.74 | 98.21 | 100.00 | 537 | 432 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO097C.TRC
Time/Date Tue Aug 22 12:40:52 1995

Second Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 30.0 | 3177 | 27.0 | 9.38 | 207 | 131 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 30.0 | 3189 | 27.0 | 9.38 | 207 | 133 |
| Minimum | 30.0 | 3165 | 27.0 | 9.38 | 207 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.28 | 1.576 | 13.9 | 16.07 | 0.00 |
| St. Dev. | 0.19 | 0.013 | 0.2 | 0.19 | 0.00 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 90.13 | 9.75 | 19.65 | 3627.95 | 227.13 |
| St. Dev. | 5.15 | 0.42 | 0.31 | 1.55 | 2.49 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.2059 | 0.1393 | 16.0904 | 3640.54 | 231.79 |
| St. Dev. | 0.0012 | 0.0166 | 1.8600 | 8.37 | 2.70 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 98.57 | 18.14 | 542 | 444 |
| St. Dev. | 0.01 | 0.20 | 9.09 | 3 | 4 |
| Maximum | 99.81 | 99.11 | 41.12 | 549 | 451 |
| Minimum | 99.74 | 98.17 | (0.94) | 537 | 432 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO096C.TRC
Time/Date Tue Aug 22 12:38:49 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 25.0 | 4703 | 30.0 | 7.03 | 207 | 126 |
| St. Dev. | 0.0 | 11106 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 25.0 | 65535 | 30.0 | 7.03 | 207 | 127 |
| Minimum | 25.0 | 2664 | 30.0 | 7.03 | 207 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.45 | 1.308 | 13.8 | 13.28 | 0.00 |
| St. Dev. | 0.12 | 0.011 | 0.2 | 0.12 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6111 | 453 | 413 | 156310 | 13846 |
| St. Dev. | 327 | 12 | 9 | 58 | 73 |
| Maximum | 6900 | 478 | 436 | 156439 | 13979 |
| Minimum | 5439 | 416 | 386 | 156147 | 13707 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 13 | 10 | 355 | 157662 | 13527 |
| St. Dev. | 0 | 1 | 33 | 297 | 67 |
| Maximum | 13 | 11 | 411 | 158289 | 13814 |
| Minimum | 13 | 8 | 294 | 156926 | 13483 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.78 | 97.77 | 14.03 | 518 | 409 |
| St. Dev. | 0.01 | 0.17 | 7.86 | 2 | 5 |
| Maximum | 99.81 | 98.17 | 30.16 | 523 | 418 |
| Minimum | 99.76 | 97.43 | 1.05 | 515 | 401 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO096C.TRC
Time/Date Tue Aug 22 12:38:49 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 25.0 | 2675 | 30.0 | 7.03 | 207 | 126 |
| St. Dev. | 0.0 | 8 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 25.0 | 2696 | 30.0 | 7.03 | 207 | 127 |
| Minimum | 25.0 | 2664 | 30.0 | 7.03 | 207 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.45 | 1.308 | 13.8 | 13.28 | 0.00 |
| St. Dev. | 0.12 | 0.011 | 0.2 | 0.12 | 0.00 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 10.74 | 1.25 | 1.19 | 431.57 | 27.80 |
| St. Dev. | 0.57 | 0.03 | 0.03 | 0.16 | 0.15 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0233 | 0.0197 | 0.0000 | 435.30 | 27.16 |
| St. Dev. | 0.0001 | 0.0123 | 0.0000 | 0.82 | 0.13 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 98.44 | 100.00 | 518 | 409 |
| St. Dev. | 0.01 | 0.98 | 0.00 | 2 | 5 |
| Maximum | 99.81 | 100.00 | 100.00 | 523 | 418 |
| Minimum | 99.76 | 97.60 | 100.00 | 515 | 401 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO096C.TRC
Time/Date Tue Aug 22 12:38:49 1995

Second Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 25.0 | 2675 | 30.0 | 7.03 | 207 | 126 |
| St. Dev. | 0.0 | 8 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 25.0 | 2696 | 30.0 | 7.03 | 207 | 127 |
| Minimum | 25.0 | 2664 | 30.0 | 7.03 | 207 | 126 |

| | AirFlow Cons. (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.45 | 1.308 | 13.8 | 13.28 | 0.00 |
| St. Dev. | 0.12 | 0.011 | 0.2 | 0.12 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 74.56 | 8.68 | 8.28 | 2997.03 | 193.07 |
| St. Dev. | 3.99 | 0.23 | 0.19 | 1.11 | 1.02 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.1617 | 0.1932 | 7.1217 | 3022.95 | 188.62 |
| St. Dev. | 0.0007 | 0.0128 | 0.6652 | 5.69 | 0.94 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 97.77 | 14.03 | 518 | 409 |
| St. Dev. | 0.01 | 0.17 | 7.86 | 2 | 5 |
| Maximum | 99.81 | 98.17 | 30.16 | 523 | 418 |
| Minimum | 99.76 | 97.43 | 1.05 | 515 | 401 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO095C.TRC
Time/Date Tue Aug 22 12:37:01 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 19.8 | 2094 | 31.0 | 4.69 | 202 | 120 |
| St. Dev. | 0.4 | 6 | 0.0 | 0.00 | 1 | 0 |
| Maximum | 20.0 | 2107 | 31.0 | 4.69 | 203 | 120 |
| Minimum | 19.0 | 2083 | 31.0 | 4.69 | 201 | 120 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 10.37 | 1.007 | 13.8 | 10.24 | 2.43 |
| St. Dev. | 0.10 | 0.008 | 0.2 | 0.10 | 0.16 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6277 | 796 | 279 | 156179 | 15422 |
| St. Dev. | 352 | 22 | 7 | 68 | 64 |
| Maximum | 7155 | 840 | 298 | 156342 | 15595 |
| Minimum | 5768 | 741 | 263 | 156050 | 15313 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 13 | 26 | 154 | 158932 | 5309 |
| St. Dev. | 0 | 2 | 32 | 340 | 1080 |
| Maximum | 13 | 30 | 209 | 159846 | 7486 |
| Minimum | 13 | 21 | 67 | 158289 | 3651 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 96.68 | 45.01 | 443 | 362 |
| St. Dev. | 0.01 | 0.20 | 11.21 | 2 | 2 |
| Maximum | 99.81 | 97.40 | 76.22 | 447 | 365 |
| Minimum | 99.77 | 96.37 | 26.96 | 440 | 353 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO095C.TRC
Time/Date Tue Aug 22 12:37:01 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 19.8 | 2094 | 31.0 | 4.69 | 202 | 120 |
| St. Dev. | 0.4 | 6 | 0.0 | 0.00 | 1 | 0 |
| Maximum | 20.0 | 2107 | 31.0 | 4.69 | 203 | 120 |
| Minimum | 19.0 | 2083 | 31.0 | 4.69 | 201 | 120 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 10.37 | 1.007 | 13.8 | 10.24 | 2.43 |
| St. Dev. | 0.10 | 0.008 | 0.2 | 0.10 | 0.16 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 10.74 | 2.14 | 0.79 | 420.14 | 30.17 |
| St. Dev. | 0.60 | 0.06 | 0.02 | 0.18 | 0.13 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0227 | 0.0515 | 0.0000 | 427.54 | 10.39 |
| St. Dev. | 0.0001 | 0.0322 | 0.0000 | 0.91 | 2.12 |

Catalytic Conversion Efficiencies

| | CO (%) | THC (%) | NOx (%) |
|---|---|---|---|
| Average | 99.79 | 97.60 | 100.00 |
| St. Dev. | 0.01 | 1.50 | 0.00 |
| Maximum | 99.81 | 100.00 | 100.00 |
| Minimum | 99.77 | 96.40 | 100.00 |

Catalyst Temperatures

| Pre- (Deg. C) | Post- (Deg. C) |
|---|---|
| 443 | 362 |
| 2 | 2 |
| 447 | 365 |
| 440 | 353 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO095C.TRC
Time/Date Tue Aug 22 12:37:01 1995

Second Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 19.8 | 2094 | 31.0 | 4.69 | 202 | 120 |
| St. Dev. | 0.4 | 6 | 0.0 | 0.00 | 1 | 0 |
| Maximum | 20.0 | 2107 | 31.0 | 4.69 | 203 | 120 |
| Minimum | 19.0 | 2083 | 31.0 | 4.69 | 201 | 120 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 10.37 | 1.007 | 13.8 | 10.24 | 2.43 |
| St. Dev. | 0.10 | 0.008 | 0.2 | 0.10 | 0.16 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 59.07 | 11.78 | 4.32 | 2309.62 | 165.87 |
| St. Dev. | 3.31 | 0.32 | 0.11 | 1.00 | 0.69 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.1248 | 0.3911 | 2.3772 | 2350.33 | 57.10 |
| St. Dev. | 0.0008 | 0.0273 | 0.4992 | 5.02 | 11.66 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.79 | 96.68 | 45.01 | 443 | 362 |
| St. Dev. | 0.01 | 0.20 | 11.21 | 2 | 2 |
| Maximum | 99.81 | 97.40 | 76.22 | 447 | 365 |
| Minimum | 99.77 | 96.37 | 26.96 | 440 | 353 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO094C.TRC
Time/Date Tue Aug 22 12:34:18 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 1637 | 36.0 | 2.73 | 202 | 116 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 15.0 | 1657 | 36.0 | 2.73 | 203 | 118 |
| Minimum | 15.0 | 1626 | 36.0 | 2.73 | 199 | 115 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.43 | 0.803 | 14.1 | 8.32 | 0.00 |
| St. Dev. | 0.18 | 0.009 | 0.3 | 0.18 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6498 | 730 | 142 | 156061 | 16189 |
| St. Dev. | 351 | 17 | 3 | 53 | 45 |
| Maximum | 7228 | 771 | 148 | 156244 | 16267 |
| Minimum | 5658 | 702 | 134 | 155952 | 16092 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 13 | 25 | 107 | 158359 | 13436 |
| St. Dev. | 0 | 1 | 15 | 389 | 40 |
| Maximum | 13 | 26 | 130 | 159068 | 13697 |
| Minimum | 13 | 23 | 76 | 157218 | 13376 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.80 | 96.62 | 24.96 | 415 | 352 |
| St. Dev. | 0.01 | 0.07 | 10.48 | 1 | 4 |
| Maximum | 99.82 | 96.80 | 46.60 | 417 | 357 |
| Minimum | 99.77 | 96.44 | 8.22 | 413 | 328 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO094C.TRC
Time/Date Tue Aug 22 12:34:18 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 1637 | 36.0 | 2.73 | 202 | 116 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 15.0 | 1657 | 36.0 | 2.73 | 203 | 118 |
| Minimum | 15.0 | 1626 | 36.0 | 2.73 | 199 | 115 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.43 | 0.803 | 14.1 | 8.32 | 0.00 |
| St. Dev. | 0.18 | 0.009 | 0.3 | 0.18 | 0.00 |

| | PreCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 11.93 | 2.11 | 0.43 | 450.08 | 33.96 |
| St. Dev. | 0.64 | 0.05 | 0.01 | 0.15 | 0.09 |

| | PostCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0235 | 0.0508 | 0.0000 | 456.70 | 28.18 |
| St. Dev. | 0.0001 | 0.0316 | 0.0000 | 1.12 | 0.08 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.80 | 97.56 | 100.00 | 415 | 352 |
| St. Dev. | 0.01 | 1.52 | 0.00 | 1 | 4 |
| Maximum | 99.82 | 100.00 | 100.00 | 417 | 357 |
| Minimum | 99.77 | 96.44 | 100.00 | 413 | 328 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO094C.TRC
Time/Date Tue Aug 22 12:34:18 1995

Second Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 1637 | 36.0 | 2.73 | 202 | 116 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 15.0 | 1657 | 36.0 | 2.73 | 203 | 118 |
| Minimum | 15.0 | 1626 | 36.0 | 2.73 | 199 | 115 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.43 | 0.803 | 14.1 | 8.32 | 0.00 |
| St. Dev. | 0.18 | 0.009 | 0.3 | 0.18 | 0.00 |

| | PreCatalyst | | Exhaust Gas | Emission Rates | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 49.69 | 8.78 | 1.79 | 1875.32 | 141.48 |
| St. Dev. | 2.68 | 0.21 | 0.04 | 0.64 | 0.39 |

| | PostCatalyst | | Exhaust Gas | Emission Rates | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.0979 | 0.2966 | 1.3405 | 1902.93 | 117.42 |
| St. Dev. | 0.0005 | 0.0089 | 0.1846 | 4.67 | 0.35 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.80 | 96.62 | 24.96 | 415 | 352 |
| St. Dev. | 0.01 | 0.07 | 10.48 | 1 | 4 |
| Maximum | 99.82 | 96.80 | 46.60 | 417 | 357 |
| Minimum | 99.77 | 96.44 | 8.22 | 413 | 328 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO093C.TRC
Time/Date Tue Aug 22 12:29:14 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 10.0 | 1078 | 41.1 | 1.17 | 201 | 112 |
| St. Dev. | 0.0 | 189 | 0.2 | 0.00 | 1 | 1 |
| Maximum | 10.0 | 1130 | 42.0 | 1.17 | 203 | 113 |
| Minimum | 10.0 | 44 | 41.0 | 1.17 | 201 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.25 | 0.588 | 14.3 | 6.18 | 0.00 |
| St. Dev. | 0.08 | 0.006 | 0.2 | 0.07 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6782 | 935 | 106 | 156069 | 16029 |
| St. Dev. | 525 | 16 | 3 | 70 | 49 |
| Maximum | 8469 | 970 | 114 | 156244 | 16101 |
| Minimum | 5695 | 890 | 99 | 155952 | 15936 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 12 | 6 | 24 | 159798 | 938 |
| St. Dev. | 0 | 1 | 8 | 472 | 1334 |
| Maximum | 12 | 7 | 44 | 161112 | 3777 |
| Minimum | 12 | 3 | 7 | 158873 | 39 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.82 | 99.40 | 77.24 | 392 | 340 |
| St. Dev. | 0.01 | 0.12 | 7.81 | 4 | 2 |
| Maximum | 99.86 | 99.68 | 93.69 | 400 | 344 |
| Minimum | 99.79 | 99.21 | 58.94 | 387 | 337 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO093C.TRC
Time/Date Tue Aug 22 12:29:14 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 10.0 | 1078 | 41.1 | 1.17 | 201 | 112 |
| St. Dev. | 0.0 | 189 | 0.2 | 0.00 | 1 | 1 |
| Maximum | 10.0 | 1130 | 42.0 | 1.17 | 203 | 113 |
| Minimum | 10.0 | 44 | 41.0 | 1.17 | 201 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.25 | 0.588 | 14.3 | 6.18 | 0.00 |
| St. Dev. | 0.08 | 0.006 | 0.2 | 0.07 | 0.00 |

| | PreCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 13.85 | 3.00 | 0.36 | 501.04 | 37.42 |
| St. Dev. | 1.07 | 0.05 | 0.01 | 0.23 | 0.12 |

| | PostCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0250 | 0.0139 | 0.0000 | 513.02 | 2.19 |
| St. Dev. | 0.0002 | 0.0092 | 0.0000 | 1.51 | 3.13 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.82 | 99.54 | 100.00 | 392 | 340 |
| St. Dev. | 0.01 | 0.30 | 0.00 | 4 | 2 |
| Maximum | 99.86 | 100.00 | 100.00 | 400 | 344 |
| Minimum | 99.79 | 99.21 | 100.00 | 387 | 337 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO093C.TRC
Time/Date Tue Aug 22 12:29:14 1995

Second Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 10.0 | 1078 | 41.1 | 1.17 | 201 | 112 |
| St. Dev. | 0.0 | 189 | 0.2 | 0.00 | 1 | 1 |
| Maximum | 10.0 | 1130 | 42.0 | 1.17 | 203 | 113 |
| Minimum | 10.0 | 44 | 41.0 | 1.17 | 201 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.25 | 0.588 | 14.3 | 6.18 | 0.00 |
| St. Dev. | 0.08 | 0.006 | 0.2 | 0.07 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 38.49 | 8.34 | 0.99 | 1391.79 | 103.96 |
| St. Dev. | 2.98 | 0.14 | 0.03 | 0.63 | 0.32 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.0696 | 0.0504 | 0.2234 | 1425.05 | 6.08 |
| St. Dev. | 0.0005 | 0.0100 | 0.0749 | 4.21 | 8.68 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.82 | 99.40 | 77.24 | 392 | 340 |
| St. Dev. | 0.01 | 0.12 | 7.81 | 4 | 2 |
| Maximum | 99.86 | 99.68 | 93.69 | 400 | 344 |
| Minimum | 99.79 | 99.21 | 58.94 | 387 | 337 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO092C.TRC
Time/Date Tue Aug 22 11:16:49 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 2777 | 29.0 | 7.11 | 205 | 125 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.15 | 2 | 1 |
| Maximum | 15.0 | 2788 | 29.0 | 7.42 | 207 | 126 |
| Minimum | 15.0 | 2765 | 29.0 | 7.03 | 203 | 124 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.21 | 1.287 | 13.8 | 13.05 | 1.62 |
| St. Dev. | 0.23 | 0.015 | 0.3 | 0.23 | 0.04 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 5927 | 531 | 330 | 156013 | 14377 |
| St. Dev. | 324 | 19 | 8 | 61 | 69 |
| Maximum | 6644 | 574 | 347 | 156147 | 14583 |
| Minimum | 5366 | 496 | 316 | 155855 | 14271 |
| Uncertainty | 1500 | 100 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 13 | 12 | 278 | 156884 | 13482 |
| St. Dev. | 0 | 1 | 29 | 357 | 125 |
| Maximum | 13 | 13 | 327 | 157413 | 13687 |
| Minimum | 13 | 9 | 205 | 156147 | 13269 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.78 | 97.81 | 15.92 | 514 | 420 |
| St. Dev. | 0.01 | 0.14 | 8.01 | 3 | 2 |
| Maximum | 99.81 | 98.21 | 36.71 | 521 | 423 |
| Minimum | 99.76 | 97.62 | 3.38 | 509 | 415 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO092C.TRC
Time/Date Tue Aug 22 11:16:49 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 2777 | 29.0 | 7.11 | 205 | 125 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.15 | 2 | 1 |
| Maximum | 15.0 | 2788 | 29.0 | 7.42 | 207 | 126 |
| Minimum | 15.0 | 2765 | 29.0 | 7.03 | 203 | 124 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.21 | 1.287 | 13.8 | 13.05 | 1.62 |
| St. Dev. | 0.23 | 0.015 | 0.3 | 0.23 | 0.04 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 17.05 | 2.40 | 1.56 | 705.17 | 47.26 |
| St. Dev. | 0.93 | 0.09 | 0.04 | 0.28 | 0.23 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0371 | 0.0380 | 0.0000 | 709.11 | 44.32 |
| St. Dev. | 0.0002 | 0.0237 | 0.0000 | 1.61 | 0.41 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.78 | 98.39 | 100.00 | 514 | 420 |
| St. Dev. | 0.01 | 1.00 | 0.00 | 3 | 2 |
| Maximum | 99.81 | 100.00 | 100.00 | 521 | 423 |
| Minimum | 99.76 | 97.62 | 100.00 | 509 | 415 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO092C.TRC
Time/Date Tue Aug 22 11:16:49 1995

First Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 15.0 | 2777 | 29.0 | 7.11 | 205 | 125 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.15 | 2 | 1 |
| Maximum | 15.0 | 2788 | 29.0 | 7.42 | 207 | 126 |
| Minimum | 15.0 | 2765 | 29.0 | 7.03 | 203 | 124 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.21 | 1.287 | 13.8 | 13.05 | 1.62 |
| St. Dev. | 0.23 | 0.015 | 0.3 | 0.23 | 0.04 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 71.03 | 10.00 | 6.50 | 2938.21 | 196.92 |
| St. Dev. | 3.89 | 0.36 | 0.16 | 1.16 | 0.94 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.1547 | 0.2191 | 5.4685 | 2954.62 | 184.67 |
| St. Dev. | 0.0007 | 0.0128 | 0.5793 | 6.72 | 1.71 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 97.81 | 15.92 | 514 | 420 |
| St. Dev. | 0.01 | 0.14 | 8.01 | 3 | 2 |
| Maximum | 99.81 | 98.21 | 36.71 | 521 | 423 |
| Minimum | 99.76 | 97.62 | 3.38 | 509 | 415 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO091C.TRC
Time/Date Tue Aug 22 11:09:27 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 10.0 | 1834 | 31.5 | 3.52 | 202 | 111 |
| St. Dev. | 0.0 | 7 | 0.5 | 0.00 | 1 | 0 |
| Maximum | 10.0 | 1846 | 32.0 | 3.52 | 203 | 113 |
| Minimum | 10.0 | 1820 | 31.0 | 3.52 | 201 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.59 | 0.840 | 13.7 | 8.48 | 1.55 |
| St. Dev. | 0.13 | 0.011 | 0.3 | 0.13 | 0.05 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6083 | 878 | 143 | 155839 | 16148 |
| St. Dev. | 394 | 20 | 3 | 64 | 83 |
| Maximum | 7082 | 915 | 150 | 155952 | 16345 |
| Minimum | 5439 | 823 | 137 | 155660 | 16053 |
| Uncertainty | 1500 | 100 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 13 | 26 | 79 | 157569 | 3012 |
| St. Dev. | 0 | 2 | 17 | 396 | 1561 |
| Maximum | 13 | 29 | 108 | 158289 | 5627 |
| Minimum | 13 | 18 | 34 | 156829 | 49 |
| Uncertainty | 2 | 3 | 3 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 97.03 | 44.92 | 407 | 350 |
| St. Dev. | 0.01 | 0.21 | 11.57 | 2 | 1 |
| Maximum | 99.82 | 97.96 | 75.09 | 410 | 352 |
| Minimum | 99.77 | 96.75 | 28.08 | 402 | 347 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO091C.TRC
Time/Date Tue Aug 22 11:09:27 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 10.0 | 1834 | 31.5 | 3.52 | 202 | 111 |
| St. Dev. | 0.0 | 7 | 0.5 | 0.00 | 1 | 0 |
| Maximum | 10.0 | 1846 | 32.0 | 3.52 | 203 | 113 |
| Minimum | 10.0 | 1820 | 31.0 | 3.52 | 201 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.59 | 0.840 | 13.7 | 8.48 | 1.55 |
| St. Dev. | 0.13 | 0.011 | 0.3 | 0.13 | 0.05 |

| | PreCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 17.06 | 3.87 | 0.66 | 686.73 | 51.75 |
| St. Dev. | 1.10 | 0.09 | 0.01 | 0.28 | 0.26 |

| | PostCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0357 | 0.0814 | 0.0000 | 694.35 | 9.65 |
| St. Dev. | 0.0002 | 0.0511 | 0.0000 | 1.75 | 5.02 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.79 | 97.88 | 100.00 | 407 | 350 |
| St. Dev. | 0.01 | 1.33 | 0.00 | 2 | 1 |
| Maximum | 99.82 | 100.00 | 100.00 | 410 | 352 |
| Minimum | 99.77 | 96.75 | 100.00 | 402 | 347 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO091C.TRC
Time/Date Tue Aug 22 11:09:27 1995

First Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 10.0 | 1834 | 31.5 | 3.52 | 202 | 111 |
| St. Dev. | 0.0 | 7 | 0.5 | 0.00 | 1 | 0 |
| Maximum | 10.0 | 1846 | 32.0 | 3.52 | 203 | 113 |
| Minimum | 10.0 | 1820 | 31.0 | 3.52 | 201 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.59 | 0.840 | 13.7 | 8.48 | 1.55 |
| St. Dev. | 0.13 | 0.011 | 0.3 | 0.13 | 0.05 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 47.39 | 10.74 | 1.83 | 1907.58 | 143.76 |
| St. Dev. | 3.07 | 0.25 | 0.04 | 0.78 | 0.74 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.0991 | 0.3188 | 1.0070 | 1928.76 | 26.81 |
| St. Dev. | 0.0005 | 0.0223 | 0.2180 | 4.85 | 13.94 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.79 | 97.03 | 44.92 | 407 | 350 |
| St. Dev. | 0.01 | 0.21 | 11.57 | 2 | 1 |
| Maximum | 99.82 | 97.96 | 75.09 | 410 | 352 |
| Minimum | 99.77 | 96.75 | 28.08 | 402 | 347 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO118C.TRC
Time/Date Tue Aug 22 14:50:55 1995

Fifth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 24.8 | 926 | 46.0 | 1.17 | 201 | 126 |
| St. Dev. | 0.4 | 5 | 0.1 | 0.00 | 1 | 1 |
| Maximum | 25.0 | 938 | 47.0 | 1.17 | 203 | 127 |
| Minimum | 24.0 | 915 | 46.0 | 1.17 | 199 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 5.41 | 0.541 | 13.4 | 5.34 | 0.00 |
| St. Dev. | 0.05 | 0.006 | 0.2 | 0.05 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 27.86 | 7.50 | 0.80 | 1204.09 | 100.99 |
| St. Dev. | 2.01 | 0.05 | 0.01 | 0.44 | 0.20 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.0687 | 0.0798 | 0.4561 | 1213.44 | 77.58 |
| St. Dev. | 0.0005 | 0.0129 | 0.0889 | 2.54 | 0.84 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.75 | 98.94 | 42.96 | 346 | 370 |
| St. Dev. | 0.02 | 0.17 | 10.76 | 2 | 2 |
| Maximum | 99.79 | 99.29 | 68.75 | 349 | 376 |
| Minimum | 99.72 | 98.68 | 26.73 | 343 | 367 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO115C.TRC
Time/Date Tue Aug 22 14:42:47 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 55.5 | 2730 | 40.2 | 10.94 | 206 | 132 |
| St. Dev. | 0.5 | 7 | 0.4 | 0.00 | 0 | 1 |
| Maximum | 56.0 | 2742 | 41.0 | 10.94 | 207 | 135 |
| Minimum | 55.0 | 2713 | 40.0 | 10.94 | 205 | 131 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 19.17 | 1.831 | 14.0 | 18.94 | 20.56 |
| St. Dev. | 0.22 | 0.011 | 0.2 | 0.22 | 0.96 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6141 | 535 | 1308 | 156589 | 14938 |
| St. Dev. | 367 | 11 | 72 | 60 | 44 |
| Maximum | 7228 | 552 | 1399 | 156731 | 14992 |
| Minimum | 5439 | 506 | 1132 | 156439 | 14846 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 15 | 4 | 1090 | 157571 | 13770 |
| St. Dev. | 1 | 0 | 290 | 262 | 138 |
| Maximum | 21 | 5 | 1382 | 158094 | 14018 |
| Minimum | 15 | 3 | 268 | 157121 | 13561 |
| Uncertainty | 2 | 3 | 20 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.75 | 99.25 | 17.54 | 563 | 428 |
| St. Dev. | 0.03 | 0.09 | 19.47 | 3 | 105 |
| Maximum | 99.79 | 99.50 | 76.35 | 567 | 498 |
| Minimum | 99.64 | 99.09 | (1.57) | 557 | 108 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO115C.TRC
Time/Date Tue Aug 22 14:42:47 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 55.5 | 2730 | 40.2 | 10.94 | 206 | 132 |
| St. Dev. | 0.5 | 7 | 0.4 | 0.00 | 0 | 1 |
| Maximum | 56.0 | 2742 | 41.0 | 10.94 | 207 | 135 |
| Minimum | 55.0 | 2713 | 40.0 | 10.94 | 205 | 131 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 19.17 | 1.831 | 14.0 | 18.94 | 20.56 |
| St. Dev. | 0.22 | 0.011 | 0.2 | 0.22 | 0.96 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 6.93 | 0.95 | 2.42 | 277.66 | 19.26 |
| St. Dev. | 0.41 | 0.02 | 0.13 | 0.11 | 0.06 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0175 | 0.0071 | 0.0000 | 279.40 | 0.00 |
| St. Dev. | 0.0015 | 0.0009 | 0.0000 | 0.46 | 0.00 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.75 | 99.25 | 100.00 | 563 | 428 |
| St. Dev. | 0.03 | 0.09 | 0.00 | 3 | 105 |
| Maximum | 99.79 | 99.50 | 100.00 | 567 | 498 |
| Minimum | 99.64 | 99.09 | 100.00 | 557 | 108 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO115C.TRC Fourth Gear
Time/Date Tue Aug 22 14:42:47 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 55.5 | 2730 | 40.2 | 10.94 | 206 | 132 |
| St. Dev. | 0.5 | 7 | 0.4 | 0.00 | 0 | 1 |
| Maximum | 56.0 | 2742 | 41.0 | 10.94 | 207 | 135 |
| Minimum | 55.0 | 2713 | 40.0 | 10.94 | 205 | 131 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 19.17 | 1.831 | 14.0 | 18.94 | 20.56 |
| St. Dev. | 0.22 | 0.011 | 0.2 | 0.22 | 0.96 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 106.84 | 14.62 | 37.38 | 4280.64 | 296.99 |
| St. Dev. | 6.38 | 0.29 | 2.07 | 1.64 | 0.87 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.2693 | 0.1091 | 31.1570 | 4307.47 | 273.77 |
| St. Dev. | 0.0233 | 0.0133 | 8.2808 | 7.15 | 2.76 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.75 | 99.25 | 17.54 | 563 | 428 |
| St. Dev. | 0.03 | 0.09 | 19.47 | 3 | 105 |
| Maximum | 99.79 | 99.50 | 76.35 | 567 | 498 |
| Minimum | 99.64 | 99.09 | (1.57) | 557 | 108 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO114C.TRC
Time/Date Tue Aug 22 14:41:14 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 50.0 | 2461 | 38.0 | 9.38 | 207 | 134 |
| St. Dev. | 0.0 | 4 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 50.0 | 2468 | 38.0 | 9.38 | 207 | 135 |
| Minimum | 50.0 | 2454 | 38.0 | 9.38 | 207 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 15.81 | 1.509 | 14.1 | 15.61 | 14.26 |
| St. Dev. | 0.14 | 0.015 | 0.2 | 0.14 | 1.02 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 7108 | 660 | 1058 | 156364 | 16805 |
| St. Dev. | 398 | 26 | 20 | 71 | 113 |
| Maximum | 8141 | 722 | 1110 | 156536 | 16968 |
| Minimum | 6279 | 611 | 1023 | 156244 | 16530 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 15 | 5 | 736 | 158678 | 13715 |
| St. Dev. | 0 | 2 | 121 | 384 | 68 |
| Maximum | 15 | 8 | 945 | 159554 | 14067 |
| Minimum | 15 | 1 | 339 | 157997 | 13639 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 99.24 | 30.41 | 531 | 458 |
| St. Dev. | 0.01 | 0.26 | 11.60 | 1 | 3 |
| Maximum | 99.82 | 99.77 | 67.63 | 533 | 463 |
| Minimum | 99.76 | 98.77 | 10.84 | 528 | 451 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO114C.TRC
Time/Date Tue Aug 22 14:41:14 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 50.0 | 2461 | 38.0 | 9.38 | 207 | 134 |
| St. Dev. | 0.0 | 4 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 50.0 | 2468 | 38.0 | 9.38 | 207 | 135 |
| Minimum | 50.0 | 2454 | 38.0 | 9.38 | 207 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 15.81 | 1.509 | 14.0 | 15.61 | 14.26 |
| St. Dev. | 0.14 | 0.015 | 0.2 | 0.14 | 1.02 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 7.34 | 1.07 | 1.79 | 253.72 | 19.83 |
| St. Dev. | 0.41 | 0.04 | 0.03 | 0.12 | 0.13 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0153 | 0.0081 | 0.0000 | 257.47 | 0.00 |
| St. Dev. | 0.0001 | 0.0029 | 0.0000 | 0.62 | 0.00 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 99.24 | 100.00 | 531 | 458 |
| St. Dev. | 0.01 | 0.26 | 0.00 | 1 | 3 |
| Maximum | 99.82 | 99.77 | 100.00 | 533 | 463 |
| Minimum | 99.76 | 98.77 | 100.00 | 528 | 451 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO114C.TRC
Time/Date Tue Aug 22 14:41:14 1995

Fourth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 50.0 | 2461 | 38.0 | 9.38 | 207 | 134 |
| St. Dev. | 0.0 | 4 | 0.0 | 0.00 | 0 | 1 |
| Maximum | 50.0 | 2468 | 38.0 | 9.38 | 207 | 135 |
| Minimum | 50.0 | 2454 | 38.0 | 9.38 | 207 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 15.81 | 1.509 | 14.0 | 15.61 | 14.26 |
| St. Dev. | 0.14 | 0.015 | 0.2 | 0.14 | 1.02 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 101.94 | 14.88 | 24.93 | 3523.89 | 275.44 |
| St. Dev. | 5.71 | 0.58 | 0.46 | 1.61 | 1.86 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.2129 | 0.1130 | 17.3376 | 3576.04 | 224.79 |
| St. Dev. | 0.0017 | 0.0397 | 2.8456 | 8.66 | 1.12 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 99.24 | 30.41 | 531 | 458 |
| St. Dev. | 0.01 | 0.26 | 11.60 | 1 | 3 |
| Maximum | 99.82 | 99.77 | 67.63 | 533 | 463 |
| Minimum | 99.76 | 98.77 | 10.84 | 528 | 451 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO113C.TRC
Time/Date Tue Aug 22 14:22:54 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.0 | 2221 | 36.0 | 7.42 | 203 | 130 |
| St. Dev. | 0.0 | 4 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 45.0 | 2229 | 36.0 | 7.42 | 205 | 131 |
| Minimum | 45.0 | 2214 | 36.0 | 7.42 | 201 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.51 | 1.319 | 13.7 | 13.34 | 16.60 |
| St. Dev. | 0.13 | 0.011 | 0.2 | 0.13 | 0.47 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 7614 | 954 | 881 | 156133 | 17890 |
| St. Dev. | 360 | 62 | 18 | 61 | 196 |
| Maximum | 8433 | 1027 | 926 | 156244 | 18097 |
| Minimum | 6973 | 712 | 850 | 156050 | 17542 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 17 | 6 | 33 | 158555 | 0 |
| St. Dev. | 0 | 2 | 12 | 286 | 0 |
| Maximum | 18 | 9 | 60 | 159068 | 0 |
| Minimum | 17 | 2 | 9 | 158094 | 0 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 99.39 | 96.21 | 486 | 430 |
| St. Dev. | 0.01 | 0.23 | 1.36 | 1 | 2 |
| Maximum | 99.80 | 99.81 | 98.95 | 490 | 435 |
| Minimum | 99.75 | 98.88 | 93.24 | 484 | 425 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO113C.TRC
Time/Date Tue Aug 22 14:22:54 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.0 | 2221 | 36.0 | 7.42 | 203 | 130 |
| St. Dev. | 0.0 | 4 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 45.0 | 2229 | 36.0 | 7.42 | 205 | 131 |
| Minimum | 45.0 | 2214 | 36.0 | 7.42 | 201 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.51 | 1.319 | 13.7 | 13.34 | 16.60 |
| St. Dev. | 0.13 | 0.011 | 0.2 | 0.13 | 0.47 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 7.46 | 1.47 | 1.42 | 240.53 | 20.04 |
| St. Dev. | 0.35 | 0.10 | 0.03 | 0.09 | 0.22 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0170 | 0.0088 | 0.0000 | 244.26 | 0.00 |
| St. Dev. | 0.0003 | 0.0030 | 0.0000 | 0.44 | 0.00 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 99.39 | 100.00 | 486 | 430 |
| St. Dev. | 0.01 | 0.23 | 0.00 | 1 | 2 |
| Maximum | 99.80 | 99.81 | 100.00 | 490 | 435 |
| Minimum | 99.75 | 98.88 | 100.00 | 484 | 425 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO113C.TRC
Time/Date Tue Aug 22 14:22:54 1995

Fourth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.0 | 2221 | 36.0 | 7.42 | 203 | 130 |
| St. Dev. | 0.0 | 4 | 0.0 | 0.00 | 1 | 1 |
| Maximum | 45.0 | 2229 | 36.0 | 7.42 | 205 | 131 |
| Minimum | 45.0 | 2214 | 36.0 | 7.42 | 201 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.51 | 1.319 | 13.7 | 13.34 | 16.60 |
| St. Dev. | 0.13 | 0.011 | 0.2 | 0.13 | 0.47 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 93.31 | 18.38 | 17.74 | 3006.60 | 250.55 |
| St. Dev. | 4.41 | 1.20 | 0.36 | 1.17 | 2.75 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.2123 | 0.1099 | 0.6734 | 3053.25 | 0.00 |
| St. Dev. | 0.0033 | 0.0378 | 0.2453 | 5.50 | 0.00 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 99.39 | 96.21 | 486 | 430 |
| St. Dev. | 0.01 | 0.23 | 1.36 | 1 | 2 |
| Maximum | 99.80 | 99.81 | 98.95 | 490 | 435 |
| Minimum | 99.75 | 98.88 | 93.24 | 484 | 425 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO112C.TRC
Time/Date Tue Aug 22 14:19:13 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.7 | 1949 | 36.0 | 6.14 | 205 | 133 |
| St. Dev. | 0.5 | 9 | 0.0 | 0.17 | 0 | 0 |
| Maximum | 40.0 | 1965 | 36.0 | 6.25 | 205 | 133 |
| Minimum | 39.0 | 1936 | 36.0 | 5.86 | 205 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 11.11 | 1.090 | 13.7 | 10.97 | 17.31 |
| St. Dev. | 0.11 | 0.009 | 0.2 | 0.11 | 0.69 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6779 | 744 | 552 | 156249 | 17537 |
| St. Dev. | 289 | 11 | 11 | 57 | 91 |
| Maximum | 7338 | 769 | 576 | 156342 | 17727 |
| Minimum | 6096 | 705 | 528 | 156147 | 17416 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 13 | 390 | 158316 | 4948 |
| St. Dev. | 0 | 1 | 41 | 218 | 1761 |
| Maximum | 15 | 15 | 486 | 158678 | 7525 |
| Minimum | 14 | 11 | 322 | 157899 | 68 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 98.21 | 29.29 | 458 | 414 |
| St. Dev. | 0.01 | 0.10 | 7.20 | 1 | 1 |
| Maximum | 99.80 | 98.52 | 42.48 | 461 | 415 |
| Minimum | 99.76 | 98.03 | 13.19 | 457 | 410 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO112C.TRC
Time/Date Tue Aug 22 14:19:13 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.7 | 1949 | 36.0 | 6.14 | 205 | 133 |
| St. Dev. | 0.5 | 9 | 0.0 | 0.17 | 0 | 0 |
| Maximum | 40.0 | 1965 | 36.0 | 6.25 | 205 | 133 |
| Minimum | 39.0 | 1936 | 36.0 | 5.86 | 205 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 11.11 | 1.090 | 13.7 | 10.97 | 17.31 |
| St. Dev. | 0.11 | 0.009 | 0.2 | 0.11 | 0.69 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 6.20 | 1.07 | 0.83 | 224.41 | 18.32 |
| St. Dev. | 0.26 | 0.02 | 0.02 | 0.08 | 0.09 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0131 | 0.0191 | 0.0000 | 227.38 | 5.17 |
| St. Dev. | 0.0001 | 0.0010 | 0.0000 | 0.31 | 1.85 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 98.21 | 100.00 | 458 | 414 |
| St. Dev. | 0.01 | 0.10 | 0.00 | 1 | 1 |
| Maximum | 99.80 | 98.52 | 100.00 | 461 | 415 |
| Minimum | 99.76 | 98.03 | 100.00 | 457 | 410 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO112C.TRC
Time/Date Tue Aug 22 14:19:13 1995

Fourth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.7 | 1949 | 36.0 | 6.14 | 205 | 133 |
| St. Dev. | 0.5 | 9 | 0.0 | 0.17 | 0 | 0 |
| Maximum | 40.0 | 1965 | 36.0 | 6.25 | 205 | 133 |
| Minimum | 39.0 | 1936 | 36.0 | 5.86 | 205 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 11.11 | 1.090 | 13.7 | 10.97 | 17.31 |
| St. Dev. | 0.11 | 0.009 | 0.2 | 0.11 | 0.69 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 68.28 | 11.77 | 9.13 | 2473.37 | 201.90 |
| St. Dev. | 2.92 | 0.18 | 0.18 | 0.90 | 1.04 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.1445 | 0.2102 | 6.4547 | 2506.09 | 56.97 |
| St. Dev. | 0.0008 | 0.0110 | 0.6828 | 3.45 | 20.35 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 98.21 | 29.29 | 458 | 414 |
| St. Dev. | 0.01 | 0.10 | 7.20 | 1 | 1 |
| Maximum | 99.80 | 98.52 | 42.48 | 461 | 415 |
| Minimum | 99.76 | 98.03 | 13.19 | 457 | 410 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO111C.TRC
Time/Date Tue Aug 22 14:16:17 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 34.7 | 1708 | 38.4 | 4.69 | 203 | 129 |
| St. Dev. | 0.5 | 11 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 35.0 | 1729 | 39.0 | 4.69 | 203 | 129 |
| Minimum | 34.0 | 1691 | 38.0 | 4.69 | 203 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.66 | 0.935 | 13.9 | 9.54 | 12.29 |
| St. Dev. | 0.13 | 0.009 | 0.2 | 0.13 | 0.61 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6341 | 721 | 304 | 156308 | 17603 |
| St. Dev. | 518 | 16 | 6 | 55 | 65 |
| Maximum | 7739 | 758 | 314 | 156439 | 17766 |
| Minimum | 5330 | 696 | 290 | 156147 | 17494 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 15 | 215 | 158053 | 4841 |
| St. Dev. | 0 | 1 | 43 | 410 | 2653 |
| Maximum | 14 | 16 | 275 | 158873 | 10689 |
| Minimum | 12 | 12 | 105 | 156829 | 58 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.78 | 97.87 | 29.13 | 435 | 373 |
| St. Dev. | 0.02 | 0.13 | 13.98 | 1 | 2 |
| Maximum | 99.82 | 98.27 | 64.97 | 440 | 376 |
| Minimum | 99.75 | 97.68 | 10.76 | 433 | 368 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO111C.TRC
Time/Date Tue Aug 22 14:16:17 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 34.7 | 1708 | 38.4 | 4.69 | 203 | 129 |
| St. Dev. | 0.5 | 11 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 35.0 | 1729 | 39.0 | 4.69 | 203 | 129 |
| Minimum | 34.0 | 1691 | 38.0 | 4.69 | 203 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.66 | 0.935 | 13.9 | 9.54 | 12.29 |
| St. Dev. | 0.13 | 0.009 | 0.2 | 0.13 | 0.61 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 5.76 | 1.03 | 0.45 | 223.16 | 18.28 |
| St. Dev. | 0.47 | 0.02 | 0.01 | 0.08 | 0.07 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0125 | 0.0219 | 0.0000 | 225.65 | 5.03 |
| St. Dev. | 0.0002 | 0.0012 | 0.0000 | 0.59 | 2.76 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 97.87 | 100.00 | 435 | 373 |
| St. Dev. | 0.02 | 0.13 | 0.00 | 1 | 2 |
| Maximum | 99.82 | 98.27 | 100.00 | 440 | 376 |
| Minimum | 99.75 | 97.68 | 100.00 | 433 | 368 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO111C.TRC
Time/Date Tue Aug 22 14:16:17 1995

Fourth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 34.7 | 1708 | 38.4 | 4.69 | 203 | 129 |
| St. Dev. | 0.5 | 11 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 35.0 | 1729 | 39.0 | 4.69 | 203 | 129 |
| Minimum | 34.0 | 1691 | 38.0 | 4.69 | 203 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.66 | 0.935 | 13.9 | 9.54 | 12.29 |
| St. Dev. | 0.13 | 0.009 | 0.2 | 0.13 | 0.61 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 55.54 | 9.93 | 4.37 | 2151.63 | 176.22 |
| St. Dev. | 4.53 | 0.23 | 0.09 | 0.76 | 0.65 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.1207 | 0.2115 | 3.1005 | 2175.64 | 48.46 |
| St. Dev. | 0.0022 | 0.0117 | 0.6213 | 5.64 | 26.64 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 97.87 | 29.13 | 435 | 373 |
| St. Dev. | 0.02 | 0.13 | 13.98 | 1 | 2 |
| Maximum | 99.82 | 98.27 | 64.97 | 440 | 376 |
| Minimum | 99.75 | 97.68 | 10.76 | 433 | 368 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO110C.TRC
Time/Date Tue Aug 22 14:14:07 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 30.0 | 1483 | 41.0 | 3.91 | 201 | 126 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 0 | ERR |
| Maximum | 30.0 | 1494 | 41.0 | 3.91 | 201 | 126 |
| Minimum | 30.0 | 1469 | 41.0 | 3.91 | 201 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.52 | 0.820 | 13.9 | 8.41 | 4.60 |
| St. Dev. | 0.13 | 0.009 | 0.2 | 0.13 | 0.62 |

| | PreCatalyst CO (ppm) | THC (ppm C3H8) | Exhaust Gas NOx (ppm) | Concentrations CO2 (ppm) | O2 (ppm) |
|---|---|---|---|---|---|
| Average | 6229 | 661 | 198 | 156402 | 16979 |
| St. Dev. | 430 | 14 | 7 | 50 | 151 |
| Maximum | 7447 | 691 | 210 | 156536 | 17231 |
| Minimum | 5585 | 630 | 184 | 156342 | 16656 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst CO (ppm) | THC (ppm C3H8) | Exhaust Gas NOx (ppm) | Concentrations CO2 (ppm) | O2 (ppm) |
|---|---|---|---|---|---|
| Average | 14 | 18 | 144 | 158209 | 13762 |
| St. Dev. | 0 | 1 | 17 | 361 | 145 |
| Maximum | 14 | 19 | 174 | 159068 | 14057 |
| Minimum | 14 | 16 | 111 | 157510 | 13541 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 97.34 | 27.49 | 411 | 337 |
| St. Dev. | 0.01 | 0.08 | 8.28 | 1 | 1 |
| Maximum | 99.82 | 97.57 | 43.00 | 413 | 339 |
| Minimum | 99.76 | 97.16 | 13.86 | 407 | 335 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO110C.TRC
Time/Date Tue Aug 22 14:14:07 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 30.0 | 1483 | 41.0 | 3.91 | 201 | 126 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 0 | ERR |
| Maximum | 30.0 | 1494 | 41.0 | 3.91 | 201 | 126 |
| Minimum | 30.0 | 1469 | 41.0 | 3.91 | 201 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.52 | 0.820 | 13.9 | 8.41 | 4.60 |
| St. Dev. | 0.13 | 0.009 | 0.2 | 0.13 | 0.62 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 5.77 | 0.96 | 0.30 | 227.85 | 17.99 |
| St. Dev. | 0.40 | 0.02 | 0.01 | 0.07 | 0.16 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0126 | 0.0256 | 0.0000 | 230.48 | 14.58 |
| St. Dev. | 0.0001 | 0.0009 | 0.0000 | 0.53 | 0.15 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 97.34 | 100.00 | 411 | 337 |
| St. Dev. | 0.01 | 0.08 | 0.00 | 1 | 1 |
| Maximum | 99.82 | 97.57 | 100.00 | 413 | 339 |
| Minimum | 99.76 | 97.16 | 100.00 | 407 | 335 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO110C.TRC
Time/Date Tue Aug 22 14:14:07 1995

Fourth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 30.0 | 1483 | 41.0 | 3.91 | 201 | 126 |
| St. Dev. | 0.0 | 6 | 0.0 | 0.00 | 0 | 0 |
| Maximum | 30.0 | 1494 | 41.0 | 3.91 | 201 | 126 |
| Minimum | 30.0 | 1469 | 41.0 | 3.91 | 201 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 8.52 | 0.820 | 13.9 | 8.41 | 4.60 |
| St. Dev. | 0.13 | 0.009 | 0.2 | 0.13 | 0.62 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 48.12 | 8.02 | 2.52 | 1898.71 | 149.91 |
| St. Dev. | 3.32 | 0.17 | 0.08 | 0.61 | 1.33 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.1053 | 0.2135 | 1.8254 | 1920.64 | 121.51 |
| St. Dev. | 0.0006 | 0.0073 | 0.2191 | 4.38 | 1.28 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.78 | 97.34 | 27.49 | 411 | 337 |
| St. Dev. | 0.01 | 0.08 | 8.28 | 1 | 1 |
| Maximum | 99.82 | 97.57 | 43.00 | 413 | 339 |
| Minimum | 99.76 | 97.16 | 13.86 | 407 | 335 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO109C.TRC
Time/Date Tue Aug 22 14:13:06 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 24.5 | 1211 | 41.8 | 2.34 | 201 | 124 |
| St. Dev. | 0.5 | 9 | 0.4 | 0.00 | 0 | 0 |
| Maximum | 25.0 | 1227 | 42.0 | 2.34 | 201 | 124 |
| Minimum | 24.0 | 1198 | 41.0 | 2.34 | 201 | 124 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.84 | 0.668 | 13.7 | 6.75 | 0.00 |
| St. Dev. | 0.08 | 0.008 | 0.2 | 0.08 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 5615 | 843 | 133 | 156380 | 17517 |
| St. Dev. | 440 | 16 | 6 | 69 | 107 |
| Maximum | 6790 | 872 | 144 | 156536 | 17776 |
| Minimum | 4928 | 804 | 120 | 156244 | 17406 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 30 | 111 | 157563 | 13614 |
| St. Dev. | 0 | 1 | 9 | 357 | 26 |
| Maximum | 14 | 33 | 124 | 158386 | 13668 |
| Minimum | 14 | 27 | 86 | 156926 | 13522 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.75 | 96.49 | 15.84 | 366 | 347 |
| St. Dev. | 0.02 | 0.13 | 8.55 | 1 | 2 |
| Maximum | 99.80 | 96.81 | 39.55 | 369 | 352 |
| Minimum | 99.72 | 96.14 | 2.12 | 363 | 343 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO109C.TRC
Time/Date Tue Aug 22 14:13:06 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 24.5 | 1211 | 41.8 | 2.34 | 201 | 124 |
| St. Dev. | 0.5 | 9 | 0.4 | 0.00 | 0 | 0 |
| Maximum | 25.0 | 1227 | 42.0 | 2.34 | 201 | 124 |
| Minimum | 24.0 | 1198 | 41.0 | 2.34 | 201 | 124 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.84 | 0.668 | 13.7 | 6.75 | 0.00 |
| St. Dev. | 0.08 | 0.008 | 0.2 | 0.08 | 0.00 |

| | PreCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 5.11 | 1.21 | 0.20 | 223.73 | 18.23 |
| St. Dev. | 0.40 | 0.02 | 0.01 | 0.10 | 0.11 |

| | PostCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0125 | 0.0423 | 0.0000 | 225.42 | 14.17 |
| St. Dev. | 0.0001 | 0.0018 | 0.0000 | 0.51 | 0.03 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.75 | 96.49 | 100.00 | 366 | 347 |
| St. Dev. | 0.02 | 0.13 | 0.00 | 1 | 2 |
| Maximum | 99.80 | 96.81 | 100.00 | 369 | 352 |
| Minimum | 99.72 | 96.14 | 100.00 | 363 | 343 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO109C.TRC
Time/Date Tue Aug 22 14:13:06 1995

Fourth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 24.5 | 1211 | 41.8 | 2.34 | 201 | 124 |
| St. Dev. | 0.5 | 9 | 0.4 | 0.00 | 0 | 0 |
| Maximum | 25.0 | 1227 | 42.0 | 2.34 | 201 | 124 |
| Minimum | 24.0 | 1198 | 41.0 | 2.34 | 201 | 124 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.84 | 0.668 | 13.7 | 6.75 | 0.00 |
| St. Dev. | 0.08 | 0.008 | 0.2 | 0.08 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 34.82 | 8.22 | 1.35 | 1523.61 | 124.12 |
| St. Dev. | 2.73 | 0.16 | 0.06 | 0.67 | 0.76 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.0852 | 0.2881 | 1.1338 | 1535.13 | 96.47 |
| St. Dev. | 0.0007 | 0.0124 | 0.0916 | 3.48 | 0.19 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.75 | 96.49 | 15.84 | 366 | 347 |
| St. Dev. | 0.02 | 0.13 | 8.55 | 1 | 2 |
| Maximum | 99.80 | 96.81 | 39.55 | 369 | 352 |
| Minimum | 99.72 | 96.14 | 2.12 | 363 | 343 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO107C.TRC
Time/Date Tue Aug 22 14:02:39 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 49.6 | 3555 | 29.9 | 12.89 | 209 | 126 |
| St. Dev. | 0.5 | 9 | 0.4 | 0.00 | 1 | 2 |
| Maximum | 50.0 | 3581 | 30.0 | 12.89 | 210 | 129 |
| Minimum | 49.0 | 3542 | 29.0 | 12.89 | 208 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 21.71 | 2.119 | 13.7 | 21.44 | 0.44 |
| St. Dev. | 0.23 | 0.019 | 0.2 | 0.23 | 1.24 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 7497 | 472 | 1741 | 156604 | 14144 |
| St. Dev. | 651 | 16 | 24 | 65 | 129 |
| Maximum | 8761 | 498 | 1790 | 156731 | 14476 |
| Minimum | 6169 | 441 | 1699 | 156439 | 13999 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 15 | 2 | 1008 | 159676 | 2837 |
| St. Dev. | 0 | 1 | 343 | 447 | 4290 |
| Maximum | 16 | 4 | 1655 | 160625 | 14086 |
| Minimum | 15 | 1 | 329 | 158873 | 49 |
| Uncertainty | 2 | 3 | 20 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.80 | 99.54 | 42.20 | 585 | 460 |
| St. Dev. | 0.02 | 0.18 | 19.29 | 4 | 13 |
| Maximum | 99.83 | 99.84 | 81.31 | 593 | 480 |
| Minimum | 99.76 | 99.11 | 6.28 | 578 | 401 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO107C.TRC
Time/Date Tue Aug 22 14:02:39 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 49.6 | 3555 | 29.9 | 12.89 | 209 | 126 |
| St. Dev. | 0.5 | 9 | 0.4 | 0.00 | 1 | 2 |
| Maximum | 50.0 | 3581 | 30.0 | 12.89 | 210 | 129 |
| Minimum | 49.0 | 3542 | 29.0 | 12.89 | 208 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 21.71 | 2.119 | 13.7 | 21.44 | 0.44 |
| St. Dev. | 0.23 | 0.019 | 0.2 | 0.23 | 1.24 |

| | PreCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 10.72 | 1.06 | 4.09 | 351.93 | 23.12 |
| St. Dev. | 0.93 | 0.04 | 0.06 | 0.15 | 0.21 |

| | PostCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0218 | 0.0048 | 0.0000 | 358.83 | 4.64 |
| St. Dev. | 0.0004 | 0.0019 | 0.0000 | 1.00 | 7.03 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.80 | 99.54 | 100.00 | 585 | 460 |
| St. Dev. | 0.02 | 0.18 | 0.00 | 4 | 13 |
| Maximum | 99.83 | 99.84 | 100.00 | 593 | 480 |
| Minimum | 99.76 | 99.11 | 100.00 | 578 | 401 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO107C.TRC
Time/Date Tue Aug 22 14:02:39 1995

Third Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 49.6 | 3555 | 29.9 | 12.89 | 209 | 126 |
| St. Dev. | 0.5 | 9 | 0.4 | 0.00 | 1 | 2 |
| Maximum | 50.0 | 3581 | 30.0 | 12.89 | 210 | 129 |
| Minimum | 49.0 | 3542 | 29.0 | 12.89 | 208 | 122 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 21.71 | 2.119 | 13.7 | 21.44 | 0.44 |
| St. Dev. | 0.23 | 0.019 | 0.2 | 0.23 | 1.24 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 147.67 | 14.60 | 56.33 | 4846.93 | 318.37 |
| St. Dev. | 12.83 | 0.49 | 0.77 | 2.01 | 2.91 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.3001 | 0.0663 | 32.6234 | 4942.01 | 63.85 |
| St. Dev. | 0.0049 | 0.0256 | 11.1118 | 13.84 | 96.88 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.80 | 99.54 | 42.20 | 585 | 460 |
| St. Dev. | 0.02 | 0.18 | 19.29 | 4 | 13 |
| Maximum | 99.83 | 99.84 | 81.31 | 593 | 480 |
| Minimum | 99.76 | 99.11 | 6.28 | 578 | 401 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO106C.TRC
Time/Date Tue Aug 22 13:31:21 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.0 | 3239 | 30.2 | 10.93 | 211 | 136 |
| St. Dev. | 0.0 | 8 | 0.4 | 0.05 | 1 | 1 |
| Maximum | 45.0 | 3252 | 31.0 | 10.94 | 212 | 136 |
| Minimum | 45.0 | 3212 | 30.0 | 10.55 | 210 | 135 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 18.88 | 1.834 | 13.8 | 18.65 | 0.00 |
| St. Dev. | 0.32 | 0.021 | 0.2 | 0.32 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6585 | 516 | 1356 | 156300 | 14732 |
| St. Dev. | 595 | 112 | 36 | 96 | 75 |
| Maximum | 7484 | 741 | 1422 | 156439 | 14885 |
| Minimum | 5549 | 400 | 1286 | 156147 | 14602 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 15 | 2 | 1071 | 156643 | 13968 |
| St. Dev. | 0 | 1 | 194 | 431 | 148 |
| Maximum | 15 | 3 | 1351 | 157607 | 14242 |
| Minimum | 15 | 1 | 528 | 155758 | 13697 |
| Uncertainty | 2 | 3 | 20 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 99.60 | 21.09 | 574 | 484 |
| St. Dev. | 0.02 | 0.12 | 13.82 | 2 | 18 |
| Maximum | 99.80 | 99.87 | 59.06 | 579 | 496 |
| Minimum | 99.73 | 99.31 | (1.61) | 568 | 385 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO106C.TRC
Time/Date Tue Aug 22 13:31:21 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.0 | 3239 | 30.2 | 10.93 | 211 | 136 |
| St. Dev. | 0.0 | 8 | 0.4 | 0.05 | 1 | 1 |
| Maximum | 45.0 | 3252 | 31.0 | 10.94 | 212 | 136 |
| Minimum | 45.0 | 3212 | 30.0 | 10.55 | 210 | 135 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 18.88 | 1.834 | 13.8 | 18.65 | 0.00 |
| St. Dev. | 0.32 | 0.021 | 0.2 | 0.32 | 0.00 |

| | PreCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 9.02 | 1.11 | 3.05 | 336.55 | 23.07 |
| St. Dev. | 0.81 | 0.24 | 0.08 | 0.21 | 0.12 |

| | PostCatalyst CO (G/mi) | THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0206 | 0.0043 | 0.0000 | 337.29 | 21.87 |
| St. Dev. | 0.0002 | 0.0013 | 0.0000 | 0.93 | 0.23 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.77 | 99.60 | 100.00 | 574 | 484 |
| St. Dev. | 0.02 | 0.12 | 0.00 | 2 | 18 |
| Maximum | 99.80 | 99.87 | 100.00 | 579 | 496 |
| Minimum | 99.73 | 99.31 | 100.00 | 568 | 385 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO106C.TRC
Time/Date Tue Aug 22 13:31:21 1995

Third Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.0 | 3239 | 30.2 | 10.93 | 211 | 136 |
| St. Dev. | 0.0 | 8 | 0.4 | 0.05 | 1 | 1 |
| Maximum | 45.0 | 3252 | 31.0 | 10.94 | 212 | 136 |
| Minimum | 45.0 | 3212 | 30.0 | 10.55 | 210 | 135 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 18.88 | 1.834 | 13.8 | 18.65 | 0.00 |
| St. Dev. | 0.32 | 0.021 | 0.2 | 0.32 | 0.00 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 112.79 | 13.89 | 38.14 | 4206.93 | 288.38 |
| St. Dev. | 10.19 | 3.03 | 1.00 | 2.58 | 1.47 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.2573 | 0.0541 | 30.1332 | 4216.16 | 273.43 |
| St. Dev. | 0.0025 | 0.0159 | 5.4521 | 11.60 | 2.90 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.77 | 99.60 | 21.09 | 574 | 484 |
| St. Dev. | 0.02 | 0.12 | 13.82 | 2 | 18 |
| Maximum | 99.80 | 99.87 | 59.06 | 579 | 496 |
| Minimum | 99.73 | 99.31 | (1.61) | 568 | 385 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO105C.TRC
Time/Date Tue Aug 22 13:30:20 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 35.0 | 2535 | 33.8 | 7.13 | 205 | 124 |
| St. Dev. | 0.0 | 10 | 0.4 | 0.17 | 2 | 2 |
| Maximum | 35.0 | 2550 | 34.0 | 7.42 | 207 | 127 |
| Minimum | 35.0 | 2515 | 33.0 | 7.03 | 203 | 120 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.70 | 1.353 | 13.6 | 13.52 | 1.20 |
| St. Dev. | 0.19 | 0.014 | 0.2 | 0.19 | 0.37 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6662 | 563 | 513 | 156158 | 16208 |
| St. Dev. | 496 | 21 | 16 | 81 | 121 |
| Maximum | 7849 | 617 | 550 | 156342 | 16384 |
| Minimum | 5950 | 531 | 491 | 155952 | 15965 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 11 | 397 | 155980 | 12830 |
| St. Dev. | 0 | 1 | 56 | 362 | 2102 |
| Maximum | 14 | 13 | 486 | 156731 | 13999 |
| Minimum | 14 | 8 | 248 | 155271 | 4838 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 98.05 | 22.53 | 497 | 415 |
| St. Dev. | 0.02 | 0.18 | 11.16 | 3 | 2 |
| Maximum | 99.82 | 98.57 | 50.77 | 502 | 420 |
| Minimum | 99.76 | 97.74 | 0.89 | 491 | 411 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO105C.TRC
Time/Date Tue Aug 22 13:30:20 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 35.0 | 2535 | 33.8 | 7.13 | 205 | 124 |
| St. Dev. | 0.0 | 10 | 0.4 | 0.17 | 2 | 2 |
| Maximum | 35.0 | 2550 | 34.0 | 7.42 | 207 | 127 |
| Minimum | 35.0 | 2515 | 33.0 | 7.03 | 203 | 120 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.70 | 1.353 | 13.6 | 13.52 | 1.20 |
| St. Dev. | 0.19 | 0.014 | 0.2 | 0.19 | 0.37 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 8.51 | 1.13 | 1.08 | 313.58 | 23.67 |
| St. Dev. | 0.63 | 0.04 | 0.03 | 0.16 | 0.18 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0179 | 0.0220 | 0.0000 | 313.22 | 18.74 |
| St. Dev. | 0.0001 | 0.0021 | 0.0000 | 0.73 | 3.08 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 98.05 | 100.00 | 497 | 415 |
| St. Dev. | 0.02 | 0.18 | 0.00 | 3 | 2 |
| Maximum | 99.82 | 98.57 | 100.00 | 502 | 420 |
| Minimum | 99.76 | 97.74 | 100.00 | 491 | 411 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO105C.TRC
Time/Date Tue Aug 22 13:30:20 1995

Third Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 35.0 | 2535 | 33.8 | 7.13 | 205 | 124 |
| St. Dev. | 0.0 | 10 | 0.4 | 0.17 | 2 | 2 |
| Maximum | 35.0 | 2550 | 34.0 | 7.42 | 207 | 127 |
| Minimum | 35.0 | 2515 | 33.0 | 7.03 | 203 | 120 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 13.70 | 1.353 | 13.6 | 13.52 | 1.20 |
| St. Dev. | 0.19 | 0.014 | 0.2 | 0.19 | 0.37 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 82.77 | 11.00 | 10.48 | 3048.66 | 230.13 |
| St. Dev. | 6.17 | 0.40 | 0.32 | 1.58 | 1.72 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.1739 | 0.2142 | 8.1118 | 3045.17 | 182.16 |
| St. Dev. | 0.0012 | 0.0207 | 1.1471 | 7.07 | 29.95 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.79 | 98.05 | 22.53 | 497 | 415 |
| St. Dev. | 0.02 | 0.18 | 11.16 | 3 | 2 |
| Maximum | 99.82 | 98.57 | 50.77 | 502 | 420 |
| Minimum | 99.76 | 97.74 | 0.89 | 491 | 411 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO104C.TRC
Time/Date Tue Aug 22 13:13:49 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.7 | 2843 | 32.7 | 8.62 | 206 | 116 |
| St. Dev. | 0.5 | 10 | 0.9 | 0.14 | 2 | 3 |
| Maximum | 40.0 | 2861 | 34.0 | 9.38 | 208 | 120 |
| Minimum | 39.0 | 2824 | 32.0 | 8.59 | 203 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.66 | 1.568 | 14.2 | 16.45 | 0.00 |
| St. Dev. | 0.71 | 0.025 | 0.4 | 0.71 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 7015 | 589 | 722 | 156128 | 16513 |
| St. Dev. | 593 | 28 | 19 | 58 | 242 |
| Maximum | 8360 | 660 | 789 | 156244 | 16919 |
| Minimum | 5914 | 538 | 689 | 155952 | 16014 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 15 | 14 | 601 | 155999 | 13677 |
| St. Dev. | 0 | 2 | 66 | 500 | 110 |
| Maximum | 15 | 17 | 710 | 157121 | 13726 |
| Minimum | 14 | 9 | 449 | 155076 | 12831 |
| Uncertainty | 2 | 3 | 10 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 97.67 | 16.73 | 504 | 353 |
| St. Dev. | 0.02 | 0.34 | 9.16 | 6 | 9 |
| Maximum | 99.83 | 98.67 | 39.66 | 514 | 371 |
| Minimum | 99.75 | 97.19 | 1.89 | 493 | 339 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO104C.TRC
Time/Date Tue Aug 22 13:13:49 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.7 | 2843 | 32.7 | 8.62 | 206 | 116 |
| St. Dev. | 0.5 | 10 | 0.9 | 0.14 | 2 | 3 |
| Maximum | 40.0 | 2861 | 34.0 | 9.38 | 208 | 120 |
| Minimum | 39.0 | 2824 | 32.0 | 8.59 | 203 | 111 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.66 | 1.568 | 14.2 | 16.45 | 0.00 |
| St. Dev. | 0.71 | 0.025 | 0.4 | 0.71 | 0.00 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 9.62 | 1.27 | 1.63 | 336.49 | 25.88 |
| St. Dev. | 0.81 | 0.06 | 0.04 | 0.12 | 0.38 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0199 | 0.0295 | 0.0000 | 336.21 | 21.44 |
| St. Dev. | 0.0002 | 0.0042 | 0.0000 | 1.08 | 0.17 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.79 | 97.67 | 100.00 | 504 | 353 |
| St. Dev. | 0.02 | 0.34 | 0.00 | 6 | 9 |
| Maximum | 99.83 | 98.67 | 100.00 | 514 | 371 |
| Minimum | 99.75 | 97.19 | 100.00 | 493 | 339 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO135C.TRC
Time/Date Tue Aug 22 16:23:51 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 0.0 | 829 | 42.7 | 0.00 | 198 | 146 |
| St. Dev. | 0.0 | 17 | 0.6 | 0.00 | 1 | 1 |
| Maximum | 0.0 | 868 | 44.0 | 0.00 | 199 | 147 |
| Minimum | 0.0 | 797 | 41.0 | 0.00 | 198 | 145 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 4.39 | 0.439 | 13.4 | 4.33 | 0.00 |
| St. Dev. | 0.03 | 0.005 | 0.2 | 0.03 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6967 | 1260 | 62 | 156444 | 17850 |
| St. Dev. | 518 | 18 | 1 | 57 | 52 |
| Maximum | 7922 | 1297 | 63 | 156536 | 17971 |
| Minimum | 5731 | 1224 | 60 | 156342 | 17747 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 199 | 145 | 0 | 160406 | 0 |
| St. Dev. | 0 | 90 | 0 | 305 | 0 |
| Maximum | 199 | 249 | 0 | 161015 | 0 |
| Minimum | 199 | 0 | 0 | 159652 | 0 |
| Uncertainty | 2 | 3 | 20 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 97.12 | 88.46 | 100.00 | 367 | 447 |
| St. Dev. | 0.22 | 7.15 | 0.00 | 5 | 2 |
| Maximum | 97.48 | 100.00 | 100.00 | 375 | 451 |
| Minimum | 96.52 | 80.11 | 100.00 | 359 | 443 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO135C.TRC Idle
Time/Date Tue Aug 22 16:23:51 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 0.0 | 829 | 42.7 | 0.00 | 198 | 146 |
| St. Dev. | 0.0 | 17 | 0.6 | 0.00 | 1 | 1 |
| Maximum | 0.0 | 868 | 44.0 | 0.00 | 199 | 147 |
| Minimum | 0.0 | 797 | 41.0 | 0.00 | 198 | 145 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 4.39 | 0.439 | 13.4 | 4.33 | 0.00 |
| St. Dev. | 0.03 | 0.005 | 0.2 | 0.03 | 0.00 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 27.74 | 7.88 | 0.41 | 978.68 | 81.21 |
| St. Dev. | 2.06 | 0.11 | 0.01 | 0.36 | 0.24 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.7933 | 1.1787 | 0.0000 | 1003.47 | 61.06 |
| St. Dev. | 0.0000 | 0.2592 | 0.0000 | 1.91 | 0.11 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 97.12 | 85.05 | 100.00 | 367 | 447 |
| St. Dev. | 0.22 | 3.24 | 0.00 | 5 | 2 |
| Maximum | 97.48 | 91.25 | 100.00 | 375 | 451 |
| Minimum | 96.52 | 80.11 | 100.00 | 359 | 443 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO125C.TRC
Time/Date Tue Aug 22 15:16:15 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 55.0 | 2075 | 50.0 | 8.59 | 204 | 117 |
| St. Dev. | 0.0 | 6 | 0.2 | 0.00 | 2 | 2 |
| Maximum | 55.0 | 2083 | 50.0 | 8.59 | 207 | 122 |
| Minimum | 55.0 | 2064 | 49.0 | 8.59 | 201 | 115 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.39 | 1.503 | 14.6 | 16.19 | 43.38 |
| St. Dev. | 0.20 | 0.011 | 0.2 | 0.20 | 1.45 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6817 | 822 | 389 | 156666 | 16594 |
| St. Dev. | 426 | 6 | 23 | 52 | 174 |
| Maximum | 7630 | 836 | 427 | 156829 | 16832 |
| Minimum | 5987 | 809 | 346 | 156536 | 16277 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 31 | 23 | 0 | 161072 | 13529 |
| St. Dev. | 15 | 25 | 0 | 237 | 486 |
| Maximum | 71 | 95 | 1 | 161501 | 14223 |
| Minimum | 19 | 4 | 0 | 160333 | 12217 |
| Uncertainty | 2 | 3 | 3 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.55 | 97.22 | 99.93 | 493 | 411 |
| St. Dev. | 0.21 | 3.00 | 0.04 | 2 | 5 |
| Maximum | 99.74 | 99.58 | 100.00 | 497 | 419 |
| Minimum | 99.03 | 88.47 | 99.81 | 488 | 400 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO125C.TRC
Time/Date Tue Aug 22 15:16:15 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 55.0 | 2075 | 50.0 | 8.59 | 204 | 117 |
| St. Dev. | 0.0 | 6 | 0.2 | 0.00 | 2 | 2 |
| Maximum | 55.0 | 2083 | 50.0 | 8.59 | 207 | 122 |
| Minimum | 55.0 | 2064 | 49.0 | 8.59 | 201 | 115 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.39 | 1.503 | 14.6 | 16.19 | 43.38 |
| St. Dev. | 0.20 | 0.011 | 0.2 | 0.20 | 1.45 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 6.64 | 1.26 | 0.62 | 239.67 | 18.46 |
| St. Dev. | 0.42 | 0.01 | 0.04 | 0.08 | 0.19 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0304 | 0.0331 | 0.0000 | 246.41 | 15.05 |
| St. Dev. | 0.0149 | 0.0394 | 0.0000 | 0.36 | 0.54 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.55 | 97.37 | 100.00 | 493 | 411 |
| St. Dev. | 0.21 | 3.12 | 0.00 | 2 | 5 |
| Maximum | 99.74 | 100.00 | 100.00 | 497 | 419 |
| Minimum | 99.03 | 88.47 | 100.00 | 488 | 400 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO125C.TRC
Time/Date Tue Aug 22 15:16:15 1995

Fifth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 55.0 | 2075 | 50.0 | 8.59 | 204 | 117 |
| St. Dev. | 0.0 | 6 | 0.2 | 0.00 | 2 | 2 |
| Maximum | 55.0 | 2083 | 50.0 | 8.59 | 207 | 122 |
| Minimum | 55.0 | 2064 | 49.0 | 8.59 | 201 | 115 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 16.39 | 1.503 | 14.6 | 16.19 | 43.38 |
| St. Dev. | 0.20 | 0.011 | 0.2 | 0.20 | 1.45 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 101.39 | 19.20 | 9.50 | 3661.55 | 282.07 |
| St. Dev. | 6.34 | 0.14 | 0.57 | 1.22 | 2.96 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.4646 | 0.5348 | 0.0069 | 3764.53 | 229.96 |
| St. Dev. | 0.2283 | 0.5782 | 0.0039 | 5.53 | 8.28 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.55 | 97.22 | 99.93 | 493 | 411 |
| St. Dev. | 0.21 | 3.00 | 0.04 | 2 | 5 |
| Maximum | 99.74 | 99.58 | 100.00 | 497 | 419 |
| Minimum | 99.03 | 88.47 | 99.81 | 488 | 400 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO124C.TRC
Time/Date Tue Aug 22 15:14:12 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 49.0 | 1860 | 48.0 | 7.42 | 203 | 135 |
| St. Dev. | 0.2 | 5 | 0.0 | 0.00 | 0 | 0 |
| Maximum | 50.0 | 1877 | 48.0 | 7.42 | 203 | 135 |
| Minimum | 49.0 | 1853 | 48.0 | 7.42 | 203 | 135 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 12.67 | 1.250 | 13.6 | 12.51 | 30.81 |
| St. Dev. | 0.11 | 0.008 | 0.2 | 0.11 | 0.54 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6160 | 927 | 202 | 156361 | 17443 |
| St. Dev. | 181 | 8 | 5 | 52 | 61 |
| Maximum | 6644 | 944 | 211 | 156439 | 17532 |
| Minimum | 5768 | 909 | 189 | 156244 | 17289 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 17 | 4 | 0 | 158889 | 14089 |
| St. Dev. | 0 | 1 | 0 | 144 | 171 |
| Maximum | 18 | 7 | 1 | 159165 | 14583 |
| Minimum | 17 | 2 | 0 | 158581 | 13843 |
| Uncertainty | 2 | 3 | 3 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.72 | 99.53 | 99.80 | 491 | 439 |
| St. Dev. | 0.01 | 0.13 | 0.07 | 1 | 2 |
| Maximum | 99.74 | 99.80 | 99.88 | 492 | 443 |
| Minimum | 99.70 | 99.23 | 99.59 | 488 | 434 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO124C.TRC
Time/Date Tue Aug 22 15:14:12 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 49.0 | 1860 | 48.0 | 7.42 | 203 | 135 |
| St. Dev. | 0.2 | 5 | 0.0 | 0.00 | 0 | 0 |
| Maximum | 50.0 | 1877 | 48.0 | 7.42 | 203 | 135 |
| Minimum | 49.0 | 1853 | 48.0 | 7.42 | 203 | 135 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 12.67 | 1.250 | 13.6 | 12.51 | 30.81 |
| St. Dev. | 0.11 | 0.008 | 0.2 | 0.11 | 0.54 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (G/mi) | CO2 (G/mi) | O2 (G/mi) |
| Average | 5.20 | 1.23 | 0.28 | 207.28 | 16.82 |
| St. Dev. | 0.15 | 0.01 | 0.01 | 0.07 | 0.06 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (G/mi) | THC (G/mi C3H8) | NOx (mG/mi | CO2 (G/mi) | O2 (G/mi) |
| Average | 0.0145 | 0.0039 | 0.0000 | 210.63 | 13.58 |
| St. Dev. | 0.0002 | 0.0027 | 0.0000 | 0.19 | 0.17 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.72 | 99.68 | 100.00 | 491 | 439 |
| St. Dev. | 0.01 | 0.22 | 0.00 | 1 | 2 |
| Maximum | 99.74 | 100.00 | 100.00 | 492 | 443 |
| Minimum | 99.70 | 99.36 | 100.00 | 488 | 434 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO124C.TRC
Time/Date Tue Aug 22 15:14:12 1995

Fifth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 49.0 | 1860 | 48.0 | 7.42 | 203 | 135 |
| St. Dev. | 0.2 | 5 | 0.0 | 0.00 | 0 | 0 |
| Maximum | 50.0 | 1877 | 48.0 | 7.42 | 203 | 135 |
| Minimum | 49.0 | 1853 | 48.0 | 7.42 | 203 | 135 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 12.67 | 1.250 | 13.6 | 12.51 | 30.81 |
| St. Dev. | 0.11 | 0.008 | 0.2 | 0.11 | 0.54 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 70.80 | 16.74 | 3.81 | 2824.05 | 229.12 |
| St. Dev. | 2.08 | 0.14 | 0.09 | 0.95 | 0.79 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.1969 | 0.0784 | 0.0077 | 2869.71 | 185.06 |
| St. Dev. | 0.0022 | 0.0220 | 0.0026 | 2.61 | 2.25 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.72 | 99.53 | 99.80 | 491 | 439 |
| St. Dev. | 0.01 | 0.13 | 0.07 | 1 | 2 |
| Maximum | 99.74 | 99.80 | 99.88 | 492 | 443 |
| Minimum | 99.70 | 99.23 | 99.59 | 488 | 434 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO123C.TRC
Time/Date Tue Aug 22 15:11:46 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.5 | 1716 | 49.7 | 6.25 | 203 | 133 |
| St. Dev. | 0.5 | 8 | 0.5 | 0.00 | 1 | 0 |
| Maximum | 46.0 | 1729 | 50.0 | 6.25 | 203 | 133 |
| Minimum | 45.0 | 1702 | 49.0 | 6.25 | 201 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 11.85 | 1.158 | 13.7 | 11.70 | 30.66 |
| St. Dev. | 0.15 | 0.008 | 0.2 | 0.15 | 0.81 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 6229 | 922 | 134 | 156378 | 17116 |
| St. Dev. | 296 | 12 | 5 | 47 | 46 |
| Maximum | 6936 | 942 | 144 | 156439 | 17231 |
| Minimum | 5622 | 891 | 127 | 156342 | 17046 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 0 | 0 | 159511 | 0 |
| St. Dev. | 0 | 0 | 0 | 230 | 0 |
| Maximum | 14 | 0 | 0 | 160138 | 0 |
| Minimum | 13 | 0 | 0 | 159165 | 0 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.78 | 99.98 | 99.79 | 477 | 398 |
| St. Dev. | 0.01 | 0.02 | 0.10 | 2 | 3 |
| Maximum | 99.80 | 100.00 | 100.00 | 480 | 404 |
| Minimum | 99.76 | 99.96 | 99.62 | 474 | 391 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO123C.TRC
Time/Date Tue Aug 22 15:11:46 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.5 | 1716 | 49.7 | 6.25 | 203 | 133 |
| St. Dev. | 0.5 | 8 | 0.5 | 0.00 | 1 | 0 |
| Maximum | 46.0 | 1729 | 50.0 | 6.25 | 203 | 133 |
| Minimum | 45.0 | 1702 | 49.0 | 6.25 | 201 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 11.85 | 1.158 | 13.7 | 11.70 | 30.66 |
| St. Dev. | 0.15 | 0.008 | 0.2 | 0.15 | 0.81 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 5.30 | 1.23 | 0.19 | 209.11 | 16.65 |
| St. Dev. | 0.25 | 0.02 | 0.01 | 0.06 | 0.04 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0116 | 0.0002 | 0.0000 | 213.30 | 13.59 |
| St. Dev. | 0.0001 | 0.0002 | 0.0000 | 0.31 | 0.18 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 99.98 | 100.00 | 477 | 398 |
| St. Dev. | 0.01 | 0.02 | 0.00 | 2 | 3 |
| Maximum | 99.80 | 100.00 | 100.00 | 480 | 404 |
| Minimum | 99.76 | 99.96 | 100.00 | 474 | 391 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO123C.TRC
Time/Date Tue Aug 22 15:11:46 1995

Fifth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 45.5 | 1716 | 49.7 | 6.25 | 203 | 133 |
| St. Dev. | 0.5 | 8 | 0.5 | 0.00 | 1 | 0 |
| Maximum | 46.0 | 1729 | 50.0 | 6.25 | 203 | 133 |
| Minimum | 45.0 | 1702 | 49.0 | 6.25 | 201 | 133 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 11.85 | 1.158 | 13.7 | 11.70 | 30.66 |
| St. Dev. | 0.15 | 0.008 | 0.2 | 0.15 | 0.81 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 66.97 | 15.58 | 2.37 | 2641.98 | 210.31 |
| St. Dev. | 3.18 | 0.20 | 0.08 | 0.80 | 0.56 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.1465 | 0.0027 | 0.0049 | 2694.91 | 171.69 |
| St. Dev. | 0.0008 | 0.0026 | 0.0023 | 3.89 | 2.25 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.78 | 99.98 | 99.79 | 477 | 398 |
| St. Dev. | 0.01 | 0.02 | 0.10 | 2 | 3 |
| Maximum | 99.80 | 100.00 | 100.00 | 480 | 404 |
| Minimum | 99.76 | 99.96 | 99.62 | 474 | 391 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO122C.TRC
Time/Date Tue Aug 22 15:10:17 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.0 | 1469 | 43.3 | 4.69 | 201 | 129 |
| St. Dev. | 0.2 | 10 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 40.0 | 1487 | 44.0 | 4.69 | 201 | 129 |
| Minimum | 39.0 | 1449 | 43.0 | 4.69 | 201 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.21 | 0.897 | 13.8 | 9.10 | 11.64 |
| St. Dev. | 0.10 | 0.008 | 0.2 | 0.10 | 1.26 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 5927 | 686 | 288 | 156402 | 17242 |
| St. Dev. | 278 | 8 | 5 | 61 | 38 |
| Maximum | 6571 | 709 | 298 | 156536 | 17309 |
| Minimum | 5293 | 666 | 275 | 156244 | 17153 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 15 | 213 | 157406 | 13891 |
| St. Dev. | 0 | 1 | 25 | 237 | 171 |
| Maximum | 14 | 16 | 262 | 157997 | 14495 |
| Minimum | 14 | 13 | 144 | 156829 | 13648 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.76 | 97.83 | 25.85 | 426 | 370 |
| St. Dev. | 0.01 | 0.11 | 8.86 | 1 | 3 |
| Maximum | 99.78 | 98.12 | 48.78 | 429 | 376 |
| Minimum | 99.73 | 97.70 | 7.65 | 423 | 361 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO122C.TRC
Time/Date Tue Aug 22 15:10:17 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.0 | 1469 | 43.3 | 4.69 | 201 | 129 |
| St. Dev. | 0.2 | 10 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 40.0 | 1487 | 44.0 | 4.69 | 201 | 129 |
| Minimum | 39.0 | 1449 | 43.0 | 4.69 | 201 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.21 | 0.897 | 13.8 | 9.10 | 11.64 |
| St. Dev. | 0.10 | 0.008 | 0.2 | 0.10 | 1.26 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 4.57 | 0.83 | 0.36 | 189.41 | 15.19 |
| St. Dev. | 0.21 | 0.01 | 0.01 | 0.07 | 0.03 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0109 | 0.0180 | 0.0000 | 190.62 | 12.23 |
| St. Dev. | 0.0001 | 0.0010 | 0.0000 | 0.29 | 0.15 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.76 | 97.83 | 100.00 | 426 | 370 |
| St. Dev. | 0.01 | 0.11 | 0.00 | 1 | 3 |
| Maximum | 99.78 | 98.12 | 100.00 | 429 | 376 |
| Minimum | 99.73 | 97.70 | 100.00 | 423 | 361 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO122C.TRC Fifth Gear
Time/Date Tue Aug 22 15:10:17 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 39.0 | 1469 | 43.3 | 4.69 | 201 | 129 |
| St. Dev. | 0.2 | 10 | 0.5 | 0.00 | 0 | 0 |
| Maximum | 40.0 | 1487 | 44.0 | 4.69 | 201 | 129 |
| Minimum | 39.0 | 1449 | 43.0 | 4.69 | 201 | 129 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 9.21 | 0.897 | 13.8 | 9.10 | 11.64 |
| St. Dev. | 0.10 | 0.008 | 0.2 | 0.10 | 1.26 |

| | PreCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 49.52 | 9.01 | 3.95 | 2053.59 | 164.65 |
| St. Dev. | 2.32 | 0.11 | 0.07 | 0.81 | 0.36 |

| | PostCatalyst CO (mg/s) | THC (mg/s C3H8) | Exhaust Gas NOx (mg/s) | Emission Rates CO2 (mg/s) | O2 (mg/s) |
|---|---|---|---|---|---|
| Average | 0.1185 | 0.1956 | 2.9289 | 2066.77 | 132.65 |
| St. Dev. | 0.0008 | 0.0107 | 0.3469 | 3.11 | 1.64 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.76 | 97.83 | 25.85 | 426 | 370 |
| St. Dev. | 0.01 | 0.11 | 8.86 | 1 | 3 |
| Maximum | 99.78 | 98.12 | 48.78 | 429 | 376 |
| Minimum | 99.73 | 97.70 | 7.65 | 423 | 361 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO121C.TRC
Time/Date Tue Aug 22 15:07:04 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 34.2 | 1292 | 43.6 | 2.73 | 200 | 129 |
| St. Dev. | 0.4 | 9 | 0.5 | 0.00 | 1 | 1 |
| Maximum | 35.0 | 1312 | 44.0 | 2.73 | 201 | 129 |
| Minimum | 34.0 | 1276 | 43.0 | 2.73 | 199 | 127 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 7.92 | 0.777 | 13.7 | 7.81 | 0.00 |
| St. Dev. | 0.12 | 0.008 | 0.2 | 0.12 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 4996 | 713 | 214 | 156527 | 16641 |
| St. Dev. | 391 | 9 | 4 | 60 | 69 |
| Maximum | 6425 | 742 | 222 | 156634 | 16763 |
| Minimum | 4527 | 697 | 203 | 156439 | 16559 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 18 | 7 | 107 | 157615 | 13857 |
| St. Dev. | 3 | 3 | 58 | 410 | 154 |
| Maximum | 26 | 11 | 181 | 158776 | 14203 |
| Minimum | 14 | 2 | 1 | 157023 | 13619 |
| Uncertainty | 2 | 3 | 5 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.65 | 99.02 | 50.14 | 403 | 357 |
| St. Dev. | 0.05 | 0.35 | 26.87 | 2 | 3 |
| Maximum | 99.72 | 99.67 | 99.55 | 409 | 363 |
| Minimum | 99.51 | 98.44 | 12.97 | 399 | 352 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO121C.TRC
Time/Date Tue Aug 22 15:07:04 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 34.2 | 1292 | 43.6 | 2.73 | 200 | 129 |
| St. Dev. | 0.4 | 9 | 0.5 | 0.00 | 1 | 1 |
| Maximum | 35.0 | 1312 | 44.0 | 2.73 | 201 | 129 |
| Minimum | 34.0 | 1276 | 43.0 | 2.73 | 199 | 127 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 7.92 | 0.777 | 13.7 | 7.81 | 0.00 |
| St. Dev. | 0.12 | 0.008 | 0.2 | 0.12 | 0.00 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 3.77 | 0.85 | 0.27 | 185.64 | 14.35 |
| St. Dev. | 0.29 | 0.01 | 0.00 | 0.07 | 0.06 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0134 | 0.0083 | 0.0000 | 186.93 | 11.95 |
| St. Dev. | 0.0024 | 0.0030 | 0.0000 | 0.49 | 0.13 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.65 | 99.02 | 100.00 | 403 | 357 |
| St. Dev. | 0.05 | 0.35 | 0.00 | 2 | 3 |
| Maximum | 99.72 | 99.67 | 100.00 | 409 | 363 |
| Minimum | 99.51 | 98.44 | 100.00 | 399 | 352 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO121C.TRC
Time/Date Tue Aug 22 15:07:04 1995

Fifth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 34.2 | 1292 | 43.6 | 2.73 | 200 | 129 |
| St. Dev. | 0.4 | 9 | 0.5 | 0.00 | 1 | 1 |
| Maximum | 35.0 | 1312 | 44.0 | 2.73 | 201 | 129 |
| Minimum | 34.0 | 1276 | 43.0 | 2.73 | 199 | 127 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 7.92 | 0.777 | 13.7 | 7.81 | 0.00 |
| St. Dev. | 0.12 | 0.008 | 0.2 | 0.12 | 0.00 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 35.87 | 8.04 | 2.53 | 1765.70 | 136.52 |
| St. Dev. | 2.81 | 0.10 | 0.04 | 0.68 | 0.56 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.1272 | 0.0787 | 1.2598 | 1777.98 | 113.69 |
| St. Dev. | 0.0231 | 0.0284 | 0.6787 | 4.63 | 1.27 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.65 | 99.02 | 50.14 | 403 | 357 |
| St. Dev. | 0.05 | 0.35 | 26.87 | 2 | 3 |
| Maximum | 99.72 | 99.67 | 99.55 | 409 | 363 |
| Minimum | 99.51 | 98.44 | 12.97 | 399 | 352 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO119C.TRC
Time/Date Tue Aug 22 15:01:39 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 29.9 | 1121 | 43.1 | 1.90 | 201 | 126 |
| St. Dev. | 0.2 | 8 | 0.2 | 0.39 | 1 | 1 |
| Maximum | 30.0 | 1141 | 44.0 | 2.34 | 201 | 127 |
| Minimum | 29.0 | 1107 | 43.0 | 1.56 | 199 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.56 | 0.658 | 13.4 | 6.48 | 0.00 |
| St. Dev. | 0.06 | 0.006 | 0.2 | 0.06 | 0.00 |

| | PreCatalyst CO (ppm) | THC (ppm C3H8) | Exhaust Gas NOx (ppm) | Concentrations CO2 (ppm) | O2 (ppm) |
|---|---|---|---|---|---|
| Average | 5471 | 844 | 155 | 156273 | 18117 |
| St. Dev. | 383 | 13 | 6 | 67 | 103 |
| Maximum | 6206 | 874 | 171 | 156439 | 18379 |
| Minimum | 4709 | 814 | 142 | 156147 | 17971 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst CO (ppm) | THC (ppm C3H8) | Exhaust Gas NOx (ppm) | Concentrations CO2 (ppm) | O2 (ppm) |
|---|---|---|---|---|---|
| Average | 15 | 23 | 118 | 156859 | 13886 |
| St. Dev. | 0 | 1 | 7 | 390 | 137 |
| Maximum | 15 | 25 | 137 | 157413 | 14116 |
| Minimum | 15 | 21 | 108 | 156050 | 13668 |
| Uncertainty | 2 | 3 | 3 | 2000 | 200 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.73 | 97.32 | 23.34 | 358 | 355 |
| St. Dev. | 0.02 | 0.09 | 4.12 | 1 | 3 |
| Maximum | 99.76 | 97.54 | 29.75 | 360 | 360 |
| Minimum | 99.69 | 97.12 | 13.15 | 356 | 349 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO119C.TRC
Time/Date Tue Aug 22 15:01:39 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 29.9 | 1121 | 43.1 | 1.90 | 201 | 126 |
| St. Dev. | 0.2 | 8 | 0.2 | 0.39 | 1 | 1 |
| Maximum | 30.0 | 1141 | 44.0 | 2.34 | 201 | 127 |
| Minimum | 29.0 | 1107 | 43.0 | 1.56 | 199 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.56 | 0.658 | 13.4 | 6.48 | 0.00 |
| St. Dev. | 0.06 | 0.006 | 0.2 | 0.06 | 0.00 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 3.91 | 0.95 | 0.18 | 175.72 | 14.82 |
| St. Dev. | 0.27 | 0.01 | 0.01 | 0.08 | 0.08 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0105 | 0.0255 | 0.0000 | 176.38 | 11.36 |
| St. Dev. | 0.0001 | 0.0009 | 0.0000 | 0.44 | 0.11 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.73 | 97.32 | 100.00 | 358 | 355 |
| St. Dev. | 0.02 | 0.09 | 0.00 | 1 | 3 |
| Maximum | 99.76 | 97.54 | 100.00 | 360 | 360 |
| Minimum | 99.69 | 97.12 | 100.00 | 356 | 349 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO119C.TRC
Time/Date Tue Aug 22 15:01:39 1995

Fifth Gear

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 29.9 | 1121 | 43.1 | 1.90 | 201 | 126 |
| St. Dev. | 0.2 | 8 | 0.2 | 0.39 | 1 | 1 |
| Maximum | 30.0 | 1141 | 44.0 | 2.34 | 201 | 127 |
| Minimum | 29.0 | 1107 | 43.0 | 1.56 | 199 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 6.56 | 0.658 | 13.4 | 6.48 | 0.00 |
| St. Dev. | 0.06 | 0.006 | 0.2 | 0.06 | 0.00 |

| | PreCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 32.55 | 7.89 | 1.51 | 1461.22 | 123.20 |
| St. Dev. | 2.28 | 0.12 | 0.06 | 0.62 | 0.70 |

| | PostCatalyst Exhaust Gas Emission Rates | | | | |
|---|---|---|---|---|---|
| | CO (mg/s) | THC (mg/s C3H8) | NOx (mg/s) | CO2 (mg/s) | O2 (mg/s) |
| Average | 0.0875 | 0.2117 | 1.1578 | 1466.70 | 94.43 |
| St. Dev. | 0.0005 | 0.0078 | 0.0717 | 3.64 | 0.93 |

Catalytic Conversion Efficiencies

| | CO (%) | THC (%) | NOx (%) |
|---|---|---|---|
| Average | 99.73 | 97.32 | 23.34 |
| St. Dev. | 0.02 | 0.09 | 4.12 |
| Maximum | 99.76 | 97.54 | 29.75 |
| Minimum | 99.69 | 97.12 | 13.15 |

Catalyst Temperatures

| | Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|
| Average | 358 | 355 |
| St. Dev. | 1 | 3 |
| Maximum | 360 | 360 |
| Minimum | 356 | 349 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO118C.TRC
Time/Date Tue Aug 22 14:50:55 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 24.8 | 926 | 46.0 | 1.17 | 201 | 126 |
| St. Dev. | 0.4 | 5 | 0.1 | 0.00 | 1 | 1 |
| Maximum | 25.0 | 938 | 47.0 | 1.17 | 203 | 127 |
| Minimum | 24.0 | 915 | 46.0 | 1.17 | 199 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 5.41 | 0.541 | 13.4 | 5.34 | 0.00 |
| St. Dev. | 0.05 | 0.006 | 0.2 | 0.05 | 0.00 |

| | PreCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 5682 | 973 | 99 | 156252 | 18019 |
| St. Dev. | 409 | 7 | 2 | 57 | 36 |
| Maximum | 6535 | 983 | 103 | 156342 | 18087 |
| Minimum | 4965 | 958 | 95 | 156147 | 17932 |
| Uncertainty | 1500 | 25 | 20 | 2000 | 200 |

| | PostCatalyst Exhaust Gas Concentrations | | | | |
|---|---|---|---|---|---|
| | CO (ppm) | THC (ppm C3H8) | NOx (ppm) | CO2 (ppm) | O2 (ppm) |
| Average | 14 | 10 | 57 | 157465 | 13843 |
| St. Dev. | 0 | 2 | 11 | 329 | 150 |
| Maximum | 14 | 13 | 72 | 158191 | 14232 |
| Minimum | 14 | 7 | 32 | 156731 | 13609 |
| Uncertainty | 2 | 3 | 3 | 2000 | 200 |

| | Catalytic Conversion Efficiencies | | | Catalyst Temperatures | |
|---|---|---|---|---|---|
| | CO (%) | THC (%) | NOx (%) | Pre- (Deg. C) | Post- (Deg. C) |
| Average | 99.75 | 98.94 | 42.96 | 346 | 370 |
| St. Dev. | 0.02 | 0.17 | 10.76 | 2 | 2 |
| Maximum | 99.79 | 99.29 | 68.75 | 349 | 376 |
| Minimum | 99.72 | 98.68 | 26.73 | 343 | 367 |

1988 Chevrolet Corsica Test Summary
Trace File: DYNO118C.TRC
Time/Date Tue Aug 22 14:50:55 1995

| | Vehicle Speed (MPH) | Engine Speed (RPM) | Manifold Pressure (KPa) | Throttle Position (%) | Coolant Temp. (Deg. F) | Intake Air Temp. (Deg. F) |
|---|---|---|---|---|---|---|
| Average | 24.8 | 926 | 46.0 | 1.17 | 201 | 126 |
| St. Dev. | 0.4 | 5 | 0.1 | 0.00 | 1 | 1 |
| Maximum | 25.0 | 938 | 47.0 | 1.17 | 203 | 127 |
| Minimum | 24.0 | 915 | 46.0 | 1.17 | 199 | 126 |

| | AirFlow (G/Sec) | Fuel Cons. (Gal/Hr) | Air/Fuel Ratio (Calculated) | Dry Exhaust Mass Flow (G/sec) | Exhaust Gas Recirculation (%) |
|---|---|---|---|---|---|
| Average | 5.41 | 0.541 | 13.4 | 5.34 | 0.00 |
| St. Dev. | 0.05 | 0.006 | 0.2 | 0.05 | 0.00 |

| | CO (G/mi) | PreCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (G/mi) | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 4.05 | 1.09 | 0.12 | 175.08 | 14.68 |
| St. Dev. | 0.29 | 0.01 | 0.00 | 0.06 | 0.03 |

| | CO (G/mi) | PostCatalyst THC (G/mi C3H8) | Exhaust Gas NOx (mG/mi | Emission Rates CO2 (G/mi) | O2 (G/mi) |
|---|---|---|---|---|---|
| Average | 0.0100 | 0.0116 | 0.0000 | 176.44 | 0.00 |
| St. Dev. | 0.0001 | 0.0019 | 0.0000 | 0.37 | 0.00 |

| | Catalytic Conversion Efficiencies CO (%) | THC (%) | NOx (%) | Catalyst Temperatures Pre- (Deg. C) | Post- (Deg. C) |
|---|---|---|---|---|---|
| Average | 99.75 | 98.94 | 100.00 | 346 | 370 |
| St. Dev. | 0.02 | 0.17 | 0.00 | 2 | 2 |
| Maximum | 99.79 | 99.29 | 100.00 | 349 | 376 |
| Minimum | 99.72 | 98.68 | 100.00 | 343 | 367 |

# VITA

Charles Scott Sluder was born in Kingsport, Tennessee on December 23, 1970. He continued to reside in Kingsport throughout his childhood. Scott attended Indian Springs Elementary School and Holston Middle School. In the summer of 1988 Scott traveled to Europe as a student ambassador with the People to People High School Student Ambassador Program. Scott graduated from Sullivan Central High School in June of 1989. In August of 1989 Scott entered the University of Tennessee at Knoxville with a declared major in Mechanical Engineering. In May of 1993 Scott completed the requirements of the cooperative education program at UT. While an undergraduate, Scott became involved with the local student branch of the Society of Automotive Engineers, eventually serving as Chairman. In 1994 he was named Outstanding Student Officer for his service to the student branch while chairman. Scott earned his undergraduate engineering degree in May of 1994. Following his graduation, Scott accepted a research assistantship at the University of Tennessee and began study toward a Master of Science degree in Mechanical Engineering. Scott received his Master of Science degree in Mechanical Engineering in December of 1995.