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Evaluation Of Automotive Emissions Reduction Devices And Processes

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U.S. ARMY TANK-AUTOMOTIVE AND ARMAMENTS COMMAND
ARMAMENTS RESEARCH, DEVELOPMENT AND
ENGINEERING CENTER
PICATINNY ARSENAL, NEW JERSEY

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DISCLAIMER

While the testing was structured to provide reproducible test conditions, there were several variations from "ideally controlled" conditions. Some of these variations resulted from the attempt to inject the reproducible conditions into a "real world" situation, and are discussed within the text of this report. While the results may not be scientifically exact, the trends observed during these tests should also be observed under strict laboratory conditions, and fall within the ranges presented in the data analysis. Deviations from the trends indicated in this report may occur in vehicles which vary substantially from the test vehicles in areas such as age, cleanliness/condition of engine, and the type of fuel and exhaust system employed. These test results make no statement as to the validity of the principles or long term performance claims of the participating vendors. In addition, these test results make no statements on vendor device/process performance claims, other than those which relate directly to emissions reduction.

ACKNOWLEDGMENTS

The authors wish to acknowledge the continued support from following organizations with regard to the timely and successful completion of this test program:

- New Jersey Department of Transportation
  - ⇒ Office of Transportation Technology
  - ⇒ Hanover Motor Pool
  - ⇒ Wayne Inspection Station of the New Jersey Division of Motor Vehicles

- Environmental Systems Products : Operating Contractor of the Wayne Division of Motor Vehicles

- GeoCenters, Inc.

- Landing Auto Center

- TACOM-ARDEC Motor Pool

EVALUATION OF AUTOMOTIVE EMISSIONS REDUCTION DEVICES AND PROCESSES

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Prepared For:

Office Of Transportation Technology
New Jersey Department Of Transportation
Trenton, New Jersey

28 February 1997

EVALUATION OF AUTOMOTIVE EMISSIONS REDUCTION DEVICES AND PROCESSES

EXECUTIVE SUMMARY

The Federal 1990 Clean Air Act Amendments (CAAA) mandate that the State of New Jersey reduce air pollution emissions from mobile sources. In response, the New Jersey Department of Transportation (NJDOT) has been working closely with the New Jersey Department of Environmental Protection (NJDEP) over the past several years to develop strategies and control measures that reduce air pollution emissions from mobile sources. This action is necessary in order to fulfill the mandates of the 1990 Federal CAAA. The State of New Jersey has enacted legislation which included provisions for the testing of emissions reducing devices and other strategies. Funding was provided to NJDOT to carry out this study.

The initial step of this work was for the NJDOT to release a Request for Information (RFI) to prospective vendors of devices or processes. The main considerations for evaluation of the RFI responses were as follows. In addition, technologies were considered that allow motor vehicles to contribute to the clean air effort in other ways.

- adaptability of the technology to mobile source applications
- experience with new or adapted technologies that will improve or make efficient or more accurate the monitoring of air quality
- new or adapted technologies that can reduce vehicular pollution through modifications of vehicular exhaust or fuel intake systems
- cost and effectiveness of new or adapted technologies for vehicle owners

The RFI was released in September 1995, and a total of twenty-three responses were received by NJDOT. NJDOT followed up by requesting technology demonstrations from each of the twenty-three respondents. Of the twenty-three, eight vendors expressed an interest to demonstrate their technologies to NJDOT. In April 1996, invitations were sent to the eight vendors to demonstrate their technology to NJDOT during the June-July 1996 time-frame. Of these, five were considered advanced enough and worthy of further evaluation. The other three technologies were in the early research and development phase and not readily available for near term implementation.

In the April 1996 time frame, NJDOT enlisted the participation of the U. S. Army Tank-Automotive and Armaments Command, Armament Research, Development and Engineering Center (TACOM-ARDEC) at Picatinny Arsenal, NJ to develop and carry out an independent, unbiased engineering evaluation of the technologies offered by the eight vendors. TACOM-ARDEC, specifically the Armament Systems Process Division and the Energetics & Warheads Division, was selected to perform this work because of its expertise in the performance of complex engineering and environmental studies, the impartiality of TACOM-ARDEC to the vendors, and the lack of any ties between TACOM-ARDEC (Federal Government) and NJDOT (State Government).

Following the individual technology demonstrations the following five vendors remained in the program:

- Metal Reaction, Inc. -- Vitalizer (Device)
- EnviroSource of New Jersey, Inc. -- Fuel Cat (Device)
- Enginewity Systems, Inc. -- Engine Cleaning (Process)
- Compliance and Research Services, Inc. -- Tailpipe Catalytic Converter (Device)
- INSET Industries, Inc. (INSET Fuel Stabilizer) (Device)

The program to evaluate the five vendors was approved by the Office of Transportation Technology, NJDOT and was subsequently initiated during November 1996. The purpose of the test program was to determine the ability of each of several emissions reduction devices and processes to address New Jersey's mobile source emission problems by reducing automobile pollutant emissions. The test program provided comparative test results on selected vehicles from an older portion of the State of New Jersey motor vehicle fleet.

Test results were statistically analyzed, and life cycle cost data documented for each vendor's device/process. In addition, a carbon balance was used to determine if any device or process produces a statistically significant change in fuel economy because a reduction in emissions is normally related to more efficient combustion. A statistical analysis of the emissions test data (ESP analytical system) provides the following discussion.

In terms of variability in the data, the IM 240 test was more reproducible and therefore better suited for discerning differences in emissions. This was realized in the analysis of the device data. Only the Compliance & Research Service's Tailpipe Catalytic Converter had a significant reduction in emissions with the ASM 2525.

Of the five devices/processes tested, the four devices, i.e., Compliance and Research's Tailpipe Catalytic Converter, Metal Reaction's "Vitalizer", EnviroSource of New Jersey's "Fuel Cat" and INSET Industries' INSET Fuel Stabilizer showed a statistically significant reduction in CO emissions. In addition, The Compliance and Research Service's Tailpipe Catalytic Converter significantly reduced NO_x, HC and CO emissions. Furthermore, the reduction in CO for this device was much greater than that realized with the other three devices that exhibited a reduction in CO. For the other three devices, the reduction in CO was basically the same order of magnitude. All three of these devices are of the same configuration and are installed in the fuel line. With regard to HC emissions, only Compliance and Research Service's Tailpipe Catalytic Converter and INSET Industries' INSET Fuel Stabilizer showed any improvement. Two of the devices, the Metal Reaction "Vitalizer" and the EnviroSource of New Jersey "Fuel Cat", demonstrated a reduction in CO_2 emissions. This may indicate an improvement in fuel economy. Because a reduction in CO was also noted, more rigorous testing would be required to quantify this reduction. The EnviroSource of New Jersey "Fuel Cat" may have caused a minor increase in NO_x emissions. One process, a combination of Enginewity System's Engine Oil Cleaning Process and Gasoline Fuel and Emissions System Cleaning Process, showed no significant emissions reductions for CO, CO_2, NO_x or HC with either the ASM 2525 or the IM 240 protocols.

Some problems were experienced with the data for the control vehicle. When the analysis conducted on the control vehicle was repeated for each of the devices/process, the factor being first vs. last run, a statistically significant difference in some of the emissions is noted. For the IM 240 test, an increase in NO_x and a decrease in CO occurred. For the ASM 2525 test, an increase in HC, CO and CO_2 occurred. It is interesting to note that in one test, a reduction in CO occurred while in the other an increase was noted. In terms of the effect this has on the data relative comparisons between devices can still be made since each device/process was evaluated by the same test protocol. Furthermore, the trends evident in the control vehicle were not realized in the test vehicle data. Since the control vehicle test was the first and last runs of the day, some of the trends may be due to a warm up of the dynamometer and the gas sampling equipment. It is recommended that this assumption be evaluated. In addition, the time between runs for the control vehicle was longer than the time between "with and without" test runs for any test vehicle. The impact that this may have can not be evaluated without further testing. Unfortunately, the manner in which the test program was configured, a vehicle was run without, then with, the device/process. If these effects are real they are confounded by any reductions resulting from the device. The impact that this may have is on the percent reductions realized. Additional testing in a controlled environment would be required to better quantify the true reductions resulting from any of these devices.

It was thus concluded that:

♦ The Compliance and Research Services, Inc. Tailpipe Catalytic Converter Device showed statistically significant reductions in nitrogen oxides (NO_x), Hydrocarbons (HC), and Carbon Monoxide (CO) in both the IM 240 and ASM 2525 testing:

Compliance and Research Services, Inc.
Tailpipe Catalytic Converter (Device)

	IM 240	ASM 2525
NO_x (%)	-16.4	-29.0
HC (%)	-37.4	-34.9
CO_2 (%)	-3.0	0.0
CO (%)	-63.6	Not Obtainable
Total Carbon (%)		-0.5

NOTES:

"RED" is statistically significant

% CO = CO (with device)/CO (without device). In all cases, either CO (with device) or CO (without device) = 0. Therefore, % CO was either = 0 or Infinite

♦ Both the Metal Reaction, Inc. Vitalizer device and EnviroSource of New Jersey Fuel-Cat Device showed statistically significant reductions in CO and CO_2 ; however, the EnviroSource Fuel-Cat device showed a statistically significant increase in NO_x (IM 240). No changes were observed in the ASM 2525.

Metal Reaction, Inc.
Vitalizer (Device)

	IM 240	ASM 2525
NO_x (%)	4.9	5.3
HC (%)	-8.5	15.9
CO_2 (%)	-2.3	-0.3
CO (%)	-13.7	Not Obtainable
Total Carbon (%)		10.0

EnviroSource of New Jersey, Inc.
Fuel-Cat (Device)

	IM 240	ASM 2525
NO_x (%)	4.1	3.2
HC (%)	0.9	1.7
CO_2 (%)	-1.0	0.0
CO (%)	-16.2	Not Obtainable
Total Carbon (%)		2.0

The INSET Industries, Inc. Fuel Stabilizer Device showed a statistically significant reduction in HC and CO for IM 240. However, there was a significant increase in NO_x for ASM 2525. This is most likely due to a variation in process rather than a change in emissions. There were no observed changes for HC or CO in ASM 2525. This device also showed a statistically significant reduction in Total Carbon which may indicate an improvement in fuel economy.

INSET Industries, Inc.
INSET Fuel Stabilizer (Device)

	IM 240	ASM 2525
NO_x (%)	-9.5	+44.8
HC (%)	-0.87	8.3
CO_2 (%)	0.0	-0.7
CO (%)	-27.4	Not Obtainable
Total Carbon (%)		-6.6

♦ The Enginewity Systems, Inc. Engine Cleaning Process showed no significant change in any test for any gaseous species (CO, CO_2, NO_x, HC)

Enginewity Systems, Inc.
Engine Cleaning (Process)

	IM 240	ASM 2525
NO_x (%)	0.0	-3.2
HC (%)	-3.7	10.7
CO_2 (%)	-1.5	0.0
CO (%)	-0.9	Not Obtainable
Total Carbon (%)		-1.8

♦ Life-cycle costs for each device/process is summarized below. The basis for this analysis, as per NJDOT direction, is a 12 year life at 15,000 miles per year (labor for installation also included).

Life Cycle Cost Per Year Based On (\$/Year)

	1 Unit	100 Units	1,000 Units
EnviroSource of NJ, Inc. "Fuel-Cat"	23	18	15
Metal Reaction, Inc. "Vitalizer"	23	21	19
INSET Industries, Inc. "INSET Fuel Stabilizer"	44	39	35
Compliance and Research, Inc. "Tailpipe Catalytic Converter"	52	52	52
Enginewity Systems, Inc. "Engine Cleaning"	87	80	69

The following recommendations are also provided:

♦ The confidence intervals obtained in these tests were rather large with respect to the percentage reduction in emissions. Additional tests, run in a more controlled environment, are recommended to quantify the actual reduction in emissions.

♦ These tests assessed the impact of the devices/processes directly after installation. A test to assess the "long term" benefit of these devices should be performed.

♦ All of these tests were conducted during winter months. A multivariate regression analysis indicated that environmental conditions may impact emissions. Devices should also be evaluated at environmental extremes.

♦ Tests were conducted on the older portion of the fleet. In addition, cars tested were predominately Chrysler K-cars or police cruisers. Impact on other vehicles and new vehicles could provide a fleet test impact.

♦ For best emission reductions, two of these devices can be used together (the Compliance and Research Tailpipe Catalytic Converter plus one of the in-line fuel devices (Metal Reaction Vitalizer, EnviroSource Fuel-Cat, or INSET Industries Fuel Stabilizer)). Additional tests to quantify the overall reduction should be performed.

The preceding results, conclusions and recommendations were achieved through the accomplishment of a comprehensive test program at the Wayne Inspection Station of the New Jersey Division of Motor Vehicles (Wayne DMV). The Wayne DMV was selected for performance of the evaluation tests because it was conveniently located near TACOM-ARDEC and had a dynamometer suitable for performing the testing. While the Wayne DMV is not certified by the EPA for conducting the ASM 2525 and IM 240 protocols, the facility is operated by the NJDMV. This is the State agency responsible for conducting emissions testing on light duty gasoline vehicles registered in the State of New Jersey.

A key decision to be made was the number of vehicles to be used for the evaluation of each device/process, since sample size is a trade-off between the ability to draw reliable inferences from the data and the minimization of test time and cost. A sample size of nine vehicles per device/process was selected so that there was a sufficient number of samples to perform the statistical analysis and discern differences in performance. This takes into account the possibility that the data from one or two vehicles might be invalid for one reason or another. The actual sample size for one device/process might drop to seven or eight vehicles. The resulting sample size of seven or eight vehicles would still represent statistically valid data. A requirement was thus established for forty-five test vehicles and one control vehicle for a total of forty-six vehicles.

Since the intention of this evaluation was to use vehicles typical of those found on New Jersey roads, the required vehicles were selected randomly from available 4-, 6-, and 8-cylinder high-mileage vehicles of the 1984 to 1993 model years. These vehicles were located at NJDOT garages and other State of New Jersey agency fleets and subjected to cursory examinations (visual, BAR-84 emissions test) to verify that the vehicles were in acceptable operating condition. As a result, minor repairs were made to a number of vehicles. The selected vehicles were then delivered by NJDOT drivers to the pre-test staging area at the Picatinny Arsenal motor pool. This location is a distance of about 25 miles from the Wayne Division of Motor Vehicles (Wayne DMV) inspection station. In order to minimize the possibility that vehicle malfunction would corrupt the data, and to insure that each vehicle was safe to be operated on the dynamometer, these vehicles were again inspected by an ASE-certified mechanic contracted by TACOM-ARDEC from a local garage. The purpose of this final screening was to validate the integrity of the exhaust system, engine mounts, ignition timing, computer codes and sensors. Additional repairs had to be made to several vehicles as a result of this inspection.

After the ASE inspection and any necessary repairs, nine acceptable vehicles were randomly, but equitably (based on number of cylinders) assigned to each vendor. A 4-cylinder Chrysler K-car was chosen as the control vehicle, since this was the single model in greatest abundance in the test fleet. Once this selection was accomplished each vendor was given the opportunity to come to Picatinny Arsenal to inspect these vehicles in the presence of TACOM-ARDEC representatives that were assigned to their device/process. The assigned vehicles were driven to the Wayne DMV by NJDOT drivers prior to the first day of a vendor's scheduled testing. Tested vehicles were returned to the Picatinny Arsenal motor pool. The control vehicle remained at Wayne DMV for the duration of the testing.

At the start of testing, four DMV inspectors, who are proficient in the operation of the dynamometer, were assigned to this program for its duration for the purpose of performing the ASM 2525 and IM 240 protocols on the test vehicles. The inspector for each test was identified so as to evaluate operator variability as a possible factor in the test results. All testing on the dynamometer was conducted in accordance with the dynamometer manufacturer's instructions.

Once at Wayne DMV, each test vehicle was driven by a NJDOT driver over a pre-established 26-mile conditioning course. Upon return to Wayne DMV, each vehicle was driven onto the dynamometer by one of the three DMV vehicle test operators and subjected to both the IM 240 and ASM 2525 Emissions Analysis Test Schedule. It was mandatory that the vehicle not be turned off between returning from the conditioning course and undergoing the dynamometer test and, at most, only a few minutes elapsed between these operations.

Each vendor then installed its device or performed its process on the vehicle in an unused lane at the station. At all times, the installation/process was performed in full view of DMV and TACOM-ARDEC personnel. One vendor, Compliance and Research, was allowed to install its device at a nearby Midas shop, at its own expense, because the installation procedure required the use of a lift.

After the installation procedure, each vehicle was again driven over the 26-mile conditioning course by a NJDOT driver. The conditioned vehicle was then again subjected to both the IM 240 and ASM 2525 Emissions Analysis Test Schedule by the DMV inspector. After completion of the second Emissions Analysis Test Schedule, the vehicle was returned to the Picatinny Arsenal motor pool to await return to the State.

Prior to the start of each day's testing, the control vehicle was tested in accordance with the approved detailed test protocol. The same control test was performed at the end of the morning test period and again at the conclusion of the day's testing. Since it was required to refuel the control car, a quantity of standard grade commercial gasoline was secured by NJDOT. This fuel was used to re-fuel the control car. The control car was used to validate that the equipment and procedures employed were operating properly during the testing period at Wayne DMV.

Vehicle testing was scheduled as follows. *However, due to procedural problems, Enginewity had to be re-scheduled, and was actually tested 8-9 Jan 97.

Vendor	Device/ Process	Testing Dates
Metal Reaction, Inc.	Vitalizer (D)	4-6 Dec 96
EnviroSource of New Jersey, Inc.	Fuel Cat (D)	9-10 Dec 96
Enginewity Systems, Inc.	Engine Cleaning (P)	11-14 Dec 96*
Compliance and Research Services, Inc.	Tailpipe Catalytic Converter (D)	16-18 Dec 96
INSET Industries, Inc.	INSET Fuel Stabilizer (D)	19-20 Dec 96

On each day of testing, the first and last runs on the dynamometer were conducted with the control car. A run on the dynamometer refers to a series in which 4 each ASM 2525 and IM 240 cycles are run alternately. In addition, prior to data collection, each car was run through an IM 240 cycle to ensure the car is sufficiently warm. During the last ASM 2525 cycle, a sample of exhaust gas was collected for analysis at TACOM-ARDEC. During dry run testing, it was discovered that when drawing a gas sample during the fourth ASM 2525 cycle, the associated emissions measurements were significantly higher than the previous three runs. A representative from Environmental Systems Products hypothesized that placing the gas sample bag on the Wayne DMV equipment exhaust line caused a back-pressure in the emissions detectors. This resulted in the detectors overloading and providing false readings. Therefore, for the testing, it was determined that when the gas sample was drawn (fourth ASM 2525 cycle), the data documented by the Wayne DMV equipment for this cycle could not be used for final analysis. The test procedure was conducted on all vehicles in addition to the control car.

Data from the control car was used to assess the consistency of the test set up within a day. In addition, because the same car was tested on numerous occasions, the variability of emissions from day to day could be assessed. Since environmental data was collected, a multivariate regression was conducted to determine if any environmental factors had an effect on emissions.

EVALUATION OF AUTOMOTIVE EMISSIONS REDUCTION DEVICES AND PROCESSES

PURPOSE

The purpose of this test program is to determine the ability of each of several emissions reduction devices and processes to address New Jersey's mobile source emission problems by reducing automobile pollutant emissions. The test program provided comparative test results on selected vehicles from an older portion of the State motor vehicle fleet. The results of the testing were analyzed, statistically evaluated, and appropriate conclusions and recommendations are documented in this final report. In addition, a carbon balance was used to determine if any device or process produces a statistically significant change in fuel economy, because a reduction in emissions is normally related to more efficient combustion.

BACKGROUND

The Federal 1990 Clean Air Act Amendments (CAAA) mandate that New Jersey reduce air pollution emissions from mobile sources. In response, the New Jersey Department of Transportation (NJDOT) has been working closely with the New Jersey Department of Environmental Protection (NJDEP) over the past several years to develop strategies and control measures that reduce air pollution emissions from mobile sources in order to fulfill the mandates of the 1990 Federal CAAA. The State of New Jersey has enacted legislation which included provisions for the testing of emissions reducing devices and other strategies. Funding was provided to NJDOT to carry out this study.

The initial step of this work was for the NJDOT to release a Request for Information (RFI) to prospective vendors of devices or processes. The main considerations for evaluation of the RFI responses were: the adaptability of the technology to mobile source applications, experience with new or adapted technologies that will improve the efficiency and/or accuracy of air quality monitoring, new or adapted technologies that can reduce vehicular pollution through vehicle modifications, or the cost and effectiveness of new or adapted technologies for vehicle owners. Technologies that allow motor vehicles to contribute to the clean air effort in other ways were also to be considered.

The RFI was released in September 1995, and a total of twenty-three responses were received by NJDOT. NJDOT followed up by requesting technology demonstrations from each of the twenty-three respondents. Of the twenty-three, eight

Finally, the U.S. Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ would like to acknowledge and thank the following organizations for their support and cooperation. Without their efforts, it would have been impossible to achieve successful completion of this test program within both schedule and cost constraints.

- New Jersey Department of Transportation
  - ⇒ Office of Transportation Technology
  - ⇒ Hanover Motor Pool
  - ⇒ Wayne Inspection Station of the New Jersey Division of Motor Vehicles

- Environmental Systems Products : Operating Contractor of the Wayne Division of Motor Vehicles

- GeoCenters, Inc.

- Landing Auto Center

- TACOM-ARDEC Motor Pool

vendors expressed an interest to demonstrate their technologies to NJDOT. In April 1996, invitations were sent to the eight vendors to demonstrate their technology to NJDOT during the June-July 1996 time-frame. Of these, five were considered advanced enough and worthy of further evaluation. The other three technologies were in the early research and development phase and not readily available for near term implementation. In the April 1996 time frame, NJDOT enlisted the participation of the U. S. Army Tank-Automotive and Armaments Command, Armament Research, Development and Engineering Center (TACOM-ARDEC) at Picatinny Arsenal, NJ to develop and carry out an independent, unbiased engineering evaluation of the technologies offered by the eight vendors. TACOM-ARDEC, specifically the Armament Systems Process Division and the Energetics & Warheads Division, was selected to perform this work because of its expertise in the performance of complex engineering and environmental studies, the impartiality of TACOM-ARDEC to the vendors, and the lack of any ties between TACOM-ARDEC (Federal Government) and NJDOT (State Government).

Following the individual technology demonstrations the following five vendors remained in the program: Metal Reaction, Inc. (Vitalizer (Device)), EnviroSource of New Jersey, Inc. ("Fuel Cat,, (Device)), INSET Industries, Inc. (INSET Fuel Stabilizer (Device)), Compliance & Research Services, Inc. (Tailpipe Catalytic Converter (Device)) and Enginewity Systems, Inc. (Engine Cleaning (Process)). TACOM-ARDEC's test proposal was accepted in August 1996 and its "Emissions Testing Detailed Test Plan,,, dated 9 October 1996, was approved by the Office of Transportation Technology, NJDOT. The program to evaluate the five vendors was subsequently initiated in November 1996.

GENERAL METHODOLOGY

Representative 4-, 6- and 8- cylinder vehicles (as available from various State motor pools, screened and inspected for suitability by NJDOT) were tested to determine their emission levels using the ASM 2525 and IM 240 test protocols before and after an emissions reduction device or procedure was installed/performed on the vehicle. An analysis of the gases from the vehicle was performed to determine if there was a statistically significant change in the emissions after the various devices or procedures were installed/performed on the vehicles.

TEST PROCEDURES

Selection and delivery of test vehicles:

A key decision to be made was the number of vehicles to be used for the evaluation of each device/process, since sample size is a trade-off between the ability to draw reliable inferences from the data and the minimization of test time and cost. A sample size of nine vehicles per device/process was selected so that there was a sufficient number of samples to perform the statistical analysis and discern differences in performance. A requirement was thus established for forty-five test vehicles and one control vehicle for a total of forty-six vehicles.

Since the intention of this evaluation was to use vehicles typical of those found on New Jersey roads, the required vehicles were selected randomly from available 4-, 6-, and 8-cylinder high-mileage vehicles of the 1984 to 1993 model years. Vehicles were located at NJDOT garages and other State of New Jersey agency fleets and subjected to cursory examinations (visual, BAR-84 emissions test). These examinations verified that the vehicles were in acceptable operating condition. As a result, minor repairs were made to a number of vehicles. The selected vehicles were then delivered by NJDOT drivers to the pre-test staging area at the Picatinny Arsenal motor pool, a distance of about 25 miles from the Wayne Inspection Station of the New Jersey Division of Motor Vehicles (hereafter referred to as "Wayne DMV"). In order to minimize the possibility that vehicle malfunction would corrupt the data, and to insure that each vehicle was safe to be operated on the dynamometer, these vehicles were again inspected by an ASE-certified mechanic contracted by TACOM-ARDEC from a local garage. The purpose of this final screening was to check out the integrity of the exhaust system, engine mounts, ignition timing, computer codes and sensors. Additional repairs had to be made to several vehicles as a result of this inspection.

The Wayne DMV was selected for performance of the evaluation tests because it was conveniently located near TACOM-ARDEC and had a dynamometer suitable for performing the testing (See Appendix C for dynamometer specifications and test protocols). While the Wayne DMV is not certified by the EPA for conducting the ASM 2525 and IM 240 protocols, the facility is operated by the NJDMV, which is the State agency responsible for conducting emissions testing on light duty gasoline vehicles registered in the State of New Jersey.

After the ASE inspection and any necessary repairs, nine acceptable vehicles were randomly, but equitably (based on number of cylinders) assigned to each vendor. A 4-cylinder Chrysler K-car was chosen as the control vehicle, since this was the single model in greatest abundance in the test fleet. Once this selection was accomplished each vendor was given the opportunity to come to Picatinny Arsenal to inspect these vehicles in the presence of TACOM-ARDEC representatives that were assigned to their device/process.

The assigned vehicles were driven to the Wayne DMV by NJDOT drivers prior to the first day of a vendor's scheduled testing. Tested vehicles were returned to the Picatinny Arsenal motor pool. The control vehicle remained at Wayne DMV for the duration of the testing.

Test controls:

At the start of testing, four DMV inspectors, who are proficient in the operation of the dynamometer, were assigned to this program for its duration for the purpose of performing the ASM 2525 and IM 240 protocols on the test vehicles. The inspector for each test was identified so as to evaluate operator variability as a possible factor in the test results.

All testing on the dynamometer was conducted in accordance with the dynamometer manufacturer's instructions. The dynamometer was calibrated each day prior to testing.

Prior to the start of each day's testing, the control vehicle was tested in accordance with the test protocol specified below and described in detail in Appendix C. The same control test was performed at the conclusion of the day's testing. Since it was required to refuel the control car, a quantity of standard grade commercial gasoline was secured by NJDOT. This fuel was used to re-fuel the control car. The control car was used to validate that the equipment and procedures employed were operating properly during the testing period at Wayne DMV.

Since the Wayne DMV is not completely enclosed, control of climatic conditions during performance of testing was not possible. Several parameters (barometric pressure, relative humidity and ambient temperature) were recorded at the beginning and end of each test session. This information will be addressed during data evaluation.

Testing of devices/processes:

The selected order of vendor testing was as follows: 1- Vitalizer, 2 - Fuel Cat, 3 - Enginewity, 4 - Compliance & Research, and 5 - INSET (It is noted that as a result of procedural problems discussed below, Enginewity had to be re-scheduled, and was actually tested last). These numbers were the assigned prefixes for all test results. The vehicles for each vendor were tested over a two- to three-day test period, as per the following procedures.

Once at Wayne DMV, each test vehicle was driven by a NJDOT driver over the conditioning course described in Appendix C-4. Upon return to Wayne DMV the vehicle was driven onto the dynamometer. The vehicle was subjected to the Emissions Analysis Test Schedule described in Appendix C-5 by one of the four DMV test operators. It was mandatory that the vehicle not be turned off between returning from the conditioning course and undergoing the dynamometer test and, at most, only a few minutes elapsed between these operations.

Each vendor then installed its device or performed its process on the vehicle in an unused lane at the station. At all times, the installation/process was performed in full view of DMV and TACOM-ARDEC personnel. One vendor, Compliance & Research, was allowed to install its device at a nearby Midas shop, at its own expense, because the installation procedure required the use of a lift.

After the installation procedure, the vehicle was again driven over the conditioning course by an NJDOT driver. The conditioned vehicle was then again subjected to the Emissions Analysis Test Schedule by the DMV inspector. After completion of the second Emissions Analysis Test Schedule, the vehicle was returned to the Picatinny Arsenal motor pool to await return to the State.

ANALYSIS OF DATA

Control Car:

On each day of testing, the first and last runs on the dynamometer were conducted with the control car. A run on the dynamometer refers to a series in which 4 each ASM 2525 and IM 240 cycles are run alternately. In addition, prior to data collection, each car was run through an IM 240 cycle to ensure the car is sufficiently warm. During the last ASM 2525 cycle, a sample of exhaust gas was collected for analysis at TACOM-ARDEC. During dry run testing, it was discovered that when drawing a gas sample during the fourth ASM 2525 cycle, the associated emissions measurements were significantly higher than the previous three runs. A representative from Environmental Systems Products hypothesized that placing the gas sample bag on the Wayne DMV equipment exhaust line caused a back-pressure in the emissions detectors. This resulted in the detectors overloading and providing false readings. Therefore, for the testing, it was determined that when the gas sample was drawn (fourth ASM 2525 cycle), the data documented by the Wayne DMV equipment for this cycle could not be used for final analysis. The test procedure was conducted on all vehicles in addition to the control car.

Data from the control car were used to assess the consistency of the test set up during a day's testing. In addition, because the same car was tested on numerous occasions, the variability of emissions from day to day could be assessed. Since environmental data were collected, a multivariate regression was conducted to determine if environmental factors had an effect on emissions.

To assess whether or not the data for the control car were homogenous within a day, a similar analysis to that which was conducted on the device data was performed. A student t test was conducted on the mean of the difference between the first and last run of the day. The results of this t test are detailed in Table I. In addition, a two way analysis of variance (ANOVA) was conducted. The factors in this model were Run (first or last) and Day. The results of this analysis indicate that a significant difference was measured in some of the emission species when the first run is compared to last run. The F and P statistics from the two way ANOVA are detailed in Table II. The actual ANOVA tables are included in Appendix D-3. In addition to this analysis, a student t test and an f test were conducted for each day to determine whether or not a statistically significant difference in the mean and variance occurred on a particular day. The results of these t tests are included in Appendix D-3. On several days, a significant difference was noted. For this test, a confidence level of 95% was used. It should be noted that when multiple t tests are conducted in this manner, there is an increase in α and the significance level is no longer 95%. The implications of these findings on the conclusions made in the device/process tests will be discussed later.

Table I

t Statistic from Comparison of First vs. Last Run

Species	tcrit @95 % df=11	Calculated t IM 240	ASM 2525
NOx	2.021	-2.44	-0.1138
HC	2.021	1.269	-2.483
CO	2.021	3.266	-1.771
CO2	2.021	0.391	-1.766

Table II

F and P statistics from the Two Way ANOVA

	NOx		HC		CO		CO2	
	F	P	F	P	F	P	F	P
IM 240, Run	4.68	0.056	0.74	0.42	9.22	0.013	0.30	0.599
IM 240, Day	1.16	0.410	2.41	0.091	2.90	0.054	4.96	0.009
ASM 2525, Run	0.27	0.623	8.03	0.018	2.02	0.186	2.92	0.118
ASM 2525, Day	3.22	0.040	3.68	0.026	1.42	0.295	2.61	0.073

For each species measured in each test, a multi variate regression was conducted. Factors used in this regression were temperature and relative humidity, measured at the time the test was conducted. This analysis indicated that temperature may have an effect on HC and CO_2 emissions as measured in the IM 240 Test. No correlation was found to exist with relative humidity.

For each emission measured in each test, a box and whisker plot was generated to demonstrate the variability in each of the species measured. These plots are included in Appendix D-3. It should be noted that these plots were generated after the data considered to be suspect was removed. In the ASM 2525 test, an occasional test run would have significantly higher readings (an order of magnitude) for all species recorded. These data were not included in the box and whisker plots.

To demonstrate the variability of the ASM 2525 and IM 240 tests, all of the data for each species were pooled so that a mean and standard deviation could be determined. A summary of the mean, standard deviation, minimum and maximum performance and range are detailed in Table III. For each species and each test, a coefficient of variation was determined. These values are presented in Table IV. These values indicate that the IM 240 test is more reproducible than the ASM 2525 test.

Table III
Average and Range for Emissions Tests Conducted on the Control Car

	ASM 2525				IM 240			
Species	Avg	Std Dev	Min	Max	Avg	Std Dev	Min	Max
NOx	96.803	52.7	26	292	0.725	0.1046	0.48	1.03
HC	3.756	2.30	0	8	0.133	0.0342	0.07	0.22
CO	0.0441	0.0392	0	0.18	6.973	1.654	3.04	11.57
CO2	14.897	0.212	14.1	15.3	317.73	16.770	286.3	371.1

Table IV
Coefficient of Variation for Each Species in Each Test*

Species	ASM 2525	IM 240
NOx	54.4	14.4
HC	61.2	25.7
CO	88.9	23.7
CO2	1.42	5.28

* Coefficient of Variation = (Standard Deviation/Mean) x 100

Device Testing:

Prior to performing a statistical analysis, all of the data were reviewed. Based on this review, some of the data were eliminated from the analysis. In some instances, one run of either the IM 240 or the ASM 2525 would be excluded. In some cases, data from an entire car would be eliminated. The data eliminated and the rationale for elimination are detailed in Appendix B-4.

To assess whether or not a device/process had an impact on emissions, a two sided student t test was conducted on both the absolute difference in the mean emissions for a series of tests with and without the device and on the fractional change in emissions with and without the device. These analyses were conducted for both the ASM 2525 and the IM 240 test cycles. Since this test was presumed to be an initial screening of the devices, a confidence interval of 80% was selected. In addition, a two-way analysis of variance was conducted on the mean of either the ASM 2525 or IM 240 data from each test series. The factors used in this model were the device and the car. The model for this analysis is as follows:

$$Y_{ij} = \mu + \beta_i + \tau_j + \varepsilon_{ij}$$

Where:

β_i Device Effect

τ_j Car Effect

The resulting ANOVA Table for the model is as follows. In this model the car effect was assumed to be random and the device/process a fixed effect.

Source	df	EMS
Device	1	$\sigma_\varepsilon^2 + 9\phi_D^2$
Car	8	$\sigma_\varepsilon^2 + 2\sigma_c^2$
Error	8	σ_ε^2
Total	17	

A summary of the results from the t test are detailed in Tables V through VIII below. The hypothesis tested for the absolute change is the mean difference in emissions significantly different than zero. A t value greater than the critical value of t (+/-) would indicate a significant difference. For the percent difference, the mean emissions measured with and without the device were divided by the mean without the device. The hypothesis tested in this case is whether the mean fractional change significantly different than one. A t value with a negative sign (-) indicates an increase in emissions with the device. A positive t value indicates a decrease in emissions with the device.

Table V

t Statistic for IM 240 Test Results, Absolute Difference

Device	# of Cars	$t_{crit,}$ $\alpha = 0.02$	NO_x	HC	CO	CO_2
1	8	1.415	-0.520	0.879	1.734	2.255
2	9	1.397	-1.512	0.216	1.020	1.952
3	7	1.440	0.528	-0.250	0.402	0.930
4	8	1.415	2.286	2.642	2.144	1.002
5	9	1.397	0.702	1.391	2.096	-0.6628

Table VI

t Statistic for IM 240 Test Results Percent Difference

Device	# of Cars	$t_{crit,}$ $\alpha = 0.02$	NO_x	HC	CO	CO_2
1	8	1.415	-1.240	0.850	1.478	2.006
2	9	1.397	-2.003	0175	1.489	1.998
3	7	1.440	0.009	0.502	0.119	0.856
4	8	1.415	1.789	4.638	6.095	1.326
5 *	9	1.397	0.905	1.507	0.988	-0.668

*It should be noted, that one car (VIN 18650) tested with device 5 had significantly different results from the other 8 cars tested. This difference was most evident in CO emissions. Since there was no rationale for eliminating this car from the analysis, it was included in the statistics detailed in the tables above. When this car is not included, the t values for CO change as follows: For the absolute difference $t_{CO} = 2.195$, for the percent difference $t_{CO} = 2.780$. These t statistics indicate a significant difference.

Table VII

t Statistic for ASM 2525 Test Results, Absolute Difference

Device	# of Cars	$t_{crit,}$ $\alpha = 0.02$	NO_x	HC	CO	CO_2
1	8	1.415	0.757	-0.257	-0.463	0.091
2	9	1.397	0.796	-0.158	0.992	-1.280
3	7	1.440	0.831	-0.929	0.432	-1.315
4	9	1.397	2.31	1.456	1.878	-1.028
5	9	1.397	-1.118	0.087	1.309	0.904

Table VIII

t Statistic for ASM 2525 Test Results, Percent Difference

Device	# of Cars	$t_{crit,}$ $\alpha = 0.02$	NO_x	HC	CO	CO_2
1	8	1.415	-0.374	-0.980	**	0.716
2	9	1.397	-0.498	-0.434	**	-0.617
3	7	1.440	0.327	-0.854	**	-0.23
4	9	1.397	2.766	2.206	**	0.06
5	9	1.397	-1.819	-1.072	**	0.812

For each device/process, the mean percent change with an 80% confidence interval was determined. The confidence interval is based on the number of cars used to determine the mean. The results are detailed in Tables IX and X. A plus (+) sign indicates an increase in emissions, a minus (-) indicates a decrease in emissions. The highlighted bars indicate a statistically significant change at the 80% confidence level.

** Unobtainable Data: % CO = CO (with device)/CO (without device). In all cases, either CO (with device) or CO (without device) = 0. Therefore, % CO was either = 0 or Infinite

Table IX

Mean Percent Change in Emissions from IM 240 Test with 80 % Confidence Interval

Device	NO_x		HC		CO		CO_2	
	% Change	CI	% Change	CI	% Change	CI	% Change	CI
1	+4.94	5.62	-8.5	8.69	-13.66	13.10	-2.3	1.6
2	+4.08	2.88	0.90	6.7	-16.20	15.40	-1.01	0.80
3	0.0	8.46	-3.7	11.45	-1.5	18.95	-0.90	1.5
4	-16.40	12.26	-37.36	10.75	-63.56	13.91	-3.0	3.21
5	-9.5	14.68	-0.865	0.81	-27.36	13.90	0.0	0.90

Table X

Mean Percent Change in Emissions from ASM 2525 Test with 80 % Confidence Interval

Device	NO_x		HC		CO		CO_2	
	% Change	CI	% Change	CI	% Change	CI	% Change	CI
1	+5.3	20.1	+15.9	22.9	**		-0.3	0.6
2	+3.2	9.0	+1.7	5.4	**		0.0	0.3
3	-3.2	14.1	+10.7	18.0	**		0.0	0.40
4	-29.0	14.6	-34.9	22.1	**		0.0	1.5
5	+44.8	34.4	+8.3	82.0	**		-0.7	1.1

A summary of the results of the two-way analysis of variance are detailed in the Tables XI and XII. The detailed ANOVA tables are attached in Appendix D-3. It should be noted that the F statistic is the square of the t statistic. The P values represent the probability that the means are from the same population. A P value less than 0.20 indicates that the means are significantly different at a confidence level of 80%. In addition, for those that exhibited a significant difference, a least significant difference test was conducted. The results, in graphical format, are attached in Appendix D-3.

Table XI
F and P Statistics for IM 240 Data

Device	NO_x		HC		CO		CO_2	
	F	P	F	P	F	P	F	P
1	0.27	.623	0.77	0.417	3.01	0.126	5.09	0.0588
2	2.29	.1690	0.05	0.836	1.06	0.334	3.81	0.0866
3	0.28	0.621	0.06	0.814	0.16	0.705	0.48	0.520
4	5.07	0.0545	2.48	0.154	5.00	0.0558	2.19	.1767
5	0.49	0.510	1.93	.2019	4.39	0.0693	0.44	0.533

Table XII
F and P Statistics for ASM 2525 Data

Device	NO_x		HC		CO		CO_2	
	F	P	F	P	F	P	F	P
1	0.57	0.481	0.07	0.8075	0.21	0.663	0.62	0.465
2	0.63	0.457	0.02	0.880	0.98	0.361	1.64	0.236
3	0.69	0.446	0.86	0.398	0.19	0.685	1.73	0.236
4	5.34	0.05	2.10	0.186	3.53	0.097	0.04	0.851
5	1.25	0.296	0.00	0.947	1.71	0.228	0.82	0.401

During each test conducted on the ASM 2525, a sample of the exhaust gas was collected and analyzed at the TACOM-ARDEC lab for specific hydrocarbon species as well as CO and CO_2. To determine whether or not a device/process caused a change in emissions of specific hydrocarbons, once again, a t test was performed. The resulting t values determined for each species are detailed in Table XIII.

Table XIII

t Statistic for Speciated Hydrocarbons (Absolute Difference)

	Device 1	Device 2	Device 3	Device 4	Device 5
Species	n=8	n=9	n=6	n=9	n=9
C3's	1.72	1.47	-0.83	1.89	-1.26
C4's	0.44	-0.48	-0.94	2.00	1.09
C5's	-0.12	0.94	-0.88	0.72	1.49
C6's	0.20	1.79	-0.89	0.76	0.93
Benzene	1.43	0.21	-0.73	-0.33	1.00
C7's	0.00	-1.71	-1.00	-1.51	0.00
Toluene	1.53	0.99	-1.25	1.74	1.00
C8's	-1.76	0.39	0.07	-0.82	0.22
Xylene's	1.52	0.53	-1.00	1.57	1.00
C9's	1.33	-1.17	-1.14	0.96	-0.13
Trimethylbenzene	0.00	1.00	0.00	-1.00	0.00
C10's	1.00	1.42	0.00	-1.48	0.00
C11,C12's	0.73	1.17	0.13	-0.93	0.99
Total HC	1.73	1.50	-0.83	1.88	-0.70
CO	0.89	0.00	-0.14	1.56	2.02
CO_2	-0.43	-0.67	1.12	-0.30	2.65
Total Carbon (C)	-0.39	-0.67	0.98	0.50	2.00

Additionally, total carbon was determined to assess changes in fuel economy. Percent changes are outlined in Table XIV. Results indicate that only Device 5 produced a statistically significant reduction in total carbon and, therefore, an increase in fuel economy.

Table XIV

Percent Changes in Total Carbon (80% Confidence Interval)

Device	n	t	% Change	CI
1	8	-0.77	10	18.3
2	9	-0.78	2	4.4
3	6	0.93	-1.8	2.3
4	9	0.34	-0.5	1.6
5	9	2.00	-6.6	4.1

DISCUSSION OF RESULTS

Note that the following designations for each individual device/process evaluated are utilized in the Discussion of Results that follows:

Device	Vendor
1	Metal Reaction, Inc. (Vitalizer)
2	EnviroSource of New Jersey (Fuel-Cat)
3	Enginewity Systems, Inc. (Engine Cleaning)
4	Compliance & Research Services, Inc. (Tailpipe Catalytic Converter)
5	INSET Industries, Inc. (INSET Fuel Stabilizer)

In terms of variability in the data, as noted in Table IV of the Analysis of Data, the IM 240 test was more reproducible and therefore better suited for discerning differences in emissions. This was realized in the data analysis of the device data. Only device 4 demonstrated a significant reduction in emissions with test procedure ASM 2525.

Of the five devices tested, four, designated as 1, 2, 4 and 5, showed a statistically significant reduction in CO emissions. One device, designated as number 4, significantly reduced NO_x, HC and CO emissions. Furthermore, the reduction in CO for this device was much greater than that realized with the other 3 devices that exhibited a reduction in CO. For the other three devices, the reduction in CO was basically the same order of magnitude. All three of these devices are of the same configuration; each being installed in the fuel line. With regard to HC emissions, only devices 4 and 5 showed any improvement. Two of the devices, 1 and 2, demonstrated a reduction in CO_2 emissions. This may indicate that an improvement in fuel economy. Because a reduction in CO was also noted, more rigorous testing would be required to quantify this reduction. Device 2 may have caused minor increase in NO_x emissions. Percent changes for species which exhibited a statistically significant change in each test are presented in Tables IX and X of the Analysis of Data.

As was noted in the Analysis of Data section of this report, there were some problems with the data for the control car. When the same analysis was conducted on the control car as was conducted on each of the device/processes, the factor being first vs. last run, a statistically significant difference in some of emissions is noted. For the IM 240 test, an increase in NO_x and a decrease in CO occurs. For the ASM 2525 test, an increase in HC, CO and CO_2 occurs. It is interesting to note that in one test, a reduction in CO occurs while in the other an increase is noted. In terms of the effect this has on the data, since each device/process was evaluated by the same test protocol, relative comparisons between the devices can still be made. Furthermore, the trends evident in the control car were not realized in the test car data. Since the control car was the first and last run of the day, some of the trends noted may be due to a warm up of the dynamometer and the gas sampling equipment. It is recommended that this assumption be evaluated. Furthermore, the time between runs for the control car was longer than the time between without and with test runs for any car. The impact this may have can not be evaluated without further testing. Unfortunately, the way in which the test was configured, where a car was run without then with the device, if these effects are real they are confounded with any reductions caused by the device. The impact this may have is on the percent reductions realized. Further testing in a controlled environment would be required to better quantify the true reductions caused by any of these devices.

VARIATIONS FROM "IDEALLY CONTROLLED" CONDITIONS

Test Site

The testing was conducted at the New Jersey Division of Motor Vehicles (NJDMV) Facility in Wayne, New Jersey, on a test lane maintained by a contractor, Environmental Systems Products (ESP). This site was selected because it had a dynamometer capable of conducting ASM 2525 and IM 240 testing. While the Wayne NJDMV facility is not certified by the EPA for the conducting ASM 2525 and IM 240 tests, the facility is operated by the NJDMV, which is the state agency responsible for conducting emissions testing on light duty gasoline vehicles registered in the state of New Jersey. The facility is not completely enclosed, therefore control of climatic conditions during testing was not possible. However, in an effort to minimize these effects, the baseline testing and device/process testing on each vehicle was initiated and completed on the same day. A multivariant analysis of the environmental conditions was performed and is addressed in the data analysis section.

Several problems were developed by the dynamometer over the course of the test program. On 12 Dec 96 the dynamometer suffered mechanical problems. It took three days to diagnose and make the appropriate repairs. The length of the delay in repairing the dynamometer precluded Enginewity from conducting all the process treatments on their vehicles for the remaining tests. This, and the fact that an analysis of the data obtained on the vendor's prior test vehicles showed erratic results, caused the invalidation of all of the results for this vendor. The vendor was rescheduled and tested again in January.

On 17 Dec 96 the system developed software problems and locked up. This occurred between tests, so there was no disruption of any test sequence. Attempts to restart and reboot the system were unsuccessful (due to the timing of the lock-up the control car was unable to be run at the end of the day to verify the day's data). The next day, an ESP service person arrived to correct the problem, which was diagnosed as lack of sufficient memory. A number of files unrelated to dynamometer operation were deleted, and the testing was resumed. Following the repair of the computer the control car was run to verify calibration; the data was analyzed and no abnormalities were found, thus the previous day's data was determined to be valid.

Problems with the computer system were experienced again on 8 Jan 97. In the first instance the system locked up, but restarting the system solved the problem. The problem occurred in between test sequences, so no disruption of any test sequence was experienced.

Later in the day the same problem that was experienced on 17 Dec 96 resurfaced. In this instance the lock-up occurred between the third and fourth test sequences on one of the test vehicles. As in Dec 96, the control car was able to be tested at the end of the day's tests. The problem was corrected on 9 Jan 97 by an ESP service person. The control car was run and the previous day's data validated. However, the fourth run and associated bag sample were not able to be run on a vehicle.

Road Course

Prior to baseline testing and device/process testing, each vehicle was run over a 26 mile road course (see map in test procedure section). The purpose of this road course was to allow a break-in period for each device/process and to bring the vehicle up to operating temperature. Due to traffic, road construction and weather conditions, the elapsed time and average vehicle speed varied. In some cases the course had to be altered. In these cases the course length was maintained. In order to minimize the effects of these course/elapsed time variations, each vehicle was subjected to a single IM 240 test sequence prior to initiation of testing. No emissions data collected during this warm-up was used in any of the subsequent data analysis.

While bringing each vehicle to operating temperature on the dynamometer may have provided a more uniform warm-up procedure, use of the road course helped incorporate a set of "real world" driving conditions. In addition, based on the difficulties experienced with the dynamometer and the test vehicles, employing the dynamometer to warm-up the vehicles would probably have only served to increase the number of vehicle problems, dynamometer down time, and the overall time required to complete the test program.

Test Vehicles

The fact that several of the vendors claimed that their devices helped clean the engine, and that one vendor performed engine cleaning processes therefore altering the operating conditions of each test vehicles, using one set of vehicles for the entire test program was not feasible. Resource restrictions, and the quantity of test vehicles required to test all five vendors severely limited the selection of test vehicles. Since the intention of this testing was to use vehicles typical of those found on New Jersey roads, vehicles were selected from the NJDOT and other state of New Jersey agency fleets. The test fleet consisted of 4-, 6- and 8-cylinder light duty gasoline cars, pick-up trucks, and vans, ranging from the 1984 to 1993 model years. In order to minimize the possibility that vehicle malfunction would corrupt the data, and to ensure that each vehicle was safe to be operated on the dynamometer, each vehicle was inspected by an ASE certified mechanic prior to the initiation of testing (see test procedure for vehicle inspection parameters). In addition, each vendor was afforded the opportunity to, under supervisor of an TACOM-

ARDEC representative, inspect or have a mechanic inspect the vehicles prior to initiation of testing.

Despite inspection by an ASE certified mechanic, several test vehicles experienced mechanical problems during baseline testing. These problems included a broken motor mount and a faulty emergency brake cable. These vehicles were deemed unsafe for operation on the dynamometer and replaced by other vehicles. Prior to this, the motor mounts and emergency brakes on the vehicles were not inspected. Subsequently the motor mounts and emergency brakes on all vehicles were inspected. One van could not maintain 25 mph during the ASM 2525 due to a sticky throttle cable. The vehicle was replaced. The vehicle was repaired and then used as a test vehicle for a subsequent vendor.

Several vehicles experienced mechanical problems following initial testing. A PCV hose joint was snapped off during device installation. The corresponding part was taken from a similar vehicle and installed. The part was reinstalled on the original vehicle following the completion of testing. One vehicle lost its resonator following baseline testing and was replaced. A new resonator was installed on the vehicle and it was used as a test vehicle for a subsequent vendor. Another vehicle experienced a flat tire on the dynamometer during device testing. The tire was replaced and the testing continued. One vehicle began leaking transmission fluid near the completion of baseline testing. Following completion of the baseline testing the vehicle was inspected and it was discovered that the transmission had been overfilled. The leak was considered minor and the vehicle continued in the test program unaltered. A coolant leak was discovered on one vehicle after returning from the road course prior to dynamometer testing. The leak was deemed minor, and the vehicle continued testing unaltered, with its temperature monitored while the vehicle was operated on the dynamometer. Finally, one vehicle experienced a ruptured transmission line during baseline testing. The vehicle was repaired and the transmission refilled prior to process testing.

Test Vehicle Fuel

Due to resource limitations, and the logistics involved in draining and refueling each of the test vehicles, laboratory grade fuel was not used. However, with the exception of the control car, none of the vehicles were refueled between initiation and completion of its testing. In the case of the control car, a quantity of fuel sufficient to complete the testing was secured. The grade of fuel may have varied from vehicle to vehicle during testing, but not between the baselining and device/process testing of each vehicle. Therefore, no variance due to fuel was introduced into the resulting trends.

ECONOMIC COMPARISON

A table which compares the costs of the five different devices/processes is presented in Appendix A-2. All of the processes/devices require approximately 0.5 hour to install, which, based on a labor rate of $55.00/hour for a professional mechanic, would cost $27.50. Since the labor is part of the engine cleaning process, installation is not calculated separately. Excluding installation, the cost for a single in-line fuel device ranges from $250 to $495. For a quantity of one hundred, the cost ranges from $225 to $446. For a quantity of one thousand, the cost ranges from $200 to $396. The NJDOT requested that the cost of all devices/processes be calculated for a maximum 12 year, 180,000 mile vehicle life, with an estimated vehicle usage of 15,000 miles/year. All of the in-line vehicles include warranties that would cover this period. As a result, the costs/year of the devices decreases proportionately on a per year and/or per mile basis.

The cost of the tailpipe catalytic converter is $50, which ranks as the lowest initial cost. Again, installation is estimated to be 0.5 hour. Custom installations may be take longer. The current warranty for the tailpipe catalytic is 25,000 miles. Based on an average vehicle use of 15,000 miles/year, a new tailpipe catalytic converter would be required approximately every 19 months. As a result, the yearly cost of the catalytic converter remains fairly constant. The range of cost for the years calculated is $47/year. to $55/year.

The cost for the engine cleaning processes is $130 for a single treatment ($80 for the engine oil system cleaning process and $50 for the gasoline fuel and emissions system cleaning process) . For one hundred treatments the cost is $119.60 per vehicle ($73.60 for the engine oil system cleaning process and $46 for the gasoline fuel and emissions system cleaning process). For one thousand treatments, the cost is $104.00 per vehicle ($64 for the engine oil system cleaning process and $40 for the gasoline fuel and emissions system cleaning process). The time required to complete treatment with both processes is approximately 0.5 hour. There is no separate charge for labor, since it is included in the treatment cost. The warranty for these treatments is 25,000 miles. Based on an average vehicle use of 15,000 miles/year, treatment would be required approximately every 19 months. The range of cost for the years calculated is $93 (1 treatment, 7 years) to $62 (1000 treatments, 5 years).

The following chart summarizes life-cycle costs for each device/process (Basis, as per NJ DOT direction, is a 12 year life at 15,000 miles/year ; labor for installation also included):

Life Cycle Cost/Year Based On

	1 Unit	**100 Units**	**1,000 Units**
EnviroSource of NJ, Inc. "Fuel-Cat"	23	18	15
Metal Reaction, Inc. "Vitalizer"	23	21	19
INSET Industries, Inc. "INSET Fuel Stabilizer"	44	39	35
Compliance and Research, Inc. "Tailpipe Catalytic Converter"	52	52	52
Enginewity Systems, Inc. "Engine Cleaning"	87	80	69

CONCLUSIONS

1. The Compliance and Research Services, Inc. Tailpipe Catalytic Converter Device showed statistically significant reductions in nitrogen oxides (NO_x), Hydrocarbons (HC), and Carbon Monoxide (CO) in both the IM 240 and ASM 2525 testing:

Compliance and Research Services, Inc.
Tailpipe Catalytic Converter (Device)

	IM 240	ASM 2525
NO_x (%)	-16.4	-29.0
HC (%)	-37.4	-34.9
CO_2 (%)	-3.0	0.0
CO (%)	-63.6	Not Obtainable
Total Carbon (%)		-0.5

NOTE: "red" is statistically significant

2. Both the Metal Reaction, Inc. Vitalizer Device and EnviroSource of New Jersey Fuel-Cat Device showed statistically significant reductions in CO and CO_2 ; however, the EnviroSource Fuel-Cat device showed a statistically significant increase in NO_x (IM 240). No changes were observed in ASM 2525:

Metal Reaction, Inc.
Vitalizer (Device)

	IM 240	ASM 2525
NO_x (%)	4.9	5.3
HC (%)	-8.5	15.9
CO_2 (%)	-2.3	-0.3
CO (%)	-13.7	Not Obtainable
Total Carbon (%)		10.0

EnviroSource of New Jersey, Inc.
Fuel-Cat (Device)

	IM 240	ASM 2525
NO_x (%)	4.1	3.2
HC (%)	0.9	1.7
CO_2 (%)	-1.0	0.0
CO (%)	-16.2	Not Obtainable
Total Carbon (%)		2.0

3. The INSET Industries, Inc. Fuel Stabilizer Device showed a statistically significant reduction in HC and CO for IM 240. However, there was a significant increase in NO_x for ASM 2525. There were no observed changes for HC or CO in ASM 2525. This device also showed a statistically significant reduction in Total Carbon which may indicate an improvement in fuel economy.

INSET Industries, Inc.
INSET Fuel Stabilizer (Device)

	IM 240	ASM 2525
NO_x (%)	-9.5	44.8
HC (%)	-0.87	8.3
CO_2 (%)	0.0	-0.7
CO (%)	-27.4	Not Obtainable
Total Carbon (%)		-6.6

4. The Enginewity Systems, Inc. Engine Cleaning Process showed no significant change in any test for any gaseous species (CO, CO_2, NO_x, HC).

Enginewity Systems, Inc.
Engine Cleaning (Process)

	IM 240	ASM 2525
NO_x (%)	0.0	-3.2
HC (%)	-3.7	10.7
CO_2 (%)	-1.5	0.0
CO (%)	-0.9	Not Obtainable
Total Carbon (%)		-1.8

RECOMMENDATIONS

1. The confidence intervals obtained in these tests were rather large with respect to the percent reduction in emissions. Additional tests, run in a more controlled environment, are recommended to quantify the actual reduction in emissions.

2. These tests assessed the impact of the devices/processes directly after installation. A test to assess the "long term" benefit of these devices should be performed.

3. All of these tests were conducted during winter months. A multivariate regression analysis indicated that environmental conditions may impact emissions. Devices should also be evaluated at environmental extremes.

4. Tests were conducted on the older portion of the fleet. In addition, cars tested were predominately Chrysler K-cars or police cruisers. Impact on other vehicles and new vehicles could provide a fleet test impact.

5. For best emission reductions, two of these devices can be used together (the Compliance and Research Tailpipe Catalytic Converter plus one of the in-line fuel devices (Metal Reaction Vitalizer, EnviroSource Fuel-Cat, or INSET Industries Fuel Stabilizer)). Additional tests to quantify the overall reduction should be performed.

APPENDIX A
Description of Devices and Processes Evaluated

1. Process Descriptions and Installation Procedures

2. Cost of Devices / Processes

INSTALLATION

IN-LINE FUEL DEVICES

Installation of the three in-line fuel devices is similar. The fuel line is cut, and the device is inserted in the fuel line as close as possible to the fuel delivery system (carburetor, injectors, etc.). The device is secured with clamps at either end, and the ground wire connected to a ground source. At some point during the installation the battery is disconnected, if applicable, to clear the vehicle's computer codes.

TAILPIPE CATALYTIC CONVERTER

The tailpipe catalytic converter is installed by cutting a sufficient length of the exhaust system and inserting the device. The device is located aft of the existing catalytic converter, but the exact location of the device varies according to vehicle. The preferred location is an area along the exhaust line which provides the best access for installation. After installation the device is secured by either clamping or welding.

ENGINE CLEANING PROCESS

The gasoline fuel and emissions system cleaning process is performed by spraying a cleaning solution into the air intake system with the vehicle's engine running. The engine oil system cleaning spray is provided by the vendor's appropriate equipment. The crankcase cleaning process is performed by draining the oil from the crankcase and introducing a cleaning solution. The cleaning solution is provided via the vendor's appropriate equipment. Following cleaning of the crankcase the engine is refilled with new oil.

2. Cost of Devices / Processes

DEVICE/PROCESS COST COMPARISON

DEVICE	VENDOR	UNIT/TREATMENT COST ($)	INSTALLATION TIME (hr*)	INSTALLATION COST ($)**	WARRANTY
1	Metal Reaction Inc. (Vitalizer)	250	0.5	27.50	15 Yr.
2	EnviroSource of New Jersey (Fuel-Cat)	250	0.5	27.50	Lifetime
3	Enginewity Systems Inc. (Engine Cleaning)	130	0.5	Not Available	25,000 miles
4	Compliance and Research Services Inc. (Tailpipe Catalytic Converter)	50	0.5	27.50	25,000 miles
5	INSET Industries Inc. (INSET Fuel Stabilizer)	495	0.5	27.50	Lifetime

* - Estimated time, rounded up to the next 30 minute interval

** - Based on installation by a professional mechanic at a cost of $55/hr. Does not apply to custom installations.

DEVICE/COST COMPARISON

(BASED ON A QUANTITY OF 1 UNIT)

DEVICE	COST ($)*	COST/ 3 YR ($)**	COST/ 5YR ($)**	COST/ 7 YR ($)**	COST / 12YR ($)**
1	277.50	93	56	40	23
2	277.50	93	56	40	23
3	130.00	87	78	93	87
4	77.50	52	47	55	52
5	522.50	174	105	75	44

(BASED ON A QUANTITY OF 100 UNITS)

DEVICE	COST ($)*	COST/ 3 YR ($)**	COST/ 5YR ($)**	COST/ 7 YR ($)**	COST / 12YR ($)**
1	252.50	84	51	36	21
2	221.25	74	44	32	18
3	119.60	80	72	85	80
4	77.50	52	47	55	52
5	473.50	158	95	68	39

*- Including installation, if applicable. Does not apply to custom installations.
** - Cost figures rounded off, estimates based on 15,000 miles/year

DEVICE/COST COMPARISON

(BASED ON A QUANTITY OF 1,000 UNITS)

DEVICE	COST ($)*	COST/ 3 YR ($)**	COST/ 5YR ($)**	COST/ 7 YR ($)**	COST / 12YR ($)**
1	227.50	76	46	33	19
2	185.00	62	37	26	15
3	104.00	69	62	74	69
4	77.50	52	47	55	52
5	423.50	141	85	61	35

*- Including installation, if applicable. Does not apply to custom installations.
** - Cost figures rounded off, estimates based on 15,000 miles/year

DEVICE/PROCESS DESCRIPTION

IN-LINE FUEL DEVICES

Three of the vendors which participated in this program, Metal Reaction, Inc. EnviroSource of New Jersey, and INSET Industries, Inc. market in-line fuel devices. The three devices, Vitalizer, Fuel-Cat, and the INSET Fuel Stabilizer are all designed to be installed in a vehicle's fuel line, as close as possible to the fuel delivery system (i.e. carburetor, injectors, etc.). All three devices are similar in construction, as viewed from the exterior of the device. Each consists of a fuel chamber, through which the fuel is passed, clamps for connecting the device to the fuel line, and a ground wire. Both Metal Reaction, Inc. and EnviroSource of New Jersey claim that, as the fuel flows through the their devices, the devices create turbulence and employ dissimilar metals which causes the fuel molecules to repel each other, resulting in more complete combustion. INSET Industries, Inc.. claims that its device aligns fuel molecules as the fuel molecules pass through the chamber, which provides for optimum fuel combustion. All three vendors claim that their devices reduce auto emissions, and increase engine performance and fuel economy. Metal Reaction, Inc. also claims that its device removes carbon deposits. INSET Industries, Inc. also claims that its device helps reduce maintenance costs.

TAILPIPE CATALYTIC CONVERTER

One of the vendors which participated in this program, Compliance And Research Services, Inc., markets a tailpipe catalytic converter. This device is designed to be installed on a vehicle's exhaust system, aft of the existing catalytic converter. The device is similar in construction, as viewed from the exterior, to existing catalytic converters. Compliance And Research Services, Inc. claims that its device reduces auto emissions by passing the exhaust gases over a catalytic material in the device.

ENGINE CLEANING PROCESS

One of the vendors which participated in this program, Enginewity Systems Inc., markets equipment which performs engine cleaning processes. As part of this test program, Enginewity Systems Inc. performed fuel system cleaning and crankcase cleaning procedures on its test vehicles. Enginewity Systems Inc., claims that its fuel system cleaning process removes harmful carbon-like build up in the intake manifold, on fuel injector tips, and on the intake valves. Enginewity Systems, Inc. claims that its crankcase cleaning process removes harmful contamination in the engine. Enginewity Systems, Inc. claims that its cleaning processes will reduce emissions, increase engine performance and fuel economy, and extend engine life.

PARTICIPATING VENDORS

Metal Reaction Inc.
7760 West 20th Avenue, Suite 6
Hialeah, Florida 33016

EnviroSource of NJ, Inc.
P.O. Box 548
Summit, New Jersey 07092-0548

Compliance And Research Services, Inc.
2 Garfield Street
Linden, New Jersey 07036-1416

INSET Industries, Inc.
9 Post Road, M-1
Oakland, New Jersey 07436

Enginewity Systems Inc.
12385 Automobile Boulevard.
Clearwater, Florida 34622

1. Process Descriptions and Installation Procedures

APPENDIX B
Description of Test Vehicles

1. Department of Transportation (DOT) Inspection Data
2. ASE Certified Mechanic's Data
3. Test Allocation of Vehicles
4. Rejection of Final Emissions Test Data for Specific Vehicles

1. DOT Inspection Data

The following compilation of DOT inspection data for the vehicles used in this test program are identified by test code numbers which must be defined. Since there were five devices/processes evaluated, each was previously assigned a number, i.e., Vitalizer - 1, Fuel Cat - 2, Enginewity - 3, Compliance & Research - 4 and INSET - 5. For each device/process evaluated, nine vehicles were used, 1 thru 9. Thus, each test vehicle had a two-digit code, referencing the device tested and the vehicle sequence in the test. For example, the fifth vehicle used for the Fuel-Cat evaluation was number "2-5". The control vehicle was obviously designated "Control".

NOTE: The vehicle used as the ninth vehicle tested during evaluation of the fourth vendor, i.e., test 4-9, was a 1991 Dodge Ram 150 pick-up with plate # TD-5666. This vehicle was used to carry the spare gasoline used to refuel the Control vehicle and was not inspected either by the NJDOT or by the ASE mechanic. It was pressed into service as the necessary ninth vehicle when mechanical problems were noted with the intended vehicle and no other vehicles were available. It was deemed satisfactory for use because of its observed performance to that point.

NJDOT VEHICLE SCREENING

CONTROL

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 TD OR (SG) # P906

MAKE Dodge

MODEL Aries

VIN # 1B3BD46D2JF23A96

NUMB OF CYL 4

MILES 29765

COMPUTER CODES CHECKED NO

IGNITION TIMING BTC 3

AIR FILTER OK

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ——

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
——

EMISSIONS READINGS CO 0.22 HC 51 CO2 10.0 OX ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] DATE: 10/19/96

NJDOT VEHICLE SCREENING

TEST 1-1

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** R938

MAKE Dodge

MODEL Van 250

VIN # 2B4HB21TXHK312948

NUMB OF CYL 8

MILES 92313

COMPUTER CODES CHECKED NO

IGNITION TIMING BTC 6

AIR FILTER OK

TIRES OK

EXHAUST LEAKS ~~ok~~ —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS **CO** 0.06 **HC** 391 **CO2** 8.5 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] **DATE:** 10/20/96

NJDOT VEHICLE SCREENING

TEST 1-3

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 89 TD OR SG# P208

MAKE Dodge

MODEL Aries

VIN # 1B3BK46D4KC468742

NUMB OF CYL 4

MILES 42231

COMPUTER CODES CHECKED ~~11~~, (37) ~~51~~ (11, 51 Cleared out)

IGNITION TIMING BTC 3

AIR FILTER OK

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS CO 0.55 HC 215 CO2 12.0 OX ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] DATE: 10/17/96

Ready

6

NJDOT VEHICLE SCREENING

TEST 1-4

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 89 **TD OR SG#** Z338

MAKE Chevy

MODEL Caprice

VIN# 1G1BL517XKR208399

NUMB OF CYL 8

MILES 131377

COMPUTER CODES CHECKED None

IGNITION TIMING —

AIR FILTER Bad

TIRES Front ok Back Left Flat Right Bald - REPAIRED -

EXHAUST LEAKS ______

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS **CO** .52 **HC** 134 **CO2** 12.6 **OX** ______

MECHANICS COMMENTS:

______

______

______

MECHANICS SIGNATURE: Bill Church **DATE:** 10/17/96

NJDOT VEHICLE SCREENING

TEST 1-5

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 **TD OR SG #** S 704

MAKE Dodge

MODEL Aries

VIN # 1B3BD46D0JF232760

NUMB OF CYL 4

MILES 71044

COMPUTER CODES CHECKED ~~#X5~~ None ~~Cleared out~~

IGNITION TIMING BTC 3°

AIR FILTER Bad

TIRES OK

EXHAUST LEAKS None

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS CO .35 **HC** 173 **CO2** 9.9 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: Bill [signature] **DATE:** 10/17/96

NJDOT VEHICLE SCREENING

TEST 1-6

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 **TD OR SG#** S199

MAKE Dodge

MODEL Aries

VIN # 1B3BD46D0JF228983

NUMB OF CYL 4

MILES 33956

COMPUTER CODES CHECKED None

IGNITION TIMING BCT 3°

AIR FILTER Fair

TIRES ok

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ____________

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)

____

EMISSIONS READINGS **CO** .25 **HC** 59 **CO2** 13.3 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: Bill Chu[illegible] **DATE:** 10/19/96

NJDOT VEHICLE SCREENING

TEST 1-7

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 91 TD OR SG # 0387

MAKE Chevy

MODEL Caprice

VIN # 1G1BL53E8MW227311

NUMB OF CYL 8

MILES 20719

COMPUTER CODES CHECKED NO

IGNITION TIMING —

AIR FILTER Fair

TIRES OK

EXHAUST LEAKS —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)

—

EMISSIONS READINGS CO .29 HC 24 CO2 14.3 OX —

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] DATE: 11/22/96

NJDOT VEHICLE SCREENING

TEST 1-8

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 ~~**TD OR SG**~~ **#** GKD11C

MAKE Buick

MODEL Ele

VIN # 1G4CW51C4J1686665

NUMB OF CYL 6

MILES 78415

COMPUTER CODES CHECKED None

IGNITION TIMING ADV 16°

AIR FILTER BAD Replaced

TIRES OK

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ok

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) ok

EMISSIONS READINGS **CO** 0.50 **HC** 94 **CO2** 14.7 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] **DATE:** 10/18/96

NJDOT VEHICLE SCREENING

TEST 1-9

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 86 **TD OR SG #** N376

MAKE Dodge

MODEL Aries

VIN # 1B3BD26D2GF286770

NUMB OF CYL 4

MILES 05112

COMPUTER CODES CHECKED NO

IGNITION TIMING BTC 6

AIR FILTER BAD Replaced

TIRES OK

EXHAUST LEAKS NO

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ____

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) ____

EMISSIONS READINGS **CO** 0.00 **HC** 8 **CO2** 8.5 **OX** ____

MECHANICS COMMENTS:

Speedometer Broken [redacted]

MECHANICS SIGNATURE: [signature] **DATE:** 10 / 17 /96

Ready

(1)

NJDOT VEHICLE SCREENING

TEST 2-1

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 **TD OR (SG) #** 5552

MAKE Dodge

MODEL Aries

VIN # 1B3BD46D2?JF237166

NUMB OF CYL 4

MILES 38992

COMPUTER CODES CHECKED NO

IGNITION TIMING BTC 3

AIR FILTER OK

TIRES OK

EXHAUST LEAKS NONE

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) NONE

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) NONE

EMISSIONS READINGS **CO** ~~[illegible]~~ 0.29 **HC** ~~[illegible]~~ 148 **CO2** 16.0 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: J Dik **DATE:** 10 / 17 /96

NJDOT VEHICLE SCREENING

TEST 2-2

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 92 **TD OR SG #** 0 799

MAKE Chevy

MODEL Caprice

VIN # 1G1BI5370NW154002

NUMB OF CYL 8

MILES 110939

COMPUTER CODES CHECKED NO

IGNITION TIMING —

AIR FILTER Ok

TIRES Ok

EXHAUST LEAKS —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ____________

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)

____

EMISSIONS READINGS **CO** 0.40 **HC** 296 **CO2** 10.9 **OX** —

MECHANICS COMMENTS:

MECHANICS SIGNATURE: J Oltz **DATE:** 11 /22 /96

NJDOT VEHICLE SCREENING

TEST 2-3

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 TD OR (SG) # M16U

MAKE Dodge

MODEL Van 250

VIN # 2B4HB21Y7JK186582

NUMB OF CYL 8

MILES 13757

COMPUTER CODES CHECKED #45 overdrive

IGNITION TIMING BTC 16

AIR FILTER Fair

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
—

EMISSIONS READINGS CO 1.09 HC 274 CO2 10.2 OX ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: J Dilt DATE: 10/17/96

Ready

NJDOT VEHICLE SCREENING

TEST 2-4

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 86 **TD OR SG #** N 936

MAKE Dodge

MODEL Aries

VIN # 1B3BD26D4GF310406

NUMB OF CYL 4

MILES 18337

COMPUTER CODES CHECKED None

IGNITION TIMING BTC 9°

AIR FILTER Bad

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS **CO** .42 **HC** 164 **CO2** 9.7 **OX** ______

MECHANICS COMMENTS:

____

____

____

MECHANICS SIGNATURE: Bill Church **DATE:** 10/18/96

NJDOT VEHICLE SCREENING

TEST 2-5

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 89 **TD OR SG #** Z353

MAKE Chevy

MODEL Caprice

VIN # 1G1BL51E5KA149016

NUMB OF CYL 8

MILES 00390

COMPUTER CODES CHECKED None

IGNITION TIMING BTC °

AIR FILTER OK

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
OK

EMISSIONS READINGS **CO** .05 **HC** 99 **CO2** 10.3 **OX** ______

MECHANICS COMMENTS:

____

____

____

MECHANICS SIGNATURE: John Dilts **DATE:** 10/18/96

NJDOT VEHICLE SCREENING

TEST 2-6

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 91 TD OR SG # 0916

MAKE Chevy

MODEL Caprice

VIN # 1G1BL5372MW225036

NUMB OF CYL 8

MILES 148084

COMPUTER CODES CHECKED None

IGNITION TIMING_______

AIR FILTER OK

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS CO 2.86 HC 276 CO2 10.2 OX_______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: Bill Church DATE: 11/22/96

NJDOT VEHICLE SCREENING

TEST 2-7

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 89 **TD OR SG #** P428

MAKE Dodge

MODEL Aries

VIN # 1B3BK46D6KC468774

NUMB OF CYL 4

MILES 40888

COMPUTER CODES CHECKED NO

IGNITION TIMING BTC 3°

AIR FILTER OK

TIRES OK

EXHAUST LEAKS ~~ok~~ none

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ok

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) ok

EMISSIONS READINGS **CO** 0.55 **HC** 265 **CO2** 10.9 **OX** ______

MECHANICS COMMENTS:

none

MECHANICS SIGNATURE: J Dilts **DATE:** 10/17/96

NJDOT VEHICLE SCREENING

TEST 2-7

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 89 **TD OR SG #** P428

MAKE Dodge

MODEL Aries

VIN # 1B3BK46D6KC468774

NUMB OF CYL 4

MILES 40888

COMPUTER CODES CHECKED NO

IGNITION TIMING BTC 3°

AIR FILTER OK

TIRES OK

EXHAUST LEAKS ~~OK~~ NONE

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS **CO** 0.55 **HC** 265 **CO2** 10.9 **OX** ______

MECHANICS COMMENTS:

NONE

MECHANICS SIGNATURE: J Dilts **DATE:** 10/17/96

NJDOT VEHICLE SCREENING

TEST 2-8

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** R484

MAKE Dodge

MODEL Aries

VIN # 1B3BD3CD7HF199843

NUMB OF CYL 4

MILES 80458

COMPUTER CODES CHECKED ~~#15 #37~~ Cleared out

IGNITION TIMING BTC 9°

AIR FILTER Bad

TIRES ok

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ok

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) None

EMISSIONS READINGS **CO** .56 **HC** 360 **CO2** 9.0 **OX** ______

MECHANICS COMMENTS:

Bearing Nosie Water Pump ? Alt. ?

MECHANICS SIGNATURE: Bill Church **DATE:** 10/17/96

NJDOT VEHICLE SCREENING

TEST 2-9

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** R683

MAKE Dodge

MODEL Aries

VIN # 1P3BP36D4HF226275

NUMB OF CYL 4

MILES 22467

COMPUTER CODES CHECKED 37 Trans Lock-up

IGNITION TIMING BTC 6

AIR FILTER Fair

TIRES Ok

EXHAUST LEAKS —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) Valve Noise

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS **CO** 000 **HC** 15 **CO2** 10.6 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] **DATE:** 10 /19 /96

At Testing

* Emmissions [illegible]

NJDOT VEHICLE SCREENING

TEST 3-1

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 89 **TD OR SG #** Z331

MAKE Chevy

MODEL Caprice

VIN # 1G1BL51E7KR182021

NUMB OF CYL 8

MILES 24798

COMPUTER CODES CHECKED NO

IGNITION TIMING ° BTC

AIR FILTER OK

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ——

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
——

EMISSIONS READINGS **CO** 0.84 **HC** 136 **CO2** 10.9 **OX** ______

MECHANICS COMMENTS:

Battery Bad

MECHANICS SIGNATURE: [signature] **DATE:** 10 /17 /96

NJDOT VEHICLE SCREENING

TEST 3-2

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 85 TD OR (SG)# M47H

MAKE Dodge

MODEL Aries

VIN # 1B3BD49D8FF333113

NUMB OF CYL 4

MILES 05597

COMPUTER CODES CHECKED NO

IGNITION TIMING BTC 6

AIR FILTER OK

TIRES Front Bad Rear Low

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS CO 5.69 HC 314 CO2 8.2 OX ______

MECHANICS COMMENTS:

____

MECHANICS SIGNATURE: _______________ DATE: ___/___/96

NJDOT VEHICLE SCREENING

TEST 3-3

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 92 **TD OR ~~SG~~ #** SP 725

MAKE Chevy

MODEL Caprice

VIN # 1G1BL5375NW150733

NUMB OF CYL 8

MILES 132317

COMPUTER CODES CHECKED____________

IGNITION TIMING_______

AIR FILTER OK

TIRES OK

EXHAUST LEAKS__________

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.)____________

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)

____

EMISSIONS READINGS **CO** .02 **HC** 33 **CO2** 11.4 **OX**_______

MECHANICS COMMENTS:

MECHANICS SIGNATURE:________________ **DATE:** ___/___/96

NJDOT VEHICLE SCREENING

TEST 3-4

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 89 **TD OR (SG)#** P46B

MAKE Dodge

MODEL Van

VIN # 2B5WB3522KK403369

NUMB OF CYL 8

MILES 19174

COMPUTER CODES CHECKED NO

IGNITION TIMING 13 BTC

AIR FILTER ________

TIRES OK

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
—

EMISSIONS READINGS **CO** .07 **HC** 22 **CO2** 10.2 **OX** ________

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] **DATE:** 12/10/96

NJDOT VEHICLE SCREENING

TEST 3-5

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** M92E

MAKE Dodge

MODEL Aries

VIN # 1B3BD36D6HF304758

NUMB OF CYL 4

MILES 10963

COMPUTER CODES CHECKED 37 Trans Lockup

IGNITION TIMING BTC 9

AIR FILTER ok

TIRES OK

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) ______

EMISSIONS READINGS **CO** 0.00 **HC** 18 **CO2** 9.4 **OX** ______

MECHANICS COMMENTS:

cracked windsheild

MECHANICS SIGNATURE: [signature] **DATE:** 10/9/96

NJDOT VEHICLE SCREENING

TEST 3-6

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 86 **TD OR (SG)#** N181

MAKE Dodge

MODEL Aries

VIN # 1B3BD26D7GF200871

NUMB OF CYL 4

MILES 34708

COMPUTER CODES CHECKED None

IGNITION TIMING BTC 9°

AIR FILTER ________

TIRES Fair

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ok

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
ok

EMISSIONS READINGS **CO** .16 **HC** 38 **CO2** 10.6 **OX** ~~[illegible]~~

MECHANICS COMMENTS:

Bad Battery

MECHANICS SIGNATURE: Bill Chmiel **DATE:** 10/19/96

NJDOT VEHICLE SCREENING

TEST 3-7

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 86 **TD OR SG #** R 105

MAKE Dodge

MODEL Van

VIN # 2B4GB11H1GK603824

NUMB OF CYL 6

MILES 16529

COMPUTER CODES CHECKED Not Abel to Scan Codes

IGNITION TIMING ——

AIR FILTER ______

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ______

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)

______

EMISSIONS READINGS **CO** .09 **HC** 40 **CO2** 6.4 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: ______ **DATE:** 12 /10 /96

NJDOT VEHICLE SCREENING

TEST 3-8

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 91 **TD OR SG #** 0727

MAKE Chevy

MODEL Caprice

VIN # 1G1BL537XMW225575

NUMB OF CYL 8

MILES 154958

COMPUTER CODES CHECKED None

IGNITION TIMING ____

AIR FILTER OK

TIRES OK

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ok

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
OK

EMISSIONS READINGS **CO** .69 **HC** 253 **CO2** 10.8 **OX** ____

MECHANICS COMMENTS:

MECHANICS SIGNATURE: Bill Church **DATE:** 11/22/96

NJDOT VEHICLE SCREENING

TEST 3-9

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 91 **~~TD OR SG~~ #** SP 385

MAKE CHEVY

MODEL CAPRICE

VIN # 1G1BL5372MW227580

NUMB OF CYL 8

MILES 119733

COMPUTER CODES CHECKED ____________

IGNITION TIMING ________

AIR FILTER OK

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS **CO** .31 **HC** 422 **CO2** 13.0 **OX** ________

MECHANICS COMMENTS:

MECHANICS SIGNATURE: ________________ **DATE:** 12 / 16 /96

NJDOT VEHICLE SCREENING

TEST 4-1

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 89 **TD OR SG#** P735

MAKE Chevy

MODEL Cav.

VIN # 1G1JC8116KJ229662

NUMB OF CYL 4

MILES 70732

COMPUTER CODES CHECKED None

IGNITION TIMING ADV 26°

AIR FILTER Fair

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS **CO** .43 **HC** 140 **CO2** 13.7 **OX** ______

MECHANICS COMMENTS:

Jump Started

MECHANICS SIGNATURE: Bill Church **DATE:** ___/___/96

NJDOT VEHICLE SCREENING

TEST 4-2

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 90 **TD OR SG #** 0132

MAKE Chevy

MODEL caprice

VIN # 1G1BL54716A153059

NUMB OF CYL 8

MILES 138124

COMPUTER CODES CHECKED NO

IGNITION TIMING ok

AIR FILTER ok

TIRES OK

EXHAUST LEAKS NO

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS **CO** .10 **HC** 301 **CO2** 103 **OX** —

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] **DATE:** 1/22/96

Fluid check

NJDOT VEHICLE SCREENING

TEST 4-3

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** R 793

MAKE Dodge

MODEL Ram Charger

VIN # 3B4GW12T0HM732063

NUMB OF CYL 8

MILES 83671

COMPUTER CODES CHECKED No [redacted] Scaner Hook up

IGNITION TIMING 8 BTC

AIR FILTER Changed New

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS **CO** 0.10 **HC** 507 **CO2** 8.5 **OX** ______

MECHANICS COMMENTS:

Inspection Sticker out of Date 10-96

MECHANICS SIGNATURE: Bill Church **DATE:** 11/22/96

NJDOT VEHICLE SCREENING

TEST 4-4

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 92 **TD ~~OR SG~~ #** SP 0744

MAKE chevy

MODEL caprice

VIN # 1G1B1537/NW152548

NUMB OF CYL 8

MILES 110629

COMPUTER CODES CHECKED NO

IGNITION TIMING ______

AIR FILTER OK

TIRES OK

EXHAUST LEAKS —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
—

EMISSIONS READINGS **CO** .037 **HC** 50 **CO2** 11.0 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] **DATE:** 12/10/96

NJDOT VEHICLE SCREENING

TEST 4-5

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 **TD OR SG#** P47P

MAKE Dodge

MODEL Aries

VIN # 1B3BD46DXJF227954

NUMB OF CYL 4

MILES 57517

COMPUTER CODES CHECKED NO

IGNITION TIMING BTC14

AIR FILTER OK

TIRES Spare Right Front

EXHAUST LEAKS —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) Vales Cover Leak

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS **CO** 0.11 **HC** 104 **CO2** 14.7 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: J Ditts **DATE:** 10 /19 /96

NJDOT VEHICLE SCREENING

TEST 4-6

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** R583

MAKE Dodge

MODEL Aries

VIN # 1P3BP36D1HF205237

NUMB OF CYL 4

MILES 34353

COMPUTER CODES CHECKED 37 - Trans Lockup

IGNITION TIMING BTC 9

AIR FILTER BAD

TIRES OK

EXHAUST LEAKS —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS **CO** 0.00 **HC** 3 **CO2** 5.7 **OX** ______

MECHANICS COMMENTS:

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MECHANICS SIGNATURE: [signature] **DATE:** 10/19/96

(1)

NJDOT VEHICLE SCREENING

TEST 4-7

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 **TD OR (SG)#** Z647

MAKE Dodge

MODEL Aries

VIN # 1B3BD46D8JF239746

NUMB OF CYL 4

MILES 64651

COMPUTER CODES CHECKED None

IGNITION TIMING BTC 3

AIR FILTER Fair

TIRES OK

EXHAUST LEAKS ———

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) KNOX

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) ———

EMISSIONS READINGS **CO** 0.24 **HC** 159 **CO2** 9.8 **OX** ______

MECHANICS COMMENTS:

KNOX

MECHANICS SIGNATURE: [signature] **DATE:** 10/17/96

NJDOT VEHICLE SCREENING

TEST 4-8

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 86 **TD OR (SG)#** M680

MAKE Dodge

MODEL Van 350

VIN # 2B5WB31W0GK609261

NUMB OF CYL 8

MILES 35125

COMPUTER CODES CHECKED None

IGNITION TIMING BTC 8°

AIR FILTER OK

TIRES OK

EXHAUST LEAKS —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
OK

EMISSIONS READINGS **CO** 1.21 **HC** 73 **CO2** 8.7 **OX** —

MECHANICS COMMENTS:

MECHANICS SIGNATURE: J Ditto **DATE:** 10 /17 /96

NJDOT VEHICLE SCREENING

TEST 5-2

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR ~~SS~~#** 4501

MAKE Dodge

MODEL P. U.

VIN # 1B7GD14H2HS518650

NUMB OF CYL 6

MILES 83863

COMPUTER CODES CHECKED Not Abel to Scan for Codes

IGNITION TIMING_______

AIR FILTER Fair

TIRES OK

EXHAUST LEAKS —

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS **CO** 0.00 **HC** 48 **CO2** 5.8 **OX**_______

MECHANICS COMMENTS:

MECHANICS SIGNATURE:________________ **DATE:** 12 / 10 /96

NJDOT VEHICLE SCREENING

TEST 5-3

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 86 **(TD) OR SG #** 9376

MAKE Dodge

MODEL Aries

VIN # 1B3BD26D8GF313440

NUMB OF CYL 4

MILES 75762

COMPUTER CODES CHECKED NO

IGNITION TIMING —

AIR FILTER OK

TIRES OK

EXHAUST LEAKS Leak — Exhust Replaced

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS **CO** .01 **HC** 7 **CO2** 7.2 **OX** ____

MECHANICS COMMENTS:

MECHANICS SIGNATURE: [signature] **DATE:** 12/10/96

NJDOT VEHICLE SCREENING

TEST 5-4

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 88 **TD OR SG #** M36C

MAKE Chevy

MODEL Caprice

VIN # 1G1BL5165JR185054

NUMB OF CYL 8

MILES 87041

COMPUTER CODES CHECKED NO

IGNITION TIMING —

AIR FILTER Fair

TIRES OK

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
OK

EMISSIONS READINGS **CO** 0.81 **HC** 180 **CO2** 15.1 **OX** ______

MECHANICS COMMENTS:

____

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MECHANICS SIGNATURE: Bill Church **DATE:** 10/18/96

NJDOT VEHICLE SCREENING

TEST 5-5

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** M95G

MAKE Dodge

MODEL Aries

VIN # 1B3BD36D1HF326487

NUMB OF CYL 4

MILES 26738

COMPUTER CODES CHECKED 37 Trans Lock up

IGNITION TIMING BTC 3

AIR FILTER Bad Replaced

TIRES OK

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) Valve cover Leak

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS **CO** 0.34 **HC** 205 **CO2** 12.7 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: J Sitz **DATE:** 10/18/96

NJDOT VEHICLE SCREENING

TEST 5-5

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** M95G

MAKE Dodge

MODEL Aries

VIN # 1B3BD36D1HF326487

NUMB OF CYL 4

MILES 26738

COMPUTER CODES CHECKED 37 Trans Lock up

IGNITION TIMING BTC 3

AIR FILTER Bad Replaced

TIRES OK

EXHAUST LEAKS ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) Valve cover Leak

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) OK

EMISSIONS READINGS **CO** 0.34 **HC** 205 **CO2** 12.7 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: J Sitz **DATE:** 10/1/8/96

NJDOT VEHICLE SCREENING

TEST 5-6

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 91 **TD OR SG #** SP 555

MAKE Chevy

MODEL Caprice

VIN # 1G1BL5373MR151429

NUMB OF CYL 8

MILES 115374

COMPUTER CODES CHECKED ____________

IGNITION TIMING _______

AIR FILTER Fair

TIRES ok

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) ok

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) ok

EMISSIONS READINGS **CO** 4.54 **HC** 567 **CO2** 12.9 **OX** _______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: ________________ **DATE:** 12 /16 /96

NJDOT VEHICLE SCREENING

TEST 5-7

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 886 **TD OR SG #** P35P

MAKE Dodge

MODEL Van

VIN # 2B4GB11H3GK603825

NUMB OF CYL 6

MILES 5325

COMPUTER CODES CHECKED Not Code Scanable

IGNITION TIMING —

AIR FILTER Fair

TIRES Ok

EXHAUST LEAKS Ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) Ok

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
ok

EMISSIONS READINGS **CO**____ **HC**____ **CO2**____ **OX**______

MECHANICS COMMENTS:

MECHANICS SIGNATURE:______________ **DATE:** 12/16/96

NJDOT VEHICLE SCREENING

TEST 5-7

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 886 **TD OR SG #** P35P

MAKE Dodge

MODEL Van

VIN # 2B4GB11H3GK603825

NUMB OF CYL 6

MILES 5325

COMPUTER CODES CHECKED Not Code Scanable

IGNITION TIMING ——

AIR FILTER Fair

TIRES Ok

EXHAUST LEAKS Ok

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) Ok

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) ok

EMISSIONS READINGS **CO**____ **HC**____ **CO2**____ **OX**____

MECHANICS COMMENTS:

MECHANICS SIGNATURE:__________ **DATE:** 12/16/96

NJDOT VEHICLE SCREENING

TEST 5-8

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 85 **TD OR SG #** P15U

MAKE Dodge

MODEL PU

VIN # 1B7GD14H6FS691881

NUMB OF CYL 6

MILES 6349

COMPUTER CODES CHECKED —

IGNITION TIMING —

AIR FILTER fair

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) —

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.) —

EMISSIONS READINGS **CO** .07 **HC** 40 **CO2** 6.1 **OX** ______

MECHANICS COMMENTS:

MECHANICS SIGNATURE: ______ **DATE:** 12/10/96

NJDOT VEHICLE SCREENING

TEST 5-9

Vehicle Inspection check list

PLEASE FILL IN OR CHECK THE FOLLOWING INFORMATION FOR EACH VEHICLE:

YEAR 87 **TD OR SG #** R500

MAKE Dodge

MODEL Aries

VIN # 1B3BD36D8HF199768

NUMB OF CYL 4

MILES 37394

COMPUTER CODES CHECKED 37

IGNITION TIMING BTC 9°

AIR FILTER Fair

TIRES OK

EXHAUST LEAKS OK

MECHANICAL PROBLEMS(BAD VALVES, BAD CAM , BAD RINGS , OIL LEAKS, FUEL LEAKS ETC.) OK

ELECTRICAL PROBLEMS(BAD CAP, BAD WIRES, BAD COIL, SHORTS ETC.)
OK

EMISSIONS READINGS **CO** .21 **HC** 69 **CO2** 12.4 **OX** ______

MECHANICS COMMENTS:

______

______

______

MECHANICS SIGNATURE: Bill Church **DATE:** 10/19/96

2. ASE Certified Mechanic's Data

NOTE: The ASE mechanic did not get a chance to inspect nine of the vehicles used in the vendor evaluations, including the control vehicle, as they were inadvertently moved to Wayne DMV before the mechanic could inspect them. These vehicles were then inspected by an NJDOT ASE-certified mechanic before use in the test program. The nine vehicles were designated Control, 3-1, 3-4, 4-1, 4-4, 5-3, 5-4, 5-7, and 5-8. See the DOT inspection data immediately preceding for the description of these vehicles.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-1

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:09 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 87 DODGE VANS B250 3/4 T
LICENSE: SGR938
VIN : 2B4HB21TXHK312948
MLG : 92,417

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5596** SGR938 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***CODES AND DATA NOT AVAILABLE ON THIS MODEL					
***TEST RESULTS:PASS					

LABOR 27.50	Information Access: 0.00	PARTS	0.00
SUBLET 0.00	SHOP SUPPLIES : 0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :______________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle cure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-2

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:58 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 88 DODGE ARIES
LICENSE: SGS165
VIN : 1B3BD46D5JF229823
MLG : 26,168

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5594** SGS165 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :______________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle secure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-3

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:36 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 89 DODGE ARIES
LICENSE: SGF208
VIN : 1B3BK46D4KC468742
MLG : 42,324

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5590** SGF208 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD.					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle ·· more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-4

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:43 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 89 CHEVY CAPRICE
LICENSE: SGZ338
VIN : 1G1BL517XKR208399
MLG : 131,450

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5591** SGZ338 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle secure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop. L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE _______.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-5

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:48 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 88 DODGE ARIES
LICENSE: SGS704
VIN : 1B2BD46D0JF232760
MLG : 71,118

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5592** SGS704 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :________________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ..ure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees ..ose made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-6

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:02 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 88 DODGE ARIES
LICENSE: SGS199
VIN : 1B3BD46D0JF228983
MLG : 34,073

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5616** SGS199 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST REUSLT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :__________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle cure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-7

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:53 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 91 CHEVY CAPRICE RWD
LICENSE: NONE
VIN : 1G1BL5378MW227311
MLG : 120,789

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5593** NONE PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50
SUBLET	0.00
Information Access:	0.00
SHOP SUPPLIES :	0.00
PARTS	0.00
EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :________________

thorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my . You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle to secure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees are those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-8

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:22 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ----------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 88 BUICK PARK AVENUE
LICENSE: GKD11C
VIN : #51
MLG : 78,757

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5588** GKD11C PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD.					
***TEST RESULT:PASS					

LABOR 27.50	Information Access: 0.00	PARTS 0.00
SUBLET 0.00	SHOP SUPPLIES : 0.00	EPA CHARGES 0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL 27.50
TOTAL 27.50

ACCEPTANCE SIGNATURE :

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle secure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 1-9

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:31 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 86 DODGE ARIES
LICENSE: SGN376
VIN : 1B3BD26DGF286770
MLG : 5,512

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5589** SGN376 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS AND EXHAUST ARE					
***GOOD,NO CODES AND DATA STEAM IS GOOD					
***TEST RESULTS:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :____________________

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-1

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:33 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 88 DODGE ARIES
LICENSE: SGS552
VIN : 1R3BD46D2JP237186
MLG : 39,065

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5611** SGS552 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-2

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:49 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 92 CHEVY CAPRICE RWD
LICENSE: NONE
VIN : 1G1BL5370NW15002
MLG : 111,009

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5614** NONE PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
..L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-3

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:19 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 88 DODGE VANS B350 1 T
LICENSE: AGM160
VIN : 2B4HB21Y7JKA86582
MLG : 13,838

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5619** AGM160 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***CODES AND DATA NOT AVAILABLE ON THIS MODEL					
***TEST REUSLT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ·cure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees .hose made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-4

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:22 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 86 DODGE ARIES
LICENSE: SGN936
VIN : 1B3BD26D4GF310406
MLG : 18,414

Date: 12/05/96 Due Date: 12/05/96 **WORK ORDER: 5609** SGN936 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME,SENSORS,EXHAUST ARE GOOD					
***NO CODES DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL 27.50

TOTAL 27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle secure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE _______.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-5

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:07 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 89 CHEVY CAPRICE
LICENSE: SGZ353
VIN : 1G1BL51ESKA149016
MLG : 699

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5617** SGZ353 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR 27.50	Information Access: 0.00	PARTS 0.00	
SUBLET 0.00	SHOP SUPPLIES : 0.00	EPA CHARGES 0.00	

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :______________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees .hose made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-6

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:25 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 91 CHEVY CAPRICE RWD
LICENSE: NONE
VIN : 1G1L5372MW225036
MLG : 148,153

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5620** NONE PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM ARE GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :______________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE _______.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-7

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:27 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 89 DODGE ARIES
LICENSE: SGF428
VIN : 1B3BK46D6KC468774
MLG : 40,962

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5610** SGF428 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle secure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-8

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
10:10 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ----------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 87 DODGE ARIES
LICENSE: SGR484
VIN : 1B3BD36D7HF199843
MLG : 80,533

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5628** SGR484 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***HAS CODE 15 SPEED SENSOR IS NOT WORKING					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle :cure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 2-9

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:36 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

-------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 87 PLYMOUTH RELIANT
LICENSE: SGR683
VIN : 1P3BP36D4HF226275
MLG : 22,542

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5622** SGR683 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***HAS CODE 51 EXHAUST LEAN OXYGEN SENSOR IS NOT					
***SWITCHING,HAS BROKEN MOTOR MOUNT					
***TEST RESULT:FAIL					

LABOR 27.50	Information Access: 0.00	PARTS	0.00
SUBLET 0.00	SHOP SUPPLIES : 0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :________________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 3-2

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
10:04 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 85 DODGE ARIES
LICENSE: SGM47A
VIN : 1B3BD49D8FF333113
MLG : 5,674

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5627** SGM47A PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***TIMING IS OFF,OXYGEN SENSOR NOT SWITCHING,					
***SPEED SENSOR IS NOT WORKING					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE _______.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 3-3

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
3:15 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 92 CHEVY CAPRICE RWD
LICENSE: NONE
VIN : 1G1BL5378NW150733
MLG : 132,391

Date: 12/18/96 Due Date: 12/18/96 **INVOICE NUMBER: 5712** NONE PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :______________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle l[illegible]re that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle t[illegible]e the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees a[illegible]se made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 3-5

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
3:20 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 87 DODGE ARIES
LICENSE: SGM92E
VIN : 1B38D36D6HF304758
MLG : 11,090

Date: 12/18/96 Due Date: 12/18/96 **INVOICE NUMBER: 5713** SGM92E PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING AND EXHAUST IS GOOD					
***CAR IS RUNNING RICH OXYGEN SENSOR IS STAYING					
***RICH					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my r[illegible] You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle l[illegible] .e that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle t[illegible] re the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees are those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE _______.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 3-6

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
3:37 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 86 DODGE ARIES
LICENSE: SCN181
VIN : 1B3BD26D7GF200871
MLG : 34,840

Date: 12/18/96 Due Date: 12/18/96 **INVOICE NUMBER: 5716** SCN181 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***CAR HAS BAD COMPUTER AND BROKEN MOTOR MOUNT					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :________________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my ri[illegible] You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle l[illegible]e that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle t[illegible]re the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees are those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.

A L L R E M O V E D P A R T S W I L L B E D I S P O S E D O F U N L E S S I I N I T I A L H E R E ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 3-7

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
3:32 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

-------------- SERVICE ---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 86 DODGE VANS B150 1/2 T
LICENSE: SGR105
VIN : 2B4G111T1GK603824
MLG : 16,598

Date: 12/18/96 Due Date: 12/18/96 **INVOICE NUMBER: 5715** SGR105 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***HAS STICKY GAS PEDAL					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :______________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my ri[illegible] You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle l[illegible]e that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle t[illegible] re the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees are those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 3-8

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:21 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 91 CHEVY CAPRICE RWD
LICENSE: NONE
VIN : 1G1BL537XMW225575
MLG : 155,027

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5598** NONE PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME NO CODES HOWEVER ENGINE DOES NOT					
***REACH OPERATING TEMPERATURE OXYGEN SENSOR IS					
***READING RICH.					
***TEST RESULT: FAIL					

LABOR 27.50	Information Access: 0.00	PARTS 0.00
SUBLET 0.00	SHOP SUPPLIES : 0.00	EPA CHARGES 0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL 27.50

TOTAL 27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my ... You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.

ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE _______.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 3-9

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
3:03 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 90 CHEVY CAPRICE
LICENSE: SCEVS
VIN : 1G1BL5372MW227580
MLG : 119,800

Date: 12/18/96 Due Date: 12/18/96 **INVOICE NUMBER: 5710** SCEVS PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within
3 days of the date shown above if I do
not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle tr[illegible] re the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees a[illegible] ,e made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
A[illegible] REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 4-2

I R

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

----- CUSTOMER INFORMATION --------
9:57 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 90 CHEVY CAPRICE
LICENSE: NONE
VIN : 1G1BL571LA153059
MLG : 138,185

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5626** NONE PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***CODES AND DATA ARE O.K					
***TIMING IS ADVANCED ENGINE IS PINGING					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00
PARTS	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASE
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ' secure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees hose made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 4-5

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
8:54 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 88 DODGE ARIES
LICENSE: SGP47P
VIN : 1B3BD46DXJF227954
MLG : 57,594

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5615** SGP47P PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle secure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 4-6

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:41 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 87 PLYMOUTH RELIANT
LICENSE: SGR583
VIN : 1P3BP36D1HF205237
MLG : 34,429

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5623** SGR583 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING AND EXHAUST ARE GOOD					
***HOWEVER SPEED SENSOR IS NOT WORKING					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ·cure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees hose made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
. REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 4-7

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
10:28 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

-------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 89 DODGE ARIES
LICENSE: S6Z647
VIN : 1B3BD46D85F239746
MLG : 64,725

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5630** S6Z647 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***CODES TIMING O.K.					
***HAS BROKEN MOTOR MOUNT					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :________________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle ' [illegible] more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle [illegible]cure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees [illegible]those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
. . .L REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 4-8

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------

8:44 AM

U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------

SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 86 DODGE VANS B350 1 T
LICENSE: SGM68U
VIN : 2B5WB31W0GK609261
MLG : 35,202

Date: 12/05/96 Due Date: 12/05/96 **INVOICE NUMBER: 5613** SGM68U PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***CODES AND DATA NOT AVAILABLE ON THIS MODEL					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees are those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE _______.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 5-1

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
2:48 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 87 DODGE ARIES
LICENSE: SGM76E
VIN : 1B3BD36D8HF304759
MLG : 27,188

Date: 12/18/96 Due Date: 12/18/96 **INVOICE NUMBER: 5709** SGM76E PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT, INSPECT RUNNING CONDITION & EVALUATE FOR IM 240 & ASM 25/25 TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASE
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle t 'e the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees a se made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
A REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 5-3

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
2:29 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE ---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 86 DODGE ARIES
LICENSE: SCEVH
VIN : 1B3BD26D8GF313440
MLG : 75,831

Date: 12/18/96 Due Date: 12/18/96 **INVOICE NUMBER: 5707** SCEVH PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :____________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.

A L L R E M O V E D P A R T S W I L L B E D I S P O S E D O F U N L E S S I I N I T I A L H E R E ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 5-5

L . . _ _R

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
9:33 AM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

--------------- SERVICE---------------
SYMPTOM: ENGINE PERFORMANCE CHECK
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 87 DODGE ARIES
LICENSE: SGM95G
VIN : 1B3BD36D1HF326487
MLG : 26,813

Date: 12/04/96 Due Date: 12/04/96 **WORK ORDER: 5599** SGM95G PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***CODES 51 AND 52					
***OXYGEN SENSOR NOT SWITCH					
***TEST RESULT:FAIL					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :______________________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees hose made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
; REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 5-6

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

--- ---- CUSTOMER INFORMATION --------
3:11 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

-------------- SERVICE---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 90 CHEVY CAPRICE
LICENSE: SCEV6
VIN : 1G1BL5373MR151429
MLG : 115,441

Date: 12/18/96 Due Date: 12/18/96 **INVOICE NUMBER: 5711** SCEV6 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULTS:PASS					

LABOR 27.50	Information Access: 0.00	PARTS	0.00
SUBLET 0.00	SHOP SUPPLIES : 0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

CASH
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50
AMOUNT PAID	27.50

ACCEPTANCE SIGNATURE :________________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle left more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle t[illegible]re the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees a[illegible]e made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop. A[illegible] REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

ASE CERTIFIED MECHANIC
VEHICLE SCREENING
TEST 5-9

LANDING AUTO CENTER

99 MOUNT ARLINGTON BLVD.
LANDING, N.J. 07850
(201) 398-1050

-------- CUSTOMER INFORMATION --------
2:43 PM
U.S. ARMY R,D & E CENTER
ARMAMENT SYSTEMS PROCESS DIV
PICATINNY ARSENAL N.J.07806
(201)724-3572
Wk:(201)724-3162

-------------- SERVICE ---------------
SYMPTOM:
SERVICE: ASE INSPECTION PHASE
YR/MAKE: 87 DODGE ARIES
LICENSE: SGR50C
VIN : 1B3BD36D8HF199768
MLG : 39,572

Date: 12/18/96 Due Date: 12/18/96 **WORK ORDER: 5708** SGR500 PAGE: 1

COMMENTS AND DESCRIPTION OF CHARGES	PRICE	PARTS & LUBRICANTS USED	QTY.	PRICE	TOTAL
ENGINE PERFORMANCE TEST	27.50				
LABOR TO HOOK UP EQUIPMENT,INSPECT RUNNING					
CONDITION & EVALUATE FOR IM 240 & ASM 25/25					
TESTING.					
***AT THIS TIME TIMING,SENSORS,EXHAUST ARE GOOD					
***NO CODES AND DATA STREAM IS GOOD					
***TEST RESULT:PASS					

LABOR	27.50	Information Access:	0.00	PARTS	0.00
SUBLET	0.00	SHOP SUPPLIES :	0.00	EPA CHARGES	0.00

This vehicle will be reassembled within 3 days of the date shown above if I do not authorize the recommended services.

QUOTE (paying by CASH)
THANK YOU FOR YOUR BUSINESS..

SUB-TOTAL	27.50
TOTAL	27.50

ACCEPTANCE SIGNATURE :______________________

I authorize the above repairs and necessary materials. Your employees may operate vehicle for inspection, testing, delivery at my risk. You will not be responsible for loss or damage to vehicle or items left in it. I agree to pay reasonable storage on vehicle more that 48 hours after notification that repairs are completed. An express Mechanics Lein is acknowledged on above vehicle ecure the amount of repairs thereto. Labor is guaranteed for 90 days or 4000 miles whichever occurs first. All other guarantees those made exclusively by the manufacturer. Warranty work that is based on this repair order must be performed at this shop.
ALL REMOVED PARTS WILL BE DISPOSED OF UNLESS I INITIAL HERE ________.

3. Test Allocation of Vehicles

CAR TESTING ORDER
VITALIZER
4 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	A
1-1a	12948	Van	87	8	C
1-2a	29823	K-Car	88	4	A
1-1b	12948	Van	87	8	C
1-3a	68742	K-Car	89	4	A
1-2b	29823	K-Car	88	4	C
1-4a[2]	08399	Chevy	89	8	A
1-3b	68742	K-Car	89	4	A
Control	31996	K-Car	88	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.
2. The car was baselined, but there was not sufficient time to install the device and complete testing. Car was baselined and tested following day.

CAR TESTING ORDER
VITALIZER
5 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	C
1-5a	32760	K-Car	88	4	A
1-4a	08399	Chevy	89	8	C
1-6a	28983	K-Car	88	4	A
1-5b	32760	K-Car	88	4	C
1-7a	27311	Police Cruiser	91	8	A
1-4b	08399	Chevy	89	8	C
1-6b	28983	K-Car	88	4	A
1-7b	27311	Police Cruiser	91	8	C
Control	31996	K-Car	88	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

CAR TESTING ORDER
FUEL CAT
9 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	A
2-1a	37166	K-Car	88	4	C
2-2a	54002	Police Cruiser	92	8	A
2-3a	86582	Ram Van	88	8	A
2-1b	37166	K-Car	88	4	C
2-2b[2]	54002	Police Cruiser	92	8	C
2-4a	10406	K-Car	88	4	A
2-3b	86582	Ram Van	88	8	C
2-2b	54002	Police Cruiser	92	8	A
2-4b	10406	K-Car	88	4	C
2-5a	49016	Chevy Caprice	89	8	A
2-6a	25036	Police Cruiser	91	8	A
2-5b	49016	Chevy Caprice	89	8	A
2-6b	25036	Police Cruiser	91	8	A
Control	31996	K-Car	88	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

2. A complete series was not run. The vehicle was run on the road course again, and retested. The data from this series was not used for overall device performance.

CAR TESTING ORDER
FUEL CAT
10 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	B
2-7a	68774	K-Car	88	4	D
2-8a[2]	99843	K-Car	87	4	A
2-8a	99843	K-Car	87	4	C
2-9a	26275	K-Car	87	4	D
2-7b	68774	K-Car	88	4	B
2-8b	99843	K-Car	87	4	C
2-9b	26275	K-Car	87	4	D
Control	31996	K-Car	88	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

2. The clutch on the dynamometer malfunctioned. The clutch was lubricated and the test sequence for this vehicle was rerun. The data from this run was not used in the device analysis.

CAR TESTING ORDER
COMPLIANACE AND RESEARCH
16 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	B
4-1a[2]	03369	Ram Van	89	8	C
4-1a	29662	Chevy Wagon	89	4	C/B[3]
4-2a[4]	53039	Police Cruiser	90	8	B
4-3a	32063	Dodge Ram	87	8	C
4-1b	29662	Chevy Wagon	89	4	B
4-3b	32063	Dodge Ram	87	8	C
4-2b[5]	53039	Police Cruiser	90	8	A
4-2a	53039	Police Cruiser	90	8	A
Control	31996	K-Car	88	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

2. Problems developed with this vehicle. It was discarded from all testing, and was replaced by a Police Cruiser (Test 4-2).

3. Drivers switched after second series.

4. Car did not have sufficient gas to run second series. Gas put into car and a baseline was run after the test with the device was performed.

5. Only the first three sets of data were obtained for the IM240.

CAR TESTING ORDER
COMPLIANACE AND RESEARCH
17 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	C
4-4a	52548	Police Cruiser	92	8	B
4-5a	27954	K-Car	88	4	C
4-6a	05237	K-Car	87	4	C/A[2]
4-4b	52548	Police Cruiser	92	8	A
4-5b	27954	K-Car	88	4	A
4-6b	05237	K-Car	87	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

2. Drivers changed after second series.

CAR TESTING ORDER
COMPLIANACE AND RESEARCH
18 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	C
4-7a	39746	K-Car	88	4	B
4-8a	09261	Ram Van	86	8	B
4-9a	42293	Ram Pick-up	91	6	A
4-7b	39746	K-Car	88	4	A
4-8b	09261	Ram Van	86	8	A
4-9b	42293	Ram Pick-up	91	6	A
Control	31996	K-Car	88	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

CAR TESTING ORDER
INSET
19 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	B
5-1a	04759	K-Car	87	4	C
5-2a	18650	Pick-up	87	6	B
5-3a	13440	K-Car	86	4	C
5-1b	04759	K-Car	87	4	C
5-2b	18650	Pick-up	87	6	B
5-3b	13440	K-Car	86	4	B
5-4a	85054	Police Cruiser	88	8	C
5-5a	26487	K-Car	87	4	B
5-4b	85054	Police Cruiser	88	8	A
5-5b	26487	K-Car	87	4	A
5-6a	51429	Police Cruiser	91	8	A
5-6b	51429	Police Cruiser	91	8	A
Control	31996	K-Car	88	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

CAR TESTING ORDER
INSET
20 DECEMBER 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	B
5-7a	03825	Van	86	6	C
5-8a	91881	Pick-up	85	6	B
5-7b	03825	Van	86	6	C
5-8b	91881	Pick-up	85	6	B
5-9a	99768	K-Car	87	4	B
5-9b	99768	K-Car	87	4	C
Control	31996	K-Car	88	4	B

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

CAR TESTING ORDER
ENGINEWITY
8 JANUARY 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	B/A[2]
3-1a	82021	Caprice	89	8	B
3-2a	33113	K-Car Wagon	85	4	A
3-3a	50733	Police Cruiser	92	8	A
3-1b	82021	Caprice	89	8	B
3-4a	03369	Van	89	8	B
3-2b	33113	K-Car Wagon	85	4	A
3-3b	50733	Police Cruiser	92	8	C
3-4b	03369	Van	89	8	B

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

2. Drivers changed after two series were completed.

CAR TESTING ORDER
ENGINEWITY
9 JANUARY 1997

TEST[1]	VIN	DESCRIPTION	YEAR	CYLINDERS	DRIVER
Control	31996	K-Car	88	4	A
3-5a	04758	K-Car	87	4	C
3-6a	00871	K-Car	86	4	B
3-7a	03824	Van	86	6	A
3-8a	25575	Police Cruiser	91	8	A
3-5b	04758	K-Car	87	4	A
3-6b	00871	K-Car	86	4	B
3-9a	27580	Police Cruiser	91	8	A
3-7b	03824	Van	86	6	C
3-8b	25575	Police Cruiser	91	8	B
3-9b	27580	Police Cruiser	91	8	A
Control	31996	K-Car	88	4	A

Notes:

1. An 'a' suffix after the Test Number indicates the baseline of the vehicle. A 'b' suffix after the test number indicates, the testing of the vehicle with a device or process.

4. Rejection of Final Emissions Test Data for Specific Vehicles

Data Not Included in Analysis with Rationale for Exclusion

Device	Plate	Data Excluded	Rationale
1	Z338	IM240 Run 1 and 2	Car not sufficiently warmed up.
1	N376	All	Significant degradation in car performance from run 1 to run 2 not attributed device.
2	SGZ353	IM240, Run 2	Data significantly different from three other tests.
2	P428	ASM2525, Run 1	Car not sufficiently warmed up
3	SGM92E	All	Significant degradation in performance from without to with. Degradation in performance during with. Not attributed to device.
3	SGN181	IM240, Run 1	Car not sufficiently warmed up.
3	SGR105	All	Car leaking transmission fluid on to exhaust system.
4	TAG0744	IM240, All	Bimodal distribution in data. Suspected car problem.
4	SGP47P	Run 4	Flat Tire during run.
5	835	IM240 Run 3	Data significantly different from three other tests.
5	SCEV6	IM240 Run 1	Car not sufficiently warmed up.
5	TO5666	IM240 Run 1	Car not sufficiently warmed up.

For the ASM2525 Test, a systematic error occurred in which data for a run was significantly different than the remaining data. It was presumed that this difference was due to the gas sampling equipment and therefore not used in any analysis. Occasions in which this occurred are detailed below:

Device	Plate	Test Run
Control	SGP906	12/10, 1st
Control	SGP906	12/19, 3rd
Control	SGP906	1/9, 3rd
1	SGS165	with - 1
1	Z338	without - 1
1	GKD11c	without - 2
2	SGN936	with - 2
2	SGZ353	without - 1
5	SGP15U	without - 3

APPENDIX C
Description of Test Procedure

1. Description of Test Facility
2. Calibration Records
    a. Constant Volume Sampler
    b. Dynamometer
3. Test Plan
4. Road Conditioning Course
5. Emissions Analysis Test Schedule

1. Description of Test Facility

EQUIPMENT LIST

ANALYZERS

Total Hydrocarbons
California Analytical Insrtuments
Modle: 240 FID

Oxides of Nitrogen
California Analytical Insrtuments
Model: 240 CLD

CO and CO_2
California Analytical Insrtuments
Model: 240 IR

CONSTANT VOLUME SAMPLER

Manufactured by: Environmental Systems Products, Tucson, Arizona

BAR 90 ANALYZER AND SAMPLE SYSTEM

Manufactured by: Environmental Systems Products, Tucson, Arizona

DYNAMOMETER

Manufactured by: Clayton Industries, El Monte, California

2. Calibration Records

a. Constant Volume Sampler

b. Dynamometer

2. Calibration Records

a. Constant Volume Sampler

CVS ation

STATION	LANE	CAL_DATE	CAL_TIME	LAST_DATE	LAST_TIME	VALID_DATE	VALID_TIME	CONCTHCZER	CONCCOZER	CONCCO2ZER
0033	1	12/3/96	155349	12/3/96	155349	12/4/96	075349	0.00	0.00	0.00
0033	1	12/4/96	085010	12/4/96	085010	12/5/96	005010	0.00	0.00	0.00
0033	1	12/5/96	090711	12/5/96	090711	12/6/96	010711	0.00	0.00	0.00
0033	1	12/6/96	085955	12/6/96	085955	12/7/96	005955	0.00	0.00	0.00
0033	1	12/9/96	091055	12/9/96	091055	12/10/96	011055	0.00	0.00	0.00
0033	1	12/10/96	082928	12/9/96	091055	12/10/96	011055	0.00	0.00	0.00
0033	1	12/10/96	083320	12/9/96	091055	12/10/96	011055	0.00	0.00	0.00
0033	1	12/10/96	083922	12/10/96	083922	12/11/96	003922	0.00	0.00	0.00
0033	1	12/11/96	085028	12/11/96	085028	12/12/96	005028	0.00	0.00	0.00
0033	1	12/12/96	082245	12/12/96	082245	12/13/96	002245	0.00	0.00	0.00
0033	1	12/12/96	160413	12/12/96	160413	12/13/96	080413	0.00	0.00	0.00
0033	1	12/13/96	081915	12/13/96	081915	12/14/96	001915	0.00	0.00	0.00
0033	1	12/14/96	082446	12/14/96	082446	12/15/96	002446	0.00	0.00	0.00
0033	1	12/16/96	085038	12/14/96	082446	12/15/96	002446	0.00	0.00	0.00
0033	1	12/16/96	085416	12/16/96	085416	12/17/96	005416	0.00	0.00	0.00
0033	1	12/29/96	134149	12/29/96	134149	12/30/96	054149	0.00	0.00	0.00
0033	1	12/19/96	074934	12/19/96	074934	12/19/96	234934	0.00	0.00	0.00
0033	1	12/20/96	075904	12/20/96	075904	12/20/96	235904	0.00	0.00	0.00
0033	1	12/27/96	101000	12/27/96	101000	12/28/96	021000	0.00	0.00	0.00
0033	1	1/7/97	080547	1/7/97	080547	1/8/97	000547	0.00	0.00	0.00
0033	1	1/8/97	075102	1/8/97	075102	1/8/97	235102	0.00	0.00	0.00
0033	1	1/9/97	075608	1/9/97	075608	1/9/97	235608	0.00	0.00	0.00
0033	1	1/30/97	090421	1/30/97	090421	1/31/97	010421	0.00	0.00	0.00
0033	1	2/5/97	111031	1/30/97	090421	1/31/97	010421	0.00	0.00	0.00
0033	1	2/5/97	111331	2/5/97	111331	2/6/97	031331	0.00	0.00	0.00

CONCNOXZER	CONCTHCSPN	CONCCOSPN	CONCCO2SPN	CONCNOXSPN	CONCTHCMID	CONCCOMID	CONCCO2MID	CONCNOXMID
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	140.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	145.00	1500.00	6040.00	110.00

CONCNOXZER	CONCTHCSPN	CONCCOSPN	CONCCO2SPN	CONCNOXSPN	CONCTHCMID	CONCCOMID	CONCCO2MID	CONCNOXMID
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	150.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	140.00	1500.00	6040.00	110.00
0.00	644.00	9330.00	37200.00	479.00	145.00	1500.00	6040.00	110.00

AVGVTHCZER	AVGVCOZER	AVGVCO2ZER	AVGVNOXZER	AVGVTHCSPN	AVGVCOSPN	AVGVCO2SPN	AVGVNOXSPN	AVGVTHCMID
-0.02	0.14	0.23	0.00	10.00	9.11	9.24	1.92	2.46
-0.02	0.09	0.23	0.02	10.00	9.01	9.22	1.91	2.46
-0.02	-0.03	0.28	0.01	10.00	8.95	9.25	1.93	2.47
-0.02	0.14	0.24	0.00	10.00	9.00	9.13	2.02	2.40
-0.02	0.10	0.28	0.00	10.00	8.99	9.16	1.88	2.45
-0.05	0.10	0.27	-0.01	-0.05	9.07	9.24	2.03	-0.05
-0.05	0.09	0.28	0.00	-0.05	9.06	9.25	2.04	-0.05
-0.02	0.11	0.28	-0.01	10.00	9.08	9.23	2.04	2.36
-0.02	-0.01	0.28	0.00	10.00	8.91	9.19	1.89	2.46
-0.02	0.11	0.28	-0.01	10.00	9.07	9.24	1.99	2.38
-0.02	0.11	0.30	0.00	10.00	9.07	9.26	1.99	2.45
-0.02	-0.01	0.21	0.00	10.00	8.98	9.23	1.97	2.35
-0.02	0.12	0.23	-0.01	10.00	9.10	9.26	2.11	2.38
-0.02	-0.05	0.20	0.00	10.00	8.90	9.22	1.66	2.41
-0.02	-0.05	0.21	0.00	10.00	8.91	9.22	1.92	2.41
-0.01	-0.02	0.27	0.02	10.00	8.95	9.21	1.83	2.45
-0.01	-0.06	0.20	0.01	10.00	8.90	9.17	1.89	2.33
-0.01	-0.07	0.22	0.00	10.00	8.92	9.18	1.89	2.37
-0.01	-0.07	0.22	0.00	10.00	8.96	9.23	1.92	2.44
-0.01	-0.03	0.15	-0.01	10.00	8.93	9.13	1.91	2.31
-0.01	-0.02	0.17	-0.01	10.00	8.96	9.20	1.99	2.33
-0.01	-0.11	0.18	0.02	10.00	8.84	9.21	1.87	2.43
-0.01	-0.07	0.22	-0.01	10.00	9.00	9.29	1.93	2.43
-0.01	-0.08	0.23	0.00	7.80	8.93	9.19	1.87	2.33
-0.01	-0.07	0.23	0.01	10.00	8.92	9.20	1.93	2.34

AVGVCOMID	AVGVCO2MID	AVGVNOXMID	SPAN_ADJ	MID_ADJ	ZERO_ADJ	ADJCOEFF_0	ADJCOEFF_1	COEFF_0	COEFF_1	COEFF_2
2.50	2.94	0.43								
2.41	2.92	0.43								
2.31	2.97	0.42								
2.45	2.90	0.44								
2.41	2.93	0.43								
2.43	2.97	0.44								
2.45	2.96	0.45								
2.46	2.96	0.45								
2.30	2.94	0.40								
2.46	2.97	0.44								
2.48	3.00	0.45								
2.34	2.92	0.43								
2.48	2.95	0.45								
2.26	2.91	0.39								
2.27	2.92	0.43								
2.31	2.93	0.42								
2.25	2.88	0.43								
2.28	2.90	0.42								
2.29	2.91	0.42								
2.30	2.85	0.43								
2.33	2.88	0.44								
2.21	2.88	0.42								
2.30	2.97	0.43								
2.26	2.91	0.00								
2.27	2.91	0.41								

COEFF_3	COEFF_4	PERCMIDTHC	PERCMIDCO	PERCMIDCO2	PERCMIDNOX	PERCSPNTHC	PERCSPNCO	PERCSPNCO2	PERCSPNNOX
		5.59	-0.43	1.22	6.48	1.09	-2.36	-0.99	-4.46
		5.63	-1.10	0.75	3.82	1.09	-4.44	-1.55	-4.91
		5.92	-1.22	0.61	2.18	1.09	-5.73	-0.82	-3.69
		3.13	-0.70	1.70	3.42	1.09	-4.70	-3.48	0.25
		4.96	-0.87	1.10	7.99	1.09	-4.92	-2.72	-5.85
		332.01	-1.91	1.49	4.19	-100.49	-3.20	-1.16	0.44
		320.98	-0.70	0.61	4.63	-100.49	-3.35	-0.82	0.81
		1.47	-0.70	1.00	5.65	1.09	-2.95	-1.26	1.03
		5.51	-1.61	0.84	0.30	1.09	-6.49	-2.27	-5.71
		2.24	-0.65	0.93	5.35	1.09	-3.24	-1.02	-1.36
		5.29	0.27	1.33	7.85	1.09	-3.14	-0.63	-1.40
		1.05	-1.22	0.96	3.29	1.09	-5.13	-1.37	-1.95
		2.49	-0.89	1.06	4.01	1.09	-2.61	-0.56	3.75
		3.37	-2.19	0.54	11.83	1.09	-6.62	-1.46	-15.84
		3.58	-2.05	0.96	6.20	1.09	-6.46	-1.51	-4.24
		5.02	-1.73	0.10	5.64	1.09	-5.74	-1.71	-8.29
		-0.14	-2.13	0.57	5.13	1.09	-6.66	-2.56	-5.71
		1.52	-1.07	0.64	5.30	1.09	-6.30	-2.32	-5.41
		4.19	-1.49	0.42	2.95	1.09	-5.37	-1.34	-4.45
		-1.10	-1.39	1.00	7.41	1.09	-6.13	-3.44	-4.56
		-0.03	-1.07	0.71	5.07	1.09	-5.50	-2.05	-1.15
		3.79	-1.83	0.12	3.42	1.09	-7.93	-1.79	-6.39
		3.78	-1.52	1.25	7.47	1.09	-4.75	0.11	-3.76
		38.64	-2.01	0.60	-98.39	-22.03	-6.15	-2.18	-6.30
		3.70	-1.85	0.37	-0.85	1.09	-6.29	-1.89	-3.95

PERCZERTHC	PERCZERCO	PERCZERCO2	PERCZERNOX	RESULT
-0.13	-1.22	-0.06	2.37	P
-0.16	-1.53	-0.07	3.12	P
-0.13	-2.22	0.21	2.45	P
-0.16	-1.24	-0.02	2.08	P
-0.14	-1.50	0.20	2.32	P
-0.49	-1.48	0.14	1.68	F
-0.49	-1.51	0.19	1.99	F
-0.20	-1.44	0.20	1.90	P
-0.17	-2.09	0.19	2.20	P
-0.21	-1.41	0.21	1.88	P
-0.16	-1.42	0.29	2.17	P
-0.20	-2.10	-0.13	2.36	P
-0.22	-1.34	-0.05	1.67	P
-0.15	-2.33	-0.18	2.32	F
-0.15	-2.35	-0.13	2.43	P
-0.05	-2.13	0.14	3.19	P
-0.06	-2.40	-0.19	2.79	P
-0.05	-2.42	-0.09	2.25	P
-0.05	-2.44	-0.11	2.34	P
-0.06	-2.22	-0.41	1.79	P
-0.08	-2.15	-0.36	1.70	P
-0.05	-2.68	-0.27	3.05	P
-0.04	-2.44	-0.08	1.86	P
-0.04	-2.48	-0.05	2.27	F
-0.03	-2.41	-0.06	2.92	P

2. Calibration Records

b. Dynamometer

CAL_DATE	CAL_TIME	CAL_PERF	CAL_PASSED	CAL_RESULT	OLDT1_ZERO	OLDT1_SPAN	OLDS1_ZERO	OLDS1_SPAN	NEWT1_ZERO
12/3/96	145911	Y	Y	0	0.00	15.91	0.00	10.01	0.01
12/3/96	150850	Y	Y	0	0.01	15.91	0.00	10.01	0.00
12/3/96	155834	Y	Y	0	0.00	15.90	0.00	10.01	0.01
12/12/96	081452	Y	Y	0	0.01	15.93	0.00	10.02	0.00
12/13/96	192518	Y	Y	0	0.00	15.88	0.00	10.02	0.00
12/27/96	091058	Y	Y	0	0.00	15.91	0.00	10.01	0.01
1/6/97	161321	Y	Y	0	0.01	15.93	0.00	10.02	0.00
1/6/97	164326	Y	Y	0	0.00	15.91	0.00	10.01	0.01
1/7/97	100356	Y	Y	0	0.01	15.92	0.00	10.01	0.01
1/7/97	120445	Y	Y	0	0.01	15.90	0.00	10.03	0.00
1/30/97	080741	Y	Y	0	0.00	15.90	0.00	10.02	0.00
2/5/97	112348	Y	Y	0	0.00	15.92	0.00	10.04	0.02

NEWT1_SPAN	NEWS1_ZERO	NEWS1_SPAN	ZEROTORQUE	SPANTORQUE	ZERO_MPH	SPAN_MPH
15.91	0.00	10.01	0.01	7.23	0.00	4.46
15.90	0.00	10.01	0.00	7.23	0.00	4.46
15.93	0.00	10.02	0.01	7.23	0.00	4.46
15.88	0.00	10.02	0.00	7.24	0.00	4.46
15.91	0.00	10.01	0.00	7.23	0.00	4.46
15.93	0.00	10.02	0.01	7.23	0.00	4.46
15.91	0.00	10.01	0.00	7.23	0.00	4.46
15.92	0.00	10.01	0.01	7.24	0.00	4.46
15.90	0.00	10.03	0.01	7.24	0.00	4.46
15.90	0.00	10.02	0.00	7.23	0.00	4.46
15.92	0.00	10.04	0.00	7.23	0.00	4.45
15.89	0.00	10.01	0.02	7.26	0.00	4.46

3. Test Plan

EMISSIONS TESTING
DETAILED TEST PLAN

PREPARED BY:

ENERGETIC SYSTEMS PROCESS DIVISION
and
ENERGETICS & WARHEADS DIVISION
U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT, AND ENGINEERING CENTER

PREPARED FOR:

OFFICE OF TRANSPORTATION TECHNOLOGY
NEW JERSEY DEPARTMENT OF TRANSPORTATION

9 OCTOBER 1996

1. BACKGROUND

The federal 1990 Clean Air Act Amendments mandate that New Jersey reduce air pollution emissions from mobile sources. One potential way of meeting this mandate is the use of devices that reduce pollutants in the air through the modification of a vehicle exhaust system or fuel intake system. Another is the removal of deposits/cleaning of the intake, exhaust (catalytic converter), and combustion chambers of an engine. Pursuant to P.L. 1995, Chapter 112, (Senate No. SCS-1700) the "Federal Clean Air Mandate Compliance Act," funds were reserved to study alternatives. The NJ Department of Transportation has requested testing to determine the effectiveness of devices submitted for study. The testing will be performed by the Armament Engineering Directorate of the U.S. Army Armament Research Development and Engineering Center (ARDEC), which is located at Picatinny Arsenal, N.J. The testing will be performed at ARDEC and at the New Jersey Division of Motor Vehicles Inspection Facility in Wayne.

2. PURPOSE

The purpose of this testing is to determine the ability of each device/process to reduce automobile pollutant emissions. The testing will provide comparative laboratory results on selected vehicles from the oldest portion of the State vehicle fleet. These vehicles represent the highest polluting vehicles in the State of New Jersey based on current DMV records. The results of the testing will be analyzed, statistically evaluated, and a cost/benefit analysis will be included in the test report. Based on the results of this cost/benefit analysis, one or more devices/processes may be subjected to further laboratory testing/fleet evaluation.

3. PREPARATION OF VEHICLES FOR TEST

a. INITIAL VEHICLE SELECTION

Vehicles in the State fleet shall be inspected and screened by the State. The vehicles selected for the test shall be randomly screened from this fleet and shall be determined to be in proper running condition.

The make, model, and year of the selected vehicles shall be those which provide an adequate sample quantity to test all 5 devices/processes, as well as a control vehicle and three spare vehicles. Following vehicle selection by the State the vehicles will be delivered to ARDEC.

b. ASE INSPECTION

Following arrival at ARDEC, the vehicles shall be inspected by an independent ASE Certified mechanic. The vehicles shall be inspected/ tested for any mechanical/electrical/physical problems that may result in questionable test data. The vehicles failing inspection/testing shall be excluded.

INSPECTION ITEMS:
Ignition Timing
Sensors (Oxygen, Idle, etc.)
Computer codes
Integrity of exhaust system

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The federal 1990 Clean Air Act Amendments mandate that New Jersey reduce air pollution emissions from mobile sources. One potential way of meeting this mandate is the use of devices that reduce pollutants in the air through the modification of a vehicle exhaust system or fuel intake system. Another is the removal of deposits/cleaning of the intake, exhaust (catalytic converter), and combustion chambers of an engine. Pursuant to P.L. 1995, Chapter 112, (Senate No. SCS-1700) the "Federal Clean Air Mandate Compliance Act," funds were reserved to study alternatives. The NJ Department of Transportation has requested testing to determine the effectiveness of devices submitted for study. The testing will be performed by the Armament Engineering Directorate of the U.S. Army Armament Research Development and Engineering Center (ARDEC), which is located at Picatinny Arsenal, N.J. The testing will be performed at ARDEC and at the New Jersey Division of Motor Vehicles Inspection Facility in Wayne.

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INSPECTION ITEMS:
Ignition Timing
Sensors (Oxygen, Idle, etc.)
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c. FINAL VEHICLE SELECTION AND VENDOR INSPECTION

After the ASE inspection, nine vehicles, which have been found to be acceptable, will be randomly assigned to each device/process. The Vehicle Identification Number (VIN) for the vehicles in each group will then be recorded. (In addition to the nine, from the acceptable vehicles, a control car will be chosen, tested and evaluated).

Once this sorting has been accomplished each vendor will be given the opportunity to come to ARDEC to inspect (for proper operation) those vehicles which have been assigned for their device/process. All inspections will be done under the observation of an ARDEC representative.

d. VEHICLE TRANSPORT

The vehicles to be tested shall be driven from Picatinny Arsenal to the DMV Inspection facility in Wayne, N.J. The driving will be done by DOT employees. On the first day of testing five of the nine vehicles shall be tested. On the second day the remaining vehicles shall be tested.

e. VEHICLE DISPOSITION

Upon completion of testing, the vehicles shall be returned to the holding lot at ARDEC. From there it is the responsibility of the NJ DOT to remove the vehicles.

4. DEVICE/PROCEDURE VENDOR SUPPLIED DATA

Prior to initiation of vehicle testing, each vendor shall provide ARDEC, through the NJ DOT, the following:

1. Cost for 1, 100, 1,000 units/treatment (with and without installation).
2. Warranted performance claims
3. Specific installation instructions and estimated installation time.
4. Performance/application limitations

5. TEST PROCEDURE

a. DMV INSPECTORS

At the start of the testing, two DMV inspectors who are certified in the operation of the dynamometer shall be selected at Wayne. These same two inspectors shall be used for the duration of the test procedure. This is to minimize any changes in the outcome due to operator variability. All testing on the dynamometer shall be conducted in accordance with the dynamometer manufacturer's instructions.

b. CONTROL TEST

Prior to the start of testing, a control car shall be tested. This car shall be used as a process control during all days of testing. Since it will be required to refuel this car, it shall be fueled with a standard grade commercially available fuel. Sufficient fuel from the same batch load will be on hand to refuel this car as necessary. This car shall be used to validate that the equipment and procedures are operating properly during the testing at the Wayne Inspection Station.

(1) EMISSIONS ANALYSIS TEST SCHEDULE

The control car shall be subjected to the following schedule:
ASM 25/25, IM 240, ASM 25/25, IM 240, ASM 25/25, IM 240, ASM 25/25, IM240
These test protocols can be found in Appendix B, with the following exceptions:

Test procedures
(a) General Requirements
(4) and (6) do not apply

(b) Vehicle Pre Inspection and Preparation
(3) does not apply

(10) Vehicle Conditioning
(i) does not apply
(ii) discretionary precondition - an ASM 25/25 shall be performed

On the third ASM 25/25 for each vehicle, a Tedlar sample bag shall be hooked up to the exhaust of the Constant Volume Sampler and an exhaust gas sample shall be drawn. This sample shall be placed in a UV protected cooler and transported back to ARDEC for analysis using Gas Chromatography and Mass Spectrometry methods described in Appendix C. All sampling and analysis shall be performed by trained personnel, and in accordance with the sampler and analytic manufacturer's instructions.

(2) CONTROL RE-RUN

The same control test shall be performed at the end of the morning period and at the end of the day. All exhaust gas samples shall be transported to ARDEC within four hours of collection, i.e. at the end of the morning test period and at the end of the day. The samples will be promptly injected into the analyzers for analysis. If during these re-runs, the exhaust gases measured deviate from the average performance by more than 2.5 standard deviations and it is determined that it is not due to a malfunction of the vehicle, the test shall be considered void. A total of five tests will be required before this condition will be imposed.

c. PRE-TEST

(1) ROAD TEST CONDITIONING

Once at the Wayne Inspection Station, the vehicles shall be driven over the course indicated in Appendix A. The vehicles shall then be brought into the Wayne Inspection Station and tested.

(2) EMISSIONS ANALYSIS

Once the vehicle has been warmed, the CVS shall be connected to the vehicle exhaust and the 'Emissions Analysis Test Schedule' described under "Control Test" shall be performed.

d. DEVICE/PROCEDURE TESTING

(1) INSTALLATION:

Once the baseline for each vehicle has been completed, the suppliers shall be provided the time to install their device or perform their procedure. The vendor shall be allowed to take each assigned vehicle off the Wayne Inspection Station lot in order to install the device/perform the procedure. The location to which the vehicles are taken shall be approved by ARDEC and DOT five business days prior to initiation of testing. Any special tools or methods employed in the installation/procedure not described in the previously provided procedures shall be noted. All installation and devices/processes shall be performed at the contractors expense.

At all time during installation, there shall be a representative from ARDEC to witness the procedure/installation to assure that it was accomplished in accordance with the procedure/description previously furnished by the vendor.

Each test vehicle shall remain under the observation of an ARDEC or DOT employee at all times during the testing phase..

(2) TEST PROCEDURE:

After installation of the device/process, the vehicle shall be subjected to the same tests and analyses described under the 'Emissions Analysis Test Schedule' section of the 'Control Test' phase.

If the test results for any vehicle indicate a potential mechanical/electrical/physical problem, this vehicle shall be set aside until the problem can be corrected. The re-inspection shall be performed by an ASE mechanic. If the problem cannot be corrected, one of the spare vehicles shall be substituted.

e. POST-TEST:

Following completion of testing, the vendor shall have the option of removing the devices from the test vehicle. The vendor shall be responsible for returning to its original condition any vehicle which has a device removed.

6. DATA ANALYSIS:

Analysis of Variance (ANOVA) and the student "t" test will be employed to analyze the data. As an initial screening, comparisons will be made at a confidence level of 80%. For devices/processes that show a significant improvement, the percentage improvement will be determined. Furthermore, based on the data generated in this test, the required percentage improvement to discern differences at the 80% level will be provided. Each parameter recorded will be individually evaluated.

The ANOVA Test is used to compare two or more means. To use this test, the following conditions must be met:

1. The samples are independent.
2. The populations can be approximated by a normal distribution.
3. Each of the populations have equal standard deviations.

This test allows the pooling of variance thereby increasing the confidence of the estimate of this parameter. In addition, through the use of a multifactor ANOVA, the variance can be apportioned to different factors.

When performing the analysis, these assumptions will be verified.

The Student "t" Test is used to make a comparison of means. To use this test, it is assumed that the population can be approximated by a normal distribution.

Each device/process will be judged solely against the pre-test condition. Due to limited sample size, no comparison between the relative improvement of each of the devices/processes will be made

7. FINAL TEST REPORT

Following the completion of all testing and data analysis, ARDEC will prepare a final test report. This report shall consist of the following:

a. Statement of the objective of the test program.

b. A description of the devices/procedures evaluated and the actual vehicles used.

c. A summary of the test procedures, including any noteworthy occurrences, difficulties encountered, etc.

d. Discussion of results, including statistical analyses. (All test data will be in the appendix to the report)

e. Cost/Benefit Analysis: The total cost of each device/process, including installation, will be compared to the percent reduction of emissions to provide a cost/benefit analysis.

f. Conclusions, Recommendations to DOT.

8. PROGRAM SCHEDULE (BASED ON ACTUAL AWARD DATE OF 7 OCT 96)

TASK	DATE
Provide NJ DOT Detailed Test Plan	21 Oct 96
Receive NJ DOT Vendor Comments	28 Oct 96
Finalize Test Plan	01 Nov 96
Initiate Device/Process Testing	05 Nov 96
Complete Device/Process Testing	03 Dec 96
Deliver Final Report	15 Jan 97

APPENDIX A
ROAD TEST COURSE

ROAD TEST COURSE

The road test course will be as described below and as shown on the accompanying map.

Starting at the Wayne DMV inspection station, exit onto Rt. 46 West (W). From Rt. 46 W, enter Rt. 80 W and proceed on Rt. 80 W to the Rt. 287 exit in Parsippany - Troy Hills. Get back onto Rt. 80 East (E) and proceed to Rt. 23, Rt. 46 exit in Wayne. Exit to Rt. 46 E. Proceed on Rt. 46 E. Take the first exit past the DMV station and take Rt. 46 W back to the DMV station.

The above route is roughly 20 to 24 miles, and will be used by all vehicles in this program. Actual odometer readings may vary because of calibration, and will be recorded. All vehicles will travel as close to the posted speed limit as possible.

APPENDIX B
TEST PROTOCOLS

United States
Environmental Protection Agency

EPA-AA-RSPD-IM-96-2
July 1996

Air

Acceleration Simulation Mode Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications

Technical Guidance

Table of Contents

§85.1 Test Standards and Calculations

(a) Emissions Standards

(1) Start-up ASM Standards. Start-up standards should be used during the first cycle of the program. The exhaust emissions standards for the following model years and vehicle types are cross-referenced by the number in the column in §85.1(a)(3), as noted in the column headings:

(i) Light Duty Vehicles.

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1994+ Tier 1	1	21	41
1991-1995	2	22	42
1983-1990	4	23	43
1981-1982	4	26	43
1980	4	26	48
1977-1979	11	30	48
1975-1976	11	30	50
1973-1974	13	34	50
1968-1972	13	34	51

(ii) High-Altitude Light Duty Vehicles.

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1983-1984	4	26	43
1982	4	29	43

(iii) Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1994+ Tier 1 ≤3750 LVW	1	21	41
1994+ Tier 1 >3750 LVW	2	22	42
1991-1995	5	26	43
1988-1990	7	29	44
1984-1987	7	29	49
1979-1983	11	31	49
1975-1978	12	32	50
1973-1974	13	34	50
1968-1972	13	34	51

(iv) High-Altitude Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)

1991+	6	28	43
1988-1990	9	30	44
1984-1987	9	30	49
1982-1983	12	33	49

(v) Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1994+ Tier 1 ≤5750 LVW	2	22	42
1994+ Tier 1 >5750 LVW	5	26	45
1991-1995	5	26	46
1988-1990	7	29	47
1984-1987	7	29	49
1979-1983	11	31	49
1975-1978	12	32	50
1973-1974	13	34	50
1968-1972	13	34	51

(vi) High-Altitude Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1991+	6	28	46
1988-1990	9	30	47
1984-1987	9	30	49
1982-1983	12	33	49

(2) Final ASM Standards. The following exhaust emissions standards are designed to achieve the emission reduction credits issued by EPA. They should only be used after at least one cycle of operation using the start-up standards in §85.1(a)(1). The exhaust emissions standards for the following model years and vehicle types are cross-referenced by the number in the column in §85.1(a)(3), as noted in the column headings:

(i) Light Duty Vehicles.

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1994+ Tier 1	1	21	41
1983-1995	1	21	41
1981-1982	1	23	41
1980	1	23	45
1977-1979	6	27	45
1975-1976	6	27	48
1973-1974	10	32	48
1968-1972	10	32	49

(ii) High-Altitude Light Duty Vehicles.

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1983-1984	2	23	41
1982	2	23	41

(iii) Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1994+ Tier 1	1	21	41
1988-1995	3	24	42
1984-1987	3	24	46
1979-1983	8	28	46
1975-1978	9	29	48
1973-1974	10	32	48
1968-1972	10	32	49

(iv) High-Altitude Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1988+	4	26	42
1984-1987	4	26	46
1982-1983	9	30	46

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Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
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Model Years	Hydrocarbons Table §85.1 (a)(3)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(3)(iii)
1988+	4	26	44
1984-1987	4	26	46
1982-1983	9	30	46

(3) ASM 2525 and 5015 Concentration Tables

(i) ASM2525 and ASM5015 Hydrocarbon (ppm C6) Table

Column # / ETW	1 5015	1 2525	2 5015	2 2525	3 5015	3 2525	4 5015	4 2525	5 5015	5 2525	6 5015	6 2525	7 5015	7 2525	8 5015	8 2525	9 5015	9 2525	10 5015	10 2525	11 5015	11 2525	12 5015	12 2525	13 5015	13 2525
1750	142	136	224	216	257	245	291	282	324	315	374	364	380	381	407	397	457	447	706	694	774	761	843	828	1118	1098
1875	134	129	212	205	243	236	275	266	306	297	353	344	368	359	384	375	431	421	665	653	729	717	794	780	1052	1034
2000	127	123	201	194	230	223	260	252	289	281	333	325	348	339	363	354	407	398	627	616	688	676	749	736	992	975
2125	121	116	191	184	219	212	246	239	274	267	316	308	329	321	343	335	385	376	592	582	650	638	707	695	938	921
2250	115	111	182	175	208	201	234	227	260	253	299	292	312	305	325	318	365	357	560	551	615	604	669	658	887	872
2375	109	106	173	167	198	192	223	216	247	241	284	277	297	290	309	302	346	339	531	522	583	573	635	624	841	827
2500	105	101	166	160	189	183	212	206	236	230	271	264	283	276	294	288	329	322	505	496	554	544	603	593	800	786
2625	100	97	159	153	181	175	203	197	225	219	259	252	270	263	281	274	314	307	481	472	528	518	574	564	761	748
2750	96	93	152	147	173	168	194	189	216	210	247	241	258	252	269	262	300	294	459	451	503	495	548	539	726	714
2875	92	89	146	141	167	161	187	181	207	201	237	231	247	241	257	251	287	281	439	431	481	473	524	515	695	683
3000	89	86	141	136	160	155	180	174	199	194	228	222	237	232	247	241	276	270	420	413	461	453	502	493	666	654
3125	86	83	136	132	155	150	173	168	191	186	219	214	228	223	238	232	265	260	404	397	443	435	482	474	639	628
3250	83	80	132	127	149	145	167	162	185	180	211	206	220	215	229	224	256	250	388	382	426	419	464	456	615	604
3375	81	78	128	123	145	140	162	157	179	174	204	199	213	208	221	216	247	241	374	368	411	404	447	440	593	583
3500	78	76	124	120	140	136	157	152	173	169	198	193	206	201	214	209	239	234	362	355	397	390	432	424	573	563
3625	76	74	120	117	136	132	152	148	168	164	192	187	200	195	207	203	231	226	350	344	384	377	418	411	554	544
3750	74	72	117	114	133	129	148	144	163	159	186	182	194	189	201	197	224	220	339	333	372	365	405	398	537	527
3875	72	70	114	111	129	125	144	140	159	155	181	177	188	184	196	191	218	213	329	323	361	355	393	386	521	512
4000	71	68	112	108	126	122	140	137	155	151	176	172	183	179	191	186	212	208	320	314	351	345	382	375	506	497
4125	69	67	109	106	123	119	137	133	151	147	172	168	179	175	186	181	206	202	311	305	341	335	371	365	492	484
4250	67	65	107	103	120	117	134	130	147	143	167	164	174	170	181	177	201	197	303	297	332	326	361	355	479	471
4375	66	64	104	101	118	114	131	127	144	140	164	160	170	166	177	173	196	192	295	290	323	318	352	346	467	459
4500	65	63	102	99	115	112	128	124	141	137	160	156	166	162	172	169	192	188	287	282	315	310	343	337	455	447
4625	63	61	100	97	113	109	125	122	137	134	156	152	162	159	169	165	187	183	280	275	308	302	335	329	444	436
4750	62	60	98	95	110	107	122	119	134	131	153	149	159	155	165	161	183	179	273	269	300	295	327	321	433	425
4875	61	59	96	93	108	105	120	117	132	128	149	146	155	152	161	157	179	175	267	262	293	288	319	313	423	415
5000	60	58	94	92	106	103	117	114	129	126	146	143	152	148	157	154	175	171	260	256	286	281	311	305	412	405
5125	58	57	93	90	104	101	115	112	126	123	143	139	148	145	154	150	171	167	254	250	279	274	304	298	402	395
5250	57	56	91	88	102	99	112	110	123	120	140	136	145	142	150	147	167	163	248	244	272	267	296	291	393	386
5375	56	55	89	86	100	97	110	107	121	118	137	133	142	139	147	144	163	159	242	238	266	261	289	284	383	376
5500	55	54	87	85	98	95	108	105	118	115	134	130	139	136	144	141	159	156	236	232	259	255	282	277	374	367
5625	54	53	86	83	96	93	106	103	116	113	131	128	136	133	141	138	156	152	231	226	253	248	276	271	365	359
5750	53	52	84	82	94	91	104	101	113	111	128	125	133	130	138	135	152	149	225	221	247	243	269	264	357	350
5875	52	51	83	80	92	90	102	99	111	108	125	122	130	127	135	132	149	146	220	216	241	237	263	258	348	342
6000	51	50	81	79	90	88	100	97	109	106	123	120	127	124	132	129	146	143	215	211	236	232	257	252	341	334
6125	50	49	80	78	89	86	98	95	107	104	120	118	125	122	129	126	143	140	210	206	231	227	251	247	333	327
6250	50	48	79	76	87	85	96	94	105	102	118	115	123	120	127	124	140	137	206	202	226	222	246	242	326	320
6375	49	48	77	75	86	84	95	92	103	101	116	113	120	118	125	122	138	135	202	198	222	218	242	237	320	314
6500	48	47	76	74	85	83	93	91	102	99	114	112	119	116	123	120	136	133	199	195	218	214	238	233	315	309
6625	48	46	76	74	84	82	92	90	101	98	113	110	117	114	121	119	134	131	196	192	215	211	234	230	310	304
6750	47	46	75	73	83	81	91	89	100	97	112	109	116	113	120	117	132	129	194	190	213	209	232	227	307	301
6875	47	46	75	73	83	81	91	89	99	97	111	109	115	113	119	117	132	129	193	189	211	207	230	225	305	299
7000	47	46	74	72	83	80	91	88	99	96	111	108	115	112	119	116	131	128	192	188	211	207	229	225	304	298
7125	47	46	74	72	82	80	90	88	98	96	111	108	115	112	119	116	131	128	192	188	211	206	229	225	304	298
7250	47	46	74	72	82	80	90	88	98	96	111	108	115	112	119	116	131	128	192	188	211	206	229	225	304	298
7375	47	46	74	72	82	80	90	88	98	96	111	108	115	112	119	116	131	128	192	188	211	206	229	225	304	298
7500	47	46	74	72	82	80	90	88	98	96	111	108	115	112	119	116	131	128	192	188	211	206	229	225	304	298

(ii) ASM2525 and ASM5015 Carbon Monoxide (%CO) Table

Column #	21	21	22	22	23	23	24	24	25	25	26	26	27
ETW	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015
1750	0.80	0.77	1.26	1.22	1.64	1.83	2.07	2.43	2.21	2.73	2.78	3.64	2.97
1875	0.75	0.73	1.19	1.16	1.55	1.72	1.91	2.29	2.09	2.58	2.63	3.43	2.81
2000	0.71	0.69	1.13	1.09	1.47	1.63	1.81	2.17	1.97	2.43	2.48	3.24	2.65
2125	0.68	0.66	1.07	1.04	1.39	1.54	1.71	2.05	1.87	2.30	2.35	3.06	2.51
2250	0.64	0.62	1.02	0.99	1.32	1.47	1.62	1.94	1.77	2.18	2.23	2.90	2.38
2375	0.61	0.59	0.97	0.94	1.26	1.39	1.54	1.85	1.69	2.07	2.12	2.76	2.26
2500	0.59	0.57	0.93	0.90	1.20	1.33	1.47	1.76	1.61	1.97	2.02	2.62	2.15
2625	0.56	0.54	0.89	0.86	1.15	1.27	1.41	1.68	1.53	1.88	1.92	2.50	2.05
2750	0.54	0.52	0.85	0.82	1.10	1.21	1.34	1.60	1.47	1.80	1.84	2.39	1.96
2875	0.52	0.50	0.82	0.79	1.05	1.16	1.29	1.54	1.41	1.72	1.76	2.29	1.88
3000	0.50	0.48	0.79	0.76	1.01	1.12	1.24	1.48	1.35	1.66	1.69	2.19	1.80
3125	0.48	0.46	0.76	0.73	0.98	1.08	1.19	1.42	1.30	1.59	1.63	2.11	1.74
3250	0.46	0.45	0.73	0.71	0.94	1.04	1.15	1.37	1.26	1.53	1.57	2.03	1.67
3375	0.45	0.43	0.71	0.69	0.91	1.00	1.11	1.32	1.21	1.48	1.52	1.96	1.62
3500	0.44	0.42	0.69	0.67	0.88	0.97	1.08	1.28	1.17	1.43	1.47	1.89	1.56
3625	0.42	0.41	0.67	0.65	0.86	0.94	1.05	1.24	1.14	1.39	1.42	1.84	1.52
3750	0.41	0.40	0.65	0.63	0.83	0.92	1.02	1.20	1.11	1.35	1.38	1.78	1.47
3875	0.40	0.39	0.63	0.61	0.81	0.89	0.99	1.17	1.08	1.31	1.34	1.73	1.43
4000	0.39	0.38	0.62	0.60	0.79	0.87	0.96	1.14	1.05	1.28	1.31	1.68	1.39
4125	0.38	0.37	0.60	0.58	0.77	0.85	0.94	1.11	1.02	1.24	1.27	1.64	1.36
4250	0.37	0.36	0.59	0.57	0.75	0.83	0.92	1.08	1.00	1.21	1.24	1.60	1.32
4375	0.36	0.35	0.58	0.56	0.74	0.81	0.89	1.06	0.97	1.18	1.21	1.56	1.29
4500	0.36	0.35	0.57	0.55	0.72	0.79	0.87	1.03	0.95	1.16	1.18	1.52	1.26
4625	0.35	0.34	0.55	0.54	0.70	0.77	0.85	1.01	0.93	1.13	1.15	1.48	1.23
4750	0.34	0.33	0.54	0.53	0.69	0.76	0.84	0.99	0.91	1.10	1.13	1.45	1.20
4875	0.34	0.33	0.53	0.52	0.67	0.74	0.82	0.97	0.89	1.08	1.10	1.42	1.17
5000	0.33	0.32	0.52	0.51	0.66	0.73	0.80	0.95	0.87	1.05	1.08	1.38	1.15
5125	0.32	0.31	0.51	0.50	0.65	0.71	0.78	0.92	0.85	1.03	1.05	1.35	1.12
5250	0.32	0.31	0.50	0.49	0.63	0.70	0.77	0.90	0.83	1.01	1.03	1.32	1.10
5375	0.31	0.30	0.49	0.48	0.62	0.68	0.75	0.89	0.81	0.99	1.01	1.29	1.07
5500	0.30	0.30	0.48	0.47	0.61	0.67	0.73	0.87	0.80	0.97	0.99	1.26	1.05
5625	0.30	0.29	0.47	0.46	0.59	0.65	0.72	0.85	0.78	0.94	0.97	1.24	1.03
5750	0.29	0.29	0.46	0.45	0.58	0.64	0.70	0.83	0.76	0.92	0.94	1.21	1.01
5875	0.29	0.28	0.45	0.44	0.57	0.63	0.69	0.81	0.75	0.91	0.92	1.18	0.98
6000	0.28	0.28	0.44	0.44	0.56	0.62	0.67	0.80	0.73	0.89	0.91	1.16	0.96
6125	0.28	0.27	0.44	0.43	0.55	0.61	0.66	0.78	0.72	0.87	0.89	1.13	0.94
6250	0.27	0.27	0.43	0.42	0.54	0.60	0.65	0.77	0.71	0.85	0.87	1.11	0.93
6375	0.27	0.26	0.42	0.42	0.53	0.59	0.64	0.76	0.69	0.84	0.86	1.09	0.91
6500	0.26	0.26	0.42	0.41	0.52	0.58	0.63	0.74	0.68	0.83	0.84	1.08	0.90
6625	0.26	0.26	0.41	0.41	0.52	0.57	0.62	0.73	0.67	0.82	0.83	1.06	0.88
6750	0.26	0.26	0.41	0.41	0.51	0.57	0.61	0.73	0.67	0.81	0.82	1.05	0.88
6875	0.26	0.25	0.40	0.40	0.51	0.56	0.61	0.72	0.66	0.80	0.82	1.04	0.87
7000	0.25	0.25	0.40	0.40	0.51	0.56	0.61	0.72	0.66	0.80	0.82	1.04	0.87
7125	0.25	0.25	0.40	0.40	0.51	0.56	0.61	0.72	0.66	0.80	0.81	1.04	0.87
7250	0.25	0.25	0.40	0.40	0.50	0.56	0.61	0.72	0.66	0.80	0.81	1.04	0.86
[illegible]	0.25	0.25	0.40	0.40	0.50	0.56	0.61	0.72	0.66	0.80	0.81	1.04	0.86
[illegible]	0.25	0.25	0.40	0.40	0.50	0.56	0.61	0.72	0.66	0.80	0.81	1.04	0.86

Column #	27	28	28	29	29	30	30	31	31	32	32	33	33	34	34
ETW	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525
1750	3.94	3.16	4.24	3.54	4.85	3.92	5.45	4.31	6.06	5.07	7.26	5.26	7.44	8.02	9.90
1875	3.71	2.98	4.00	3.34	4.57	3.70	5.14	4.06	5.70	4.78	6.84	4.96	7.05	7.56	9.90
2000	3.51	2.82	3.77	3.16	4.31	3.49	4.85	3.83	5.38	4.51	6.45	4.68	6.68	7.14	9.90
2125	3.32	2.67	3.57	2.99	4.08	3.31	4.58	3.63	5.09	4.26	6.10	4.43	6.34	6.75	9.66
2250	3.14	2.51	3.38	2.83	3.86	3.13	4.34	3.44	4.82	4.04	5.78	4.20	6.00	6.40	9.14
2375	2.98	2.40	3.21	2.69	3.66	2.98	4.12	3.26	4.57	3.83	5.48	3.98	5.69	6.07	8.67
2500	2.84	2.29	3.05	2.56	3.48	2.83	3.91	3.10	4.35	3.65	5.21	3.79	5.41	5.76	8.25
2625	2.70	2.18	2.91	2.44	3.32	2.70	3.73	2.96	4.14	3.48	4.96	3.61	5.15	5.51	7.85
2750	2.58	2.09	2.78	2.33	3.17	2.58	3.56	2.83	3.95	3.32	4.73	3.45	4.92	5.26	7.50
2875	2.47	2.00	2.66	2.23	3.03	2.47	3.41	2.71	3.78	3.18	4.53	3.30	4.70	5.03	7.17
3000	2.37	1.92	2.55	2.14	2.91	2.37	3.27	2.60	3.62	3.05	4.34	3.17	4.51	4.83	6.87
3125	2.28	1.84	2.45	2.06	2.79	2.28	3.14	2.50	3.48	2.93	4.17	3.04	4.33	4.64	6.60
3250	2.20	1.78	2.36	1.99	2.69	2.20	3.02	2.40	3.35	2.82	4.01	2.93	4.17	4.47	6.35
3375	2.12	1.72	2.28	1.92	2.60	2.12	2.91	2.32	3.23	2.72	3.87	2.83	4.02	4.31	6.13
3500	2.05	1.66	2.20	1.86	2.51	2.05	2.82	2.24	3.12	2.63	3.74	2.73	3.88	4.17	5.92
3625	1.98	1.61	2.13	1.80	2.43	1.99	2.73	2.17	3.02	2.55	3.62	2.65	3.76	4.04	5.73
3750	1.92	1.56	2.07	1.74	2.36	1.93	2.64	2.11	2.93	2.47	3.51	2.57	3.64	3.91	5.55
3875	1.87	1.52	2.01	1.69	2.29	1.87	2.57	2.05	2.85	2.40	3.40	2.49	3.54	3.80	5.39
4000	1.82	1.48	1.95	1.65	2.22	1.82	2.49	1.99	2.77	2.33	3.31	2.43	3.44	3.70	5.24
4125	1.77	1.44	1.90	1.61	2.16	1.77	2.43	1.94	2.69	2.27	3.22	2.36	3.34	3.60	5.09
4250	1.72	1.40	1.85	1.56	2.11	1.73	2.36	1.89	2.62	2.21	3.13	2.30	3.25	3.51	4.96
4375	1.68	1.37	1.81	1.53	2.06	1.68	2.31	1.84	2.55	2.16	3.05	2.24	3.17	3.42	4.83
4500	1.64	1.34	1.76	1.49	2.01	1.64	2.25	1.80	2.49	2.11	2.98	2.19	3.09	3.34	4.71
4625	1.60	1.30	1.72	1.46	1.96	1.61	2.19	1.76	2.43	2.06	2.90	2.14	3.02	3.26	4.60
4750	1.57	1.28	1.68	1.42	1.91	1.57	2.14	1.72	2.37	2.01	2.83	2.09	2.95	3.18	4.49
4875	1.53	1.25	1.64	1.39	1.87	1.53	2.09	1.68	2.32	1.96	2.77	2.04	2.87	3.11	4.38
5000	1.49	1.22	1.60	1.36	1.82	1.50	2.04	1.64	2.26	1.92	2.70	1.99	2.81	3.03	4.28
5125	1.46	1.19	1.57	1.33	1.78	1.46	2.00	1.60	2.21	1.87	2.64	1.95	2.74	2.97	4.18
5250	1.43	1.16	1.53	1.30	1.74	1.43	1.95	1.56	2.16	1.83	2.58	1.90	2.68	2.90	4.08
5375	1.39	1.14	1.50	1.27	1.70	1.40	1.90	1.53	2.11	1.79	2.51	1.86	2.61	2.83	3.98
5500	1.36	1.11	1.46	1.24	1.66	1.37	1.86	1.49	2.06	1.75	2.46	1.82	2.55	2.77	3.89
5625	1.33	1.09	1.43	1.21	1.62	1.34	1.82	1.46	2.01	1.71	2.40	1.77	2.49	2.70	3.80
5750	1.30	1.07	1.40	1.19	1.59	1.31	1.78	1.43	1.96	1.67	2.34	1.74	2.43	2.64	3.71
5875	1.27	1.04	1.37	1.16	1.55	1.28	1.74	1.40	1.92	1.63	2.29	1.70	2.38	2.59	3.62
6000	1.25	1.02	1.34	1.14	1.52	1.25	1.70	1.37	1.88	1.60	2.24	1.66	2.33	2.53	3.54
6125	1.22	1.00	1.31	1.11	1.49	1.23	1.66	1.34	1.84	1.57	2.19	1.63	2.28	2.48	3.47
6250	1.20	0.98	1.28	1.09	1.46	1.20	1.63	1.31	1.80	1.54	2.15	1.60	2.23	2.43	3.40
6375	1.18	0.96	1.26	1.07	1.43	1.18	1.60	1.29	1.77	1.51	2.11	1.57	2.19	2.39	3.34
6500	1.16	0.95	1.24	1.06	1.41	1.16	1.57	1.27	1.74	1.48	2.07	1.54	2.15	2.35	3.28
6625	1.14	0.94	1.23	1.04	1.39	1.15	1.55	1.25	1.72	1.46	2.04	1.52	2.12	2.32	3.23
6750	1.13	0.93	1.21	1.03	1.37	1.14	1.54	1.24	1.70	1.45	2.02	1.50	2.10	2.29	3.20
6875	1.12	0.92	1.20	1.02	1.36	1.13	1.52	1.23	1.68	1.44	2.00	1.49	2.08	2.28	3.17
7000	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.23	1.68	1.43	2.00	1.49	2.08	2.27	3.17
7125	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.22	1.68	1.43	2.00	1.49	2.08	2.27	3.17
7250	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.22	1.68	1.43	2.00	1.49	2.08	2.27	3.17
[illegible]	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.22	1.68	1.43	2.00	1.49	2.08	2.27	3.17
[illegible]	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.22	1.68	1.43	2.00	1.49	2.08	2.27	3.17

(iii) ASM2525 and ASM5015 Nitric Oxide (% NO) Table

Column #	41	41	42	42	43	43	44	44	45	45	46	46	47	47	48	48	49	49	50	50	51	51
ETW	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525
1750	1212	1095	1819	1642	2272	2114	2725	2587	3178	3060	3631	3532	4084	4005	4990	4950	4990	4960	4990	4980	4990	4990
1875	1142	1031	1713	1547	2181	1991	2649	2435	3117	2879	3586	3323	4054	3767	4990	4655	4990	4738	4990	4906	4990	4990
2000	1077	973	1616	1460	2058	1877	2499	2295	2941	2713	3383	3131	3824	3548	4707	4384	4778	4535	4919	4838	4990	4990
2125	1018	920	1527	1380	1944	1774	2360	2167	2776	2561	3192	2955	3609	3348	4441	4136	4578	4349	4853	4776	4990	4990
2250	964	871	1446	1307	1839	1678	2232	2050	2625	2422	3018	2794	3411	3165	4197	3909	4395	4179	4792	4720	4990	4990
2375	915	827	1372	1240	1744	1592	2115	1943	2487	2295	2859	2646	3231	2998	3974	3701	4228	4024	4736	4668	4990	4990
2500	869	786	1304	1179	1657	1512	2009	1845	2361	2179	2714	2512	3066	2845	3771	3512	4076	3881	4685	4620	4990	4990
2625	828	749	1242	1123	1577	1440	1912	1756	2246	2073	2581	2389	2916	2706	3585	3339	3936	3752	4639	4577	4990	4990
2750	791	715	1186	1072	1504	1374	1823	1675	2142	1976	2460	2277	2779	2579	3416	3181	3809	3579	4596	4374	4990	4772
2875	756	684	1134	1026	1438	1313	1742	1601	2046	1888	2350	2175	2654	2463	3261	3037	3669	3417	4484	4176	4892	4556
3000	725	656	1088	984	1378	1258	1668	1533	1959	1808	2249	2082	2539	2357	3120	2906	3510	3270	4290	3996	4680	4359
3125	696	630	1045	945	1323	1208	1601	1471	1879	1734	2157	1997	2435	2260	2992	2787	3366	3135	4114	3832	4488	4180
3250	670	607	1006	910	1273	1163	1539	1415	1806	1667	2073	1920	2340	2172	2874	2677	3234	3012	3952	3681	4311	4016
3375	647	585	970	878	1227	1121	1483	1363	1740	1606	1997	1849	2253	2092	2767	2577	3113	2899	3804	3544	4150	3866
3500	625	566	937	848	1184	1082	1432	1316	1679	1550	1926	1784	2174	2018	2668	2486	3002	2796	3669	3418	4002	3728
3625	605	547	907	821	1146	1047	1384	1273	1623	1498	1862	1724	2100	1950	2578	2401	2900	2701	3544	3302	3867	3602
3750	586	531	879	796	1110	1014	1340	1233	1571	1451	1802	1669	2033	1887	2494	2323	2806	2614	3429	3195	3741	3485
3875	569	515	853	773	1077	984	1300	1195	1523	1407	1747	1618	1970	1829	2417	2251	2719	2533	3323	3096	3625	3377
4000	553	501	829	751	1046	956	1262	1161	1479	1365	1695	1570	1912	1775	2345	2184	2638	2457	3224	3003	3517	3276
4125	538	487	807	731	1017	930	1227	1128	1437	1327	1647	1526	1857	1724	2277	2122	2562	2387	3131	2917	3416	3182
4250	524	475	786	712	990	905	1194	1098	1398	1291	1602	1484	1806	1677	2214	2063	2490	2320	3044	2836	3321	3094
4375	510	463	766	694	964	882	1162	1069	1360	1257	1559	1444	1757	1632	2154	2007	2423	2258	2961	2759	3230	3010
4500	498	451	747	677	939	859	1132	1042	1325	1224	1518	1406	1711	1589	2096	1953	2359	2198	2883	2686	3145	2930
4625	486	440	728	661	916	838	1104	1015	1291	1193	1479	1370	1666	1548	2042	1903	2297	2140	2807	2616	3063	2854
4750	474	430	711	645	893	818	1076	990	1259	1163	1441	1336	1624	1508	1989	1854	2238	2085	2735	2549	2983	2780
4875	463	420	694	630	872	798	1049	966	1227	1134	1405	1302	1583	1470	1938	1806	2180	2032	2665	2483	2907	2709
5000	452	410	677	615	850	778	1023	942	1196	1106	1369	1269	1542	1433	1889	1760	2125	1980	2597	2420	2833	2640
5125	441	400	661	600	830	760	998	919	1167	1078	1335	1237	1503	1397	1840	1715	2070	1930	2530	2359	2760	2573
5250	431	391	646	586	810	741	974	896	1138	1051	1301	1206	1465	1362	1793	1672	2017	1881	2466	2298	2690	2507
5375	420	382	631	573	790	723	950	874	1109	1025	1269	1176	1428	1327	1747	1629	1966	1833	2403	2240	2621	2443
5500	410	373	616	559	771	706	926	853	1082	1000	1237	1147	1392	1294	1703	1587	1916	1786	2341	2183	2554	2381
5625	401	364	601	546	752	689	904	832	1055	975	1206	1118	1357	1261	1659	1547	1867	1740	2282	2127	2489	2321
5750	391	356	587	534	734	673	882	812	1029	951	1176	1090	1323	1230	1617	1508	1820	1697	2224	2074	2426	2262
5875	383	348	574	522	717	657	860	793	1004	928	1147	1064	1290	1199	1577	1471	1774	1654	2168	2022	2366	2206
6000	374	340	561	510	701	642	840	774	980	906	1120	1039	1259	1171	1539	1435	1731	1614	2116	1973	2308	2152
6125	366	333	549	499	685	628	822	757	958	886	1094	1015	1230	1144	1503	1401	1690	1577	2066	1927	2254	2102
6250	359	326	538	489	671	615	804	741	937	867	1070	993	1203	1119	1469	1371	1653	1542	2020	1884	2204	2056
6375	352	320	528	480	658	604	788	727	919	850	1049	973	1179	1096	1439	1343	1619	1510	1979	1846	2159	2014
6500	346	315	519	473	647	593	775	714	902	835	1030	956	1158	1077	1413	1318	1590	1483	1943	1813	2119	1977
6625	341	311	512	466	638	585	763	704	889	823	1014	941	1140	1060	1391	1298	1565	1460	1913	1785	2087	1947
6750	338	307	507	461	631	578	755	696	879	813	1003	931	1127	1048	1374	1283	1546	1443	1890	1764	2062	1924
6875	335	305	503	458	626	574	749	691	872	807	995	924	1118	1040	1364	1273	1534	1432	1875	1750	2046	1909
7000	335	305	502	457	624	573	747	689	870	805	992	921	1115	1037	1360	1269	1530	1428	1870	1745	2040	1904
7125	335	305	502	457	625	573	747	689	870	805	992	921	1115	1037	1360	1269	1531	1428	1874	1745	2045	1904
7250	335	305	502	457	625	573	747	689	870	805	992	921	1115	1037	1360	1269	1531	1428	1874	1745	2045	1904
7375	335	305	502	457	625	573	747	689	870	805	992	921	1115	1037	1360	1269	1531	1428	1874	1745	2045	1904
7500	335	305	502	457	625	573	747	689	870	805	992	921	1115	1037	1360	1269	1531	1428	1874	1745	2045	1904

(b) Test Score Calculation

(1) <u>Exhaust Gas Measurement Calculation</u>.

(i) <u>Measurement Start</u>. The analysis and recording of exhaust gas concentrations shall begin 15 seconds after the applicable test mode begins, or sooner if the system response time (to 100%) is less than 15 seconds. The analysis and recording of exhaust gas concentrations shall not begin sooner than the time period equivalent to the response time of the slowest transducer.

(ii) <u>Sample Rate</u>. Exhaust gas concentrations shall be analyzed at a minimum rate of once per second.

(iii) <u>Emission Measurement Calculations</u>. Partial stream (concentration) emissions shall be calculated based on a running 10 second average. The values used for HC(j), CO(j), and NO(j) are the raw (uncorrected) tailpipe concentrations.

(A) $$AvgHC = \frac{\sum_{j-10}^{j} HC(j) * DCF(j)}{10}$$

(B) $$AvgCO = \frac{\sum_{j-10}^{j} CO(j) * DCF(j)}{10}$$

(C) $$AvgNO = \frac{\sum_{j-10}^{j} NO(j) * DCF(j)}{10}$$

(iv) <u>Dilution Correction Factor</u>. The analyzer software shall multiply the raw emissions values by the Dilution Correction Factor (DCF) during any valid ASM emissions test. The DCF accounts for exhaust sample dilution (either intentional or unintentional) during an emissions test. The analyzer software shall calculate the DCF using the following procedure, and shall select the appropriate vehicle fuel formula. If the calculated DCF exceeds 3.0 then a default value of 3.0 shall be used.

(A) $$X = \frac{[CO_2]_{measured}}{[CO_2]_{measured} + [CO]_{measured}}$$

Where $[CO_2]_{measured}$ and $[CO]_{measured}$ are the instantaneous ASM emissions test readings.

(B) Calculate $[CO_2]_{adjusted}$ using the following formulas.

(1) For Gasoline:

$$[CO_2]_{adjusted} = \left[\frac{X}{4.644+1.88X}\right] * 100$$

(2) For Methanol or Ethanol:

$$[CO2]adjusted = \left[\frac{X}{4.73+1.88X}\right]*100$$

(3) For Compressed Natural Gas (CNG):

$$[CO2]adjusted = \left[\frac{X}{6.64+1.88X}\right]*100$$

(4) For Liquid Propane Gas (LPG):

$$[CO2]adjusted = \left[\frac{X}{5.39+1.88X}\right]*100$$

(C) Calculate the DCF using the following formula:

$$DCF = \frac{[CO2]adjusted}{[CO2]measured}$$

(v) NO Humidity Correction Factor. The NO measurement shall be adjusted based on relative humidity using a correction factor K_h, calculated as follows:

(A) $K_h = \dfrac{1}{1 - 0.0047(H-75)}$

(B) H = Absolute humidity in grains of water per pound of dry air.

$$= \frac{(43.478)Ra*Pd}{P_B-(Pd*Ra/100)}$$

(C) Ra = Relative humidity of the ambient air, percent.

(D) Pd = Saturated vapor pressure, mm Hg at the ambient dry bulb temperature. If the temperature is above 86_F, then it shall be used in lieu of the higher temperature, until EPA supplies final correction factors.

(E) P_B = Barometric pressure, mm Hg.

(2) Pass/Fail Determination. A pass or fail determination shall be made for each applicable test mode based on a comparison of the applicable test standards and the measured value for HC, CO, and NO as described in §85.1(b)(1)(iii). A vehicle shall pass the test mode if the emission values for HC, CO, and NO are simultaneously below or equal to the applicable short test standards for all three pollutants. A vehicle shall fail the test mode if the values for HC, CO, or NO, or any combination of the three, are above the applicable standards at the expiration of the test time.

§85.2 Test Procedures

(a) General Requirements.

(1) Vehicle Characterization. The following information shall be determined for the vehicle being tested and used to automatically select the dynamometer power absorption settings:

(i) Vehicle type: LDGV, LDGT1, LDGT2, HDGT, and others as needed
(ii) Chassis model year
(iii) Make
(iv) Model
(v) Number of cylinders
(vi) Cubic inch or liters displacement of the engine
(vii) Transmission type
(viii) Equivalent Test Weight.

(2) Ambient Conditions. The ambient temperature, absolute humidity, and barometric pressure shall be recorded continuously during the test cycle or as a single set of readings up to 4 minutes before the start of the driving cycle.

(3) Restart. If shut off, the vehicle shall be restarted as soon as possible before the test and shall be running for at least 30 seconds prior to the start of the ASM driving cycle.

(4) Void Test Conditions. The test shall immediately end and any exhaust gas measurements shall be voided if the instantaneous measured concentration of CO plus CO_2 falls below six percent or the vehicle's engine stalls at any time during the test sequence.

(5) Vehicle Brakes. The vehicle's brakes shall not be applied during the test modes. If the vehicles brakes are applied during testing the mode timer shall be reset to zero (tt = 0).

(6) Test Termination. The test shall be aborted or terminated upon reaching the overall maximum test time.

(b) Vehicle Pre-inspection and Preparation.

(1) Accessories. All accessories (air conditioning, heat, defogger, radio, automatic traction control if switchable, etc.) shall be turned off (if necessary, by the inspector).

(2) Exhaust Leaks. The vehicle shall be inspected for exhaust leaks. Audio assessment while blocking exhaust flow, or gas measurement of carbon dioxide or other gases shall be acceptable. Vehicles with leaking exhaust systems shall be rejected from testing.

(3) Fluid Leaks. The vehicle shall be inspected for fluid leaks. Vehicles with leaking engine oil, transmission fluid, or coolant shall be rejected from testing.

(4) Mechanical Condition. Vehicles with obvious mechanical problems (engine, transmission, brakes, or exhaust) that either create a safety hazard or could bias test results shall be rejected from testing.

(5) Operating Temperature. The vehicle shall be at normal operating temperature prior to the start of the test. The vehicle temperature gauge, if equipped and operating, shall be checked to assess temperature. Vehicles in overheated condition shall be rejected from testing.

(6) Tire Condition. Vehicles shall be rejected from testing if tread indicators, tire cords, bubbles, cuts, or other damage are visible. Vehicles shall be rejected from testing if they have space-saver spare tires or if they do not have reasonably sized tires on the drive axle or axles. Vehicles may be rejected if they have different sized tires on the drive axle or axles. In test-and-repair facilities, drive wheel tires shall be checked with a gauge for adequate tire pressure. In test-only facilities, drive wheel tires shall be visually checked for adequate pressure level. Drive wheel tires that appear low shall be inflated to approximately 30 psi, or to tire side wall pressure, or vehicle manufacturer's recommendation. Alternatively, vehicles with apparent low tire pressure may be rejected from testing.

(7) Gear Selection. The vehicle shall be operated during each mode of the test with the gear selector in drive for automatic transmissions and in second (or third if more appropriate) for manual transmissions for the loaded modes.

(8) Roll Rotation. The vehicle shall be maneuvered onto the dynamometer with the drive wheels positioned on the dynamometer rolls. Prior to test initiation, the rolls shall be rotated until the vehicle laterally stabilizes on the dynamometer. Vehicles that cannot be stabilized on the dynamometer shall be rejected from testing. Drive wheel tires shall be dried if necessary to prevent slippage.

(9) Vehicle Restraint. Testing shall not begin until the vehicle is restrained. Any restraint system shall meet the requirements of §85.3(a)(5)(ii). In addition, the parking brake shall be set for front wheel drive vehicles prior to the start of the test, unless parking brake functions on front axle or if is automatically disengaged when in gear.

(10) Vehicle Conditioning.

(i) Queuing Time. When a vehicle waits in a queue more than 20 minutes or when a vehicle is shut-off for more than 5 minutes prior to the test, vehicle conditioning shall be performed for 60 seconds, as specified in §85.2(b)(10)(ii)(C). Emissions may be monitored during this cycle and if passing readings are obtained, as specified for the ASM cycle in §85.2(d), then the cycle may be terminated and the respective ASM mode skipped.

(ii) Discretionary Preconditioning. At the program's discretion, any vehicle may be preconditioned using any of the following methods:

(A) Non-loaded Preconditioning. Increase engine speed to approximately 2500 rpm, for up to 4 minutes, with or without a tachometer.

(B) Loaded Preconditioning. Drive the vehicle on the dynamometer at 30 miles per hour for up to 240 seconds at road-load.

(C) ASM Preconditioning. Drive the vehicle on the dynamometer using either mode of the ASM test as specified in §85.2(d).

(D) Transient Preconditioning. After maneuvering the vehicle onto the dynamometer, drive a transient cycle consisting of speed, time, acceleration, and load relationships such as the IM240.

(c) Equipment Preparation and Settings.

(1) Analyzer Warm-Up. Emission testing shall be locked out until the analyzer is warmed-up and stable. The analyzer shall reach stability within 30 minutes from startup. If an analyzer does not achieve stability within the allotted time frame, it shall remain locked out from testing. The instrument shall be considered "warmed-up" when the zero and span readings for HC, CO, NO, and CO_2 have stabilized within the accuracy values specified in §85.3(c)(3) for five minutes without adjustment (this does not require span gas verification of warm-up, but provides the quality assurance method for checking).

(2) Emission Sample System Purge. While a lane is in operation, the sample system shall be continuously purged after each test for at least 15 minutes if not taking measurements.

(3) Probe Insertion. The sample probe shall be inserted into the vehicle's tailpipe to a minimum depth of 10 inches. If the vehicle's exhaust system prevents insertion to this depth, a tailpipe extension shall be used.

(4) Multiple exhaust pipes. Exhaust gas concentrations from vehicle engines equipped with functionally independent multiple exhaust pipes shall be sampled simultaneously.

(5) Analyzer Preparation. The analyzer shall perform an automatic zero, an ambient air reading, and an HC hang-up check prior to each test. This process shall occur within two minutes of the start of the test.

(i) Automatic Gas Zero. The analyzer shall conduct automatic zero adjustments using the zero gas specified in §85.4(d)(2)(iii). The zero adjustment shall include the HC, CO, CO_2, and NO channels. Bottled or generated zero air may be used.

(ii) Ambient Air Reading. Filtered ambient air shall be introduced to the analyzer before the sample pump, but after the sample probe, hose, and filter/water trap. The analyzer shall record the concentrations of the four measured gases, but shall make no adjustments.

(iii) HC Hang-up Determination. The analyzer shall sample ambient air through the probe to determine background pollution levels and HC hang-up. The analyzer shall be locked out from testing until (1) the sample through probe has less than 15 ppm HC, 0.02% CO, and 25 ppm NO; and, (2) the residual HC in the sampling system (probe sample - ambient air reading) is less than 7 ppm.

(6) Cooling System. When ambient temperatures exceed 72°F, testing shall not begin until the cooling system blower is positioned and activated. The cooling system blower shall be positioned to direct air to the vehicle cooling system, but shall not be directed at the catalytic converter.

(7) Dynamometer Warm-Up. The dynamometer shall be automatically warmed-up prior to official testing and shall be locked out until it is warmed-up. Dynamometers resting (not operated for at least 30 seconds and at least 15 mph) for more than 30 minutes shall pass the coast-down check specified in §85.4(b)(1) prior to use in testing. As specified in §85.4(a)(2), control charts may be used to demonstrate allowing a longer duration of inactivity before a required warm-up.

(8) Load Setting. Prior to each mode, the system shall automatically select the load setting of the dynamometer from a look-up table supplied by EPA or the state.

(9) Engine Speed. Engine speed measurement equipment shall be attached on all 1996 and newer light duty vehicles and trucks, and in test-and-repair programs, engine speed shall also be monitored on all pre-1996 vehicles. Starting in 1998, the SAE-standardized OBD plug shall be used on 1996 and newer vehicles. Engine speed measurement equipment shall meet the requirements of §85.3(c)(5).

(d) Test Procedures.

The test sequence shall consist of either a single ASM mode or both ASM modes described in §85.2(d)(1) and (2), and may be performed in either order (with appropriate chnage in transition requirements in §85.2(d)(1)(iv)). Vehicles that fail the first-chance test described in §85.2(d) shall receive a second-chance test if the conditions in §85.2(e) apply. The test timer shall start (tt=0) when the conditions specified in §85.2(c)(2) and §85.2(c)(3) are met and the mode timer initiates as specified in §85.2(d)(1) or §85.2(d)(2). The test sequence shall have an overall maximum test time of 290 seconds (tt=290). The test shall be immediately terminated or aborted upon reaching the overall maximum test time.

(1) ASM5015 Mode.

(i) The mode timer shall start (mt=0) when the dynamometer speed (and corresponding power) is maintained within 15±1.0 miles per hour for 5 continuous seconds. If the inertia simulation error exceeds the tolerance specified in §85.3(a)(4)(ii)(A) (or §85.3(a)(4)(ii)(B) if used) for more than 3 consecutive seconds after the mode timer is started, the test mode timer shall be set to mt=0. Should this happen a second time, the test shall be aborted. The dynamometer shall apply the correct torque for 15.0 mph for the torque at any testing speed within the tolerance of 15±1.0 miles per hour (i.e., constant torque load over speed range). The torque tolerance shall be ± 5% of the correct torque at 15 mph.

(ii) The dynamometer power shall be automatically selected from an EPA-supplied or EPA-approved look-up table, based upon the vehicle identification information described in §85.2(a)(1). Vehicles not listed in the look-up table and for which ETW is not available shall be tested using the following default settings:

Default ASM5015 Actual Horsepower Settings
For 8.6" Dynamometers $HP5015_{8}$

↓Vehicle Type Number of Cylinders→	3	4	5 & 6	8	> 8
Sedans	7.9	11.4	13.8	16.4	16.0
Station Wagons	8.1	11.7	13.8	16.1	16.1
Mini-vans	10.2	14.1	15.8	17.9	18.2
Pickup Trucks	9.6	13.1	16.4	19.2	21.1
Sport/Utility	10.1	13.4	15.5	19.4	21.1
Full Vans	10.3	13.9	17.7	19.6	20.5

Default ASM5015 Actual Horsepower Settings
For 20" Dynamometers $HP5015_{20}$

↓Vehicle Type Number of Cylinders→	3	4	5 & 6	8	> 8
Sedans	8.1	11.8	14.3	16.9	16.6
Station Wagons	8.3	12.1	14.2	16.6	16.6
Mini-vans	10.4	14.5	16.3	18.5	18.7
Pickup Trucks	9.8	13.4	16.8	19.8	21.7
Sport/Utility	10.5	13.8	15.9	19.9	21.7
Full Vans	10.8	14.4	18.2	20.2	21.1

If the dynamometer speed or torque falls outside the speed or torque tolerance for more than 2 consecutive seconds, or for more than 5 seconds total, the mode timer shall reset to zero and resume timing. The minimum mode length shall be determined as described in §85.2(d)(iii). The maximum mode length shall be 90 seconds elapsed time (mt=90).

During the 10 second period used for the pass decision, the dynamometer speed shall not fall more than 0.5 mph (absolute drop, not cumulative). If the speed at the end of the 10 second period is more than 0.5 mph less than the speed at the start of the 10 second period, testing shall continue until the speed stabilizes enough to meet this criterion.

The ten second emissions window shall be matched to the corresponding vehicle speed trace time window. This shall be performed by subtracting the nominal response time for the analyzers from the mode time to determine the time for the corresponding vehicle speed.

(iii) The pass/fail analysis shall begin after an elapsed time of 25 seconds (mt=25). A pass or fail determination shall be made for the vehicle and the mode shall be terminated as follows:

(A) The vehicle shall pass the ASM5015 mode and the mode shall be immediately terminated if, at any point between an elapsed time of 25 seconds (mt=25) and 90 seconds (mt=90), the 10 second running average measured values for each pollutant are simultaneously less than or equal to the applicable test standards described in §85.1(a).

(B) The vehicle shall fail the ASM5015 mode and the mode shall be terminated if the requirements of §85.2(d)(1)(iii)(A) are not satisfied by an elapsed time of 90 seconds (mt=90).

(iv) Upon termination of the ASM5015 mode, the vehicle shall immediately begin accelerating to the speed required for the ASM2525 mode. The dynamometer torque shall smoothly transition during the acceleration period and shall automatically reset to the load required for the ASM2525 mode as specified in §85.2(d)(2)(i) once the roll speed specified in §85.2(d)(2)(i) is achieved.

(2) ASM2525 Mode.

(i) The mode timer shall start (mt=0) when the dynamometer speed (and corresponding power) are maintained within 25±1.0 miles per hour for 5 continuous seconds. If the inertia simulation error exceeds the tolerance specified in §85.3(a)(4)(ii)(A) (or §85.3(a)(4)(ii)(B) if used) for more than 3 consecutive seconds after the mode timer is started, the test mode timer shall be set to mt=0. Should this happen a second time, the test shall be aborted. The dynamometer shall apply the correct torque for 25.0 mph for the torque at any testing speed within the tolerance of 25±1.0 miles per hour (i.e., constant torque load over speed range). The torque tolerance shall be ± 5% of the correct torque at 25 mph.

(ii) The dynamometer power shall be automatically selected from an EPA-supplied or EPA-approved look-up table, based upon the vehicle identification information described in §85.2(a)(1). Vehicles not listed in the look-up table and for which ETW is not available shall be tested using the following default settings:

Default ASM2525 Actual Horsepower Settings
For 8.6" Dynamometers $HP2525_8$

↓Vehicle Type Number of Cylinders→	3	4	5 & 6	8	> 8
Sedans	6.7	9.5	11.5	13.7	13.3
Station Wagons	6.8	9.7	11.5	13.4	13.3
Mini-vans	8.8	11.7	13.2	14.9	15.3
Pickup Trucks	8.0	10.9	13.6	16.0	17.8
Sport/Utility	8.8	11.2	12.9	16.1	17.8
Full Vans	9.0	11.6	14.7	16.3	17.2

Default ASM2525 Actual Horsepower Settings
For 20" Dynamometers $HP2525_{20}$

↓Vehicle Type Number of Cylinders→	3	4	5 & 6	8	> 8
Sedans	6.9	10.1	12.3	14.5	14.3
Station Wagons	7.0	10.4	12.2	14.2	14.4
Mini-vans	8.9	12.5	14.0	15.9	16.3
Pickup Trucks	8.1	11.4	14.4	16.9	18.8
Sport/Utility	8.9	11.8	13.6	17.1	18.8
Full Vans	9.1	12.5	15.5	17.3	18.3

If the dynamometer speed or torque falls outside the speed or torque tolerance for more than two consecutive seconds, or for more than 5 seconds total, the mode timer shall reset to zero and resume timing. The minimum mode length shall be determined as described in §85.2(d)(2)(iii). The maximum mode length shall be 90 seconds elapsed time (mt=90).

During the 10 second period used for the pass decision, the dynamometer speed shall not fall more than 0.5 mph (absolute drop, not cumulative). If the speed at the end of the 10 second period is more than 0.5 mph less than the speed at the start of the 10 second period, testing shall continue until the speed stabilizes enough to meet this criterion.

(iii) The pass/fail analysis shall begin after an elapsed time of 25 seconds (mt=25). A pass or fail determination shall be made for the vehicle and the mode shall be terminated as follows:

(A) The vehicle shall pass the ASM2525 mode if, at any point between an elapsed time of 25 seconds (mt=25) and 90 seconds (mt=90), the 10-second running average measured values for each pollutant are simultaneously less than or equal to the applicable test standards described in §85.1(a). If the vehicle passed the ASM5015 mode, as described in §85.2(d)(1)(iii), the ASM2525 mode shall be terminated upon obtaining passing scores for all three pollutants. If the vehicle failed the ASM5015 mode, the ASM2525 mode shall continue for an elapsed time of 90 seconds (mt=90).

(B) The vehicle shall fail the ASM2525 mode and the mode shall be terminated if the requirements of §85.2(d)(2)(iii)(A) are not satisfied by an elapsed time of 90 seconds (mt=90).

(e) Second Chance Tests.

(1) If the vehicle fails the first-chance test, the test timer shall reset to zero (tt=0) and a second-chance test shall be performed, except as noted below. The second-chance test shall have an overall maximum test time of 145 seconds (tt=145) if one mode is repeated, an overall maximum time of 290 seconds (tt=290) if two modes are repeated.

(2) Repetition or extension of failed modes for two mode ASM tests. Except in the case of vehicles subject to preconditioning specified in §85.2(b)(10(i), if at least 90 seconds of loaded preconditioning is performed, as specified in §85.2(b)(10)(ii), then the second-chance test may be omitted.

(i) If the vehicle failed only the first mode (ASM5015) of the first chance test, then that mode shall be repeated upon completion of the second mode (ASM2525). The repeated mode shall be performed as described in §85.2(d)(1) except that the provisions of §85.2(d)(1)(iv) shall be omitted. The test will terminate when the mode ends or when the vehicle passes, whichever occurs first.

(ii) If the vehicle is failing only the second mode (ASM2525) of the first chance test, then the second mode shall not end at 90 seconds but shall continue for up to 180 seconds. Mode and test timers shall not reset but rather continue up to 180 seconds. The provisions of §85.2(d)(2) shall continue to apply throughout the 180 second test period.

(iii) If the vehicle failed both modes (ASM5015 and ASM2525) of the first chance test, then the vehicle shall receive a second-chance test for the ASM5015. If the vehicle fails the second-chance ASM5015, then the vehicle shall fail the test. Otherwise, the vehicle shall also receive a second-chance ASM2525.

(3) Repetition of failed modes for single mode ASM tests.

(ii) If the vehicle is failing at the end of the mode then the test mode shall not end at 90 seconds but shall continue for up to 180 seconds. Mode and test timers shall not reset but rather continue up to 180 seconds. The provisions of §85.2(d)(1) or §85.2(d)(2) shall continue to apply throughout the 180 second test period.

§85.3 Test Equipment Specifications

(a) Dynamometer Specifications.

(1) General Requirements

(i) Only one diameter of dynamometer shall be used in a program.

(ii) The dynamometer structure (e.g., bearings, rollers, pit plates, etc.) shall accommodate all light-duty vehicles and light-duty trucks up to 8500 pounds GVWR.

(iii) Dynamometer ASM load horsepower (HP5015 or HP2525) shall be automatically selected based on the vehicle parameters in the test record.

(iv) All dynamometers shall have an identification plate permanently affixed showing at a minimum, the dynamometer manufacturers name, the system provider's name, production date, model number, serial number, dynamometer type, maximum axle weight, maximum HP absorbed, roll diameter, roll width, base inertia weight, and electrical requirements.

(v) Alternative dynamometer specifications or designs may be allowed if proposed by a state and upon a determination by the Administrator that, for the purpose of properly conducting an approved short test, the evidence supporting such deviations show that proper vehicle loading will be applied.

(2) Power Absorption.

(i) Vehicle Loading. The vehicle loading used during the ASM driving cycles shall follow the equation in §85.3(a)(2)(ii) at 15 and 25 mph. Unless otherwise noted, any horsepower displayed during testing shall be expressed as HP.

(ii) IHP = THP - PLHP - GTRL

HP = IHP + PLHP

Where:

HP = The actual Horsepower value contained in the look-up table for a vehicle being tested (using the ASM5015 or 2525) on a dynamometer with the specified diameter rollers. The actual horsepower is the sum of the indicated horsepower and the parasitic losses (PLHP)

IHP = Indicated Horsepower value set on the dynamometer.

THP = Total Horsepower for an ASM test includes indicated, tire losses, and parasitics. This value is independent of roll size.

GTRL = Generic Tire/Roll Interface Losses at the specified speed (15 or 25 mph) on a dynamometer with the specified diameter rollers.

PLHP = Parasitic Losses Horsepower due to internal dynamometer friction. A value is specific to each individual dynamometer and speed.

(*iii*) Range of Power Absorber. The range of the power absorber shall be sufficient to simulate the load required to perform an ASM5015 and an ASM2525 on all light-duty vehicles and light-duty trucks up to 8500 pounds GVWR. The power absorber shall absorb, at 14 mph and above, a minimum of 25 horsepower continuously for a steady-state test of at least 5 minutes, with 3 minutes between each test.

(iv) Parasitic Losses. The parasitic losses (PLHP) in each dynamometer system (including but not limited to windage, bearing friction, and system drive friction) shall be characterized at 15 and 25 mph upon initial acceptance, and during each dynamometer calibration. The parasitic power losses shall be determined as indicated in §85.4(b)(2).

(v) Power Absorber. Only electric power absorbers shall be used unless alternatives are proposed by the state and approved by the Administrator. The power absorber shall be adjustable in 0.1 hp increments at both 15 MPH and 25 MPH. The accuracy of the power absorber (PAU + parasitic losses) shall be ±0.25 horsepower or ±2% of required power, whichever is greater, in either direction of rotation. For field auditing the accuracy shall be ±0.5 horsepower.

(vii) Accuracy Over the Operating Range. The dynamometer's accuracy when warm shall not deviate more than ±0.5 horsepower over the full ambient operating range of 35°F to 110°F. This may be accomplished by intrinsic design or by software correction techniques. At any constant temperature, the dynamometer shall have an accuracy of ±0.5 horsepower within 15 seconds of the start of the test, and shall have an accuracy of ±0.25 horsepower within 30 seconds of the start of the test. For temperatures outside the specified range, the dynamometer shall provide correction or proceed with a manufacturer warm-up sequence until full warm condition has been reached.

(3) Rolls.

(i) Size and Type. The dynamometer shall be equipped with twin rolls. The rolls shall be electrically or mechanically coupled side-to-side and front-to-rear. The dynamometer roll diameter shall be between 8.5 and 21.0 inches. The spacing between the roll centers shall comply with the equation in §85.3(a)(3)(ii) to within 0.5 inches and -0.25 inches of the calculated value. Fixed dynamometer rolls shall have an inside track width of no more than 30 inches and outside track width of at least 100 inches. Rolls moveable from side-to-side may be used if adequate measures are taken to prevent tire damage from lateral vehicle movement and the dynamometer sufficiently accommodates track widths of the full range of vehicles to be tested on the dynamometer. Alternative track widths, roll sizes, and number of rolls may be used if approved by the state and the Administrator and if adequate measures are taken to prevent tire damage from lateral vehicle movement and the dynamometer sufficiently accommodates track widths of the full range of vehicles to be tested on the dynamometer.

(ii) Roll Spacing = (24.375+D) * Sin 31.5153

D = dynamometer roll diameter.

Roll spacing and roll diameter are expressed in inches.

(iii) Design. The roll size, surface finish, and hardness shall be such that tire slippage is minimized under all weather conditions; that water removal is maximized; that the specified accuracy of the distance and speed measurements are maintained; and that tire wear and noise are minimized.

(4) Inertia.

(i) Base Inertia. The dynamometer shall be equipped with mechanical flywheel(s) or with full inertia simulation providing a total base inertia weight of 2000 pounds ±40 pounds. Any deviation from the 2000 pound base inertia shall be quantified and the coast-down time shall be corrected accordingly. Any deviation from the stated inertia shall be quantified and the inertia simulation shall be corrected accordingly. The actual inertia weight shall be marked on the ID plate required in §85.3(a)(1)(iv).

(ii) Inertia/Inertia Simulation. The dynamometer shall be capable of conducting, at a minimum, diagnostic level transient inertia simulations with an acceleration rate between 0 and 3.3 miles per hour per second with a minimum load (power) of 25 horsepower at 14 mph over the inertia weight range of 2000 pounds to 6000 pounds. For the diagnostic level inertia simulation, the 25 horsepower criterion is a requirement on acceleration only, while for the full inertia simulation option, the requirement is for both acceleration and deceleration. Mechanical inertia simulation shall be provided in 500 pound increments; electric inertia simulation shall be provided in 1 pound increments. Any deviation from the stated inertia shall be quantified and the inertia simulation shall be corrected accordingly. Mechanical or electrical inertia simulation, or a combination of both, may be used, subject to review and approval by the state.

(A) Diagnostic Level Simulation.

1. System Response. The torque response to a step change shall be at least 90% of the requested change within 300 milliseconds.

2. Simulation Error. An inertia simulation error (ISE) shall be continuously calculated any time the actual dynamometer speed is between 10 MPH and 60 MPH. The ISE shall be calculated by the

equation in §85.3(a)(4)(ii)(C), and shall not exceed 3% of the inertia weight selected (IW_S) for the vehicle under test.

(B) Full Inertia Simulation. (Recommended Option)

1. System Response. The torque response to a step change shall be at least 90% of the requested change within 100 milliseconds after a step change is commanded by the dynamometer control system, and shall be within 2% of the commanded torque by 300 milliseconds after the command is issued. Any overshoot of the commanded torque value shall not exceed 25% of the torque value.

2. Simulation Error. An inertia simulation error (ISE) shall be continuously calculated any time the actual dynamometer speed is between 10 MPH and 60 MPH. The ISE shall be calculated by the equation in §85.3(a)(4)(ii)(C), and shall not exceed 1% of the inertia weight selected (IW_S) for the vehicle under test.

(C) Inertia Simulation Error Calculation.

$$ISE = [(IW_S - I_t) / (IW_S)] * 100$$

$$I_t = I_m + \left(\frac{1}{V}\right) \int_0^t (F_m - F_{rl})\, dt$$

Where:

ISE	=	Inertia Simulation Error
IW_S	=	Inertia Weight Selected
I_t	=	Total inertia being simulated by the dynamometer (kg)
I_t (lb force)	=	It (kg) * 2.2046
I_m	=	Base (mechanical inertia of the dynamometer (kg)
V	=	Measured roll speed (m/s)
F_m	=	Force measured by the load cell (translated to the roll surface) (N)
F_{rl}	=	Road load force (N) required by IHP at the measure roll speed (V)
t	=	Time (sec)

(5) Other Requirements.

(i) Vehicle Speed. The measurement of roll speed shall be accurate within 0.1 mph over the full operating range. The dynamometer shall accommodate vehicle speeds of up to 60 mph.

(ii) Vehicle Restraint. The vehicle shall be restrained during the driving cycle. The restraint system shall be designed to insure that vertical and horizontal force on the drive wheels does not significantly affect emission levels. The restraint system shall allow unobstructed vehicle ingress and egress and shall be capable of safely restraining the vehicle under all reasonable operating conditions without damaging the suspension system.

(iii) Vehicle Cooling. The test system shall provide for a method to prevent overheating of the vehicle. The test shall be conducted with the hood open and the cooling system activated when ambient temperature exceeds 72°F. The cooling method used shall direct air to the test vehicle's cooling system. The cooling system capacity shall be at least 3000 SCFM within 12 inches of the intake to the vehicle's cooling system. The cooling system shall avoid improper cooling of the catalytic converter.

(iv) Four-Wheel Drive. If used, four-wheel drive dynamometers shall insure the application of correct vehicle loading as defined in §85.3(a)(2), shall not damage the four wheel drive system of the vehicle, and shall accomodate vehicles equipped with anti-lock brakes and/or traction control. Front and rear wheel rolls shall maintain speed synchronization within 0.2 mph.

(v) Installation. Either in-floor or above ground installations of the dynamometer are acceptable. In all cases, installation must be performed so that the test vehicle is approximately level (±5°) while on the dynamometer during testing.

(vi) Augmented Braking. Dynamometers shall apply augmented braking on major decelerations during transient drive cycles, if such cycles are used in the program. The dynamometer software shall provide a signal output to inform the operator when augmented braking is activated.

(b) Emission Sampling System.

(1) The sampling system shall be designed to insure durable, leak free operation and be easily maintained. Materials that are in contact with the gases sampled shall not contaminate or change the character of the gases to be analyzed, including gases from vehicles not fueled by gasoline (except diesels). The system shall be designed to be corrosion-resistant and be able to withstand typical vehicle exhaust temperatures when the vehicle is driven through the ASM test cycle for 290 seconds.

(2) The sampling system shall draw exhaust gas from the vehicle, shall remove particulate matter and aerosols from the sampled gas, shall drain condensed water from the sample if necessary, and shall deliver the resultant gas sample to the analyzers/sensors for analysis and then deliver the analyzed sample directly outside the building. The sampling system shall, at a minimum, consist of a tailpipe probe, flexible sample line, water removal system, a particulate trap, sample pump, and flow control components.

(3) Sample Probe.

(i) Insertion. The sample probe shall allow at least a 16 inch insertion depth of the sample point into the vehicle's exhaust. In addition, the probe shall be inserted at least 10 inches into the vehicle's exhaust. Use of a tailpipe extension is permitted as long as the extension does not change the exhaust back pressure by more than ±1.0 inch of water pressure.

(ii) Retention. The probe shall incorporate a positive means of retention to prevent it from slipping out of the tailpipe during use. High through-put test systems may use alternative means to insure probe retention.

(iii) Flexibility. The probe shall be designed so that the tip extends 16 inches into the tailpipe. The probe tip shall be shielded so that debris is not scooped up by the probe when it is inserted into the tailpipe. High through-put test systems may use alternative means to insure adequate probe insertion.

(iv) Probe Tip. Probe tips shall be designed and constructed to prevent sample dilution.

(v) Materials. All materials in contact with exhaust gas prior to and throughout the measurement portion of the system shall be unaffected by and shall not affect the sample (i.e., the materials shall not react with the sample, and they shall not taint the sample). Acceptable materials include stainless steel, Teflon, silicon rubber, and Tedlar. Dissimilar metals with thermal expansion factors of more than 5% shall not be used in either the construction of probes or connectors. The sample probe shall be constructed of stainless steel or other non-corrosive, non-reactive material which can withstand exhaust gas temperatures at the probe tip of up to 1,100_F for 10 minutes.

(vi) System Hoses and Connections. Hoses and all other sample handling components must be constructed of, or plated with a non-reactive, non-corrosive, high temperature material which will not affect, or be affected by, the exhaust constituents and tracer gases.

(vii) Dual Exhaust. The sample system shall provide for the testing of dual exhaust equipped vehicles. When testing a vehicle with functional dual exhaust pipes, a dual sample probe of a design certified by the analyzer manufacturer to provide equal flow in each leg shall be used. The equal flow requirement is considered to be met if the flow rate in each leg of the probe has been measured under two sample pump flow rates (the normal rate and a rate equal to the onset of low flow), and if the flow rates in each of the legs are found to be equal to each other (within 15% of the flow rate in the leg having lower flow).

(4) Particulate Filter. The particulate filter shall be capable of trapping 97% of all particulate and aerosols 5 microns or larger. The filter element shall not absorb or adsorb hydrocarbons. The filter housing shall be transparent or translucent to allow the operator to observe the filter element's condition without removing the housing.

The filter element shall be easily replaceable and shall provide for reliable sealing after filter element changes.

(5) Water Trap. The water trap shall be sized to remove exhaust sample water from vehicles fueled with gasoline, propane, compressed natural gas, reformulated gasoline, alcohol blends or neat, and oxygenated fuels. The filter element, bowl and housing shall be inert to these fuels as well as to the exhaust gases from vehicles burning these fuels. The condensed water shall be drained from the water trap's bowl either continuously or automatically on a periodic basis such that the following performance requirement is maintained. Sufficient water shall be trapped, regardless of fuel, to prevent condensation in the sample system or in the optical bench's sample cell.

(6) Low Flow Indication. The analyzer shall lock out official testing when the sample flow is below the acceptable level. The sampling system shall be equipped with a flow meter (or equivalent) that shall indicate sample flow degradation when measurement error exceeds 3% of the gas value used for checking, or causes the system response time to exceed 13 seconds to 90 percent of a step change in input (excluding NO), whichever is less.

(7) Exhaust Ventilation System. The high quantities of vehicle emissions generated during loaded mode testing shall be properly vented to prevent buildup of hazardous concentrations of HC, CO, CO_2 and NOx. Sufficient ventilation shall be provided in the station to maintain HC, CO, CO_2 and NO levels below OSHA standards.

(i) The ventilation system shall discharge the vehicle exhaust outside the building.

(ii) The flow of the exhaust collection system shall not cause dilution of the exhaust at the sample point in the probe.

(iii) The flow of the exhaust collection system shall not cause a change of more than ±1.0 inches of water pressure in the vehicle's exhaust system at the exhaust system outlet.

(c) Analytical Instruments.

(1) General Requirements.

(i) Measured Gases. The analyzer system shall consist of analyzers for HC, CO, NO, and CO_2, (O_2 optional) and digital displays for exhaust concentrations of HC, CO, NO, and CO_2, and for vehicle speed.

(ii) Emission Accuracy. The system shall ensure that the analytical system provides an accurate accounting of the actual exhaust emissions produced during the test, taking into consideration the individual channel accuracies, repeatabilities, interference effects, sample transport times, and analyzer response times.

(iii) Sample Rate. The analyzer shall be capable of measuring exhaust concentrations of the gases specified in §85.3(c)(1)(i) at a minimum rate of once per second.

(iv) Alternative Equipment. Alternative analytic equipment specification, materials, designs, or detection methods may be allowed if proposed by a state and upon a determination by the Administrator, that for the purpose of properly conducting a test, the evidence supporting such deviations will not significantly affect the proper measurement of emissions.

(2) Performance Requirements.

(i) Temperature Operating Range. The analyzer system and all associated hardware shall operate within the performance specifications described in §85.3(c)(3) at ambient air temperatures ranging from 35_F to 110_F. Analyzers shall be designed so that adequate air flow is provided around critical components to prevent overheating (and automatic shutdown) and to prevent the condensation of water vapor which could reduce the reliability and durability of the analyzer. The analyzer system shall otherwise include necessary features to keep the sampling system within the specified range.

(ii) Humidity Operating Range. The analyzer system and all associated hardware shall operate within the performance specifications described in §85.3(c)(3) at a minimum of 85% relative humidity throughout the required temperature range.

(iii) Interference Effects. The interference effects for non-interest gases shall not exceed ±4 ppm for hydrocarbons, ±0.02% for carbon monoxide, ±0.20% for carbon dioxide, and ±20 ppm for nitric oxide when using the procedure specified in §85.4(d)(5)(iv). Corrections for collision-broadening effects of combined high CO and CO_2 concentrations shall be taken into account in developing the factory calibration curves, and are included in the accuracy specifications.

(iv) Barometric Pressure Compensation. Barometric pressure compensation shall be provided. Compensation shall be made for elevations up to 6000 feet (above mean sea level). At any given altitude and ambient conditions specified in §85.3(c)(2)(i) and (ii), errors due to barometric pressure changes of ±2 inches of mercury shall not exceed the accuracy limits specified in §85.3(c)(3).

(v) System Lockout During Warm-up. Functional operation of the gas sampling unit shall remain disabled through a system lockout until the instrument meets stability and warm-up requirements. The instrument shall be considered "warm" when the zero and span readings for HC, CO, NO, and CO_2 have stabilized, within the accuracy values specified in §85.3(c)(3) for five minutes without adjustment.

(vi) Zero Drift Lockout. If zero or span drift cause the optical bench signal levels to move beyond the adjustment range of the analyzer, the system shall be locked out from testing.

(vii) Electromagnetic Isolation and Interference. Electromagnetic signals found in an automotive service environment shall not cause malfunctions or changes in the accuracy in the electronics of the analyzer system. The instrument design shall ensure that readings do not vary as a result of electromagnetic radiation and induction devices normally found in the automotive service environment, including high energy vehicle ignition systems, radio frequency transmission radiation sources, and building electrical systems.

(viii) Vibration and Shock Protection. System operation shall be unaffected by the vibration and shock encountered under the normal operating conditions encountered in an automotive service environment.

(ix) Propane Equivalency Factor. The nominal PEF range shall be between 0.490 and 0.540. For each audit/calibration point, the nominal PEF shall be conveniently displayed for the quality assurance inspector and other authorized personnel. If an optical bench must be replaced in the field, any external labels shall be changed to correspond to the nominal PEF of the new bench. The analyzer shall incorporate an algorithm relating PEF to HC concentration. Corrections shall be made automatically. The corrected PEF value may cover the range of 0.470 to 0.560.

(x) System Response Requirements. The response time from the probe to the display for HC, CO, and CO_2 analyzers shall not exceed 8 seconds for 90% of a step change in input, nor shall it exceed 12 seconds to 95% of a step change in input. The response time for a step change in O_2 from 20.9% O_2 to 0.1% O_2 shall be no longer than 40 seconds. For NO analyzers, the response time shall not exceed 12 seconds for 90% of a step change in input. The response time for a step change in NO from a stabilized reading to 10% of that reading shall be no longer than 12 seconds.

(3) Detection Methods, Instrument Ranges, Accuracy, and Repeatability.

(i) Hydrocarbon Analysis. Hydrocarbon analysis shall be determined by non-dispersive infrared (NDIR) analyzer. The analyzer shall cover at least the range of 0 ppm HC to 9999 ppm HC, where ppm HC is parts per million of hydrocarbon volume as hexane. The accuracy of the instrument from 0-2000 ppm HC shall be ±3% of point or 4 ppm C6, whichever is greater. The accuracy of the instrument between 2001 ppm HC and 5000 ppm HC shall be at least ±5% of point. The accuracy of the instrument between 5001 ppm HC and 9999 ppm HC shall be at least ±10% of point. The instrument shall comply with the quality control specifications in §85.4(d).

(ii) Carbon Monoxide Analysis. Carbon monoxide analysis shall be determined by non-dispersive infrared (NDIR) analyzer. The analyzer shall cover at least the range of 0.00 % CO to 14.00% CO, where % CO is % volume CO. The accuracy of the instrument between 0.01% and 10.00% CO shall be ±3% of point or 0.02% CO, whichever is greater. The accuracy of the instrument between 10.01% and 14.00% shall be at least ±5% of point. The instrument shall comply with the quality control specifications in §85.4(d).

(iii) Carbon Dioxide Analysis. Carbon dioxide analysis shall be determined by non-dispersive infrared (NDIR) analyzer. The analyzer shall cover at least the range of 0.0 % CO_2 to 18.0% CO_2. The accuracy of the instrument between 0.01% and 16.00% CO_2 shall be ±3% of point or 0.3% CO_2, whichever is greater. The accuracy of the instrument between 16.01% and 18.00% shall be at least ±5% of point. The instrument shall comply with the quality control specifications in §85.4(d).

(iv) Nitric Oxide Analysis. The analyzer shall cover at least the range of 0 ppm NO to 5000 ppm NO, where ppm NO is parts per million nitric oxide. The accuracy of the instrument between 0 and 4000 ppm shall be at least ±4% of point or 25 ppm NO, whichever is greater. The accuracy of the instrument between 4001 and 5000 ppm shall be at least ±8% of point. The instrument shall comply with the quality control specifications in §85.4(d).

(v) Oxygen Analysis. (optional) If an oxygen analyzer is included, the analyzer shall cover at least the range of 0.0% O_2 to 25.0% O_2. The accuracy of the instrument over this range shall be at least 5% of point or ±0.1% O_2, whichever is greater. The instrument shall comply with the quality control specifications in §85.4(d).

(vi) Repeatability. The repeatability for the HC analyzer in the range of 0-1400 ppm HC shall be 2% of point or 3 ppm HC absolute, whichever is greater. In the range of 1400-2000 ppm HC, the repeatability shall be 3% of point. The repeatability for the CO analyzer in the range of 0-7.00% CO shall be 2% of point or 0.02% CO absolute, whichever is greater. In the range of 7.00% to 10.00% CO, the repeatability shall be 3% of point. The repeatability for the CO_2 analyzer in the range of 0-10.0% CO_2 shall be 2% of point or 0.1% CO_2 absolute, whichever is greater. In the range of 10.0% to 16.0% CO_2, the repeatability shall be 3% of point. The repeatability of the NO analyzer shall be 3% of point or 20 ppm NO, whichever is greater. The repeatability of the O_2 analyzer shall be 3% of point or 0.1% O_2, whichever is greater.

(vii) Rounding Rule. Rounding beyond the decimal places shown in §85.3(c)(3) shall follow the standard mathematical practice of going to the next higher number for any numerical value of five or more. This shall also hold true for pass/fail decisions. For example, if 2.00% CO passes and 2.01% CO fails, and the reading is 2.0049%, the value shall be rounded down and the decision shall be a pass. If the reading is 2.0050, the value shall be rounded up and the decision shall be a fail. The value displayed and printed on the test report shall be consistent with the value used for the pass/fail decision.

(4) Ambient Conditions. The current relative humidity, dry-bulb temperature, and barometric pressure shall be measured and recorded prior to the start of every inspection in order to calculate Kh (nitric oxide correction factor §85.1(b)(1)(v)).

(i) Relative Humidity. The relative humidity measurement device shall cover the range from 5% to 95% RH, between 35_F - 110_F, with a minimum accuracy of ±3% RH. Wet bulb thermometers shall not be used.

(ii) Dry-bulb Temperature. The dry-bulb temperature device shall cover the range from 0_F - 140_F with a minimum accuracy of 3_F.

(iii) Barometric Pressure. The barometric pressure measurement device shall cover the range from 610 mm Hg - 810 mm Hg absolute (24-32 inches), and 35_F - 110_F, with a minimum accuracy of ±3% of point or better.

(5) Engine Speed Detection. The analyzer shall utilize a tachometer capable of detecting engine speed in revolutions per minute (rpm) with a 0.5 second response time and an accuracy of ±3% of the true rpm. Starting in 1998, on vehicles equipped with onboard diagnostic (OBD) systems, the engine speed shall be taken by connecting to the SAE standardized OBD link on 1996 and newer vehicles. RPM readings shall be recorded on a second-by-second basis for the 10 second period upon which the pass/fail basis is based.

(6) OBD Fault Code Retrieval. Starting in 1998, the system shall include the hardware and software necessary to access the onboard computer systems on 1996 and newer vehicles, determine OBD readiness, and recover stored fault codes using the SAE standardized link.

(d) Automated Test Process Software and Displays.

(1) Software. The testing process, data collection, and quality control features of the analyzer system shall be automated to the greatest degree possible. The software shall automatically select the emission standards and set the vehicle load based on an EPA-provided or approved look-up table. Vehicle identification information shall be derived from a database accessed over a real-time data system to a host computer system. Entry of license plate and all or part of the VIN shall be sufficient to access the vehicle record. Provision shall be made for manual entry of data for vehicles not in the host computer system.

(2) Test and mode timers. The analyzer shall be capable of simultaneously determining the amount of time elapsed in a test (overall test time), and in a mode within that test (mode time).

(3) Clocks and Timers. The clock used to check the coast-down time shall be accurate to within 0.1% of reading between 0.5 and 100 seconds, with a resolution of 0.001 seconds. The test mode timers used shall be accurate to within 0.1% of reading between 10 and 1000 seconds with a resolution of 0.1 seconds.

(4) Driver's Aid. The system shall be equipped with a driver's aid that shall be clearly visible to the driver as the test is performed. The aid shall continuously display the required speed, the number of seconds into the test mode, the driver's actual speed/time performance (a display showing the deviation between set-point and actual driving trace), engine RPM, the use of augmented braking, and necessary prompts and alerts. The driver's aid shall also be capable of displaying test and equipment status and other messages as required. Dynamic information being displayed shall be refreshed at a minimum rate of twice per second. Emissions values shall not be displayed during official testing.

(5) Minimum Analyzer Display Resolution. The analyzer electronics shall have sufficient resolution to achieve the following:

HC	1	ppm HC as hexane
NO	1	ppm NO
CO	0.01	% CO
CO_2	0.1	% CO_2
O2	0.1	% O2 (optional)
RPM	10	RPM
Speed	0.1	mph
Load	0.1	hp
Relative Humidity	1	% RH
Dry Bulb Temperature	1	_F
Barometric Pressure	1	mm HG

§85.4 Quality Control Requirements

(a) General Requirements

(1) Minimums. The frequency and standards for quality control specified here are minimum requirements, unless modified as specified in §85.4(a)(2). Greater frequency or tighter standards may be used as needed.

(2) Statistical Process Control. Reducing the frequency of the quality control checks, modifying the procedure or specification, or eliminating the quality control checks altogether may be allowed if the state demonstrates and the Administrator determines, for the purpose of properly conducting an approved short test, that sufficient Statistical Process Control (SPC) data exist to make a determination, that the SPC data support such action, and that taking such action will not significantly reduce the quality of the emissions measurements. Should emission measurement performance or quality deteriorate as a result of allowing such actions, the approval shall be suspended and the frequencies, procedures specifications, or checks specified here or otherwise approved shall be reinstated, pending further determination by the Administrator.

(b) Dynamometer

(1) Coast Down Check.

(i) The calibration of each dynamometer shall be automatically checked every 72 hours in low volume stations (less than 4000 tests per year) and daily in high volume stations by a dynamometer coast-down procedure equivalent to §86.118-78 (for reference see National Vehicle and Fuel Emission Laboratory's Testing Services Division test procedure TP-302A and TP-202) between the speeds of 30-20 mph if the ASM2525 is used and 20-10 mph if the ASM5015 is used. All rotating dynamometer components shall be included in the coast-down check. Speed windows smaller than ± 5 mph may be used provided that they show the same calibration capabilities.

(ii) The base dynamometer inertia (2000 pounds) shall be checked at two random horsepower settings for each speed range. The two random horsepower settings shall be between 8.0 and 18.0 horsepower. A shunt resistor for a load cell performance check shall not be used.

(iii) The coast-down procedure shall use a vehicle off-dynamometer type method or equivalent. Using a vehicle to bring the dynamometer up to speed and removing the vehicle before the coast-down shall not be permitted. If either the measured 30-20 mph coast-down time or 20-10 mph coast-down time is outside the window bounded by the Calculated Coast-Down Time (CCDT) (seconds) ±7% then it shall be locked out for official testing purposes until recalibration allows a passing value.

(A) Randomly select an IHP_{2525} value that is between 8.0 hp and 18.0 hp and set dynamometer PAU to this value.

Coast-down dynamometer from 30-20 mph.

$$CCDT_{@ 25\ mph} = \frac{\left(\frac{0.5 * DIW}{32.2}\right) * (V_{30}^2 - V_{20}^2)}{550 * (IHP2525 + PLHP25)}$$

Where:

DIW	=	Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.
V_{30}	=	Velocity in feet/sec at 30 mph.
V_{20}	=	Velocity in feet/sec at 20 mph.
IHP2525	=	Randomly selected ASM2525 indicated horsepower.
PLHP25	=	Parasitic Horsepower for specific dynamometer at 25 mph.

(B) Randomly select an IHP5015 value that is between 8.0 hp and 18.0 hp and set dynamometer PAU to this value.

Coast-down dynamometer from 20-10 mph.

$$CCDT_{@ 15\ mph} = \frac{\left(\frac{0.5 * DIW}{32.2}\right) * (V_{20}^2 - V_{10}^2)}{550 * (IHP5015 + PLHP15)}$$

Where:

DIW	=	Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.
V_{20}	=	Velocity in feet/sec at 20 mph.
V_{10}	=	Velocity in feet/sec at 10 mph.
IHP5015	=	Randomly selected ASM5015 indicated horsepower.
PLHP15	=	Parasitic Horsepower for specific dynamometer at 15 mph.

(2). Parasitic Value Calculations.

(i) Parasitic losses shall be calculated using the following equations at 25 and 15 mph whenever a coast-down check is performed. The indicated horsepower (IHP) shall be set to zero for these tests. This is only necessary if the coast-down values do not verify in §85.4(b)(1)(iii) above.

(ii) Parasitic losses at 25 mph for a dynamometer with specified diameter rollers.

$$PLHP_{25} = \frac{\left(\frac{0.5 * DIW}{32.2}\right) * (V_{30}^2 - V_{20}^2)}{550 * (ACDT)}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{30} = Velocity in feet/sec at 30 mph.

V_{20} = Velocity in feet/sec at 20 mph.

ACDT = Actual coast-down time required for dynamometer to coast from 30 to 20 mph.

(iii) Parasitic losses at 15 mph for a dynamometer with specified diameter rollers.

$$PLHP_{15} = \frac{\left(\frac{0.5 * DIW}{32.2}\right) * (V_{20}^2 - V_{10}^2)}{550 * (ACDT)}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{20} = Velocity in feet/sec at 20 mph.

V_{10} = Velocity in feet/sec at 10 mph.

ACDT = Actual coast-down time required for dynamometer to coast from 20 to 10 mph.

(3) Roll Speed. Roll speed and roll counts shall be checked at least once per week by an independent means (e.g., photo tachometer). Deviations greater than ±0.2 mph or a comparable tolerance in roll counts shall require corrective action. Alternatively, a redundant roll speed transducer independent of the primary transducer may be used in lieu of the weekly comparison. Accuracy of redundant systems shall be checked bimonthly.

(4) Load Measuring Device. If the dynamometer fails a coast-down check or requires a recalibration for any other reason, the load measuring device shall be checked using a dead-weight method or an equivalent procedure proposed by the state and approved by the Administrator. The check shall cover at least three points over the range of loads used for vehicle testing. Dead weights shall be traceable to the National Institute of Standards (NIST) and shall be accurate to within ±0.1%. The dynamometer shall provide an automatic load measuring device calibration and verification feature.

(5) Acceptance Check.

(i) Load Cell Verification (if equipped). This test confirms the proper operation of the dynamometer load cell and associated systems. Weights in the proper range shall be supplied by the system supplier. Weights shall be NIST traceable to 0.1% of point.

(A) Calibrate the load cell according to the manufacturer's direction.

(B) Using a dead weight method, load the test cell to 20%, 40%, 60%, and 80% (in ascending order) of the range used for ASM testing. Record the readings for each weight. Remove the weights in the same steps (descending order) and record the results.

(C) Perform steps A through B two more times (total of three). Calculate the average value for each weight. Multiply each average weight from E by the length of the torque arm.

(D) *Acceptance Criteria:* The difference for each reading from the weight shall not exceed 1% of full scale.

(ii) Speedometer Verification. This test confirms the accuracy of the dynamometer's speedometer.

(A) Set dynamometer speed to 15 mph. Independently measure and record dynamometer speed. Repeat at 25 mph.

(B) *Acceptance Criteria:* The difference for each reading from set dynamometer speed shall not exceed 0.2 mph.

(iii) Parasitics Verification. Parasitic losses shall be calculated using the following equations at 25 and 15 mph . The indicated horsepower (IHP) shall be set to zero for these tests. Using time versus speed data from the system, calculate PLHP for 25 mph and 15 mph.

(A) Parasitic losses at 25 mph for a dynamometer with specified diameter rollers.

$$PLHP_{25} = \frac{\left(\frac{0.5 * DIW}{32.2}\right) * (V_{30}^2 - V_{20}^2)}{550 * (CDT)}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{30} = Velocity in feet/sec at 30 mph.

V_{20} = Velocity in feet/sec at 20 mph.

CDT = Coast-down time required for dynamometer to coast from 30 to 20 mph.

(B) Parasitic losses at 15 mph for a dynamometer with specified diameter rollers.

$$PLHP_{15} = \frac{\left(\frac{0.5 * DIW}{32.2}\right) * (V_{20}^2 - V_{10}^2)}{550 * (CDT)}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{20} = Velocity in feet/sec at 20 mph.

V_{10} = Velocity in feet/sec at 10 mph.

CDT = Coast-down time required for dynamometer to coast from 20 to 10 mph.

(C) *Acceptance Criteria:* The difference between the externally calculated value and the machine calculated value shall not exceed 0.25 HP.

(iv) Verify Coast-Down. The coast-down procedure shall use a vehicle off-dynamometer type method or equivalent. Using a vehicle to bring the dynamometer up to speed and removing the vehicle before the coast-down shall not be permitted.

(A) Randomly select an IHP2525 value that is between 8.0 hp and 18.0 hp and set dynamometer PAU to this value.

Coast-down dynamometer from 30-20 mph.

$$CCDT_{@25\ mph} = \frac{\left(\frac{0.5 * DIW}{32.2}\right) * (V_{30}^2 - V_{20}^2)}{550 * (IHP2525_{yy} + PLHP_{25-yy})}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{30} = Velocity in feet/sec at 30 mph.

V_{20} = Velocity in feet/sec at 20 mph.

IHP2525 = Randomly selected ASM2525 indicated horsepower.

$PLHP_{25}$ = Parasitic Horsepower for specific dynamometer at 25 mph.

(B) Randomly select an IHP5015 value that is between 8.0 hp and 18.0 hp and set dynamometer PAU to this value.

Coast-down dynamometer from 20-10 mph.

$$CCDT_{@15\ mph} = \frac{\left(\frac{0.5 * DIW}{32.2}\right) * (V_{20}^2 - V_{10}^2)}{550 * (IHP5015_{yy} + PLHP15_{yy})}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{20} = Velocity in feet/sec at 20 mph.

V_{10} = Velocity in feet/sec at 10 mph.

IHP5015 = Randomly selected ASM5015 indicated horsepower.

$PLHP_{15}$ = Parasitic Horsepower for specific dynamometer at 15 mph.

(C) *Acceptance Criteria:* The measured 30-20 mph coast-down time and the 20-10 mph coast-down time must be inside the window bounded by CCDT (seconds) ± 7%.

(c) Emission Sampling System.

(1) Leak Check. The entire sample system shall be checked for vacuum leaks on a daily basis and proper flow on a continuous basis. This may be accomplished using a vacuum decay method, reading a span gas, or other methods proposed by a state and approved by the Administrator. The analyzer shall not allow an error of more than 1% of reading using the high-range span gas described in §85.4(d)(2)(iii)(C). The analyzer shall be locked out from testing if the leak check is not performed when due or fails to pass the check.

(2) Dilution. The flow rate on the analyzer shall not cause more than 10% dilution during sampling of exhaust of a 1.6 liter engine a normal idle. Ten percent dilution is defined as a sample of 90% exhaust and 10% ambient air.

(3) Dilution Acceptance Test.

(i) Set vehicle with 1.6 liter maximum engine displacement at factory - recommended idle speed, OEM configuration exhaust system, transmission in neutral, hood up (a fan to cool the engine may be used if needed). Set idle speed not to exceed 920 RPM. (Set for 900 RPM with a tolerance ± 20 RPM.)

(ii) With a laboratory grade analyzer system, sample the exhaust at 40 centimeters depth with a flow sample rate below 320 liters per hour. Allow sufficient time for this test. Record all HC, CO, NO, CO_2, and O_2 readings.

A chart recorder or electronically stored data may be used to detect the point of stable readings.

(iii) While operating the candidate analyzer system in a mode which has the same flow rate as the official test mode, record the levels of HC, CO, NO, CO_2, and O_2. Ensure that the probe is installed correctly.

(iv) Repeat step (ii).

(v) *Acceptance Criteria:* If the difference of the readings between (ii) and (iv) exceed five percent of the average of (ii) and (iv), repeat (ii), (iii), and (iv); otherwise average (ii) and (iv) and compare with (iii). If (iii) is within 10 percent of the average of (ii) and (iv), then the equipment meets the dilution specification.

(d) Analytic Instruments.

(1) General Requirements. The analyzer shall, to the extent possible, maintain accuracy between gas calibrations taking into account all errors, including noise, repeatability, drift, linearity, temperature, and barometric pressure.

(2) Two-Point Gas Calibration and Low-Range Audit .

(i) Analyzers shall automatically require a zero gas calibration and a high-range gas calibration for HC, CO, NO, and CO_2. The system shall also use a low-range gas to check the calibration in the range of vehicle emission standards. In high volume stations (4000 or more tests per year), analyzers shall be calibrated within four hours before each test. In low volume stations (below 4000 tests per year), analyzers shall be calibrated within 72 hours before each test. If the system does not calibrate or is not calibrated, the analyzer shall lock out from testing until corrective action is taken.

(ii) Gas Calibration and Check Procedure. Gas calibration shall be accomplished by introducing span gases that meet the requirements of 85.4(d)(2)(iii) into the calibration port. The pressure in the sample cell shall be the same with the calibration gas flowing as with the sample flowing during testing. The analyzer channels shall be adjusted to the center of the allowable tolerance range as a result of the calibration. The system shall record the gas reading data from before the adjustment and other data pertinent to control charting analyzer performance.

(A) Zero the analyzer and perform a leak check.

(B) Calibrate the analyzer using the high-range calibration gas specified in §85.4(d)(2)(iii).

(C) Introduce the low-range check gas specified in §85.4(d)(2)(iii). If the low-range check gas readings differ from the label value by more than ±2%, the analyzer shall be locked out from testing.

(iii) The following gases shall be used for the 2-point calibration and low-range audit.

(A) Zero Gas

O_2	=	20.7%
HC	<	1 ppm THC
CO	<	1 ppm
CO_2	<	400 ppm
NO	<	1 ppm
N_2	=	Balance 99.99 % pure

(B) Low-Range Audit Gas

HC	=	200 ppm propane
CO	=	0.5 %
CO_2	=	6.0 %
NO	=	300 ppm
N_2	=	Balance 99.99 % pure

(C) High-Range Calibration Gas

HC	=	3200 ppm propane
CO	=	8.0 %
CO_2	=	12.0 %
NO	=	3000 ppm
N_2	=	Balance 99.99 % pure

(iv) Traceability. The audit and span gases used for the gas calibration shall be traceable to National Institute of Standards and Technology (NIST) standards ±1%. Gases shall have a zero blend tolerance. Stations that use large capacity gas bottles (size B or larger) and that provide a quality control check to insure proper entry of gas values, may use gases with a blend tolerance of up to 5%. Gases with a 5% blend tolerance may also be used by any station if the analyzer system reads the bar-coded calibration gas bottle specifications and adjusts the calibration accordingly.

(3) Five-Point Calibration Audit.

(i) Analyzers shall automatically require and successfully pass a five point gas audit for HC, CO, NO, and CO_2. For high volume stations, audits shall be checked monthly. In low volume stations, analyzers shall undergo the audit procedure every six months.

(ii) Gas Audit Procedure. Calibration auditing shall be accomplished by introducing audit gas through the probe. The pressure in the sample cell shall be the same with the audit gas flowing as with the sample flowing during testing.

(A) Zero the analyzer and perform a leak check.

(B) Flow the low range audit gas specified in §85.4(d)(3)(iii) through the sample probe, ensuring that the tip is equal to ambient barometric pressure ±0.1 inches Hg (a balloon teed into the gas flow line is an acceptable pressure indicator; the balloon should stand slightly erect).

(C) When the HC, CO, NO, and CO_2 readings have stabilized (no less than 20 seconds of gas flow) record them as well as the PEF value at each audit blend.

(D) Repeat steps B and C for each audit gas specified in §85.4(d)(3)(iii).

(E) Compare the readings with the audit gas values. Divide the HC reading by its PEF using the following relationship:

$$\text{Tolerance \%} = 100 * \frac{(\text{Reading - Cylinder Value})}{\text{Cylinder Value}}$$

(F) If the tolerance exceeds ±4.0% for CO, CO_2, and HC/PEF, or ±5.0% for NO, then the analyzer shall fail the gas audit and shall be locked out from testing until it passes.

(iii) The following gases shall be used for the five-point calibration audit.

(A) Zero Audit Gas
O2 = 20.7% (if O2 span is desired)
HC < 0.1 ppm THC
CO < 0.5 ppm
CO_2 < 1 ppm
NO < 0.1 ppm
N_2 = Balance 99.99 % pure

(B) Low Range Audit Gas
HC = 200 ppm propane
CO = 0.5 %
CO_2 = 6.0 %
NO = 300 ppm
N_2 = Balance 99.99 % pure

(C) Low-Middle Range Audit Gas
HC = 960 ppm propane
CO = 2.4 %
CO_2 = 3.6 %
NO = 900 ppm
N_2 = Balance 99.99 % pure

(D) High-Middle Range Audit Gas
HC = 1920 ppm propane
CO = 4.8 %

CO_2 = 7.2 %
NO = 1800 ppm
N_2 = Balance 99.99 % pure

(E) High Range Audit Gas
HC = 3200 ppm propane
CO = 8.0 %
CO_2 = 12.0 %
NO = 3000 ppm
N_2 = Balance 99.99 % pure

(iv) Traceability. The gases used for the audit shall be traceable to National Institute of Standards and Technology (NIST) standards ±1%. Gases shall have a zero blend tolerance.

(4) Service, Repair and Modification.

(i) Each time an analyzer's emissions measurement system, sensor, or other related electronic components are repaired or replaced, the calibration audit required in §85.4(d)(3) shall be performed, at a minimum, prior to returning the unit to service.

(ii) Each time the sample line integrity is broken, a leak check shall be performed prior to testing.

(5) Acceptance Testing.

(i) Analyzer accuracy. This test confirms the ability of the candidate instruments to read various concentrations of gases within the tolerances required by this specification. The test compares the response of the candidate instrument with that of standard instruments, and also estimates the uncertainty of the readings.

The analyzer shall be zeroed and gas calibrated using the high-range calibration gas. The instrument shall be tested using propane, carbon monoxide, carbon dioxide, and nitric oxide in nitrogen, with a certified accuracy of ±1%, in the following concentrations: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% of full scale for the analyzers. Full scale is defined in §85.3(c)(3).

(A) Introduce the gases in ascending order of concentrations beginning with the zero gas. Record the readings of the standard and candidate instruments to each concentration value.

(B) After the highest concentration has been introduced and recorded, introduce the same gases to the standard and candidate analyzers in descending order, including the zero gas. Record the reading of analyzers to each gas, including negatives (if any).

(C) Repeat steps A and B for the candidate only, four more times (total of five times).

(D) Calculations:

1. Calculate the average value of each concentration for the readings of the standard instruments.

2. Calculate the mean and standard deviation of each candidate's readings for each concentration. Include both upscale and downscale readings for the same gas concentration. (All calculations may not be possible for zero concentrations.)

3. For each concentration, calculate the difference between the candidate mean and the standard average.

4. For each concentration, compute the following:

(i) $Y_1 = x + K_{sd}$

(ii) $Y_2 = x - K_{sd}$

Where

K_{sd} = std dev * 3.5 for zero and the highest concentration value

K_{sd} = std dev * 2.5 for all other concentration values

x = mean (arithmetic average) of the set of candidate readings.

5. Compute the uncertainty (U) of the calibration curve for each concentration as follows:

(i) U_1 = concentration value - Y_1

(ii) U_2 = concentration value - Y_2

6. *Acceptance Criteria:*

(a) For each concentration, the differences calculated in Step 3 shall be no greater than the accuracy tolerances specified in §85.3(c)(3) for each instrument.

(b) For each concentration, the uncertainties, (U_1 and U_2) shall be no greater than the accuracy tolerances required in §85.3(c)(3).

(ii) <u>Analyzer System Repeatability</u>. This test characterizes the ability of the instrument to give consistent readings when repeatedly sampling the same gas concentration.

(A) Using an 80% full scale gas, introduce the gas through the calibration port. Record the readings.

(B) Purge with ambient air for at least 30 seconds but no more than 60 seconds.

(C) Repeat steps A and B above four more times.

(D) Repeat steps A, B, and C, introducing the gas through the sample probe.

(E) *Acceptance Criteria:* The differences between the highest and lowest readings from both ports shall not exceed the values specified in §85.3(c)(3)(vi).

(iii) Analyzer System Response Time. This test determines the speed of response of the candidate instrument when a sample is introduced at the sample probe.

(A) Gas calibrate the candidate instrument per the manufacturer's instructions.

(B) Using a solenoid valve or equivalent selector system, remotely introduce an 80% full scale gas to the probe. The gas pressure at the entrance to the probe shall be equal to room ambient.

(C) Measure the elapsed time required for the instrument display to read 90% and 95% of the final stabilized reading for HC, CO, CO_2 and NO. (Optional: Also, measure the time required for the O_2 analyzer to read 0.1% O_2). Alternatively the bench outputs may be recorded against a time base to determine the response time. Record all times in seconds.

(D) Switch the solenoid valve to purge with zero air for at least 40 seconds but no more than 60 seconds.

(E) Measure the elapsed time required for the NO instrument display to read 10% of the stabilized reading in Step C.

(F) Repeat steps A, B, and C, two more times (total three times).

(G) *Acceptance Criteria:* The response (drop time for O_2 and NO; rise time for HC, CO, CO_2 and NO) times shall meet the requirement specified in §85.3(c)(2)(x). The response time shall also be within ±1 second of the nominal response time supplied by the equipment supplier for use in §85.5(b)(5).

(iv) Analyzer Interference Effects. The following acceptance test procedure shall be performed at 45_F, 75_F, and 105_F conditions, except as noted.

(A) Zero and span the instrument.

(B) Sample the following gases for at least one minute. Record the response of each channel to the presence of these gases.

1. 16% Carbon Dioxide in Nitrogen.
2. 1600 ppm Hexane in Nitrogen.
3. 10% Carbon Monoxide in Nitrogen.
4. 3000 ppm Nitric Oxide in Nitrogen.
5. 75 ppm Sulfur Dioxide (SO_2) in Nitrogen.
6. 75 ppm Hydrogen Sulfide (H_2S) in Nitrogen.

(C) Water-Saturated Hot Air. Water-saturated hot air shall be drawn through the probe from the top of a sealed vessel partially filled with water through which ambient air will be bubbled. The water shall be maintained at a temperature of 122_F ± 9_F. This test shall be performed at only the 75_F, and 105_F conditions.

(D) *Acceptance Criteria:* The interference effects shall not exceed the limits specified in §85.3(c)(2)(iii).

(v) Electromagnetic Isolation and Interference. This test shall measure the ability of the candidate instrument to withstand electromagnetic fields which could exist in vehicle testing and repair facilities. For all tests described below, sample "Low-Middle Range Audit Gas" specified in §85.4(d)(3)(iii)(C), at atmospheric pressure, through the sample probe. Record analyzer reading during test periods.

(A) Radio Frequency Interference Test.

1. Use a test vehicle with an engine having a high energy ignition system (or equivalent), a solid core coil wire and a 3/8" air gap. Leave engine off.

2. Locate the candidate instrument within 5 feet of the ignition coil. Gas calibrate the candidate instrument.

3. Sample gas specified above. Wait 20 seconds, and record analyzer readings.

4. Start engine. With the hood open and gas flowing to the analyzer, cycle the engine from idle through 25 mph on the dynamometer at ASM loads and record the analyzer readings.

5. Relocate the instrument to within 6 inches of one side of the vehicle near the engine compartment. Follow procedure described in step 4 and record analyzer readings.

6. Relocate the instrument to within 6 inches of the other side of the vehicle near the engine compartment. Follow procedure described in step 4 and record analyzer readings.

7. *Acceptance Criteria:* The analyzer readings shall deviate no more than 0.5% full scale.

(B) Induction Field Test. Use a variable speed (commutator type) hand drill having a plastic housing and rated at 3 amps or more. While the analyzer is sampling the gas, vary the drill speed from zero to maximum while moving from the front to the sides of the instrument at various heights.

Acceptance Criteria: The analyzer readings shall deviate no more than 0.5% full scale.

(C) Line Interference Test. Plug the drill used in part B above into one outlet of a #16-3 wire extension cord approximately 20 feet long. Connect the instrument into the other outlet of the extension cord. Repeat part B above.

Acceptance Criteria: The analyzer readings shall deviate no more than 0.5% full scale.

(D) VHF Band Frequency Interference Test. Locate both a citizens ban radio (CB), with output equivalent to FCC legal maximum, and a highway patrol transmitter (or equivalent) within 50 feet of the instrument. While the analyzer is sampling the gas, press and release transmit button of the both radios several times.

Acceptance Criteria: The analyzer readings shall deviate no more than 0.5% full scale.

(E) Ambient Conditions Instruments. Upon installation and every six months thereafter, the performance of the ambient conditions instruments shall be cross checked against a master weather station.

Acceptance Criteria: The individual instruments shall be within the tolerance specified in §85.3(c)(4).

§85.5 Test Record Information

The following information shall be collected for each test performed (both passing and failing tests), recorded in electronic form, and made available to EPA upon request.

(a) General Information.

(1) Test Record Number
(2) Inspection station and inspector numbers
(3) Test system number
(4) Dynamometer site
(5) Date of test
(6) Emission test start time and the time final emission scores are determined.
(7) Vehicle identification number
(8) License plate number
(9) Test certificate number
(10) Vehicle model year, make, and type
(11) Number of cylinders or engine displacement
(12) Transmission type
(13) Odometer reading
(14) Type of test performed (i.e., initial test, first retest, or subsequent retest)

(b) Ambient Test Conditions.

(1) Relative humidity (%)
(2) Dry-bulb temperature (_F).
(3) Atmospheric pressure (mm Hg)
(4) NO correction factor
(5) Nominal response time for each instrument (Transport + T90)

(c) ASM Mode or Modes. The following information shall be captured separately for each test mode (ASM5015 and/or ASM2525) performed.

(1) Final HC running average (AvgHC) (ppm)
(2) Final CO running average (AvgCO) (%)
(3) Final NO running average (AvgNO) (ppm)
(4) Total horsepower used to set the dynamometer (THP5015) (hp)
(5) Engine RPM running average corresponding to the final test score
(6) Dilution correction factor (DCF)

(d) Diagnostic/Quality Assurance Information.

(1) Test time (seconds)
(2) Mode time (seconds)
(3) Vehicle speed (mph) for each second of the test
(4) Engine RPM for each second of the test
(5) Dynamometer load (pounds) for each second of the test
(6) HC concentration (ppm) for each second of the test, not corrected for dilution
(7) CO concentration (%) for each second of the test, not corrected for dilution
(8) NO concentration (ppm) corrected for humidity for each second of the test, not corrected for dilution

(9) CO_2 concentration (%) for each second of the test

(10) O_2 concentration (%) for each second of the test (optional)

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High-Tech I/M Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications: IM240 and Functional Evaporative System Tests

Revised

Technical Guidance

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Table of Contents

Introduction

This document is the successor to the April 1994 version of "High-Tech I/M Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications." It incorporates changes discussed by the I/M Test Committee since April 1994 and thus includes the latest standards and procedures recommended for IM240 testing. Several major additions and changes have been made. The draft supplemental technical guidance dynamometer specifications that were issued in August of 1994 under separate cover are now incorporated, with changes discussed in Committee, into this document. This version also includes the standards for fast-passing vehicles and for heavy-duty vehicles; fast-fail references have been deleted. This version includes the evaporative system pressure tests, including the gas cap pressure test, the fuel inlet pressure test, and the canister end pressure test. Finally, this version incorporates the recommended reporting format for vehicles that fail the IM240. Many other smaller changes were made to the document as well.

§85.2205 Test Standards

(a) IM240 Emission Standards

(1) Two Ways to Pass Standards. If the corrected, composite emission rates calculated in §85.2205(b) exceed standards for any exhaust component, additional analysis of test results shall look at the second phase of the driving cycle separately. Phase 2 shall include second 94 through second 239. Second-by-second emission rates in grams, and composite emission rates in grams per mile for Phase 2 and for the entire test shall be recorded for each gas. For any given exhaust component, if the composite emission level is equal to or below the composite standard or if the Phase 2 grams per mile emission level is equal to or below the applicable Phase 2 standard, then the vehicle shall pass the test for that exhaust component.

(2) Start-up Standards. Start-up standards should be used during the first two years of program operation. Tier 1 standards are recommended for 1996 and newer vehicles and may be used for 1994 and newer vehicles certified to Tier 1 standards. The following exhaust emissions standards, in grams per mile, are recommended:

(i) Light Duty Vehicles.

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1	0.80	0.50	15.0	12.0	2.0	2.0
1991-1995	1.20	0.75	20.0	16.0	2.5	2.5
1983-1990	2.00	1.25	30.0	24.0	3.0	3.0
1981-1982	2.00	1.25	60.0	48.0	3.0	3.0
1980	2.00	1.25	60.0	48.0	6.0	6.0
1977-1979	7.50	5.00	90.0	72.0	6.0	6.0
1975-1976	7.50	5.00	90.0	72.0	9.0	9.0
1973-1974	10.0	6.00	150	120	9.0	9.0
1968-1972	10.0	6.00	150	120	10.0	10.0

(ii) High-Altitude Light Duty Vehicles.

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1983-1984	2.00	1.25	60.0	48.0	3.0	3.0
1982	2.00	1.25	75.0	60.0	3.0	3.0

(iii) Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1						
(≤3750 LVW)	0.80	0.50	15.0	12.0	2.0	2.0
(>3750 LVW)	1.00	0.63	20.0	16.0	2.5	2.5
1991-1995	2.40	1.50	60.0	48.0	3.0	3.0

1988-1990	3.20	2.00	80.0	64.0	3.5	3.5
1984-1987	3.20	2.00	80.0	64.0	7.0	7.0
1979-1983	7.50	5.00	100	80.0	7.0	7.0
1975-1978	8.00	5.00	120	96.0	9.0	9.0
1973-1974	10.0	6.00	150	120	9.0	9.0
1968-1972	10.0	6.00	150	120	10.0	10.0

(iv) High-Altitude Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1991+	3.00	2.00	70.0	56.0	3.0	3.0
1988-1990	4.00	2.50	90.0	72.0	3.5	3.5
1984-1987	4.00	2.50	90.0	72.0	7.0	7.0
1982-1983	8.00	5.00	130	104	7.0	7.0

(v) Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1						
(≤5750 LVW)	1.00	0.63	20.0	16.0	2.5	2.5
(>5750 LVW)	2.40	1.50	60.0	48.0	4.0	4.0
1991-1995	2.40	1.50	60.0	48.0	4.5	4.5
1988-1990	3.20	2.00	80.0	64.0	5.0	5.0
1984-1987	3.20	2.00	80.0	64.0	7.0	7.0
1979-1983	7.50	5.00	100	80.0	7.0	7.0
1975-1978	8.00	5.00	120	96.0	9.0	9.0
1973-1974	10.0	6.00	150	120	9.0	9.0
1968-1972	10.0	6.00	150	120	10.0	10.0

(vi) High-Altitude Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1991+	3.00	2.00	70.0	56.0	4.5	4.5
1988-1990	4.00	2.50	90.0	72.0	5.0	5.0
1984-1987	4.00	2.50	90.0	72.0	7.0	7.0
1982-1983	8.00	5.00	130	104	7.0	7.0

(vii) Heavy-Duty Trucks (greater than 8500 pounds GVWR).*

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2

* The heavy-duty truck standards provided here were calculated using new vehicle certification standards and have not be subjected to field testing. This document provides no other guidance on heavy duty truck testing. Thus, anyone interested in performing IM240 tests on heavy-duty trucks should proceed with appropriate caution.

1998+	2.00	1.30	30.0	24.0	4.0	4.0
1991-1997	3.00	1.90	60.0	48.0	6.0	6.0
1987-1990	3.00	1.90	60.0	48.0	8.0	8.0
1985-1986	5.00	3.10	75.0	60.0	8.0	8.0
1979-1984	6.00	3.80	100.0	80.0	8.0	8.0
1974-1978	10.0	6.30	150.0	120.0	10.0	10.0
1970-1973	10.0	6.30	175.0	140.0	10.0	10.0
pre-1970	20.0	12.50	200.0	160.0	15.0	15.0

(3) Final Standards. The following exhaust emissions standards, in grams per mile, are recommended for vehicles tested in the calendar years 1997 and later. Tier 1 standards are recommended for all 1996 and newer vehicles but may be used for 1984 and newer vehicles.

(i) Light Duty Vehicles.

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1	0.60	0.40	10.0	8.0	1.5	1.5
1983-1995	0.80	0.50	15.0	12.0	2.0	2.0
1981-1982	0.80	0.50	30.0	24.0	2.0	2.0
1980	0.80	0.50	30.0	24.0	4.0	4.0
1977-1979	3.00	2.00	65.0	52.0	4.0	4.0
1975-1976	3.00	2.00	65.0	52.0	6.0	6.0
1973-1974	7.00	4.50	120	96.0	6.0	6.0
1968-1972	7.00	4.50	120	96.0	7.0	7.0

(ii) High-Altitude Light Duty Vehicles.

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1983-1984	1.20	0.75	30.0	24.0	2.0	2.0
1982	1.20	0.75	45.0	36.0	2.0	2.0

(iii) Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1						
(≤3750 LVW)	0.60	0.40	10.0	8.0	1.5	1.5
(>3750 LVW)	0.80	0.50	13.0	10.0	1.8	1.8
1988-1995	1.60	1.00	40.0	32.0	2.5	2.5
1984-1987	1.60	1.00	40.0	32.0	4.5	4.5
1979-1983	3.40	2.00	70.0	56.0	4.5	4.5
1975-1978	4.00	2.50	80.0	64.0	6.0	6.0
1973-1974	7.00	4.50	120	96.0	6.0	6.0
1968-1972	7.00	4.50	120	96.0	7.0	7.0

(iv) High-Altitude Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1988+	2.00	1.25	60.0	48.0	2.5	2.5
1984-1987	2.00	1.25	60.0	48.0	4.5	4.5
1982-1983	4.00	2.50	90.0	72.0	4.5	4.5

(v) Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1						
(≤5750 LVW)	0.80	0.50	13.0	10.0	1.8	1.8
(>5750 LVW)	0.80	0.50	15.0	12.0	2.0	2.0
1988-1995	1.60	1.00	40.0	32.0	3.5	3.5
1984-1987	1.60	1.00	40.0	32.0	4.5	4.5
1979-1983	3.40	2.00	70.0	56.0	4.5	4.5
1975-1978	4.00	2.50	80.0	64.0	6.0	6.0
1973-1974	7.00	4.50	120	96.0	6.0	6.0
1968-1972	7.00	4.50	120	96.0	7.0	7.0

(vi) High-Altitude Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1988+	2.00	1.25	60.0	48.0	3.5	3.5
1984-1987	2.00	1.25	60.0	48.0	4.5	4.5
1982-1983	4.00	2.50	90.0	72.0	4.5	4.5

(vii) Heavy-Duty Trucks (greater than 8500 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1998+	2.00	1.30	30.0	24.0	4.0	4.0
1991-1997	2.00	1.30	40.0	32.0	5.0	5.0
1987-1990	2.00	1.30	40.0	32.0	6.0	6.0
1985-1986	3.00	1.90	50.0	40.0	6.0	6.0
1979-1984	5.00	3.10	75.0	60.0	6.0	6.0
1974-1978	10.0	6.30	150.0	120.0	10.0	10.0
1970-1973	10.0	6.30	175.0	140.0	10.0	10.0
pre-1970	20.0	12.50	200.0	160.0	15.0	15.0

(4) Fast-Pass. Vehicles may be fast-passed using the following algorithm. Fast-pass shall only be used when more than one vehicle is waiting in the queue for a test.

(i) Beginning at second 30 of the driving cycle, cumulative second-by-second emission levels for each second, calculated from the start of the cycle in grams, shall be compared to the cumulative fast-pass emission standards for the second under consideration. For exhaust components subject to Phase 2 standards, cumulative second-by-second emission levels calculated from second 109 forward in grams shall be compared to cumulative second-by-second fast-pass Phase 2 emission standards for the second under consideration.

(ii) A vehicle shall pass the IM240 for a given exhaust component if either of the following conditions occur:

(A) cumulative emissions of the exhaust component for the full driving cycle are below the full cycle fast-pass standard for the second under consideration; or,

(B) at second 94 and later, if the exhaust component is subject to Phase 2 standards, cumulative Phase 2 emissions are below the Phase 2 fast-pass standards for the second under consideration;

(iii) Testing may be terminated when fast-pass criteria are met for all subject exhaust components and for purge as described in §85.2205(c)(1) or §85.2205(c)(3)(ii) in the same second.

(v) If a fast-pass determination cannot be made for all subject exhaust components and for purge before the driving cycle ends, the pass/fail determination for each component shall be based on composite or Phase 2 emissions over the full driving cycle as described in §85.2205(a)(1).

(vi) Vehicles may be fast-passed using other approaches if approved by the Administrator. States are encourage to develop and use equations to define fast-pass standards for each composite emission standard rather than using tabular standards for each second of the test. EPA-developed tabular fast-passed standards are included in Appendix A. Fast-pass standards developed by Colorado's contractor are included in Appendix B.

(b) Transient Test Score Calculations

(1) Composite Scores. The composite scores for the test shall be determined by dividing the sum of the mass of each exhaust component obtained in each second of the test by the number of miles driven in the test. The first data point is the sample taken from t=0 to t=1. The composite test value shall be calculated by the equation in (b)(1)(i):

(i) Composite gpm $= \dfrac{\sum_{sec=0}^{s} \text{grams of emissions}}{\sum_{sec=0}^{s} \text{miles traveled}}$

Where: s = duration of test in seconds for fast pass
= 239 seconds for complete IM240

(2) Second-by-Second Mass Calculations. The mass of each exhaust component shall be calculated to five significant digits for each second of the test using the following equations:

(i) Hydrocarbon mass: $HC_{mass} = V_{mix} * Density_{HC} * \dfrac{HC_{conc}}{1000000}$

(ii) Carbon Monoxide mass: $CO_{mass} = V_{mix} * Density_{CO} * \dfrac{CO_{conc}}{1000000}$

(iii) Oxides of Nitrogen mass: $NOx_{mass} = V_{mix} * Density_{NO2} * K_H * \dfrac{NO_{xconc}}{1000000}$

(iv) Carbon Dioxide mass: $CO2_{mass} = V_{mix} * Density_{CO2} * \dfrac{CO2_{conc}}{100}$

(3) Meaning of Terms.

(i) HC_{mass} = Hydrocarbon emissions in grams per second.

(ii) $Density_{HC}$ = Density of hydrocarbons is 16.33 grams per cubic foot assuming an average carbon to hydrogen ratio of 1:1.85 at 68°F and 760 mm Hg pressure.

(iii) HC_{conc} = Average hydrocarbon concentration per second of the dilute exhaust sample measured as described in §85.2226(c)(4), and corrected for background, in ppm carbon equivalent, i.e., equivalent propane * 3.

(A) $HC_{conc} = HC_e - HC_d (1 - \frac{1}{DF})$ Where:

(B) HC_e = Hydrocarbon concentration of the dilute exhaust sample as measured in ppm carbon equivalent.

(C) HC_d = Background hydrocarbon concentration of the dilution air, sampled as described in §85.2221(b)(5), as measured in ppm carbon equivalent.

(D) DF $= \frac{13.4}{CO2_e + (HC_e + CO_e) * 10^{-4}}$, calculated on a second-by-second basis.

(iv) V_{mix} = The CVS flow rate in cubic feet per second corrected to standard temperature and pressure.

(v) CO_{mass} = Carbon monoxide emissions in grams per second.

(vi) $Density_{CO}$ = Density of carbon monoxide is 32.97 grams per cubic foot at 68°F and 760 mm Hg pressure.

(vii) CO_{conc} = Average carbon monoxide concentration per second of the dilute exhaust sample measured as in §85.2226(c)(4), and corrected for background, water vapor, and CO_2 extraction, in ppm.

(A) $CO_{conc} = CO_e - CO_d \left(1 - \frac{1}{DF}\right)$

(B) CO_e = Carbon monoxide concentration of the dilute exhaust in ppm.

(C) CO_d = Background carbon monoxide concentration of the dilution air, sampled as described in §85.2221(b)(5), in ppm.

(viii) NO_{xmass} = Oxides of nitrogen emissions in grams per second.

(ix) $Density_{NO2}$ = Density of oxides of nitrogen is 54.16 grams per cubic foot assuming they are in the form of nitrogen dioxide at 68°F and 760 mm Hg pressure.

(x) NO_{xconc} = Average concentration of oxides of nitrogen per second of the dilute exhaust sample measured as described in §85.2226(c)(4), and corrected for background in ppm.

(A) $NOx_{conc} = NOx_e - NOx_d \left(1 - \frac{1}{DF}\right)$

(B) NOx_e = Oxides of nitrogen concentration of the dilute exhaust sample as measure in ppm.

(C) NOx_d = Background oxides of nitrogen concentration of the dilution air, sampled as described in §85.2221(b)(5), measured in ppm.

(xi) K_H = humidity correction factor.

(A) K_H = $\frac{1}{1 - 0.0047\,(H - 75)}$

(B) H = Absolute humidity in grains of water per pound of dry air.

(C) H = $\frac{(43.478)\,R_a * P_d}{P_B - (P_d * \frac{R_a}{100})}$

(D) R_a = Relative humidity of the ambient air, percent.

(E) P_d = Saturated vapor pressure, mm Hg at the ambient dry bulb temperature. If the temperature is above 86° F, then it shall be used in lieu of the higher temperature, until EPA supplies final correction factors.

(F) P_B = Barometric pressure, mm Hg.

(xii) CO_{2mass} = Carbon dioxide emissions in grams per second.

(xiii) $Density_{CO2}$ = Density of carbon dioxide is 51.81 grams per cubic foot at 68°F and 760 mm Hg.

(xiv) CO_{2conc} = Average carbon dioxide concentration per second of the dilute exhaust sample measured as described in §85.2226(c), and corrected for background in percent.

(A) $CO_{2conc} = CO_{2e} - CO_{2d}\,(1-\frac{1}{DF})$

(B) CO_{2d} = Background carbon dioxide concentration of the dilution air, sampled as described in §85.2221(b)(5), measured in percent.

(c) Evaporative System Purge Test Standards

(1) Total Flow Method. The vehicle shall pass the purge test when the total volume of flow exceeds one standard liter. If total volume of flow is less than 1.0 standard liter at the conclusion of the transient driving cycle, the vehicle shall fail. Any measurement below the noise specification in §85.2227(b)(2)(vi) shall not be included in the total flow calculation.

(2) Total Flow Method Fast-Pass. Vehicles may be passed using the following algorithm.

(i) Beginning at second 30 of the driving cycle, cumulative second-by-second purge levels for each second, in liters, shall be compared to the cumulative fast-pass purge standards for the second under consideration.

(ii) A vehicle shall pass the purge test if cumulative purge levels are above the fast-pass standard for the second under consideration.

(iii) Testing may be terminated when a fast-pass decision has been made for purge and for all subject exhaust components as described in §85.2205(a)(4).

(v) If a fast-pass decision cannot be made for purge and for all subject exhaust components before the driving cycle ends, the pass/fail determination for purge shall be based on purge levels over the full driving cycle as described in §85.2205(c)(1).

(d) Evaporative System Pressure Test Standards

(1) Visual Check. The vehicle shall fail the evaporative system visual check if any part of the system is missing, damaged, improperly connected, or disconnected as described in §85.2222(b).

(2) Canister End Pressure Test Standards. The vehicle shall fail the pressure test if the system cannot maintain a pressure above eight inches of water for up to two minutes after being pressurized to 14±0.5 inches of water. The vehicle shall also fail if it does not posess a check valve, as identified in the Look-up Table, and if no pressure drop is detected when the gas cap is loosened as described in §85.2222(c)(4).

(3) Fuel Inlet Pressure Test.

(i) Pass/Fail Determination. Flow rate, fill pressure, and decay pressure shall be measured at 2 Hz, averaged over 1 second intervals, and curve fitted using a least squares technique. If the volume compensated pressure drop is more than the pressure loss determined from starting and ending pressures in the Pressure Decay Reference Equation in §85.2205(c)(3)(ii), the vehicle shall fail. Otherwise the vehicle shall pass. If not using volume compensation, the vehicle shall fail if the loss in pressure exceeds 6 inches of water.

(ii) Pressure Decay Reference Equation. This equation provides pressure loss values equivalent to a loss of pressure from 14 to 8 inches of water when the starting pressure is other than 14 inches of water.

$$P = 40 * (0.9967 - 2.7 * 10^{-6} * t)^{t}$$

Where:

P = Starting or ending pressure, in inches of water.

t = Time, in seconds.

(iii) Fast-Pass. Fast-pass determinations may be made anytime during the pressure decay between 20 and 120 seconds if the measured pressure exceeds the corresponding Pressure Test Reference Equation cutpoint, from §85.2205 (c)(3)(ii), by 1 inch of water pressure. The cutpoint is determined by adding 1 inch of water to the pressure value at a time t. The pressure at time t corresponds to the pressure at the equivalent "start time" plus the time in seconds between 20 and 120 when the fast pass determination is made. States may propose and the Administrator may approve other fast pass algorithms provided they minimize false results.

(iv) Pressure Drop. For vehicles without vapor control valves (burp valves), the clamp(s) shall be removed from the hose(s) and the system shall be monitored for a gradual pressure drop. If no pressure drop is detected, the vehicle shall fail the test. If the Pressure Test Look-up Table identifies the vehicle as possessing a vapor control valve, the system shall not be monitored for a loss of pressure.

(4) Gas Cap Test.

(i) Pressure Decay Method. If pressure decays by 6 inches of water or more during the 10 second period, the vehicle shall fail the fuel cap integrity test.

(ii) Flow Rate Method. The fuel cap leak rate shall be compared to an orifice with a National Institute of Standards and Technology traceable flow rate which will result in a pass/fail flow rate threshold of 60 cubic centimeters per minute of air at 30 inches of water column. If the leak rate exceeds 60 cubic centimeters per minute at a pressure of 30 inches of water column, the cap shall fail the test.

§85.2221 IM240 and Evaporative System Purge Test Procedures

(a) General Requirements

(1) Data Collection. The following information shall be determined for the vehicle being tested and used to automatically select the dynamometer inertia and power absorption settings:

(i) Vehicle type: LDGV, LDGT1, LDGT2, HDGT, and others as needed,
(ii) Chassis model year,
(iii) Make,
(iv) Model,
(v) Number of cylinders, or cubic inch displacement of the engine, and
(vi) Transmission type.

(2) Ambient Conditions. The ambient temperature, absolute humidity, and barometric pressure shall be recorded continuously during the transient or as a single set of readings up to 4 minutes before the start of the transient driving cycle.

(3) Restart. If shut off, the vehicle shall be restarted as soon as possible before the test and shall be running at least 30 seconds prior to the transient driving cycle.

(b) Pre-inspection and Preparation

(1) Accessories. All accessories (air conditioning, heat, defogger, radio, automatic traction control if switchable, etc.) shall be turned off (if necessary, by the inspector).

(2) Leaks. The vehicle shall be inspected for exhaust leaks. Audio assessment while blocking exhaust flow or gas measurement of carbon dioxide or other gases shall be acceptable. Vehicles with leaking exhaust systems shall be rejected from testing.

(3) Operating Temperature. The vehicle temperature gauge, if equipped and operating, shall be checked to assess temperature. If the temperature gauge indicates that the engine is not at normal operating temperature, the vehicle shall not be fast-failed and shall get a second-chance emission test if it fails the initial test for any criteria exhaust component. Vehicles in overheated condition shall be rejected from testing.

(4) Tire Condition. Vehicles shall be rejected from testing if the tire cords, bubbles, cuts, or other damage are visible. Vehicles shall be rejected that have space-saver spare tires on the drive axle. Vehicles may be rejected that do not have reasonably sized tires. Vehicle tires shall be visually checked for adequate pressure level. Drive wheel tires that appear low shall be inflated to approximately 30 psi, or to tire side wall pressure, or manufacturer's recommendation. Tires of vehicles being tested for the purposes of program evaluation under §51.353(c) shall have their tires inflated to tire side wall pressure.

(5) Ambient Background. Background concentrations of hydrocarbons, carbon monoxide, oxides of nitrogen, and carbon dioxide (HC, CO, NO_X, and CO_2,

respectively) shall be sampled as specified in §85.2226(b)(2)(iv) to determine background concentration of constant volume sampler dilution air. The sample shall be taken for a minimum of 15 seconds within 120 seconds of the start of the transient driving cycle, using the same analyzers used to measure tailpipe emissions except as provided in §85.2221(f)(3). Average readings over the 15 seconds for each gas shall be recorded in the test record. Testing shall be prevented until the average ambient background levels are less than 20 ppmC HC, 30 ppm CO, and 2 ppm NOx, or outside ambient air levels (not influenced by station exhaust), which ever are greater.

(6) Sample System Purge. While a lane is in operation, the CVS shall continuously purge the CVS hose between tests, and the sample system shall be continuously purged when not taking measurements.

(7) Negative Values. Negative gram per second readings shall be integrated as zero and recorded as such.

(c) Equipment Positioning and Settings

(1) Purge Equipment. If an evaporative system purge test is to be performed:

(i) The evaporative canister shall be checked unless the canister is inaccessible. A missing or obviously damaged canister shall result in failure of the visual evaporative system check.

(ii) The evaporative system shall be visually inspected for the appearance of proper hose routing and connection of hoses, unless the canister is inaccessible. If any evaporative system hose is disconnected, then the vehicle shall fail the visual evaporative system check. All hoses disconnected for the test shall be reconnected after a purge flow test is performed.

(iii) The purge flow measurement equipment shall be connected in series between the evaporative canister and the engine, preferably on the canister end of the hose. For vehicles equipped with a service port for evaporative functional testing, the measurement equipment shall be connected to the port.

(2) Roll Rotation. The vehicle shall be maneuvered onto the dynamometer with the drive wheels positioned on the dynamometer rolls. Prior to test initiation, the rolls shall be rotated until the vehicle laterally stabilizes on the dynamometer. Drive wheel tires shall be dried if necessary to prevent slippage during the initial acceleration.

(3) Cooling System. Testing shall not begin until the test-cell cooling system is positioned and activated whenever ambient temperature exceeds 72°F. The vehicle hood shall be open whenever ambient temperature exceeds 72°F. The cooling system shall be positioned to direct air to the vehicle cooling system, but shall not be directed at the catalytic converter.

(4) Vehicle Restraint. Testing shall not begin until the vehicle is restrained. Any restraint system shall meet the requirements of §85.2226(a)(5)(ii). In addition, the parking brake shall be set for front wheel drive vehicles prior to the start of the test.

(5) Dynamometer Settings. Dynamometer power absorption and inertia weight settings shall be automatically chosen from an EPA-supplied electronic look-up table which will be referenced based upon the vehicle identification information obtained in (a)(1). Vehicles not listed shall be tested using default power absorption and inertia settings as follows:

VEHICLE TYPE	NUMBER OF CYLINDERS	TRACK ROAD LOAD HORSEPOWER	TEST INERTIA WEIGHT
All	3	12.1	2000
All	4	12.8	2500
All	5	14.5	3000
All	6	14.5	3000
LDGV	8	16.2	3500
LDGT	8	17.7	4000
LDGV	10	16.2	3500
LDGT	10	19.2	4500
LDGV	12	17.7	4000
LDGT	12	20.7	5000

(6) Exhaust Collection System. The exhaust collection system shall be positioned to insure complete capture of the entire exhaust stream from the tailpipe during the transient driving cycle. The system shall meet the requirements of §85.2226(b)(2).

(d) **Vehicle Conditioning**

(1) Queuing Time. When the vehicle queue exceeds 20 minutes, a vehicle shall get a second-chance emission test if it fails the initial test and all criteria exhaust components are at or below 1.5 times the standard.

(2) Program Evaluation. Vehicles being tested for the purpose of program evaluation under §51.353(c) shall receive two full transient emission tests (i.e., a full 240 seconds each). Results from both tests and the test order shall be separately recorded in the test record. Emission scores and results provided to the motorist may be from either test.

(3) Discretionary Preconditioning. At the program's discretion, any vehicle may be preconditioned using any of the following methods:

(i) Non-loaded Preconditioning. Increase engine speed to approximately 2500 rpm, for up to 4 minutes, with or without a tachometer.

(ii) Loaded Preconditioning. Drive the vehicle on the dynamometer at 30 miles per hour for up to 240 seconds at road-load .

(iii) Transient Preconditioning. After maneuvering the vehicle onto the dynamometer, drive a transient cycle consisting of speed, time, acceleration, and load relationships similar to that of the transient driving cycle in §85.2221(e)(1).

(4) Second-Chance Purge Testing. Vehicles that exhibit significant purge activity during the driving cycle but do not accumulate one liter of purge shall receive a second-chance purge test. The second-chance test may be the Transient Driving Cycle or modified sequences of shorter duration designed to rapidly produce purge activity.

(e) Vehicle Emission Test Sequence

(1) Transient Driving Cycle. The vehicle shall be driven over the following cycle:

Time second	Speed mph	Time second	Speed mph	Time second	Speed mph	Time second	Speed mph	Time second	Speed mph
0	0	48	25.7	96	0	144	24.6	192	54.6
1	0	49	26.1	97	0	145	24.6	193	54.8
2	0	50	26.7	98	3.3	146	25.1	194	55.1
3	0	51	27.5	99	6.6	147	25.6	195	55.5
4	0	52	28.6	100	9.9	148	25.7	196	55.7
5	3	53	29.3	101	13.2	149	25.4	197	56.1
6	5.9	54	29.8	102	16.5	150	24.9	198	56.3
7	8.6	55	30.1	103	19.8	151	25	199	56.6
8	11.5	56	30.4	104	22.2	152	25.4	200	56.7
9	14.3	57	30.7	105	24.3	153	26	201	56.7
10	16.9	58	30.7	106	25.8	154	26	202	56.3
11	17.3	59	30.5	107	26.4	155	25.7	203	56
12	18.1	60	30.4	108	25.7	156	26.1	204	55
13	20.7	61	30.3	109	25.1	157	26.7	205	53.4
14	21.7	62	30.4	110	24.7	158	27.3	206	51.6
15	22.4	63	30.8	111	25.2	159	30.5	207	51.8
16	22.5	64	30.4	112	25.4	160	33.5	208	52.1
17	22.1	65	29.9	113	27.2	161	36.2	209	52.5
18	21.5	66	29.5	114	26.5	162	37.3	210	53
19	20.9	67	29.8	115	24	163	39.3	211	53.5
20	20.4	68	30.3	116	22.7	164	40.5	212	54
21	19.8	69	30.7	117	19.4	165	42.1	213	54.9
22	17	70	30.9	118	17.7	166	43.5	214	55.4
23	14.9	71	31	119	17.2	167	45.1	215	55.6
24	14.9	72	30.9	120	18.1	168	46	216	56
25	15.2	73	30.4	121	18.6	169	46.8	217	56
26	15.5	74	29.8	122	20	170	47.5	218	55.8
27	16	75	29.9	123	20.7	171	47.5	219	55.2
28	17.1	76	30.2	124	21.7	172	47.3	220	54.5
29	19.1	77	30.7	125	22.4	173	47.2	221	53.6
30	21.1	78	31.2	126	22.5	174	47.2	222	52.5
31	22.7	79	31.8	127	22.1	175	47.4	223	51.5
32	22.9	80	32.2	128	21.5	176	47.9	224	50.5
33	22.7	81	32.4	129	20.9	177	48.5	225	48
34	22.6	82	32.2	130	20.4	178	49.1	226	44.5
35	21.3	83	31.7	131	19.8	179	49.5	227	41
36	19	84	28.6	132	17	180	50	228	37.5
37	17.1	85	25.1	133	17.1	181	50.6	229	34
38	15.8	86	21.6	134	15.8	182	51	230	30.5
39	15.8	87	18.1	135	15.8	183	51.5	231	27
40	17.7	88	14.6	136	17.7	184	52.2	232	23.5
41	19.8	89	11.1	137	19.8	185	53.2	233	20
42	21.6	90	7.6	138	21.6	186	54.1	234	16.5
43	23.2	91	4.1	139	22.2	187	54.6	235	13
44	24.2	92	0.6	140	24.5	188	54.9	236	9.5
45	24.6	93	0	141	24.7	189	55	237	6
46	24.9	94	0	142	24.8	190	54.9	238	2.5
47	25	95	0	143	24.7	191	54.6	239	0

(2) Driving Trace. The inspector shall follow an electronic, visual depiction of the time/speed relationship of the transient driving cycle (hereinafter, the trace). The visual depiction of the trace shall be of sufficient magnification and adequate detail

to allow accurate tracking by the driver and shall permit the driver to anticipate upcoming speed changes. The trace shall also clearly indicate gear shifts as specified in §85.2221(e)(3).

(3) Shift Schedule. For vehicles with manual transmissions, inspectors shall shift gears according to the following shift schedule:

Shift Sequence *gear*	Speed *miles per hour*	Nominal Cycle Time *seconds*
1 - 2	15	9.3
2 - 3	25	47.0
De-clutch	15	87.9
1 - 2	15	101.6
2 - 3	25	105.5
3 - 2	17	119.0
2 - 3	25	145.8
3 - 4	40	163.6
4 - 5	45	167.0
5 - 6	50	180.0
De-clutch	15	234.5

Gear shifts shall occur at the points in the driving cycle where the specified speeds are obtained. For vehicles with fewer than six forward gears the same schedule shall be followed with shifts above the highest gear disregarded.

(4) Speed Excursion Limits. Speed excursion limits shall apply as follows:

(i) The upper limit is 2 mph higher than the highest point on the trace within 1 second of the given time.

(ii) The lower limit is 2 mph lower than the lowest point on the trace within 1 second of the given time.

(iii) Speed variations greater than the tolerances (such as may occur during gear changes) are acceptable provided they occur for no more than 2 seconds on any occasion.

(iv) Speeds lower than those prescribed during accelerations are acceptable provided the vehicle is operated at maximum available power during such accelerations until the vehicle speed is within the excursion limits.

(v) Exceedances of the limits in §85.2221(i) through §85.2221(iii) shall automatically result in a void test. The station manager can override the automatic void of a test if the manager determines that the conditions specified in §85.2221(e)(4)(iv) occurred. Tests shall be aborted if the upper excursion limits are exceeded. Tests may be aborted if the lower limits are exceeded.

(5) Speed Variation Limits.

(i) A linear regression of feedback value on reference value shall be performed on each transient driving cycle for each speed using the method of least squares, with the best fit equation having the form: $y = mx + b$, where:

(A) y = The feedback (actual) value of speed;

(B) m = The slope of the regression line;

(C) x = The reference value; and

(D) b = The y-intercept of the regression line.

(ii) The standard error of estimate (SE) of y on x shall be calculated for each regression line. A transient driving cycle lasting the full 240 seconds that exceeds the following criteria shall be void and the test shall be repeated:

(A) SE = 2.0 mph maximum.

(B) m = 0.96 - 1.01.

(C) r^2 = 0.97 minimum.

(D) b = ±2.0 mph.

(iii) A transient driving cycle that ends before the full 240 seconds that exceeds the following criteria shall be void and the test shall be repeated:

(A) SE = *(Reserved)*

(B) m = *(Reserved)*

(C) r^2 = *(Reserved)*

(D) b = *(Reserved)*

(6) Distance Criteria. The actual distance traveled for the transient driving cycle and the equivalent vehicle speed (i.e., roll speed) shall be measured. If the absolute difference between the measured distance and the theoretical distance for the actual test exceeds 0.05 miles, the test shall be void.

(7) Vehicle Stalls. Vehicle stalls during the test shall result in a void and a new test. More than 3 stalls shall result in test failure.

(8) Dynamometer Controller Check. For each test, the measured horsepower, and inertia if electric simulation is used, shall be integrated from 55 seconds to 81 seconds (divided by 26 seconds), and compared with the theoretical road-load horsepower (for the vehicle selected) integrated over the same portion of the cycle. The same procedure shall be used to integrate the horsepower between 189 seconds to 201 seconds (divided by 12 seconds). The theoretical horsepower shall be calculated based on the observed speed during the integration interval. If the absolute difference between the theoretical horsepower and the measured horsepower exceeds 0.5 hp, the test shall be void. For vehicles over 8500 pounds GVWR, if the absolute difference between the theoretical horsepower and the

measured horsepower exceeds 2 hp, the test shall be void. Alternate error checking methods may be used if shown to be equivalent.

(9) Inertia Weight Selection. Operation of the inertia weight selected for the vehicle shall be verified as specified in §85.2226(a)(4)(iii). For systems employing electrical inertia simulation, an algorithm identifying the actual inertia force applied during the transient driving cycle shall be used to determine proper inertia simulation. For all dynamometers, if the observed inertia is more than 1% different from the required inertia, the test shall be void.

(10) CVS Operation. The CVS operation shall be verified for each test for a CFV-type CVS by measuring either the absolute pressure difference across the venturi or measuring the blower vacuum behind the venturi for minimum levels needed to maintain choke flow for the venturi design. The operation of an SSV-type CVS shall be verified throughout the test by monitoring the difference in pressure between upstream and throat pressure. The minimum values shall be determined from system calibrations. Monitored pressure differences below the minimum values shall void the test.

(11) Fuel Economy. For each test, the health of the overall analysis system shall be evaluated by checking a test vehicle's fuel economy for reasonableness, relative to upper and lower limits, representing the range of fuel economy values normally encountered for the test inertia and horsepower selected. For each inertia selection, the upper fuel economy limit shall be determined using the lowest horsepower setting typically selected for the inertia weight, along with statistical data, test experience, and engineering judgment. A similar process for the lower fuel economy limit shall be used with the highest horsepower setting typically selected for the inertia weight. For test inertia selections where the range of horsepower settings is greater than 5 horsepower, at least two sets of upper and lower fuel economy limits shall be determined and appropriately used for the selected test inertia. Tests with fuel economy results in excess of 1.5 times the upper limit shall result in a void test.

(f) Emission Measurements

(1) Exhaust Measurement. The emission analysis system shall sample and record dilute exhaust HC, CO, CO_2, and NO_x during the transient driving cycle as described in §85.2226(c).

(2) Purge Measurement. The analysis system shall sample and record the purge flow in standard liters per second and total volume of flow in standard liters over the course of the actual driving cycle as described in §85.2227(b).

(3) Integrity Measurement. The analysis system shall measure and record the integrity of the evaporative system and the gas cap as described in §85.2227(c).

§85.2222 Evaporative System Pressure Test Procedures

(a) General Requirements

(1) The on-vehicle pressure tests described in §85.2222(c) and (d) shall be performed after any tailpipe emission test to be performed on a vehicle. Gas cap tests described in §85.2222(e) and (f) may be performed before or after the tailpipe emission test.

(2) The pressure test shall be conducted in a manner that minimizes changes in temperature, since pressure measurements are affected by changes in the vapor space temperature.

(3) The Look-up Table identifies which on-vehicle pressure test to perform on a given vehicle. Vehicles receiving the canister end pressure test specified in §85.2222(c) do not need to receive any other pressure tests. Vehicles receiving the fuel inlet pressure test specified in §85.2222(d) should also be given one of the gas cap pressure tests specified in §§85.2222(e) and (f).

(4) Alternative procedures may be used if they are shown to be equivalent or better to the satisfaction of the Administrator. Except in the case of government-run test facilities claiming sovereign immunity, any damage done to the evaporative emission control system during this test shall be repaired at the expense of the inspection facility.

(b) Pre-inspection and Preparation

(1) The evaporative canister(s) shall be visually checked to the degree practical. A missing or obviously damaged canister(s) shall fail the visual evaporative system check.

(2) The evaporative system hoses shall be visually inspected for the appearance of proper routing, connection, and condition, to the degree practical. If any evaporative system hose is misrouted, disconnected, or damaged, the vehicle shall fail the visual evaporative system check.

(3) If the gas cap is missing, obviously defective or the wrong style cap for the vehicle, the vehicle shall fail the visual evaporative system check.

(c) Canister-End Pressure Test

(1) Equipment Set-up. Test equipment shall be connected to the fuel tank canister hose at the canister end. The gas cap shall be checked to ensure that it is properly, but not excessively tightened, and shall be tightened if necessary.

(2) Pressure Value. The system shall be pressurized to 14 ±0.5 inches of water without exceeding 26 inches of water system pressure.

(3) Stability. Close off the pressure source, seal the evaporative system and monitor pressure decay for up to two minutes.

(4) Depressurization. Loosen the gas cap after a maximum of two minutes and monitor for a sudden pressure drop, indicating that the fuel tank was pressurized.

(5) Reconnection. The inspector shall carefully ensure that all items disconnected or lossened in the course of the test are properly reconnected at the conclusion of the test.

(d) Fuel Inlet Pressure Test

(1) Equipment Set-up. The vapor vent line(s) from the gas tank to the canister(s) shall be clamped off as close to the canister(s) as practical without damaging evaporative system hardware. If the line(s) can not be clamped (for example a rigid line), they shall be removed at the canister(s) and capped or plugged. Dual fuel tanks shall be checked individually if the complete vapor control system can not be accessed by pressurizing from the fill pipe interface of only one fuel tank. A fuel inlet adapter, as specified in §85.2227(c), appropriate to the style of fuel inlet on the vehicle (not the gas cap on the vehicle) shall be selected based on a software prompt and shall be installed on the vehicle's fuel inlet.

(2) Pressure Value. The gas tank shall be pressurized to a value at or slightly above the minimum test pressure specified in the Look-up Table.

(3) Stability. Pressure stability shall be maintained for a period of 10 seconds prior to the start of the pressure decay measurement. Pressure shall not increase by more than 0.5 inches of water during the first 20 seconds of the decay measurement. Alternate definitions of stability may be proposed by the state and approved by the Administrator provided they minimize the risk of false results.

(4) Volume Compensation. (Optional) Pressure decay measurements are affected by the vapor volume (fuel tank level) in the fuel tank. Volume-compensated pressure decay measurements will increase test repeatability, and are therefore recommended. Measure the volume-compensated pressure decay for up to 120 seconds after stability is achieved, using the equation in §85.2222(d)(5). This equation is based on normalizing the pressure decay measurements to a vapor volume of 50 liters. States may propose and the Administrator may approve other methods of compensation for differences in fuel tank vapor volume.

(5) $$P = P_0 * k^{\left(t * \frac{V}{V_s}\right)}$$

Where:

P = Pressure, in inches of water at time t, compensated for differences in fuel tank vapor space volume.

P_0 = The stabilized pressure at the start of the decay portion of the pressure test, in inches of water.

k = A constant derived from curve fitting the pressure/time data from the decay portion of the pressure test, using the equation:

$$P = P_0 * k^t$$

t = Time measured from the start of the decay portion of the pressure test, in seconds.

V_s = Reference volume of the fuel vapor space, 50 liters.

V = Volume of the fuel vapor space, in liters, calculated using the following equation:

$$V = \left(P_b * 13.6 + \frac{ÆP}{2}\right) * \frac{ÆV}{(ÆP + ÆP_L)}$$

Where:

P_b = Barometric pressure, in inches of Hg.

ÆP = Pressure increase during the fill period, in inches of water.

ÆV = The flow meter measured volume of gas which pressurizes the vapor space, in liters at 20 C and 1 atmosphere.

$ÆP_L$ = The loss in pressure due to the presence of a leak during the fill process, in inches of water.

$$ÆP_L = \sum_{t=0}^{t} P_0 * k^{\left(\frac{ln P_t - ln P_0}{ln k} - 1\right)} - P_0 * k^{\left(\frac{ln P_t - ln P_0}{ln k}\right)}$$

Where:

_ = Summation of the second-by-second pressure loss during the fill period.

P_0 = The stabilized pressure at the start of the decay portion of the pressure test, in inches of water.

k = A constant derived from curve fitting the pressure/time data from the <u>decay</u> portion of the pressure test, using the equation:

$$P = P_0 * k^t$$

P_t = Pressure values reported in one second intervals during the <u>fill</u> period, in inches of water.

(e) Gas <u>Cap Leak Test - Pressure</u> Decay <u>Method</u>

(1) The fuel cap shall be removed from the fuel inlet and installed on a test rig with a nominal 1 liter head space and be pressurized to 28±1.0 inch of water.

(2) The pressure decay shall be monitored for 10 seconds after stability is achieved for 10 seconds.

(3) The fuel cap shall be replaced on the fuel inlet and tightened appropriately.

(f) **Gas Cap Leak Test - Flow Rate Method**

(1) The fuel cap shall be removed from the fuel inlet and installed on the flow test device using the adapter appropriate for the fuel cap, as specified in §85.2227(c).

(2) The fuel cap shall be pressurized to approximately 30 inches of water until flow rate measurements meeting the requirements of §85.2205(d)(4)(ii) are met.

(3) The fuel cap shall be replaced on the fuel inlet and tightened appropriately.

§85.2226 IM240 Equipment Specifications

(a) Dynamometer Specifications

(1) General Requirements.

(i) The dynamometer structure (e.g., bearings, rollers, pit plates, etc.) shall accommodate all light-duty vehicles and light-duty trucks up to 8500 pounds GVWR.

(ii) Road load horsepower and inertia simulation shall be automatically selected based on the vehicle parameters in the test record.

(iii) Alternative dynamometer specifications or designs may be proposed by a state and approved based upon a determination by the Administrator that, for the purpose of properly conducting an approved short test, the evidence supporting such deviations will not cause improper vehicle loading.

(2) Power Absorption.

(i) Coefficients. The coefficients A_V, B_V, and C_V, from vehicle track coast down testing, and referenced in the equations in this section are those specified during new car certification, or as specified by a vehicle class designator determined by the Administrator. Coefficients shall be calculated to a minimum of five (5) significant digits by the equations specified in §85.2226(a)(2)(i)(A) through §85.2226(a)(2)(i)(C). Power fractions determined from track coast-down data shall be calculated to a minimum of two (2) significant digits as specified in §85.2226(a)(2)(i). In the absence of new car certification coefficients information or a vehicle class designator identifying a power fraction, the default power fractions in §85.2226(a)(2)(i)(J) shall be used.

(A) $$A_V = \frac{A_V PF}{50} * (TRLHP_{@\,50\,mph}) \text{ hp/mph}$$

(B) $$B_V = \frac{B_V PF}{2500} * (TRLHP_{@\,50\,mph}) \text{ hp/mph}^2$$

(C) $$C_V = \frac{C_V PF}{125000} * (TRLHP_{@\,50\,mph}) \text{ hp/mph}^3$$

(D) Where $A_V PF$, $B_V PF$, and $C_V PF$ are power fractions (PF), and indicate the fraction of the total power reflected by each coefficient A_V, B_V, and C_V.

(E) $A_V PF + B_V PF + C_V PF = 1$

(F) Derivation of $A_V PF$, $B_V PF$, and $C_V PF$ from known track coast-down curves shall be computed as follows:

(1) $$A_V PF = \frac{A_V (50)}{\{A_V (50) + B_V (2500) + C_V (125{,}000)\}}$$

(2) $$B_V PF = \frac{B_V (2500)}{\{A_V (50) + B_V (2500) + C_V (125{,}000)\}}$$

(3) $$C_V PF = \frac{C_V (125{,}000)}{\{A_V (50) + B_V (2500) + C_V (125{,}000)\}}$$

(4) Default values:

$A_V PF = 0.35$

$B_V PF = 0.10$

$C_V PF = 0.55$

(ii) Vehicle Loading. The true vehicle loading used during the transient driving cycle shall follow the equation in §85.2226(a)(2)(iii) between 10 and 60 mph. The dynamometer controls shall set the dynamometer loading to achieve the coast-down target time (±1 second) with the vehicle on the dynamometer using the vehicle-specific inertia test weights. A conversion equation or table of target time versus horsepower for the dynamometer design shall be used. Target time shall be converted to horsepower by the equation §85.2226(a)(2)(iv) or pre-defined horsepower values may be used.

(iii) $$TRLHP_{@\ Obmph} = \{A_V * Obmph\} + \{B_V * Obmph^2\} + \{C_V * Obmph^3\}$$

Av, Bv, Cv = Coefficients specified in §85.2226(a)(2)(i) for vehicle track coast down curves.

Obmph = Observed mph

TRLHP = Track Road Load Horsepower, which includes loading contributions from the power absorber, parasitic losses, and tire/roll interface losses.

(iv) $$\text{Track Road-Load Horsepower} = \frac{\left(\frac{0.5 * ETW}{32.2}\right) * (V_1^2 - V_2^2)}{(550 * ET)}$$

ET = Elapsed time for the vehicle on the road to coast down from 55 to 45 mph, and from 22 to 18 mph

ETW = Inertia weight in pounds

V_1 = Initial velocity in feet/second (i.e., velocity at either 55 or 22 mph)

V_2 = Final velocity in feet/second (i.e., velocity at either 45 or 18 mph)

(v) In practice, the true vehicle loading is derived from equations of "force" (i.e., F=MA). In determining vehicle load on a dynamometer, applied loads in units of force tangential to the roll surface are not dependent on the roll diameter used, whereas applied loads in units of torque of horsepower are dependent on the roll diameter. The equation in §85.2226(a)(2)(vi) may be used to convert track road-load horsepower values in §85.2226(a)(2)(iii) to units of force.

(vi) $TRLF_{@\ Obmph} = \{A_f\} + \{B_f * Obmph\} + \{C_f * Obmph^2\}$

TRLF = Track Road-Load Force (in units of pounds)
A_f = $375 * A_v$ (A_v in HP/mph units)
B_f = $375 * B_v$ (B_v in HP/mph^2 units)
C_f = $375 * C_v$ (C_v in HP/mph^3 units)

A_f, B_f, C_f = Equivalent force coefficients to the coefficients specified in §85.2226(a)(2)(i) for vehicle track coast down curves.

(vii) Range and Curve of Power Absorber. The range of power absorber at 50 mph shall be sufficient to cover track road-load horsepower (TRLHP) values between 4 and 35 horsepower. The absorption shall be adjustable across the required horsepower range at 50 mph in 0.1 horsepower increments. The accuracy of the power absorber shall be ±0.25 horsepower or ±2% of point whichever is greater.

(viii) Parasitic Losses (General Requirements). The parasitic losses in each dynamometer system (such as windage, bearing friction, and system drive friction) shall be characterized between 10 and 60 mph upon initial acceptance. There shall be no sudden discontinuities in parasitic losses below 10 mph. Further, when added to the lowest possible loading of the power absorber (dynamometer motoring is considered a negative load), the parasitic losses must be sufficiently small such that proper loading will occur between 10 and 60 mph for a vehicle with a 50 mph track road-load horsepower value of 4 horsepower. The parasitic horsepower losses shall be characterized either digitally in five mph increments and linearly interpolated in-between, or the data at 10 mph increments shall fit the equation in §85.2226(a)(2)(ix) to within 2 percent of point.

(ix) $PLHP = \{A_p * (Obmph)\} + \{(B_p) * (Obmph)^2\} + \{(C_p) * (Obmph)^3\}$

PLHP= Dynamometer parasitic losses.

A_p, B_p, and C_p are curve coefficients necessary to properly characterize the dynamometer parasitic losses for the inertia weight(s) used.

(x) Parasitic Losses (Low Speed Requirements). The coast down time of the dynamometer between 8 and 12 mph shall be greater than or equal to the value calculated by the equation in §85.2226(a)(2)(xi) when the dynamometer is set for a 2000 pound vehicle with a track road-load horsepower of 4 horsepower at 50 mph.

(xi) Low Speed Loading. The following procedure is used to determine if a dynamometer system is correctly loading a vehicle with an ETW of 2000 pounds and a TRLHP of 6.0 horsepower at low speeds. Use "default" coefficients from §85.2226(a)(2)(i)(F)(4). Dynamometer must be warmed up prior to this procedure.

(A) Select vehicle with a driven axle weight between 1200 and 1300 pounds (sandbags or other ballast may be used to achieve this weight). Record vehicles driven axle weight to the nearest pound.

(B) Calculate the actual tire/roll interface losses (ATRL) using the following sub procedure.

(1) Determine PLHP for dynamometer system being tested.

(2) Calculate GTRL using equations from §§85.2226(a)(2)(xiii) and (xv) or (xvi).

(3) Calculate IHP using the following formula:

IHP = TRLHP-PLHP-GTRL

(4). Set dynamometer based on IHP calculated is step C above.

(5) Perform dynamometer coast down with vehicle selected in step 1 correctly positioned on rolls. Record coast down time from 12 mph to 8 mph.

(6) Calculate new TRLHP based on 12 mph to 8 mph coast

(7) Calculate actual tire/roll interface losses (ATRL) using the following equation.

ATRL= TRLHP-PLHP-IHP

(C) Using calculated ATRL determine new IHP using the following formula:

$$IHP = TRLHP-PLHP-ATRL$$

(D) Set dynamometer based on IHP calculated is step 3 above.

(E) Perform dynamometer coast down with vehicle selected in step 1 correctly positioned on rolls. Record coast down time from 12 mph to 8 mph.

(F) The maximum, average, and minimum time limits for the on-dynamometer coast-down window at 10 mph ($DT_{Max\ @\ 10\ mph}$, $DT_{Ave\ @\ 10\ mph}$, and $DT_{Min\ @\ 10\ mph}$) shall be calculated by the following equations.

$$DT_{Max\ @\ 10\ mph} = \frac{\left(\frac{0.5 * ETW}{32.17405}\right) * (V_{12}^2 - V_8^2)}{550 * (TRLHP_{@\ 10\ mph} - 0.088\ HP)}$$

$$DT_{Ave\ @\ 10\ mph} = \frac{\left(\frac{0.5 * ETW}{32.17405}\right) * (V_{12}^2 - V_8^2)}{550 * (TRLHP_{@\ 10\ mph})}$$

$$DT_{Min\ @\ 10\ mph} = \frac{\left(\frac{0.5 * ETW}{32.17405}\right) * (V_{12}^2 - V_8^2)}{550 * (TRLHP_{@\ 10\ mph} + 0.088\ HP)}$$

(xii) Tire/Roll Interface Losses. Generic tire/roll interface losses shall be determined for each dynamometer design used, and applied to obtain proper vehicle loading. A means to select or determine the appropriate generic tire/roll interface loss for each test vehicle shall be employed. Dynamometer design parameters include roll diameter, roll spacing, and roll surface finish. Generic tire/roll interface losses may be determined by the acceptance procedures in §85.2234(b)(4). Alternatively, generic values determined by the Administrator, or by a procedure accepted by the Administrator, may be used. The equation in §85.2226(a)(2)(xiii) may be used to quantify tire/roll interface losses. Coefficients for equation in §85.2226(a)(2)(xiii) shall be calculated to a minimum of five (5) significant digits by the equations specified in §85.2226(a)(2)(xiii)(A) through §85.2226(a)(2)(xiii)(I). Tire loss power fractions determined from track coast-down data shall be calculated to a minimum of two (2) significant digits as specified in §85.2226(a)(2)(xiii)(J). In the absence of new car certification information or a vehicle class designator identifying a tire loss power fraction, the default tire loss power fractions indicated equations §85.2226(a)(2)(xiii)(E) through §85.2226(a)(2)(xiii)(I) shall be used as specified in §85.2226(a)(2)(xiii)(J).

(xiii) $GTRL_{@\ Obmph} = \{A_t * (Obmph)\} + \{B_t * (Obmph)^2\} + \{C_t * (Obmph)^3\}$

$GTRL_{@\ Obmph}$ = Generic Tire/Roll Interface losses at the observed mph

Where: A_t, B_t, and C_t are curve coefficients necessary to properly characterize the tire/roll interface losses.

(A)	A_t	=	$(A_tPF / 50)$	*	(GTRL@ 50 mph)	hp/mph
(B)	B_t	=	$(B_tPF / 2500)$	*	(GTRL@ 50 mph)	hp/mph2
(C)	C_t	=	$(C_tPF / 125{,}000)$	*	(GTRL@ 50 mph)	hp/mph^3
(D)	A_{t8}	=	(0.76/ 50)	*	(GTRL@ 50 mph)	hp/mph
(E)	B_{t8}	=	(0.33 / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(F)	C_{t8}	=	(-0.09 / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3
(G)	A_{t20}	=	(0.65 / 50)	*	(GTRL@ 50 mph)	hp/mph
(H)	B_{t20}	=	(0.48 / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(I)	C_{t20}	=	(-0.13 / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3

(J) Where:

(1) A_t, B_t, and C_t are curve coefficients necessary to properly characterize the tire/roll interface losses.

(2) A_{t8}, B_{t8}, and C_{t8} are curve coefficients when using twin 8.625 inch diameter rolls.

(3) A_{t20}, B_{t20}, and C_{t20} are curve coefficients when using twin 20.0 inch diameter rolls.

(4) A_tPF, B_tPF, and C_tPF indicate the fraction of the total tire loss power fraction reflected by each coefficient A_t, B_t, and C_t.

(5) $A_tPF + B_tPF + C_tPF = 1$

(6) Derivation of A_tPF, B_tPF, and C_tPF from known track or dynamometer data shall be computed as follows:

$$A_tPF = \frac{A_t(50)}{\{A_t(50) + B_t(2500) + C_t(125{,}000)\}}$$

$$B_tPF = \frac{B_t(2500)}{\{A_t(50) + B_t(2500) + C_t(125{,}000)\}}$$

$$C_tPF = \frac{C_t(125{,}000)}{\{A_t(50) + B_t(2500) + C_t(125{,}000)\}}$$

(xiv) In the absence of new car certification GTRL@ 50 mph or a vehicle class designator, the GTRL@ 50 mph shall be calculated

(xiii) $GTRL_{@\ Obmph} = \{A_t * (Obmph)\} + \{B_t * (Obmph)^2\} + \{C_t * (Obmph)^3\}$

$GTRL_{@\ Obmph}$ = Generic Tire/Roll Interface losses at the observed mph

Where: A_t, B_t, and C_t are curve coefficients necessary to properly characterize the tire/roll interface losses.

(A)	A_t	=	(A_tPF / 50)	*	(GTRL@ 50 mph)	hp/mph
(B)	B_t	=	(B_tPF / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(C)	C_t	=	(C_tPF / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3
(D)	A_{t8}	=	(0.76/ 50)	*	(GTRL@ 50 mph)	hp/mph
(E)	B_{t8}	=	(0.33 / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(F)	C_{t8}	=	(-0.09 / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3
(G)	A_{t20}	=	(0.65 / 50)	*	(GTRL@ 50 mph)	hp/mph
(H)	B_{t20}	=	(0.48 / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(I)	C_{t20}	=	(-0.13 / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3

(J) Where:

(1) A_t, B_t, and C_t are curve coefficients necessary to properly characterize the tire/roll interface losses.

(2) A_{t8}, B_{t8}, and C_{t8} are curve coefficients when using twin 8.625 inch diameter rolls.

(3) A_{t20}, B_{t20}, and C_{t20} are curve coefficients when using twin 20.0 inch diameter rolls.

(4) A_tPF, B_tPF, and C_tPF indicate the fraction of the total tire loss power fraction reflected by each coefficient A_t, B_t, and C_t.

(5) $A_tPF + B_tPF + C_tPF = 1$

(6) Derivation of A_tPF, B_tPF, and C_tPF from known track or dynamometer data shall be computed as follows:

$$A_tPF = \frac{A_t\,(50)}{\{A_t\,(50) + B_t\,(2500) + C_t\,(125{,}000)\}}$$

$$B_tPF = \frac{B_t\,(2500)}{\{A_t\,(50) + B_t\,(2500) + C_t\,(125{,}000)\}}$$

$$C_tPF = \frac{C_t\,(125{,}000)}{\{A_t\,(50) + B_t\,(2500) + C_t\,(125{,}000)\}}$$

(xiv) In the absence of new car certification GTRL@ 50 mph or a vehicle class designator, the GTRL@ 50 mph shall be calculated

(A) by the equation in §85.2226(a)(2)(xv) when using twin 8.625 inch diameter rolls

(B) by the equation in §85.2226(a)(2)(xvi) when using twin 20.0 inch diameter rolls

(xv) For 8.625" dynamometers:

GTRL@ 50 mph = (-0.378193) + {(0.0033207) * (DAXWT)}

Where: DAXWT = Axle weight on the drive tires
GTRL@ 50 mph = Losses for 8.625 inch diameter roll

(xvi) For 20" dynamometers:

GTRL@ 50 mph = (reserved) + {(reserved) * (DAXWT)}

Where: DAXWT = Axle weight on the drive tires
GTRL@ 50 mph = Losses for 20.0 inch diameter roll

(xvii) Indicated Horsepower. The power absorption for each test shall be selected at 50 mph. The indicated power absorption (IHP) at 50 mph after accounting for parasitic and generic tire losses shall be determined by the equation in §85.2226(a)(2)(xv).

(xviii) $IHP_{@\,50\,mph} = TRLHP_{@\,50\,mph} - PLHP_{@\,50\,mph} - GTRL_{@\,50\,mph}$

(xix) In systems where the power absorption is actively controlled, the indicated horsepower at each speed between 0 and 60 mph shall conform to the equation in §85.2226(a)(2)(xvii). Approximations for a smooth curve with no discontinuities may be used between 0 and 10 mph.

(xx) $IHP_{@\,Obmph} = TRLHP_{@\,Obmph} - PLHP_{@\,Obmph} - GTRL_{@\,Obmph}$

(3) Rolls.

(i) Size and Type. The dynamometer shall be equipped with twin rolls. The rolls shall be coupled side to side. In addition, the front and rear rolls shall be coupled. The dynamometer roll diameter shall be between 8.5 and 21.0 inches. The spacing between the roll centers shall comply with the equation in §85.2226(a)(3)(ii) to within +0.5 inches and -0.25 inches. The parasitic and generic tire/roll interface losses for the specific roll diameter, spacing, and surface finish used shall be determined as indicated in §85.2226(a)(2)(viii), (a)(2)(ix), and §85.2226(a)(2)(xii) as necessary to properly load vehicles as defined in §85.2226(a)(2)(ii) and §85.2226(a)(2)(iii). The dynamometer rolls shall accommodate an inside track width of 30 inches and an outside track width of at least 100 inches.

(ii) Roll Spacing = (24.375 + D) * SIN 31.5153

D = dynamometer roll diameter.

Roll spacing and dynamometer roll diameter are expressed in inches.

(iii) Design. The roll size, surface finish, and hardness shall be such that tire slippage on the first acceleration of the transient driving cycle is minimized under all weather conditions; that the specified accuracy of the distance measurement is maintained; and that tire wear and noise are minimized.

(4) Inertia.

(i) Mechanical Inertia Simulation. The dynamometer shall be equipped with mechanical flywheels providing test inertia weights between at least 2000 to 5500 pounds, in increments of no greater than 500 pounds. The tolerance on the base inertia weight and the flywheels shall be within 1% of the specified test weights. The proper inertia weight for any test vehicle shall be selectable.

(ii) Electric Inertia Simulation. Electric inertia simulation, or a combination of electric and mechanical simulation may be used in lieu of mechanical flywheels, provided that the performance of the electrically simulated inertia complies with the following specifications. Exceptions to these specifications may be allowed upon a determination by the Administrator that such exceptions would not significantly increase vehicle loading or emissions for the purpose of properly conducting an approved short test.

(A) System Response. The torque response to a step change shall be at least 90% of the requested change within 100 milliseconds after a step change is commanded by the dynamometer control system, and shall be within 2 percent of the commanded torque by 300 milliseconds after the command is issued. Any overshoot of the commanded torque value shall not exceed 25 percent of the torque value.

(B) Simulation Error. An inertia simulation error (ISE) shall be continuously calculated any time the actual dynamometer speed is above 10 MPH and below 60 MPH. The ISE shall be calculated by the equation in §85.2226(a)(4)(ii)(C), and shall not exceed 1 percent of the inertia weight selected (IW_s) for the vehicle under test.

(C) $ISE = (IW_s - I_t) / (IW_s) * 100$

(D) $I_t = I_m + \left(\frac{1}{V}\right) \int_0^t (F_m - F_{rl})\, DT$

Where:

I_t = Total inertia being simulated by the dynamometer (kg)

I_t (lb force) = It (kg) * 2.2046

I_m = Base (mechanical inertia of the dynamometer (kg)

V = Measured roll speed (m/s)

F_m = Force measured by the load cell (translated to the roll surface) (N)

F_{rl} = Road load force (N) required by IHP at the measured roll speed (V)

t = Time (sec)

(iii) Inertia Weight Selection. For dynamometer systems employing mechanical inertia flywheels, the test system shall be equipped with a method, independent from the flywheel selection system, that identifies which inertia weight flywheels are actually rotating during the transient driving cycle.

(5) Other Requirements.

(i) Test Distance and Vehicle Speed. The total number of dynamometer roll revolutions shall be used to calculate the distance traveled. Pulse counters may be used to calculate the distance directly if there are at least 16 pulses per revolution. The measurement of the actual roll distance for the composite and each phase of the transient driving cycle shall be accurate to within ±0.01 mile. The measurement of the roll speed shall be accurate to within ±0.1 mph. Roll speed measurement systems shall be capable of accurately measuring a 3.3 mph per second acceleration rate over a one second period with a starting speed of 10 mph.

(ii) Vehicle Restraint. The vehicle shall be restrained during the transient driving cycle. The restraint system shall be designed to minimize vertical and horizontal force on the drive wheels such that emission levels are not significantly affected. The restraint system shall allow unobstructed vehicle ingress and egress and shall be capable of safely restraining the vehicle under all reasonable operating conditions.

(iii) Vehicle Cooling. The test system shall provide for a method to prevent overheating of the vehicle. The cooling method shall direct air to the cooling system of the test vehicle. The cooling system capacity shall be 5400 ±300 SCFM within 12 inches (30.5 cm) of the intake to the vehicle's cooling system. The cooling system design shall avoid improper cooling of the catalytic convertor.

(iv) Four-Wheel Drive. If used, four-wheel drive dynamometers shall insure the application of correct vehicle loading as defined in §85.2226(a)(2) and shall not damage the four wheel drive system of the vehicle. Front and rear wheel rolls shall maintain speed synchronization within 0.2 mph.

(v) Augmented Braking. Fully automatic augmented braking shall be used from seconds 85 through 95 and after second 223 of the driving cycle. Fully automatic augmented braking may be used in other deceleration periods of the driving cycle with the approval of the Administrator. During the periods of augmented braking the operator shall be made aware that augmented braking is occurring and shall be trained not to use the vehicle accelerator during these periods. It shall be automatically interlocked such that it can be actuated only while the vehicle brakes are applied. Simultaneous engine acceleration is systematically prevented through periodic quality assurance.

(b) Constant Volume Sampler

(1) General Design Requirements.

(i) Venturi Type. A constant volume sampling (CVS) system of the critical flow venturi (CFV) or the sub-sonic venturi (SSV) type shall be used to collect vehicle exhaust samples. The CVS system and components shall generally conform to the specifications in §86.109-90.

(ii) CVS Flow Size. The CVS system shall be sized in a manner that prevents condensation in the dilute sample over the range of ambient conditions to be encountered during testing. A 700 SCFM system is assumed to satisfy this requirement. The range of ambient conditions may require the use of heated sample lines. A 350 SCFM CVS system and heated lines may be used to eliminate condensation and to increase measured concentrations for better resolution. Should the heated sample lines be used, the sample line and components (e.g., filters, etc.) shall be heated to a minimum of 120° F and a maximum of 250°F, which shall be monitored during the transient driving cycle.

(iii) CVS Compressor. The CVS compressor flow capacity shall be sufficient to maintain proper flow in the main CVS venturi with an adequate margin. For CFV CVSs the margin shall be sufficient to maintain choke flow. The capacity of the blower relative to the CFV flow capacity shall not be so large as to create a limited surge margin.

(iv) Materials. All materials in contact with exhaust gas shall be unaffected by and shall not affect the sample (i.e., the materials shall not react with the sample, and neither shall they taint the sample as a result of out gassing). Acceptable materials include stainless steel, Teflon®, silicon rubber, and Tedlar®.

(v) Alternative Approaches. Alternative CVS specifications, materials, or designs may be allowed upon a determination by the Administrator, that for the purpose of properly conducting an approved short test, the evidence supporting such deviations will not significantly affect the proper measurement of emissions.

(2) Sample System.

(i) Sample Probe. The sample probe within the CVS shall be designed such that a continuous and adequate volume of sample is collected for analysis. The system shall have a method for determining if the sample collection system has deteriorated or malfunctioned such that an adequate sample is not being collected, or that the response time has deteriorated such that the time correlation for each emission constituent is no longer valid.

(ii) CVS Mixing Tee.

(A) Design and Effect. The mixing tee for diluting the vehicle exhaust with ambient air shall be at the vehicle tailpipe exit as in §86.109-90(a)(2)(iv). The dilution mixing tee shall be capable of collecting exhaust from all light-duty vehicle and light-duty truck exhaust systems. The design used shall not cause static pressure in the tailpipe to change such that the emission levels are significantly affected. A change of ±1.0 inch of water, or less, shall be acceptable.

(B) Locating Device. The mixing tee shall have a device for positively locating the tee relative to the tailpipe with respect to distance from the tailpipe, and with respect to positioning the exhaust stream from the tailpipe(s) in the center of the mixing tee flow area. The locating device, or the size of the entrance to the tee shall be such that if a vehicle moves laterally from one extreme position on the dynamometer to the other extreme, that mixing tee will collect all of the exhaust sample.

(iii) Dual Exhaust. For dual exhaust systems, the design used shall insure that each leg of the sample collection system maintains equal flow. Equal flow will be assumed if the design of the "Tee" intersection for the dual CVS hoses is a "Y" that minimizes the flow loss from each leg of the "Y," if each leg of the dual exhaust collection system is approximately equal in length (± 1 foot), and if the dilution area at the end of each leg is approximately equal. In addition, the CVS flow capacity shall be such that the entrance flow velocity for each leg of the dual exhaust system is sufficient to entrain all of the vehicle's exhaust from each tailpipe.

(iv) Background Sample. The mixing tee shall be used to collect the background sample. The position of the mixing tee for taking the background sample shall be within 12 lateral and 12 longitudinal feet of the position during the transient driving cycle, and approximately 4 vertical feet from the floor.

(v) Integrated Sample. A continuous dilute sample shall be provided for integration by the analytical instruments in a manner similar to the method for collecting bag samples as described in §86.109.

(c) Analytical Instruments

(1) General Requirements.

(i) The emission analysis system shall automatically sample, integrate, and record the specified emission values for HC, CO, CO2, and NOx. Performance of the analytical instruments with respect to accuracy and precision, drift, interferences, noise, etc. shall be similar to instruments used for testing under §86 Subparts B, D, and N. Analytical instruments shall perform in this manner in the full range of operating conditions in the lane environment.

(ii) Alternative analytic equipment specifications, materials, designs, or detection methods may be allowed upon a determination by the Administrator, that for the purpose of properly conducting an approved short test, the evidence supporting such deviations will not significantly affect the proper measurement of emissions.

(2) Detection Methods and Instrument Ranges.

(i) Total Hydrocarbon Analysis. Total hydrocarbon analysis shall be determined by a flame ionization detector. If a 700 SCFM CVS is used, the analyzer calibration curve shall cover at least the range of 0 ppmC to 2,000 ppmC. Use of a different CVS flow capacity shall require an adjustment to these ranges. Appropriate documentation supporting any adjustment in ranges shall be available. Such documentation shall also address the ability of any altered ranges to accurately measure all cutpoints, including cutpoints for vehicles older than those specified in §85.2205(a), that may be used in the specific I/M program for which the altered ranges are proposed to be used. The calibration curve must comply with the quality control specifications in §85.2234(d) for calibration curve generation.

(ii) Carbon Monoxide Analysis. CO analysis shall be determined using a non-dispersive infrared analyzer. If a 700 SCFM CVS is used, CO analysis shall cover at least the range of 0 ppm to 10,000 ppm (1%). In order to meet the calibration curve requirements, two CO analyzers may be required - one from 0 to 1000 or 2000 ppm, and one from 0 to 1% CO. Use of a different CVS flow capacity shall require an adjustment to these ranges. Appropriate documentation supporting any adjustment in ranges shall be available. Such documentation shall also address the ability of any altered ranges to accurately measure all cutpoints, including cutpoints for vehicles older than those specified in §85.2205(a), that may be used in the specific I/M program for which the altered ranges are proposed to be used. The calibration curve requirements and the quality control specifications in §85.2234(d) apply to both analyzers.

(iii) Carbon Dioxide Analysis. CO_2 analysis shall be determined using an NDIR analyzer. If a 700 SCFM CVS is used, CO_2 analysis shall cover at least the range of 0 ppm to 40,000 ppm (4%). Use of a different CVS flow capacity shall require an adjustment to these ranges. Appropriate documentation supporting any adjustment in ranges shall be available. Such documentation shall also address the ability of any altered ranges to accurately measure all cutpoints, including cutpoints for vehicles older than those specified in §85.2205(a), that may be used in the specific I/M program for which the altered ranges are proposed to be used. The calibration curve must comply with the quality control specifications in §85.2234(d) for calibration curve generation.

(iv) Oxides of Nitrogen Analysis. NOx analysis shall be determined using chemiluminescense. The NOx measurement shall be the sum of nitrogen oxide and nitrogen dioxide. If a 700 SCFM CVS is used, the NOx analysis shall cover at least the range of 0 ppm to 500 ppm. Use of a different CVS flow capacity shall require an adjustment to these ranges. Appropriate documentation supporting any adjustment in ranges shall be available. Such documentation shall also address the ability of any altered ranges to accurately measure all cutpoints, including cutpoints for vehicles older than those specified in §85.2205(a), that may be used in the specific I/M program for which the altered ranges are proposed to be used. The calibration curve must comply with the quality control specifications in §85.2234(d) for calibration curve generation.

(3) System Response Requirements. The governing requirement for system response is the ability of the integration system to measure vehicle emissions to within ±5% of that measured from a bag sample simultaneously collected over the same integration period, on both clean and dirty vehicles. Historically, continuously integrated emission analyzers have been required to have a response time of 1.5 seconds or less to 90% of a step change, where a step change was 60% of full scale or better. System response times between a step change at the probe and reading 90% of the change have generally been less than 4 - 10 seconds. Systems proposed that exceed these historical values shall provide an engineering explanation as to why the slower system response of the integrated system will compare to the bag reading within the specified 5%.

(4) Integration Requirements.

(i) The analyzer voltage responses, CVS pressure(s), CVS temperature(s), dynamometer speed, and dynamometer power shall be sampled at a frequency of no less than 5 Hertz, and the voltage levels shall be averaged over 1 second intervals.

(ii) The system shall properly time correlate each analyzer signal and the CVS signals to the driving trace.

(iii) The one-second average analyzer voltage levels shall be converted to concentrations by the analyzer calibration curves. Corrected concentrations for each gas shall be derived by subtracting the pre-test background concentrations from the measured concentrations, according to the method in §85.2205(b). The corrected concentrations shall be converted to grams for each second using the equations specified in §85.2205(b) to combine the concentrations with the CVS flow over the same interval. The grams of emissions per test phase shall be determined using the equations in §85.2205(b).

(iv) When multiple analyzers are used for any constituent, the integration system shall simultaneously integrate both analyzers. The integrated values for the lowest analyzer in range shall be used for each second.

(v) For all constituents, the background concentration levels from the lowest range analyzer shall be used, including the case where multiple analyzers may have been used.

(5) Analytical System Design.

(i) Materials. All materials in contact with exhaust gas prior to and throughout the measurement portion of the system shall be unaffected by and shall not affect the sample (i.e., the materials shall not react with the sample, and neither shall they taint the sample as a result of out gassing). Acceptable materials include stainless steel, Teflon, silicon rubber, and Tedlar®.

(ii) Bag Ports. All analysis systems shall have provisions for reading a sample bag. A portable pump for sampling such bags is permitted.

(iii) System Filters. The sample system shall have an easily replaceable filter element to prevent particulate matter from reducing the reliability of the analytical system. The filter element shall provide for reliable sealing after filter element changes. If the sample line is heated, the filter system shall also be heated.

(iv) Availability of Intermediate Calculation Variables. Upon request prior to a test, all intermediate calculation variables shall be available to be downloaded to electronic files or hard copy. These variables shall include those that calculate the vehicle emission test results, perform emission analyzer and dynamometer function checks, and perform quality assurance and quality control measurements.

§85.2227 Evaporative System Inspection Equipment

(a) General Requirements

(1) Equipment Design. Automated and computerized test systems shall be used for the evaporative system tests. Pass/fail decisions shall be made automatically. The systems shall be tamper resistant and designed to avoid damage to the vehicle during installation, testing, and removal.

(2) Alternative Systems. Alternative purge or pressure test equipment, specifications, materials, or designs, may be proposed by a state and approved upon a determination by the Administrator that, for the purpose of properly conducting an approved short test, the evidence supporting such deviations will not appreciably or adversely affect the proper determination of system integrity, the proper measurement of purge, or the proper operation of the vehicle.

(b) Evaporative Purge System

(1) General Requirements. The evaporative purge analysis system shall measure the instantaneous purge flow in standard liters/minute, and shall compute the total volume of the flow in standard liters over the transient driving cycle.

(2) Specifications. The purge flow measuring system shall comply with the following requirements.

(i) Flow Capacity. A minimum of 50 liters per minute.

(ii) Pressure Drop. Maximum of 16 inches of water at 50 liters per minute for the complete system including hoses necessary to connect the system to the vehicle.

(iii) Totaled Flow. 0 to 100 liters of volume

(iv) Response Time. 410 milliseconds maximum to 90% of a step change between approximately 2 and 10 liters per minute measured with air.

(v) Accuracy.

(A) ±2.0 liters per minute between 10 and 50 liters per minute (rate)

(B) ±0.15 liters per minute between 0 and 10 liters per minute (rate)

(C) ±4% of 50 standard liters total flow volume between 10 and 50 liters total flow volume over one minute.

(D) ±1.5% of 10 standard liters between 0 and 10 liters total volume flow over one minute.

(vi) Noise. The maximum noise shall be less than 0.001 liters per second

(vii) Calibration Gas. Air

(3) Automatic Operation. Vehicle purge flow shall be monitored with a computerized system at a minimum sample rate of 1 Hz, shall automatically capture average (if sampled faster than 1 Hz) second-by-second readings, and shall automatically derive a pass/fail decision. In determining the total volume of flow, the monitoring system shall not count signal noise as flow volume. The test sequence shall be automatically initiated when the transient driving cycle test is initiated.

(4) Adaptability. The purge flow system shall have sufficient adapters to connect in a leak-tight manner with the variety of evaporative systems and hose deterioration conditions in the vehicle fleet. The purge measurement system shall not substantially interfere with purge flow.

(c) Evaporative System Pressure Test Equipment

(1) General Requirements.

(i) Pressure Gas. Nitrogen (N_2), or an equivalent non-toxic, non-greenhouse, inert gas, shall be used for pressurizing the evaporative system.

(ii) Automatic Operation. The process for filling the evaporative system, monitoring compliance, recording data, and making a pass/fail decision shall be automatic. After the determination that the evaporative system has been filled to the specified pressure level, and upon initiation of the test, the pressure level in the evaporative system shall be recorded at a frequency of no less than 1 Hertz until the conclusion of the test.

(iii) Test Abort. The system shall be equipped with an abort system that positively shuts off and relieves pressure. The abort system shall be capable of being activated quickly and conveniently by the inspector should the need arise.

(2) Adapters and Clamps.

(i) Canister Hose Adapters. The system shall have sufficient adapters to connect in a leak-tight manner with the variety of evaporative systems and hose deterioration conditions in the vehicle fleet.

(ii) Fuel Inlet Adapters. Fuel inlet adapters that fit on the vehicle's fuel inlet in a manner similar to the gas cap and designed to admit a pressurized source of gas into the fuel tank shall be used for the fuel inlet pressure test specified in §85.2222(d). Inlet specific adapters shall be available for at least 95 percent of the fuel inlets that are used on U.S. light duty vehicles and light duty trucks for the model years covered by the program. Varying internal volumes of the adapter assemblies shall not affect the accuracy of the test results. Adapters shall be made available within two years of the introduction of new model year vehicles.

(iii) Hose Clamp. The hose clamp used for the fuel inlet pressure test shall be designed to apply only enough pressure to close the hose without damaging it. The nose of the clamp shall be smooth-surfaced or otherwise designed to avoid abrasion of the vehicle hose.

(3) Pressure Gauge. The device for measuring pressure in the vehicle's evaporative system shall have a minimum range of 0 to 50 inches of water and an accuracy of ±0.3 inches of water (2% of 15) or better.

(4) Flow Meter. A flow meter with a range of at least 0 to 10 liters per minute and ±5% accuracy shall be used for the measurement of flow.

(5) Gas Cap Tester. The tester shall provide a visual or digital signal that the required air supply pressure is within the acceptable range and the flow comparison test is ready to be conducted. The tester shall incorporate an upstream maintainable filter. If the tester is battery powered, it must be equipped with an automatic shutoff and a low-battery indicator. A NIST traceable reference passing fuel cap of nominal 52-56 cubic centimeters per minute, and a NIST traceable reference failing fuel cap of nominal 64-68 cubic centimeters per minute shall be supplied with the tester for daily test verification. Leak rate measurements shall be accurate to ±3 cubic centimeters per minute.

(6) Flow Standard. The flow standard shall be a square edged circular orifice with a NIST traceable flow rate which in combination with the comparison circuitry will produce a pass/fail threshold of 60 cubic centimeters at 30 inches of water column. Transducers used in the comparison circuitry shall have accuracy traceable to NIST. The supply pressure may be obtained using room air and any convenient low pressure source. The tester shall control the supply pressure and prevent over pressurization.

§85.2234 IM240 Test Quality Control Requirements

(a) General Requirements

(1) Minimums. The frequency and standards for quality control specified here are minimum requirements, unless modified as specified in §85.2234(2). Greater frequency or tighter standards may be used as needed.

(2) Statistical Process Control. Reducing the frequency of the quality control checks, modifying the procedure or specifications, or eliminating the quality control checks altogether may be allowed if the Administrator determines, for the purpose of properly conducting an approved short test, that sufficient Statistical Process Control (SPC) data exist to make a determination, that the SPC data support such action, and that taking such action will not significantly reduce the quality of the emission measurements. Should emission measurement performance or quality deteriorate as a result of allowing such actions, the approval shall be suspended, and the frequencies, procedures, specifications, or checks specified here or otherwise approved shall be reinstated, pending further determination by the Administrator.

(3) Modifications. The Administrator may modify the frequency and standards contained in this section if found to be impractical.

(b) Dynamometer

(1) Coast Down Check.

(i) The calibration of each dynamometer shall be checked on a weekly basis by a dynamometer coast-down equivalent that in §86.118-78 (for reference see EOD Test Procedures TP-302A and TP-202) between the speeds of 55 to 45 mph, and between 22 to 18 mph. All rotating dynamometer components shall be included in the coast-down check for the inertia weight selected.

(ii) The base dynamometer and the base plus each prime inertia weight flywheel, if any, shall be checked with at least two horsepower settings within the normal range of the inertia weight. For dynamometers that use electrical inertia simulation and have a base inertia outside of the range of 3000 pounds to 4500 pounds, the coast-down check shall be conducted with at least two horsepower settings at the base inertia, and two settings at either 2500 pounds or 4500 pounds, whichever is furthest from the base inertia weight. For both mechanical flywheel dynamometers and electrical inertia simulation dynamometers, the horsepower settings selected shall correspond to a vehicle / engine category that matches the inertia weight selected for the coast-down test. Where the base inertia, or the base inertia plus the smallest flywheel results in a coast-down inertia of less than 2250 pounds, only one horsepower setting is required for the check.

(iii) The coast-down procedure shall use a vehicle off-dynamometer type method or equivalent. If a vehicle is used to motor the dynamometer to the beginning coast-down speed, the vehicle shall be lifted off the dynamometer rolls before the coast-down test begins. If the difference between the measured coast-down time and the theoretical coast-down time is greater than ±1 second on the 55 to 45 mph coast-down as calculated by §85.2234(b)(1)(iii)(A) or (B), official testing shall automatically be prevented, and corrective action shall be taken to bring the dynamometer into calibration. Official testing shall also automatically be prevented, and corrective action shall be taken to bring the dynamometer into calibration, if the difference between the measured coast-down time and the theoretical coast-down time for 22 to 18 mph is outside of the time window calculated by §85.2234(b)(1)(iii)(C) or (D). For tests using inertia weights of 8500 lbs. and above, if the difference between the measured coast-down time and the theoretical coast-down time is outside of the time window calculated by §85.2234(b)(1)(iii)(C) or (D) for the 22 mph to the 18 mph coast-down when substituting 0.27 HP for the allowable force-error (equivalent to 5.0 pounds-force at 20 mph), official testing shall automatically be prevented, and corrective action shall be taken to bring the dynamometer into calibration.

(A) The off-dynamometer target coast-down time at 50 mph ($DET_{@50\ mph-8}$) for dynamometers with 8.265 inch rolls shall be calculated as follows.

$$DET_{@50mph-8} = \frac{\left(\frac{0.5 * ETW}{32.2}\right) * (V_{55}^2 - V_{45}^2)}{550 * (TRLHP_{@50mph} - GTRL_{@50mph-8})}$$

(B) The off-dynamometer target coast-down time at 50 mph ($DET_{@50\ mph-20}$) for dynamometers with 20.0 inch rolls shall be calculated as follows.

$$DET_{@50mph-20} = \frac{\left(\frac{0.5 * ETW}{32.2}\right) * (V_{55}^2 - V_{45}^2)}{550 * (TRLHP_{@50mph} - GTRL_{@50mph-20})}$$

(C) The maximum and minimum time limits for the off-dynamometer coast-down window at 20 mph ($DT_{Max\ @\ 20\ mph-8}$, $DT_{Min\ @\ 20\ mph-8}$) for dynamometers with 8.265 inch rolls shall be calculated by the following equations. The TRLHP and GTRL used in these calculations shall be determined from the same vehicle / engine category used to determine the 50 mph off-dynamometer target coast-down time. If the calculated maximum value ($DT_{Max\ @\ 20\ mph-8}$) exceeds twice the target value calculated for a specific vehicle / engine category ($DT_{Ave\ @\ 20\ mph-8}$), or if the maximum value is a negative number, a value equal to twice the target value shall be substituted for the maximum time limit.

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$$DT_{Max@20mph-8} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}^2-V_{18}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-8}-0.17HP)}$$

$$DT_{Ave@20mph-8} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}^2-V_{18}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-8})}$$

$$DT_{Min@20mph-8} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}^2-V_{18}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-8}+0.17HP)}$$

(D) The maximum and minimum time limits for the off-dynamometer coast-down window at 20 mph ($DT_{Max\ @\ 20\ mph-20}$, $DT_{Min\ @\ 20\ mph-20}$) for dynamometers with 20.0 inch rolls shall be calculated by the following equations. The TRLHP and GTRL used in these calculations shall be determined from the same vehicle / engine category used to determine the 50 mph off-dynamometer target coast-down time.

$$DT_{Max@20mph-20} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}^2-V_{18}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-20}-0.17HP)}$$

$$DT_{Min@20mph-20} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}^2-V_{18}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-20}+0.17HP)}$$

(E) Where:

$DET_{@\ 50\ mph-dd}$ = Off-dynamometer target coast-down time (seconds) at 50 mph for a dynamometer with a roll diameter corresponding to the designator "dd".

$DT_{Max\ @\ 20\ mph-dd}$ = Upper off-dynamometer target coast-down time limit (seconds) at 20 mph for a dynamometer with a roll diameter corresponding to the designator "dd"

$DT_{Ave\ @\ 20\ mph-dd}$ = Off-dynamometer target coast-down time (seconds) at 20 mph for a dynamometer with a roll diameter corresponding to the designator "dd"

$DT_{Min\ @\ 20\ mph-dd}$ = Lower off-dynamometer target coast-down time limit (seconds) at 20 mph for a dynamometer with a roll diameter corresponding to the designator "dd"

$TRLHP_{@\ 50\ mph}$ = Track Road Load Horsepower at 50 mph for a specific vehicle engine category selected for the coast down check.

$TRLHP_{@\ 20\ mph}$ = Track Road Load Horsepower at 20 mph for the corresponding specific vehicle engine category selected for the 50 mph coast down check.

$GTRL_{@\ 50\ mph\text{-}dd}$ = Generic Tire/Roll Horsepower loss at 50 mph for a dynamometer with "dd" roll size, and corresponding to the specific vehicle engine category selected for the 50 mph coast down check.

$GTRL_{@\ 20\ mph\text{-}dd}$ = Generic Tire/Roll Horsepower loss at 20 mph for a dynamometer with "dd" roll size, and corresponding to the specific vehicle engine category selected for the 50 mph coast down check.

ETW = Equivalent Test Weight (i.e., inertia weight) in pounds corresponding to the specific vehicle engine category selected for the 50 mph coast down check.

V_{xx}^2 = Velocity in feet per second corresponding to the mph value "xx"

0.17 HP = Horsepower representation of an allowable force-error of 3.3 pounds-force at 20 mph. This allowable force-error is approximately equivalent to a ± 2 second tolerance in the off-dynamometer target coast-down time at 50 mph for a dynamometer with 8.625" rolls when using a TRLHP computed from the EPA on-dynamometer target coast-down time. This force-error is approximately equivalent to a ± 1.25 second tolerance in the off-dynamometer target coast-down time at 50 mph for a dynamometer with 20.0" rolls.

(iv) The clock used to check the coast-down time shall be accurate to 0.1 percent of reading between 10 and 1000 seconds with a resolution of 0.01 seconds.

(v) The results of each dynamometer coast-down check performed shall be automatically computed and recorded on electronic media with a date and time stamp.

(2) Roll Speed. Roll speed and roll counts shall be checked each operating day by an independent means (e.g., photo tachometer). Deviations of greater than ±0.2 mph or a comparable tolerance in roll counts shall require corrective action. Alternatively, a redundant roll speed transducer independent of the primary

transducer may be used in lieu of the daily comparison. Accuracy of redundant systems shall be checked monthly.

(3) Warm-Up. Dynamometers shall be in a warmed up condition for use in official testing. Warm-up is defined as sufficient operation that allows the dynamometer to meet the coast down time (within 3 seconds) identified for the specific dynamometer during calibration. The reference coast-down time shall be the value for 55 to 45 mph with the lightest inertia weight and lowest horsepower for that weight used during weekly calibrations. Alternatively, the reference coast-down time shall be the value for 22 to 18 mph with the lightest inertia weight and lowest horsepower for that weight used during weekly calibration, with a time standard of ±20%. Warm-up may be checked by comparing the measured parasitic losses at least 25 mph to reference values established during calibration.

(4) Acceptance Testing. Upon initial installation and prior to beginning official testing, the performance of each dynamometer and dynamometer design shall be verified for compliance with the requirements in §85.2226(a). Specific acceptance verification requirements are described in §85.2234(b)(4)(i) through §85.2234(b)(4)(v).

(i) Coast Down / Vehicle Loading Check Following Installation. The coast down performance of each dynamometer shall be checked to verify the ability of the dynamometer and dynamometer load setting system to meet dynamometer target coast down times prior to beginning official testing. The performance shall be checked by the procedure defined in §85.2234(b)(4)(i)(A) through §85.2234(b)(4)(i)(J), or by a comparable procedure acceptable to the Administrator.

(A) The dynamometer shall be warmed-up by the dynamometer manufacturer's procedure.

(B) At least three vehicle / engine categories shall be selected from the EPA Look-Up table for vehicle loading. The vehicle / engine categories should cover the range of expected test vehicles. If look-up table data is not available at the time of acceptance testing, TRLHP values can be selected from the table of default values in §85.2221 (c)(5). If default TRLHP values are used, drive-axle weight (DAXWT) shall be computed as 46.0 percent of the test inertia weight in the table for 2250 pounds and above. A value of 63 percent of the test inertia weight in the table shall be used for 2249 pounds and below.

(C) The dynamometer shall be set for the first vehicle/engine category selected based on the variables used to uniquely index the vehicle engine category (e.g., model year, manufacturer, model, number of cylinders, engine size, and transmission type).

(D) The dynamometer shall be coasted down from 65 mph to 5 mph with the settings pre-selected in §85.2234(b)(4)(i)(C).

(E) The 55 mph to 45 mph, and the 22 mph to 18 mph coast down times shall be recorded for the data collected in §85.2234(b)(4)(i)(D).

(F) The dynamometer shall be coasted down from 65 mph to 5 mph after having been adjusted for each of the other two vehicle engine categories, and the 55 mph to 45 mph, and the 22 mph to 18 mph coast down times shall be recorded for each coast-down.

(G) The coast-downs specified in §85.2234(b)(4)(i)(C) through §85.2234 (b)(4)(i)(F) shall be replicated for a total of three coast-down tests for each vehicle inertia category. The replications of the coast-downs for each vehicle engine category shall be run in random sequence.

(H) The off-dynamometer target coast-down time at 50 mph ($DET_{@ 50 mph\text{-}dd}$) for each vehicle / engine category shall be calculated as specified in §85.2234(b)(1)(iii)(A) or (B) for the applicable dynamometer roll size.

(I) The upper and lower off-dynamometer coast-down time limits at 20 mph ($DT_{Max @ 20 mph\text{-}dd}$, $DT_{Min @ 20 mph\text{-}dd}$) for each vehicle / engine category shall be calculated as specified in §85.2234(b)(1)(iii)(C) or (D) for the applicable dynamometer roll size.

(J) The dynamometer vehicle loading is considered acceptable if each measured 55 mph to 45 mph coast-down time for each vehicle / engine category tested is within ±1 second of the off-dynamometer target coast-down time determined in (b)(4)(i)(H) above, and if each measured 22 mph to 18 mph coast-down time for each vehicle / engine category tested is within the off-dynamometer target coast-down time limits determined in (b)(4)(i)(I) above.

(ii) Vehicle Loading Check of Dynamometer Design. For each dynamometer design used, the I/M Program Office shall obtained and maintain a report verifying the ability of the dynamometer design to properly load vehicles as specified in §85.2226(a). The dynamometer manufacturer may prepare the report. The report shall identify how each requirement in §85.2226(a) is performed by the specific dynamometer design used. In addition, where specific performance levels or characterizations are specified {e.g., §85.2226 (a)(2)(viii), §85.2226(2)(x), §85.2226(4)(ii) and §85.2226(a)(5)}, test data with supporting analysis verifying compliance shall be included. At a minimum, the test data shall include a comparison and analysis of the expected coast-down times versus the actual vehicle on-dynamometer coast-down times for at least three vehicles spanning the range of drive axle weights and horsepower. Actual track coast-down data and curves shall be available for the makes and models of vehicles selected from which the expected coast-down times shall be derived. The analysis shall also graphically compare the track horsepower curves to curves generated from the on-dynamometer coast-down testing. Reasons for variations in time, equivalent to one horsepower, between the expected coast-down times and the actual vehicle on-dynamometer coast-down times, or variations between the curves of more than one horsepower shall be explained in the report.

(iii) <u>Alternative Coast Down / Vehicle Loading Check</u>. This procedure may be used in lieu of the procedures in §85.2234(b)(4)(i). The coast down performance of each dynamometer shall be checked with at least two categories of vehicles to verify the ability of the dynamometer and dynamometer load setting system to meet dynamometer target coast down times. The coast down performance of each dynamometer design used shall be checked with at least 6 categories of vehicles to determine the ability of the dynamometer design to properly load the vehicle over the required speed range as defined in §85.2226(a)(2). The performance of the design shall be checked by the procedure defined §85.2234(b)(4)(ii)(A) through §85.2234(b)(4)(ii)(L), or by a comparable procedure acceptable to the Administrator.

(A) The dynamometer shall be warmed-up by the dynamometer manufacturer's procedure, and the tires and drive train on the test car shall be warmed-up by operating the vehicle at 50 mph for 20 minutes. The tire pressure in the test vehicles shall be at 45 psi.

(B) The dynamometer indicated power (IHP) and inertia weight for the vehicle shall be selected for the test vehicle.

(C) The test vehicle shall be coasted down from 65 mph to 5 mph on the dynamometer with the settings pre-selected in §85.2234(b)(4)(i)(B).

(D) The 55 mph to 45 mph, and the 22 mph to 18 mph coast down times shall be recorded for the data collected in §85.2234(b)(4)(i)(C).

(E) The test vehicle shall again be coasted down from 65 mph to 5 mph on the dynamometer with the dynamometer power absorber reset to a load of zero.

(F) A speed versus horsepower equation of the form in §85.2226(a)(2)(iii) shall be determined for the data collected in §85.2234(b)(4)(i)(E).

(G) The test vehicle shall be removed from the dynamometer, and the dynamometer shall be coasted down from 65 mph to 5 mph with the dynamometer power absorber set to a load of zero.

(H) A speed versus horsepower equation of the form in §85.2226(a)(2)(ix) for parasitic losses (PLHP) shall be determined for the data collected in §85.2234(b)(4)(i)(G).

(I) The tire/roll interface losses shall be determined by subtracting the horsepower curve determined in §85.2234(b)(4)(i)(H) from the horsepower curve determined in §85.2234(b)(4)(i)(F). The tire loss curve (GTRL) shall be in the form specified in §85.2226(a)(2)(xiii).

(J) Repeat the steps in §85.2234(b)(4)(i)(B) through §85.2234(b)(4)(i)(I) to obtain a total of three sets of data for each test vehicle. The dynamometer and vehicle may be warmed-up as needed to meet the requirements in §85.2234(b)(4)(i)(A).

(K) For each test vehicle, compute the average 55 mph to 45 mph coast down time, the average 22 mph to 18 mph coast down time, and the average tire/roll interface loss curve as measured in §85.2234(b)(4)(i)(B) through §85.2234(b)(4)(i)(J).

(L) The dynamometer vehicle loading is considered acceptable if, for each test vehicle, the average values determined in §85.2234(b)(4)(i)(K) are within ±1 second of the 55 mph to 45 mph for the target time specified in §85.2226(a)(2)(ii), are within ±7 percent of the 22 mph to 18 mph that is calculated from §85.2226(a)(2)(iii) and §85.2226(a)(2)(iv), and within ±15 percent of a generic tire/roll loss curve for the category of vehicle.

(iv) Load Measuring Device Check. The load measuring device on each dynamometer shall be checked by a dead-weight method (or equivalent) at least six points across the range of loads used for vehicle testing. Physical checking weights shall be traceable to NIST standards to within ± 0.5 percent. Equivalent methods shall document the method used to verify equivalent accuracy. The accuracy of the interpreted value used for calculation or control shall be within ±1 percent of full scale.

(v) Vehicle Inertia Loading. The actual inertia applied to the vehicle by each inertia weight, in combination with the base inertia, shall be verified for each dynamometer to insure compliance with the requirements in §85.2226(a)(4)(i) or §85.2226(a)(4)(ii) as applicable.

(vi) Parasitic loss check between 8 and 12 mph. The coast down time of each dynamometer between 8 and 12 mph shall be verified for compliance with the requirements of §85.2226(a)(2)(x).

(vii) Speed and Distance Check. The performance of the speed and distance measuring system of each dynamometer shall be verified for compliance with the requirements of §85.2226(a)(5)(i). The ability to resolve acceleration as specified in §85.2226(a)(5)(i) need only be generically verified for the design used. If more than one design is used, each design shall be verified.

(viii) Warm-up System Check. The dynamometer warm-up system shall be checked for compliance with the requirements in §85.2234(b)(3) by conducting a coast down check immediately following completion of the warm-up specified by the dynamometer manufacturer or the system. The design of the warm-up system should be checked across the range of temperatures experience in-use, and particularly at the lower speeds.

(5) Coast-down Times. Following acceptance, 55 to 45 mph, and 22 to 18 mph coast-down times shall be determined for quality control purposes with the vehicle off the dynamometer for each inertia weight and for at least 2 horsepower settings within the normal range of the inertia weight as required in §85.2234(b)(1)(ii). These quality control values shall be determined when the dynamometer has been set to meet either the coast-down target times with the vehicle on the dynamometer (i.e., 55 to 45 mph and 22 to 18 mph), or the equation coefficients. The I/M program manager, may however, select different vehicle/engine categories to check coast-down times as in §85.2234(b)(4)(i) for audit purposes.

(c) **Constant Volume Sampler**

(1) Flow Calibration. The flow of the CVS shall be calibrated at six flow rates upon initial installation, 6 months following installation, and every 12 months thereafter. The flow rates shall include the nominal rated flow-rate and a rate below the rated flow-rate for both critical flow venturis and subsonic venturis, and a flow-rate above the rated flow for sub-sonic venturis. The flow calibration points shall cover the range of variation in flow that typically occurs when testing. A complete calibration shall be performed following repairs to the CVS that could affect flow.

(2) System Check. CVS flow calibration at the nominal CVS design flow shall be checked once per operating day using a procedure that identifies deviations in flow from the true value. A procedure equivalent to that in §86.119(c) shall be used. Deviations greater than ±4% shall result in automatic lockout of official testing until corrected.

(3) Cleaning Flow Passages. The sample probe shall be checked at least once per month and cleaned if necessary to maintain proper sample flow. CVS venturi passages shall be checked once per year and cleaned if necessary.

(4) Probe Flow. The indicator identifying the presence of proper probe flow for the system design (e.g., proportional flow for CFV systems, minimum flow for time correlation of different analyzers) shall be checked on a daily basis. Lack of proper flow shall require corrective action.

(5) Leak Check. The vacuum portion of the sample system shall be checked for leaks on a daily basis and each time the system integrity is violated (e.g., changing a filter).

(6) Bag Sample Check. On a quarterly basis, vehicle exhaust shall be collected in sample bags with simultaneous integrated measurement of the sample. At least one bag each for Phase 1 and for Phase 2 of the transient test cycle shall be conducted. Differences between the two measurement systems greater than 10% shall result in

system lockout until corrective action is taken. For the purposes of acceptance testing, the differences shall be no greater than 5%.

(7) Response Time Check. The response time of each analyzer shall be checked upon initial installation, during each check for compliance with §85.2234(c)(6), after each repair or modification to the flow system that would reasonably be expected to affect the response time, and at least once per week. The check shall include the complete sample system from the sample probe to the analyzer. Statistical process control shall be used to monitor compliance and establish fit for use limits based on the requirements in §85.2226(c). At a minimum, response time measurements that deviate significantly from the average response time for all CVS systems designed to the same specification in the program shall require corrective action before testing may resume.

(8) Mixing Tee Acceptance Test.

(i) The design of the mixing tee shall be evaluated by running the transient driving cycle on at least two vehicles, representing the high and low ends of engine displacement and inertia. Changes in the static tailpipe pressure with and without CVS, measured on a second-by-second basis within 3 inches of the end of the tailpipe, shall not exceed ±1.0 inch of water.

(ii) The ability of the mixing tee design to capture all of the exhaust as a vehicle moves laterally from one extreme position on the dynamometer to the other extreme shall be evaluated with back-to-back testing of three vehicles, representing the high and low ends of engine displacement and inertia. The back-to-back testing shall be done with the mixing tee at the tailpipe and with an airtight connection to the tailpipe (i.e., the mixing tee will be effectively moved downstream, as in typical FTP testing). The difference in carbon-balance fuel economy between the mixing tee located at the vehicle and the positive connection shall be no greater than 5%.

(iii) The design of the dual exhaust system shall be evaluated with back-to-back testing of three vehicles, representing the high and low ends of engine displacement and inertia, with an airtight connection to the tailpipe (i.e., the mixing tee will be effectively moved downstream, as in typical FTP testing, for these qualification tests). The difference in carbon-balance fuel economy between the two methods shall be no greater than 5%.

(d) Analysis System

(1) Calibration Curve Generation.

(i) Upon initial installation, calibration curves shall be generated for each analyzer. If an analyzer has more than one measurement transducer, each transducer shall be considered as a separate analyzer in the analysis system for the purposes of curve generation and analysis system checks.

(ii) The calibration curve shall consider the entire range of the analyzer as one curve.

(iii) At least 5 calibration points plus zero shall be used in the lower portion of the analyzer range corresponding to an average concentration of approximately 2 gpm for HC, 30 gpm for CO, 3 gpm for NOx, and 400 gpm for CO_2. When both a low range analyzer and a high range analyzer are used for a single interest gas (e.g., CO), the high range analyzer shall use at least 5 calibration points plus zero in the lower portion of the high range scale corresponding to approximately 100% of the full-scale value of the low range analyzer. For all analyzers, at least 5 calibration points shall be used to define the calibration curve above the 5 lower calibration points. The calibration zero gas shall be used to set the analyzer to zero.

(iv) Gas dividers may be used to obtain the intermediate points for the general range classifications specified.

(v) The calibration curves generated shall be a polynomial of the best fit and no greater than 4^{th} order, and shall fit the data within 2.0% at each calibration point as specified in §86.121-90, §86.122-78, §86.123-78, and §86.124-78. An exception to the 2% fit may be allowed with approval by the Administrator if supported by appropriate data for the lowest two non-zero calibration points, provided that those points are below a value corresponding to an average concentration of approximately 1 gpm for HC, 15 gpm for CO, 1.5 gpm for NOx, and 200 gpm for CO_2. For those points the allowable curve fit may be increased to no more than 5%. (For reference, see EPA NVFEL Procedure No. 204)

(vi) Each curve shall be verified for each analyzer with a confirming calibration standard between 40-80% of full scale that is not used for curve generation. Each confirming standard shall be measured by the curve within 2.5%.

(2) Spanning Frequency. The zero and up-scale span points shall be checked at 2 hour intervals following the daily mid-scale curve check specified in §85.2234(d)(4) and adjusted if necessary. If the up-scale span point drifts by more than 2.0% from the previous check or, for the first check performed after the daily calibration check described in §85.2234(d)(4), from the daily check official testing shall be prevented and corrective action shall be taken to bring the system into compliance. If the zero point drifts by more than 2 ppmC HC, 1 ppm NOx, 10 ppm CO, or 40 ppm CO2, official testing shall be prevented and corrective action shall be taken to bring the system into compliance. Or, the unit may be zeroed prior to each test.

(3) Limit Check. The tolerance on the adjustment of the up-scale span point shall be 0.4% of point. A software algorithm to perform the zero and span adjustment and subsequent calibration curve adjustment shall be used. Cumulative software up-scale zero and span adjustments greater than ±10% from the latest calibration curve shall cause official testing to be prevented and corrective action shall be taken to bring the system into compliance.

(4) Daily Calibration Checks. The curve for each analyzer shall be checked and adjusted to correctly read zero using a working zero gas, and an up-scale span gas within the tolerance in §85.2234(d)(3), and then by reading a mid-scale span gas within 2.5% of point, on each operating day prior to vehicle testing. If the analyzer does not read the mid-scale span point within 2.5% of point, the analyzer shall automatically be prevented from official testing. The up-scale span gas concentration for each analyzer shall correspond to approximately 80% of full scale, and the mid-point concentration shall correspond to approximately 15% of full scale.

(5) Weekly NOx Convertor Checks. The convertor efficiency of the NO_2 to NO convertor shall be checked on a weekly basis. The check shall be equivalent to §86.123-78 (for reference see EOD Form 305-01) except that the concentration of the NO gas shall be in the range of 100-300 ppm. Alternative methods may be used if approved by the Administrator.

(6) Weekly NO/NOx Flow Balance. The flow balance between the NO and NOx test modes shall be checked weekly. The check may be combined with the NOx convertor check as illustrated in EPA NVFEL Form 305-01.

(7) Monthly Calibration Checks. The basic calibration curve shall be verified monthly by the same procedure used to generate the curve in §85.2234(d)(1), and to the same tolerances.

(8) FID Check.

(i) Upon initial operation, and after maintenance to the detector, each FID shall be checked, and adjusted if necessary, for proper peaking and characterization using the procedures described in SAE Paper No. 770141 or by analyzer manufacturer recommended procedures.

(ii) The response of each FID to a methane concentration of approximately 50 ppm CH_4 shall be checked once per month. If the response is outside of the range of 1.00 to 1.30, corrective action shall be taken to bring the FID response within this range. The response shall be computed by the equation in §85.2234(d)(9)(iii).

(iii) $$\text{Ratio of Methane Response} = \frac{\text{FID response in ppmC}}{\text{ppm } CH_4 \text{ in cylinder}}$$

(9) Integrator Checks. Upon initial operation, and every three months thereafter, emissions from a vehicle with transient cycle test values between 60% and 400% of the 1984 LDGV standard shall be simultaneously sampled by the normal integration method and by the bag method in each lane. The data from each method shall be put into a historical data base for determining normal and deviant performance for each test lane, facility, and all facilities combined. Specific deviations between the integrator and bag readings exceeding ±10% shall require corrective action.

(10) Cross-Checks. On a quarterly basis, and whenever gas bottles are changed, each analyzer in a given facility shall analyze a sample of a test gas. The test gas shall be independent of the gas used for the daily calibration check in §85.2234(d)(4), in independent bottles. The same test gas, or gas mixture shall be used for all analyzers. The concentration of the gas shall be one of three values corresponding to approximately 0.5 to 3 times the cutpoint (in gpm) for 1984 and later model year vehicles for the constituent. One of the three values shall be at the lower end of the range, another shall be at the higher end of the range, and the other shall be near the middle of the range. The values selected shall be rotated in a random manner for each cross-check. The value of the checking sample may be determined by a gas divider. The deviation in analysis from the concentration of the checking sample for each analyzer shall be recorded and compared to the historical mean and standard deviation for the analyzers at the facility and at all facilities. Any reading exceeding 3 sigma shall cause the analyzer to be placed out of service.

(11) Interference -- Laboratory Testing. The design of each CO, CO_2, and NOx analyzer shall be checked for water vapor interference prior to initial service. The interference limits in this paragraph shall apply to analyzers used with a CVS of 700 SCFM or greater. For analyzers used with lower flow rate CVS units, the allowable interference response shall be proportionately adjusted downward.

(i) CO Analyzer. A gas mixture of 4% CO_2 in N_2 bubbled through water with a saturated-mixture temperature of 40°C shall produce a response on the CO analyzer of no greater than 15 ppm at 40°C. Also, a gas mixture of 4 percent CO_2 in N_2 shall produce a response on the CO analyzer of no greater than 10 ppm at 40°C.

(ii) CO2 Analyzer. A calibration zero gas bubbled through water with a saturated-mixture temperature of 40°C shall produce a response on the CO_2 analyzer of no greater than 60 ppm.

(iii) NOx Analyzer. A calibration zero gas bubbled through water with a saturated-mixture temperature of 40°C shall produce a response on the NOx analyzer of no greater than 1 ppm. Also, a gas mixture of 4 percent CO2 in either N2 or air shall produce a response on the NOx analyzer of no greater than 1.0 ppm at 40°C.

(12) Interference -- Field Testing. Each CO, CO_2, and NOx analyzers shall be checked for water vapor interference prior to initial service, and on a yearly basis thereafter. The in-field check prior to initial service and the yearly checks shall be performed on a high ambient temperature summer day (or simulated conditions). For analyzers used with lower flow rate CVS units, the allowable interference response shall be proportionately adjusted downward. The allowable interference level shall be adjusted to coincide with the saturated-mixture temperature used. For the CO analyzer, a rejection ratio of 9,000 to 1 shall be used for this calculation. A ratio of 2000 to 1 shall be used for CO_2 analyzers. A ratio of 90,000 to 1 shall be used for NOx analyzers.

(e) Gases

(1) General Requirements. Gas blends may contain up to three of any of the following components: HC , CO, CO2, and NO. The HC component shall be propane. The diluent for blends containing HC shall be air. The diluent for blends containing NO shall be N2. CO and CO2 may be used with either air or N2 as the diluent. Blends containing four interest components may be used only if approved by the Administrator. Blends containing NO2 shall also require approval by the Administrator prior to use, except if used to perform the NOx converter check specified in §85.2234(d)(5). Any interference effects between components in a gas blend shall be addressed in the quality control and quality assurance process. When a gas audit of the analytical system is performed, the auditor shall indicate whether CO2 is present in the audit gas mixture prior to performing the audit.

(2) Calibration Gases. Gases used to generate and check calibration curves shall be traceable to a NIST SRM, CRM, NTRM, or RGM and have a stated uncertainty to within 1% of the standard by Gas Comparison methods. Calibration zero gas shall be used when using a gas divider to generate intermediary calibration gases.

(3) Span Gases. Gases used for up-scale span adjustment, cross-checks, and for mid-scale span checks shall be traceable to NIST SRM, CRM, NTRM, or RGM and have a stated uncertainty to within 2% of the standard by Gas Comparison methods. Span gas concentrations shall be verified immediately after a monthly calibration curve check and before being put into service. If the reading on the span gases exceeds 2.5% of the label value, the system or gases shall be taken out of service until corrective action is taken. When a gas divider is used to generate span gases, the diluent gas shall not have impurities any greater than the working zero gas.

(4) Calibration Zero Gas. The impurities in the calibration zero gas shall not exceed 0.1 ppmC, 0.5 ppm CO, 1 ppm CO2, and 0.1 ppm NO. Calibration zero grade air shall be used for the FID zero calibration gas. Calibration zero grade nitrogen or calibration zero grade air shall be used for CO, CO2, and NOx zero calibration gases.

(5) Working Zero Gas. The impurities in working zero grade gases shall not exceed 1 ppmC, 2 ppm CO, 400 ppm CO2, and 0.3 ppm NOx. Working zero grade air or calibration zero grade air shall be used for the FID zero span gas. Working or calibration zero grade nitrogen or air shall be used for CO, CO2, and NOx zero span gases.

(6) FID Fuel. The fuel for the FID shall consist of a mixture of 40% (±2%) hydrogen, and the balance helium. The FID oxidizer shall be zero grade air, which can consist of artificial air containing 18 to 21 mole percent of oxygen.

(7) Gas Naming Protocol. Gases used for calibration or auditing shall be named according to a written established practice that has been approved by the Administrator.

(f) **Overall System Performance**

(1) Emission Levels. For each test lane, the average, median, 10th percentile and 90th percentile of the composite emissions (HC, CO, CO_2, and NOx) measured shall be monitored on a monthly basis. Differences in the monthly average of greater than ±10% by any one lane from the facility-average or combined facility-average, or by any one facility from the combined facility-average shall require an investigation to determine whether the single lane or facility has a systematic equipment or operating error or difference. Where it can be determined that the averages from one facility (or facilities) are offset from the average of the other facilities based on the mix of vehicles tested, the ±10% limit shall be compared to the expected offset. If systematic equipment or operating errors or differences causing the offset are found, such errors shall be corrected. The sample period may be adjusted to assure that a reasonably random sample of vehicles was tested in each lane.

(2) Pass/Fail Status. The average number of passing vehicles and the average number of failing vehicles shall be monitored monthly for each test lane. Differences in the monthly average of greater than ±15% by any one lane from the facility-average or combined facility-average, or by any one facility from the combined facility-average shall require an investigation to determine whether the single lane or facility has a systematic equipment or operating error or difference. Where it can be determined that the averages from one facility (or facilities) are offset from the average of the other facilities based on the mix of vehicles tested, the ±15% limit shall be compared to the expected offset. If systematic equipment or operating errors or differences causing the offset are found, such errors shall be corrected. The sample period may be adjusted to assure that a reasonably random sample of vehicles was tested in each lane.

(g) **Control Charts**

(1) General Requirements. Control charts and Statistical Process Control theory shall be used to determine, forecast, and maintain performance of each test lane, each facility, and all facilities in a given network. The control charts shall cover the performance of key parameters in the test system. When key parameters approach control chart limits, close monitoring of such systems shall be initiated and corrective actions shall be taken when needed to prevent such systems from exceeding control chart limits. If any key parameter exceeds the control chart limits, corrective action shall be taken to bring the system into compliance. The control chart limits specified are those values listed for the test procedures, the equipment specifications, and the quality control specifications that cause a test to be voided or require equipment to be removed from service. These values are "fit for use" limits, unlike a strict interpretation of SPC control chart theory which may use tighter limits to define the process. The test facility is encouraged to apply SPC strict control chart theory to determine when equipment or processes could be improved. No action shall be required until the equipment or process exceeds the "fit for use limits" specified in this section.

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(g) Control Charts

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(2) Control Charts for Individual Test Lanes. In general, control charts for individual test lanes shall include parameters that will allow the cause for abnormal performance of a test lane to be pinpointed to individual systems or components. Test lane control charts shall include at a minimum:

(i) Overall number of voided tests

(ii) Number of voided tests by type

(iii) Level of difference between theoretical and measured coast-down times

(iv) Level of difference between theoretical and measured CVS flow

(v) Level of up-scale span change from last up-scale span (not required if software corrections are tracked)

(vi) Level of mathematical or software correction to the calibration curve as a result of an up-scale span change (if used)

(vii) Level of difference between the analyzer response to the daily cross-check, and the test gas concentration

(viii) Level of difference between the integrated measurements and the bag measurements

(ix) The system response time

(x) Level of the FID CH_4 response ratio

(xi) Level of the ambient background concentrations

(xii) The average, median, 10th percentile and 90th percentile of the composite emissions (HC, CO, CO_2, and NOx) measured over the defined periodic basis

(xiii) Average number of passing vehicles, and average number of failing vehicles over the defined periodic basis

(xiv) Level of difference between theoretical or measured values for other parameters measured during quality assurance procedures

(3) Control Charts for Individual Facilities. Control charts for individual facilities shall consist of facility-averages of the test lane control charts for each test lane at the facility.

(4) Combined Control Charts for All Facilities. Combined control charts for all of the facilities in a given network shall consist of an average of the facility-average control charts for each facility.

(5) <u>Control Charts of Individual Inspectors</u>. Control charts for individual inspectors shall include parameters that will allow the cause for abnormal performance to be evaluated. Control charts for individual inspectors shall be compared to the combined control charts for each facility and for the network.

§85.2235 Evaporative Test System Quality Control Requirements

(a) Evaporative Purge Analysis System Flow Checks

(1) Daily Check. Each flow meter used to measure purge flow shall be checked each operating day with simulated purge flow (e.g., auxiliary pneumatic pump) against a reference flow measuring device with performance specifications equal to or better than those specified for the purge meter. The check shall be made at a flow rate of between 4 and 5 liters per minute. The test shall be conducted for one minute. Deviations greater than ±0.3 liters per minute, or ±3% of total flow from the values determined by the reference device shall require corrective action.

(2) Monthly Check. On a monthly basis, the calibration of purge meters shall be checked for total volume of flow at 0.8, 2, 20, and 35 liters over 4 minutes with a device or method capable of measuring these flow volumes to within ±0.2 liters over the test period. Deviations exceeding 1.5 times the specifications in §85.2227(b)(2)(v)(D) shall require corrective action.

(3) Alternative Frequencies. Where appropriate, control charts and statistical process control (SPC) theory shall be used to determine, forecast, and maintain performance of the purge measurement system.

(b) Evaporative System Integrity Checks

(1) Daily Checks. Relevant parameters of the evaporative system integrity analysis system shall be checked on each operating day.

(i) Systems that monitor pressure decay shall be checked for integrity. If, after the vehicle attachment end of the checking system is capped and the checking system is pressurized to between 14 and 28 inches of water, the pressure system changes more than 0.2 inches of water over 15 seconds, testing shall be automatically prevented until corrective action is taken.

(ii) The gas cap flow tester shall be verified daily by testing and correctly identifying the passing and failing reference fuel caps. The tester shall be automatically locked out from use until it properly fails and passes the reference caps. Flow calibration of the reference fuel caps shall be conducted before initial usage and thereafter as required by examining quality control data.

(2) Weekly Check. Pressure gauges or measurement devices shall be checked on a weekly basis against a reference gauge or device equal to or better than the specified performance requirements. Deviations exceeding the specified accuracy shall require corrective action.

(3) Annual Check. The flow standard orifice shall be calibrated before initial usage and thereafter on an annual basis unless quality control data suggests other intervals are appropriate. The flow calibration method shall be traceable to NIST.

(4) Filter Check. The gas cap flow tester filter shall be maintained in accordance with the leak test manufacturer's recommendations.

(5) Alternative Frequencies. Where appropriate, control charts and statistical process control (SPC) theory shall be used to determine, forecast, and maintain performance of the overall pressure and flow test measurement systems.

§85.2239 Test Report

(a) General Test Report Information

(1) Vehicle Description.

(i) License plate number,
(ii) Vehicle identification number,
(iii) Weight class, and
(iv) Odometer reading.

(2) Date and end time of the tailpipe emission measurement test.

(3) Name or identification number of the individual performing the test and the location of the test station and lane.

(4) For failed vehicles, a statement indicating the availability of warranty coverage as provided in Section 207 of the Clean Air Act.

(5) A statement certifying that the short tests were performed in accordance with applicable regulations.

(b) Tests and Results

(1) Test Types and Standards. The test report shall indicate the types of tests performed on the vehicle and the test standards for each. Test standards shall be displayed to the appropriate number of significant digits as in §85.2205(a). For the IM240 the reported standards shall be the composite test standards.

(2) Test Scores. The test report shall show the scores for each test performed. Test scores shall be displayed to the same number of significant digits as the standards.

(3) IM240 Scores. The reported score for the IM240 shall be in units of grams per mile and shall be selected based upon the following:

(i) If the emissions of any exhaust component on the composite IM240 are below the applicable standard in §85.2205(a), then the vehicle shall pass for that constituent and the composite score shall be reported.

(ii) If the emissions of any exhaust component on the composite IM240 exceed the applicable standard in §85.2205(a) but are below the Phase 2 standard, then the vehicle shall pass for that component and the Phase 2 score shall be reported.

(iii) If the emissions of any exhaust component on the composite IM240 exceed the applicable standard in §85.2205(a)(2) through §85.2205(a)(4) and exceed the Two Ways to Pass Standard as described in §85.2205(a)(1), then the vehicle shall fail for that component and the composite score shall be reported.

(iv) If a passing decision is made for all three exhaust components on the IM240, and for purge before the end of the full driving cycle according to the criteria described in §85.2205(a)(4) and §85.2205(c)(2), the passing results and reported emissions levels shall be those obtained at the time the test is terminated. Emission levels for the IM240 shall be reported in grams per mile calculated using the full IM240 mileage (not actual mileage). The emission standards reported shall be the composite standards (i.e., not the fast-pass standards).

(4) Purge Scores. The score for the purge test shall be reported in units of liters and shall be selected based upon the following:

(i) If purge levels at the conclusion of the transient driving cycle are below the applicable standard in §85.2205(c)(1), then the vehicle shall fail.

(ii) If a passing decision is made for all three exhaust components on the IM240, and for purge before the end of the full driving cycle according to the criteria described in §85.2205(a)(4) and §85.2205(c)(3), the passing result and reported cumulative purge levels shall be those obtained at the time the test is terminated.

(5) Pressure Test Scores. The score(s) for the pressure test(s) shall be reported as a change in pressure expressed in inches of water.

(6) Test Results. The test report shall indicate the pass/fail result for each test performed and the overall result. In the case of exhaust emission tests, the report shall indicate the pass/fail status for each component for which standards apply.

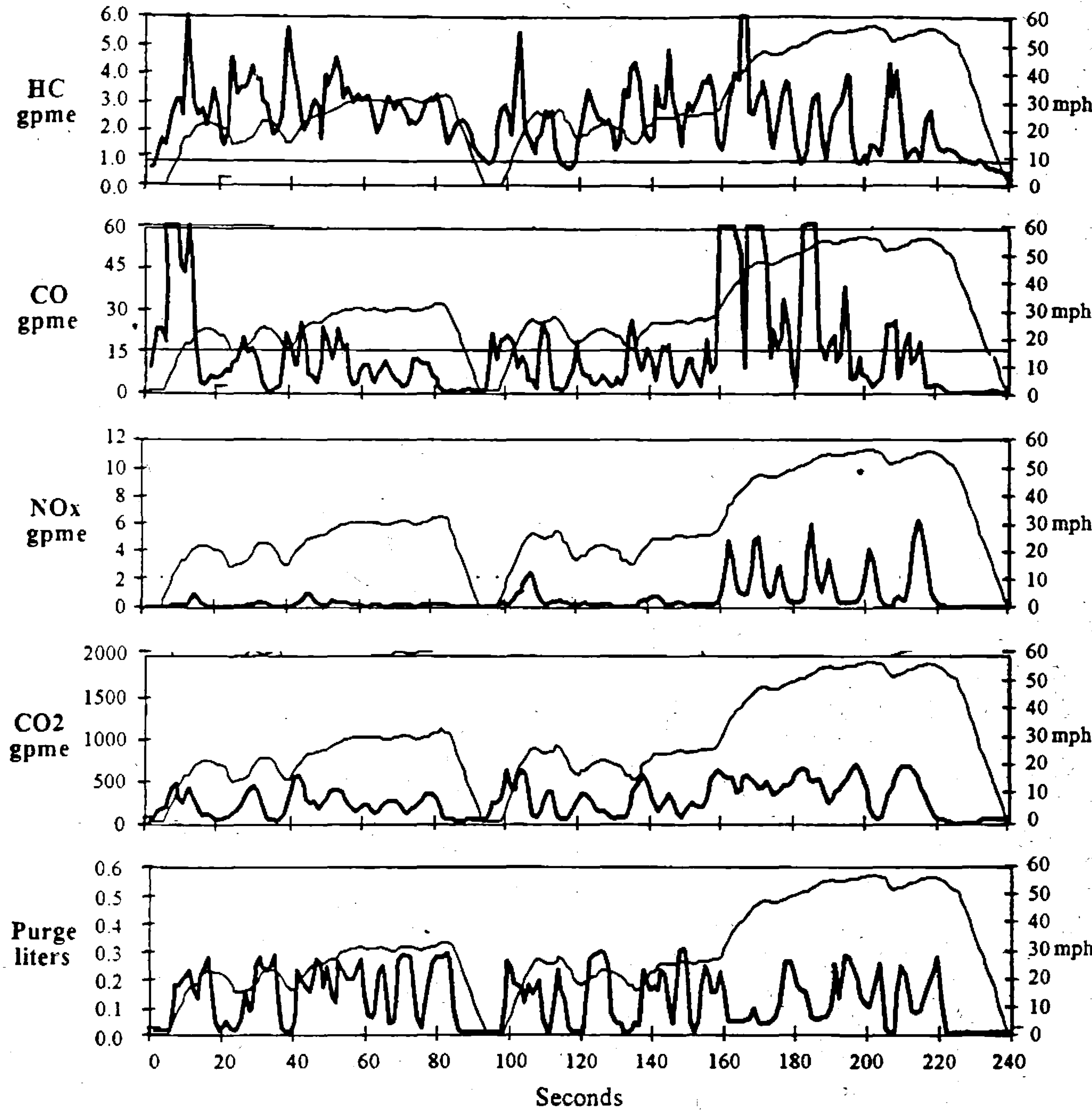
(7) Second-by-Second Measurements. For vehicles failing the IM240, a graph showing the second-by-second emission levels (see following example), for each exhaust component in grams per mile equivalent, and for purge in liters per second shall be given to the motorist.

§85.2239

Recommended IM240 Second-By-Second Emissions Report

Test Number 4719

				Emission	Actual	Cutpoint
Model Year	1988	Test Weight	3000	Emission	Actual	Cutpoint
Make	XXXX	TRLHP	14.7	HC (gpm)	2.45	0.80
Model	YYYY	Traction Control	No	CO (gpm)	23.1	15.0
Cylinders	4	ABS	No	NOx (gpm)	0.71	2.00
Transmission	Auto	Purge Test	Yes	CO2 (gpm)	279	n/a
Vehicle Type	LDGV	Press Test	Yes	Purge (L)	30.2	1.0


HC gpme
6.0
5.0
4.0
3.0
2.0
1.0
0.0
CO gpme
60
45
30
15
0
NOx gpme
12
10
8
6
4
2
0
CO2 gpme
2000
1500
1000
500
0
Purge liters
0.6
0.5
0.4
0.3
0.2
0.1
0.0
60
50
40
30 mph
20
10
0
0 20 40 60 80 100 120 140 160 180 200 220 240
Seconds

§85.2231 Terms

(a) **Definitions**

(1) Track coast-down target time: The new vehicle certification track coast-down time between 55 and 45 mph.

(2) Road load horsepower: The power required for a vehicle to maintain a given constant speed taking into account power losses due to such things as wind resistance, tire losses, bearing friction, etc.

(3) Tier 1: New gaseous and particulate tailpipe emission standards for use in certifying new light duty vehicles and light duty trucks phased in beginning with the 1994 model year.

(4) CVS hose: The hose, connecting to the tailpipe of the vehicle, that carries exhaust and dilution air to the stationary portion of the CVS system.

(b) **Abbreviations**

(1)	CFV:	Critical flow venturi
(2)	CH_4:	Methane
(3)	CO_2:	Carbon dioxide
(4)	CO:	Carbon monoxide
(5)	CRM:	Certified reference material
(6)	CVS:	constant volume sampler
(7)	FID:	Flame ionization detector
(8)	gpm:	Grams per mile
(9)	GVWR:	Gross Vehicle Weight Rating
(10)	HC:	Hydrocarbons
(11)	HDGT:	Heavy-Duty Gasoline-powered Truck greater than 8500 pounds GVWR
(12)	hp:	horsepower
(13)	Hz:	cycles per second (Hertz)
(14)	I/M:	Inspection and Maintenance
(15)	IW:	Inertia weight
(16)	LDGT1:	Light-Duty Gasoline-powered Truck from 0 to 6000 pounds GVWR
(17)	LDGT2:	Light-Duty Gasoline-powered Truck from 6001 to 8500 pounds GVWR
(18)	LDGV:	Light-Duty Gasoline-powered Vehicle
(19)	LVW	Loaded Vehicle Weight
(20)	mph:	Miles per hour
(21)	NDIR:	non-dispersive infrared
(22)	NIST:	National Institute for Standards and Technology
(23)	NO_2:	Nitrogen dioxide
(24)	NO:	Nitrogen oxide
(25)	NOx:	Oxides of nitrogen
(26)	NVFEL:	National Vehicle and Fuel Emissions Laboratory
(27)	Obmph:	Observed dynamometer speed in mph of the loading roller, if rolls are not coupled
(28)	PLHP:	Parasitic horsepower loss at the observed dynamometer speed in mph
(29)	ppm:	parts per million by volume
(30)	ppmC:	parts per million, carbon

(31) psi: Pounds per square inch
(32) RFP: Request for Proposal
(33) RLHP Road Load Horsepower
(34) rpm: revolutions per minute
(35) SCFM: standard cubic feet per minute
(36) SPC: Statistical process control
(37) SRM: Standard reference material
(38) SSV: Subsonic venturi
(39) TRLHP: Track road-load horsepower

Appendix A

Guidance on the Use of Fast-Pass IM240 Standards

Guidance on the Use of Fast-Pass IM240 Standards

A fast-pass decision is made by measuring the vehicle's cumulative emissions of each pollutant in each second, and comparing them to cumulative emission fast-pass standards for each pollutant for the second of the test under consideration. In general, if the vehicle's cumulative emissions are below a given level for all pollutants the vehicle passes. Testing continues until decisions are made for each pollutant and for purge. Measurements of all constituents shall continue to be taken as long as the test continues, including those constituents for which a decision has already been made.

These fast-pass standards are derived from an Arizona IM240 data set which included 3,718 tests. Fast-pass standards for each second represent the tenth lowest cumulative emission levels in that second obtained for vehicles failing the IM240 using the two-ways-to-pass criteria. Hence, vehicles that fall below this level are showing lower cumulative emissions at that point in the test than the cleanest vehicles failing the full test and therefore pass. Fast-pass determinations begin at second 30 of the IM240 cycle.

Beginning at second 104, fast pass decisions for HC and CO are based upon analysis of cumulative emissions in phase 2, the portion of the test beginning at second 94, as well as emission levels accumulated from the beginning of the test (the "composite" test). Fast-pass standards are derived for phase 2 of the test as described above. Since the phase 2 standards for NOx are the same as the composite, the phase 2 NOx fast-pass standards are also the same as the composite.

The fast-pass algorithm for purge is essentially the same as for tailpipe emissions. Second-by-second cumulative purge levels are compared with second-by-second cumulative purge pass standards. Fast-pass standards correspond to the tenth highest cumulative purge levels for failing vehicles. There are no Phase 2 standards for purge.

A vehicle passes the IM240/purge test if cumulative composite purge is above the cumulative composite purge fast-pass standard, and if any of the following three conditions occur:

- cumulative composite emissions of HC, CO, and NOx are below the composite fast-pass standards;
- cumulative phase 2 emissions of HC, CO, and NOx are below the phase 2 fast-pass standards;
- any combination of the first two conditions exist.

Scores

HC_t = cumulative composite HC at time = t seconds
CO_t = cumulative composite CO at time = t seconds
NOx_t = cumulative composite NOx at time = t seconds
P_t = cumulative composite purge at time = t seconds

HC_{bt} = cumulative Phase 2 HC at time = t seconds
CO_{bt} = cumulative Phase 2 CO at time = t seconds
NOx_{bt} = cumulative Phase 2 NOx at time = t seconds

Cumulative composite scores represent the cumulative grams of emissions from $t = 0$ seconds
Cumulative Phase 2 scores represent the cumulative grams of emissions from $t = 104$ seconds

Fast-Pass Standards

HC_{pt} = composite HC fast-pass standard at time = t seconds
CO_{pt} = composite CO fast-pass standard at time = t seconds
NOx_{pt} = composite NOx fast-pass standard for failing vehicles at time = t seconds
P_{pt} = composite purge fast-pass standard at time = t seconds

HC_{pbt} = Phase 2 HC fast-pass standard at time = t seconds
CO_{pbt} = Phase 2 CO fast-pass standard at time = t seconds
NOx_{pbt} = Phase 2 NOx fast-pass standard at time = t seconds

Fast-Pass Conditions

For $t > 30$ seconds, the vehicle shall pass if:
$HC_t < HC_{pt}$ and $CO_t < CO_{pt}$, $NOx_t < NOx_{pt}$, and $P_t > P_{pt}$
additionally, for $t > 104$ seconds, the vehicle shall pass if:
$HC_{bt} < HC_{pbt}$ and $CO_{bt} < CO_{pbt}$ and $NOx_{bt} < NOx_{pbt}$ and $P_t > P_{pt}$, or
$HC_t < HC_{pt}$ and $CO_{bt} < CO_{pbt}$ and $NOx_{bt} < NOx_{pbt}$ and $P_t > P_{pt}$, or
$HC_t < HC_{pt}$ and $CO_t < CO_{pt}$ and $NOx_{bt} < NOx_{pbt}$ and $P_t > P_{pt}$, or
$HC_{bt} < HC_{pbt}$ and $CO_t < CO_{pt}$ and $NOx_{bt} < NOx_{pbt}$ and $P_t > P_{pt}$, or
$HC_{bt} < HC_{pbt}$ and $CO_t < CO_{pt}$ and $NOx_t < NOx_{pt}$ and $P_t > P_{pt}$, or
$HC_{bt} < HC_{pbt}$ and $CO_{bt} < CO_{pbt}$ and $NOx_t < NOx_{pt}$ and $P_t > P_{pt}$,

IM240 FAST-PASS EMISSION STANDARDS

(grams)

Sec IM240	Hydrocarbons						Carbon Monoxide						Oxides of Nitrogen			Evap System Purge
	Composite 0.8	Phase 2 0.5	Composite 1.25	Phase 2 0.75	Composite 2.00	Phase 2 1.25	Composite 15.0	Phase 2 12.0	Composite 20.0	Phase 2 16.0	Composite 30.0	Phase 2 24.0	2.0	2.5	3.0	
30	0.124	n/a	0.247	n/a	0.407	n/a	0.693	n/a	1.502	n/a	3.804	n/a	0.167	0.262	0.419	0.14
31	0.126	n/a	0.253	n/a	0.415	n/a	0.773	n/a	1.546	n/a	3.985	n/a	0.177	0.275	0.425	0.14
32	0.129	n/a	0.258	n/a	0.423	n/a	0.837	n/a	1.568	n/a	4.215	n/a	0.188	0.301	0.431	0.15
33	0.135	n/a	0.263	n/a	0.436	n/a	0.851	n/a	1.582	n/a	4.440	n/a	0.214	0.317	0.449	0.15
34	0.140	n/a	0.268	n/a	0.451	n/a	0.853	n/a	1.593	n/a	4.579	n/a	0.232	0.327	0.476	0.16
35	0.146	n/a	0.277	n/a	0.464	n/a	0.857	n/a	1.602	n/a	4.688	n/a	0.240	0.330	0.497	0.16
36	0.150	n/a	0.283	n/a	0.468	n/a	0.900	n/a	1.621	n/a	4.749	n/a	0.243	0.332	0.515	0.16
37	0.153	n/a	0.293	n/a	0.475	n/a	0.960	n/a	1.631	n/a	4.783	n/a	0.245	0.334	0.516	0.17
38	0.156	n/a	0.297	n/a	0.487	n/a	1.034	n/a	1.702	n/a	4.813	n/a	0.246	0.336	0.519	0.18
39	0.160	n/a	0.298	n/a	0.506	n/a	1.070	n/a	1.784	n/a	4.876	n/a	0.246	0.337	0.527	0.18
40	0.165	n/a	0.313	n/a	0.530	n/a	1.076	n/a	1.879	n/a	5.104	n/a	0.250	0.354	0.542	0.19
41	0.169	n/a	0.320	n/a	0.549	n/a	1.083	n/a	2.162	n/a	5.217	n/a	0.260	0.366	0.560	0.19
42	0.172	n/a	0.327	n/a	0.569	n/a	1.102	n/a	2.307	n/a	5.383	n/a	0.277	0.410	0.598	0.19
43	0.173	n/a	0.342	n/a	0.588	n/a	1.111	n/a	2.343	n/a	5.571	n/a	0.311	0.414	0.616	0.20
44	0.177	n/a	0.360	n/a	0.609	n/a	1.114	n/a	2.376	n/a	5.888	n/a	0.328	0.438	0.645	0.20
45	0.197	n/a	0.376	n/a	0.621	n/a	1.157	n/a	2.406	n/a	6.199	n/a	0.343	0.477	0.670	0.20
46	0.200	n/a	0.389	n/a	0.636	n/a	1.344	n/a	2.433	n/a	6.245	n/a	0.359	0.506	0.691	0.21
47	0.208	n/a	0.408	n/a	0.649	n/a	1.482	n/a	2.458	n/a	6.318	n/a	0.373	0.518	0.716	0.22
48	0.221	n/a	0.423	n/a	0.666	n/a	1.530	n/a	2.483	n/a	6.418	n/a	0.383	0.522	0.735	0.22
49	0.232	n/a	0.434	n/a	0.679	n/a	1.542	n/a	2.774	n/a	6.540	n/a	0.385	0.526	0.765	0.22
50	0.235	n/a	0.444	n/a	0.696	n/a	1.553	n/a	2.844	n/a	6.690	n/a	0.400	0.554	0.802	0.23
51	0.238	n/a	0.454	n/a	0.712	n/a	1.571	n/a	2.900	n/a	6.875	n/a	0.410	0.574	0.836	0.24
52	0.240	n/a	0.465	n/a	0.727	n/a	1.595	n/a	2.936	n/a	7.029	n/a	0.434	0.587	0.868	0.24
53	0.242	n/a	0.472	n/a	0.745	n/a	1.633	n/a	3.133	n/a	7.129	n/a	0.464	0.601	0.890	0.24
54	0.246	n/a	0.478	n/a	0.760	n/a	1.685	n/a	3.304	n/a	7.359	n/a	0.472	0.615	0.918	0.24
55	0.249	n/a	0.485	n/a	0.776	n/a	1.689	n/a	3.407	n/a	7.722	n/a	0.480	0.629	0.936	0.24
56	0.252	n/a	0.493	n/a	0.797	n/a	1.693	n/a	3.456	n/a	8.017	n/a	0.491	0.643	0.947	0.24
57	0.261	n/a	0.500	n/a	0.814	n/a	1.700	n/a	3.480	n/a	8.249	n/a	0.500	0.667	0.958	0.24
58	0.271	n/a	0.505	n/a	0.826	n/a	1.723	n/a	3.518	n/a	8.425	n/a	0.506	0.678	0.970	0.25
59	0.276	n/a	0.514	n/a	0.837	n/a	1.852	n/a	3.560	n/a	8.563	n/a	0.509	0.683	0.982	0.25
60	0.278	n/a	0.537	n/a	0.849	n/a	1.872	n/a	3.593	n/a	8.686	n/a	0.512	0.686	0.994	0.25
61	0.280	n/a	0.540	n/a	0.862	n/a	1.872	n/a	3.628	n/a	8.804	n/a	0.516	0.693	1.019	0.26
62	0.282	n/a	0.543	n/a	0.872	n/a	1.872	n/a	3.641	n/a	8.916	n/a	0.519	0.699	1.042	0.26
63	0.283	n/a	0.546	n/a	0.887	n/a	1.900	n/a	3.655	n/a	9.025	n/a	0.523	0.703	1.049	0.26
64	0.284	n/a	0.551	n/a	0.895	n/a	1.917	n/a	3.680	n/a	9.138	n/a	0.529	0.707	1.058	0.27
65	0.285	n/a	0.559	n/a	0.903	n/a	1.944	n/a	3.700	n/a	9.250	n/a	0.533	0.711	1.062	0.27
66	0.286	n/a	0.567	n/a	0.925	n/a	2.000	n/a	3.728	n/a	9.354	n/a	0.535	0.716	1.064	0.27
67	0.288	n/a	0.575	n/a	0.933	n/a	2.060	n/a	3.857	n/a	9.457	n/a	0.540	0.721	1.070	0.28
68	0.291	n/a	0.588	n/a	0.945	n/a	2.064	n/a	3.894	n/a	9.575	n/a	0.551	0.726	1.077	0.28
69	0.294	n/a	0.595	n/a	0.959	n/a	2.076	n/a	3.943	n/a	9.728	n/a	0.563	0.742	1.085	0.29
70	0.296	n/a	0.601	n/a	0.970	n/a	2.104	n/a	3.983	n/a	9.938	n/a	0.575	0.759	1.092	0.29
71	0.298	n/a	0.606	n/a	0.980	n/a	2.117	n/a	4.009	n/a	10.140	n/a	0.588	0.773	1.101	0.29
72	0.300	n/a	0.610	n/a	0.988	n/a	2.125	n/a	4.023	n/a	10.222	n/a	0.600	0.784	1.111	0.29
73	0.302	n/a	0.617	n/a	0.997	n/a	2.130	n/a	4.023	n/a	10.261	n/a	0.603	0.790	1.121	0.30
74	0.304	n/a	0.631	n/a	1.022	n/a	2.138	n/a	4.053	n/a	10.278	n/a	0.604	0.794	1.131	0.30
75	0.307	n/a	0.643	n/a	1.037	n/a	2.152	n/a	4.063	n/a	10.290	n/a	0.613	0.799	1.141	0.30
76	0.308	n/a	0.651	n/a	1.051	n/a	2.170	n/a	4.077	n/a	10.715	n/a	0.624	0.809	1.159	0.31
77	0.308	n/a	0.659	n/a	1.064	n/a	2.188	n/a	4.225	n/a	10.790	n/a	0.646	0.821	1.164	0.31
78	0.308	n/a	0.667	n/a	1.075	n/a	2.200	n/a	4.243	n/a	10.844	n/a	0.651	0.833	1.186	0.32
79	0.314	n/a	0.676	n/a	1.087	n/a	2.212	n/a	4.260	n/a	10.921	n/a	0.659	0.839	1.221	0.32
80	0.320	n/a	0.681	n/a	1.097	n/a	2.212	n/a	4.282	n/a	11.010	n/a	0.673	0.844	1.260	0.32
81	0.324	n/a	0.685	n/a	1.105	n/a	2.221	n/a	4.322	n/a	11.090	n/a	0.696	0.857	1.268	0.32
82	0.327	n/a	0.689	n/a	1.114	n/a	2.222	n/a	4.398	n/a	11.136	n/a	0.706	0.870	1.272	0.33
83	0.329	n/a	0.694	n/a	1.136	n/a	2.227	n/a	4.482	n/a	11.136	n/a	0.715	0.883	1.277	0.33
84	0.333	n/a	0.700	n/a	1.160	n/a	2.236	n/a	4.515	n/a	11.165	n/a	0.724	0.894	1.288	0.34
85	0.336	n/a	0.705	n/a	1.182	n/a	2.243	n/a	4.518	n/a	11.191	n/a	0.737	0.902	1.310	0.34
86	0.339	n/a	0.709	n/a	1.201	n/a	2.262	n/a	4.520	n/a	11.205	n/a	0.747	0.907	1.319	0.34
87	0.343	n/a	0.713	n/a	1.217	n/a	2.271	n/a	4.522	n/a	11.211	n/a	0.748	0.910	1.320	0.35
88	0.347	n/a	0.717	n/a	1.233	n/a	2.284	n/a	4.522	n/a	11.211	n/a	0.748	0.912	1.337	0.35
89	0.350	n/a	0.721	n/a	1.248	n/a	2.299	n/a	4.523	n/a	11.211	n/a	0.748	0.913	1.348	0.35
90	0.356	n/a	0.724	n/a	1.262	n/a	2.308	n/a	4.526	n/a	11.211	n/a	0.748	0.914	1.361	0.36
91	0.358	n/a	0.727	n/a	1.271	n/a	2.326	n/a	4.527	n/a	11.220	n/a	0.748	0.915	1.366	0.36
92	0.360	n/a	0.729	n/a	1.279	n/a	2.330	n/a	4.527	n/a	11.294	n/a	0.748	0.916	1.369	0.37
93	0.363	n/a	0.731	n/a	1.287	n/a	2.331	n/a	4.528	n/a	11.332	n/a	0.748	0.917	1.373	0.37
94	0.367	n/a	0.734	n/a	1.295	n/a	2.344	n/a	4.528	n/a	11.355	n/a	0.748	0.918	1.375	0.37
95	0.370	n/a	0.740	n/a	1.302	n/a	2.347	n/a	4.528	n/a	11.383	n/a	0.748	0.919	1.377	0.38
96	0.372	n/a	0.748	n/a	1.309	n/a	2.355	n/a	4.529	n/a	11.410	n/a	0.748	0.920	1.379	0.38
97	0.376	n/a	0.759	n/a	1.316	n/a	2.395	n/a	4.575	n/a	11.433	n/a	0.748	0.921	1.381	0.39
98	0.388	n/a	0.771	n/a	1.325	n/a	2.451	n/a	4.703	n/a	11.516	n/a	0.748	0.922	1.383	0.39
99	0.396	n/a	0.783	n/a	1.339	n/a	2.508	n/a	4.805	n/a	11.820	n/a	0.751	0.924	1.385	0.39
100	0.405	n/a	0.793	n/a	1.356	n/a	2.590	n/a	4.886	n/a	12.104	n/a	0.764	0.929	1.399	0.40
101	0.410	n/a	0.810	n/a	1.365	n/a	2.660	n/a	4.957	n/a	12.344	n/a	0.789	0.941	1.405	0.40
102	0.411	n/a	0.823	n/a	1.378	n/a	2.749	n/a	5.104	n/a	12.781	n/a	0.822	0.970	1.466	0.40
103	0.412	n/a	0.836	n/a	1.397	n/a	2.913	n/a	5.340	n/a	13.472	n/a	0.867	1.027	1.485	0.41

Appendix A

104	0.413	0.007	0.853	0.016	1.420	0.055	3.162	0.038	5.496	0.094	14.405	0.582	0.905	1.093	1.546	0.41
105	0.421	0.008	0.871	0.017	1.445	0.094	3.170	0.039	5.625	0.122	14.808	0.800	0.925	1.155	1.623	0.41
106	0.428	0.009	0.887	0.022	1.470	0.110	3.197	0.061	5.815	0.151	14.965	0.925	0.955	1.234	1.699	0.42
107	0.430	0.010	0.899	0.029	1.491	0.116	3.288	0.062	6.473	0.191	15.121	0.973	0.985	1.275	1.760	0.42
108	0.455	0.013	0.931	0.036	1.506	0.132	3.419	0.108	7.037	0.234	15.372	1.091	0.993	1.305	1.788	0.43
109	0.459	0.015	0.947	0.040	1.517	0.151	3.587	0.168	7.419	0.246	15.530	1.113	0.995	1.320	1.798	0.43
110	0.462	0.017	0.957	0.047	1.528	0.159	3.595	0.173	7.643	0.257	15.687	1.213	0.996	1.332	1.842	0.43
111	0.464	0.021	0.965	0.052	1.542	0.172	3.640	0.237	7.759	0.286	16.018	1.344	1.010	1.346	1.864	0.44
112	0.466	0.024	0.971	0.056	1.559	0.186	3.740	0.266	7.824	0.379	16.527	1.399	1.028	1.358	1.888	0.44
113	0.468	0.024	0.977	0.061	1.578	0.199	3.868	0.280	7.889	0.425	16.810	1.520	1.034	1.378	1.905	0.44
114	0.471	0.025	0.983	0.064	1.594	0.207	3.877	0.291	7.960	0.457	16.961	1.640	1.044	1.406	1.920	0.44
115	0.488	0.026	1.003	0.072	1.605	0.216	3.934	0.314	8.024	0.477	17.120	1.684	1.059	1.426	1.926	0.45
116	0.513	0.029	1.030	0.081	1.615	0.229	4.015	0.331	8.076	0.494	17.135	1.693	1.075	1.438	1.939	0.46
117	0.538	0.032	1.041	0.082	1.625	0.235	4.061	0.345	8.111	0.504	17.249	1.786	1.080	1.448	1.958	0.46
118	0.561	0.035	1.050	0.083	1.642	0.240	4.063	0.350	8.130	0.512	17.451	2.007	1.080	1.460	1.972	0.47
119	0.577	0.035	1.052	0.092	1.670	0.245	4.079	0.356	8.148	0.519	17.509	2.084	1.081	1.462	1.981	0.47
120	0.580	0.036	1.055	0.094	1.694	0.261	4.140	0.367	8.211	0.529	17.605	2.179	1.091	1.467	1.987	0.47
121	0.586	0.038	1.061	0.097	1.705	0.267	4.185	0.388	8.478	0.529	17.734	2.264	1.096	1.476	1.991	0.48
122	0.594	0.040	1.071	0.100	1.717	0.277	4.199	0.407	8.548	0.530	18.049	2.328	1.111	1.494	1.996	0.48
123	0.603	0.041	1.081	0.103	1.732	0.287	4.205	0.463	8.561	0.531	18.447	2.375	1.122	1.505	2.012	0.48
124	0.610	0.042	1.091	0.106	1.747	0.298	4.212	0.480	8.568	0.532	18.592	2.437	1.135	1.517	2.040	0.49
125	0.615	0.042	1.102	0.108	1.763	0.308	4.232	0.506	8.572	0.533	18.657	2.543	1.138	1.546	2.060	0.49
126	0.624	0.042	1.110	0.110	1.779	0.316	4.298	0.518	8.584	0.548	18.796	2.593	1.139	1.569	2.069	0.50
127	0.628	0.045	1.116	0.112	1.795	0.322	4.344	0.522	8.592	0.610	18.952	2.641	1.139	1.586	2.092	0.50
128	0.632	0.046	1.121	0.114	1.810	0.329	4.361	0.525	8.596	0.614	19.137	2.663	1.139	1.596	2.114	0.50
129	0.637	0.046	1.125	0.116	1.823	0.338	4.366	0.528	8.597	0.622	19.329	2.672	1.139	1.603	2.132	0.50
130	0.641	0.049	1.128	0.118	1.835	0.346	4.369	0.530	8.601	0.631	19.519	2.676	1.139	1.605	2.144	0.51
131	0.643	0.050	1.130	0.120	1.845	0.354	4.372	0.530	8.605	0.640	19.707	2.683	1.139	1.606	2.152	0.52
132	0.644	0.052	1.132	0.122	1.854	0.356	4.435	0.534	8.608	0.646	19.882	2.817	1.139	1.607	2.157	0.52
133	0.645	0.054	1.134	0.123	1.862	0.357	4.523	0.550	8.626	0.650	19.905	2.992	1.139	1.607	2.160	0.52
134	0.647	0.054	1.135	0.124	1.870	0.359	4.524	0.554	8.650	0.652	20.049	3.111	1.139	1.608	2.163	0.53
135	0.651	0.054	1.143	0.127	1.883	0.362	4.525	0.590	8.660	0.738	20.460	3.234	1.139	1.614	2.165	0.53
136	0.658	0.055	1.147	0.130	1.888	0.364	4.531	0.616	8.767	0.754	20.746	3.304	1.160	1.616	2.168	0.54
137	0.663	0.055	1.156	0.134	1.896	0.368	4.534	0.639	9.029	0.780	21.068	3.310	1.174	1.631	2.171	0.54
138	0.666	0.056	1.163	0.139	1.911	0.378	4.542	0.653	9.238	0.795	21.380	3.320	1.183	1.643	2.186	0.54
139	0.668	0.059	1.186	0.146	1.928	0.391	4.553	0.662	9.389	0.804	21.748	3.354	1.197	1.656	2.235	0.55
140	0.670	0.061	1.253	0.149	1.949	0.402	4.554	0.683	9.493	0.810	22.046	3.436	1.223	1.673	2.298	0.55
141	0.672	0.061	1.262	0.151	1.969	0.408	4.554	0.696	9.583	0.815	22.348	3.443	1.255	1.703	2.333	0.56
142	0.675	0.061	1.271	0.153	1.982	0.422	4.554	0.708	9.626	0.818	22.397	3.452	1.272	1.739	2.373	0.56
143	0.678	0.063	1.277	0.155	1.999	0.428	4.554	0.721	9.669	0.821	22.407	3.490	1.286	1.767	2.406	0.56
144	0.681	0.064	1.283	0.157	2.011	0.432	4.554	0.739	9.716	0.825	22.417	3.552	1.304	1.774	2.416	0.56
145	0.684	0.065	1.291	0.162	2.022	0.434	4.554	0.742	9.763	0.840	22.922	3.588	1.307	1.785	2.420	0.57
146	0.686	0.066	1.294	0.164	2.035	0.439	4.554	0.743	9.809	0.847	22.951	3.600	1.312	1.806	2.424	0.57
147	0.688	0.067	1.296	0.166	2.043	0.450	4.554	0.745	9.852	0.855	22.976	3.616	1.317	1.830	2.435	0.58
148	0.690	0.068	1.298	0.168	2.049	0.460	4.554	0.748	9.885	0.865	23.017	3.627	1.321	1.844	2.455	0.58
149	0.692	0.069	1.303	0.169	2.063	0.467	4.554	0.751	9.932	0.874	23.073	3.636	1.325	1.845	2.471	0.59
150	0.694	0.070	1.316	0.170	2.085	0.472	4.554	0.762	9.986	0.891	23.161	3.676	1.328	1.846	2.484	0.59
151	0.696	0.071	1.330	0.171	2.104	0.480	4.556	0.789	10.039	0.914	23.218	3.882	1.332	1.852	2.495	0.59
152	0.698	0.072	1.342	0.172	2.117	0.491	4.556	0.790	10.072	0.929	23.253	4.011	1.338	1.868	2.509	0.59
153	0.700	0.073	1.348	0.173	2.127	0.503	4.565	0.794	10.090	0.937	23.337	4.047	1.344	1.877	2.522	0.59
154	0.702	0.073	1.353	0.175	2.138	0.505	4.612	0.799	10.105	0.942	23.425	4.067	1.350	1.879	2.533	0.59
155	0.704	0.074	1.362	0.178	2.152	0.515	4.834	0.805	10.146	0.949	23.534	4.081	1.357	1.886	2.541	0.60
156	0.706	0.077	1.365	0.180	2.168	0.522	5.702	0.842	10.245	1.375	23.652	4.116	1.365	1.900	2.552	0.60
157	0.708	0.079	1.366	0.189	2.186	0.527	5.841	0.990	10.397	1.576	23.739	4.251	1.379	1.910	2.589	0.61
158	0.710	0.082	1.373	0.198	2.205	0.537	6.170	1.038	10.923	1.943	24.606	5.099	1.414	1.936	2.631	0.61
159	0.712	0.082	1.397	0.203	2.224	0.549	6.670	1.357	11.970	2.820	25.615	5.383	1.466	1.954	2.704	0.61
160	0.716	0.086	1.423	0.207	2.242	0.568	7.425	1.455	13.421	3.281	26.073	6.362	1.514	1.986	2.758	0.61
161	0.750	0.095	1.440	0.214	2.268	0.586	8.379	1.546	15.289	3.483	28.496	7.926	1.559	2.050	2.802	0.62
162	0.784	0.107	1.452	0.221	2.308	0.610	9.648	1.824	15.912	3.620	29.772	8.429	1.591	2.131	2.904	0.62
163	0.805	0.115	1.465	0.229	2.352	0.648	10.918	2.746	16.530	4.168	31.056	9.201	1.641	2.235	2.960	0.63
164	0.840	0.122	1.509	0.247	2.406	0.677	12.157	3.073	17.622	4.338	33.351	10.825	1.719	2.320	3.027	0.63
165	0.853	0.127	1.533	0.274	2.421	0.699	12.731	3.633	18.366	4.682	34.890	12.291	1.777	2.395	3.127	0.64
166	0.874	0.159	1.555	0.309	2.435	0.720	12.831	4.505	19.869	5.633	35.937	13.366	1.832	2.488	3.187	0.64
167	0.903	0.186	1.576	0.318	2.470	0.738	12.892	4.952	20.711	6.137	37.012	14.428	1.919	2.563	3.306	0.64
168	0.910	0.189	1.598	0.322	2.501	0.767	12.932	5.254	22.319	6.853	37.892	15.318	1.972	2.645	3.384	0.65
169	0.914	0.200	1.618	0.333	2.537	0.828	13.702	5.730	23.751	7.136	39.028	15.699	2.013	2.746	3.467	0.65
170	0.916	0.220	1.636	0.343	2.571	0.855	14.139	6.051	24.842	7.320	40.406	16.073	2.100	2.778	3.565	0.66
171	0.919	0.236	1.666	0.356	2.625	0.869	14.964	6.333	25.410	7.685	41.379	16.475	2.200	2.792	3.640	0.66
172	0.931	0.247	1.685	0.385	2.657	0.885	15.704	6.490	25.798	8.052	42.033	17.158	2.251	2.810	3.718	0.67
173	0.948	0.257	1.726	0.409	2.683	0.900	16.253	6.796	26.122	8.344	42.432	17.532	2.270	2.847	3.781	0.67
174	0.983	0.267	1.742	0.433	2.701	0.941	16.907	7.205	26.353	8.602	42.742	17.965	2.301	2.874	3.827	0.68
175	1.018	0.283	1.756	0.453	2.717	0.979	17.655	8.151	26.638	8.898	43.399	18.242	2.318	2.905	3.852	0.68
176	1.027	0.295	1.769	0.463	2.732	1.002	18.020	8.230	27.219	9.251	43.895	18.283	2.335	2.950	3.903	0.68
177	1.035	0.312	1.784	0.507	2.756	1.025	18.349	8.584	27.279	10.253	44.227	18.480	2.349	3.001	3.930	0.68
178	1.051	0.318	1.802	0.523	2.781	1.047	18.671	8.800	27.320	10.828	44.926	19.576	2.387	3.047	3.970	0.68
179	1.074	0.323	1.822	0.528	2.811	1.065	18.972	8.847	27.352	10.933	45.256	20.015	2.423	3.104	4.015	0.68
180	1.084	0.337	1.843	0.541	2.853	1.089	19.228	8.913	27.822	11.060	45.553	20.203	2.462	3.173	4.074	0.68
181	1.099	0.345	1.864	0.549	2.898	1.109	20.123	9.122	28.763	11.188	45.753	20.433	2.503	3.238	4.159	0.68
182	1.121	0.350	1.884	0.559	2.946	1.133	20.405	9.532	29.402	11.345	46.210	21.025	2.545	3.302	4.230	0.68
183	1.132	0.359	1.896	0.571	2.988	1.158	20.754	10.256	29.971	11.733	47.017	21.882	2.586	3.372	4.286	0.68
184	1.152	0.387	1.915	0.584	3.023	1.184	21.684	10.862	30.276	12.598	48.185	22.204	2.627	3.452	4.334	0.68
185	1.161	0.398	1.940	0.598	3.057	1.209	21.955	10.996	30.988	12.953	48.741	22.859	2.673	3.545	4.388	0.68

186	1.168	0.400	1.958	0.613	3.076	1.222	22.650	11.206	31.095	13.213	49.462	23.533	2.749	3.648	4.447	0.69
187	1.175	0.402	1.972	0.624	3.101	1.231	22.989	11.514	31.314	14.131	50.313	24.281	2.804	3.701	4.505	0.70
188	1.181	0.405	1.985	0.629	3.120	1.239	23.535	11.894	31.833	14.839	51.285	25.078	2.851	3.759	4.561	0.72
189	1.188	0.418	1.991	0.629	3.136	1.254	23.876	12.019	32.239	15.137	52.076	25.276	2.894	3.821	4.625	0.72
190	1.203	0.429	1.993	0.638	3.151	1.278	24.018	12.170	32.547	15.138	52.857	25.578	2.931	3.870	4.696	0.73
191	1.219	0.442	1.995	0.648	3.163	1.300	24.464	12.517	32.855	15.141	52.876	25.859	2.971	3.892	4.731	0.73
192	1.233	0.457	2.001	0.659	3.209	1.313	24.685	12.598	33.153	15.595	53.067	25.985	3.020	3.914	4.780	0.74
193	1.251	0.473	2.015	0.663	3.223	1.324	24.931	12.625	33.444	15.658	53.777	26.153	3.077	3.955	4.837	0.74
194	1.255	0.487	2.031	0.671	3.237	1.340	25.188	12.653	33.482	15.704	54.242	26.582	3.132	3.997	4.876	0.74
195	1.258	0.501	2.047	0.681	3.263	1.367	25.468	12.777	33.516	15.729	54.489	27.067	3.185	4.035	4.928	0.75
196	1.265	0.510	2.063	0.693	3.302	1.387	25.627	12.906	33.549	16.058	54.601	27.456	3.219	4.089	4.972	0.76
197	1.280	0.512	2.079	0.709	3.338	1.402	25.746	12.989	33.653	16.987	54.912	27.805	3.268	4.146	5.025	0.76
198	1.293	0.514	2.094	0.725	3.372	1.417	25.850	13.060	33.973	17.064	55.588	28.070	3.299	4.206	5.104	0.76
199	1.301	0.516	2.109	0.740	3.390	1.432	25.974	13.165	34.159	17.073	56.266	28.590	3.350	4.243	5.189	0.76
200	1.313	0.518	2.122	0.754	3.428	1.446	26.141	13.242	34.191	17.153	56.617	28.914	3.406	4.295	5.275	0.77
201	1.324	0.527	2.130	0.767	3.470	1.460	26.225	13.412	34.250	17.332	56.863	29.063	3.466	4.351	5.336	0.77
202	1.332	0.540	2.137	0.775	3.493	1.477	26.338	13.662	34.469	17.406	57.204	29.502	3.497	4.398	5.366	0.77
203	1.341	0.547	2.157	0.787	3.509	1.492	26.547	13.773	34.716	17.641	57.371	29.697	3.514	4.410	5.387	0.78
204	1.357	0.553	2.172	0.795	3.522	1.501	26.818	13.942	34.969	17.922	57.487	29.713	3.517	4.419	5.427	0.79
205	1.375	0.559	2.194	0.803	3.533	1.510	27.052	14.090	35.144	18.484	57.728	29.783	3.519	4.426	5.444	0.79
206	1.392	0.563	2.222	0.854	3.550	1.522	27.393	14.224	35.418	18.553	58.097	29.942	3.523	4.429	5.447	0.80
207	1.408	0.567	2.245	0.859	3.578	1.561	27.501	14.426	35.766	18.658	58.572	30.284	3.545	4.453	5.477	0.81
208	1.422	0.571	2.268	0.872	3.607	1.585	27.632	14.498	35.949	18.953	59.024	30.755	3.570	4.486	5.520	0.81
209	1.433	0.575	2.279	0.892	3.630	1.597	27.803	14.776	36.010	19.266	59.321	31.287	3.600	4.542	5.560	0.82
210	1.443	0.579	2.288	0.896	3.658	1.607	27.953	14.907	36.548	19.309	59.715	31.549	3.619	4.598	5.603	0.83
211	1.453	0.595	2.301	0.903	3.701	1.627	28.205	14.916	37.179	19.731	60.045	31.820	3.639	4.638	5.657	0.83
212	1.463	0.605	2.316	0.924	3.745	1.645	28.543	15.014	37.651	19.902	60.453	32.250	3.686	4.715	5.698	0.84
213	1.468	0.614	2.332	0.938	3.778	1.656	28.997	15.221	38.041	20.012	60.935	32.546	3.732	4.774	5.762	0.85
214	1.470	0.622	2.345	0.941	3.814	1.663	29.000	15.472	38.591	20.260	61.307	32.808	3.791	4.829	5.827	0.85
215	1.474	0.627	2.354	0.951	3.825	1.669	29.005	15.555	38.852	20.739	61.666	33.060	3.833	4.872	5.849	0.85
216	1.478	0.638	2.362	0.966	3.835	1.674	29.081	15.652	38.861	21.346	62.148	33.204	3.890	4.931	5.884	0.86
217	1.481	0.643	2.368	0.979	3.844	1.685	29.281	15.969	38.926	21.810	62.532	33.341	3.932	4.960	5.908	0.86
218	1.484	0.643	2.376	0.980	3.853	1.700	29.483	16.028	39.194	22.001	62.546	33.414	3.960	4.963	5.921	0.87
219	1.487	0.645	2.384	0.981	3.864	1.704	29.734	16.375	39.474	22.290	62.559	33.514	3.997	4.965	5.931	0.87
220	1.490	0.651	2.391	1.005	3.874	1.706	29.803	16.487	39.668	22.324	62.570	33.640	4.013	4.968	5.939	0.88
221	1.493	0.655	2.395	1.016	3.891	1.709	29.821	16.524	39.781	22.343	62.846	33.692	4.035	4.971	5.947	0.88
222	1.504	0.663	2.400	1.022	3.928	1.711	29.847	16.578	39.890	22.522	63.097	33.711	4.038	4.974	5.952	0.88
223	1.522	0.671	2.405	1.028	3.966	1.714	29.862	16.684	39.954	22.661	63.150	33.733	4.050	4.977	5.955	0.89
224	1.547	0.675	2.409	1.035	4.008	1.718	29.873	16.755	39.984	22.666	63.150	33.770	4.066	4.979	5.957	0.90
225	1.549	0.684	2.413	1.041	4.010	1.721	30.008	16.770	39.989	22.667	63.150	33.796	4.070	4.980	5.959	0.90
226	1.562	0.694	2.415	1.045	4.012	1.723	30.126	16.805	39.990	22.668	63.150	33.810	4.072	4.981	5.961	0.91
227	1.574	0.701	2.417	1.051	4.016	1.726	30.127	16.865	39.990	22.669	63.150	33.821	4.072	4.982	5.963	0.91
228	1.579	0.702	2.419	1.055	4.019	1.729	30.127	16.960	39.990	22.670	63.150	33.839	4.073	4.983	5.966	0.92
229	1.584	0.708	2.420	1.059	4.057	1.731	30.208	16.960	39.991	22.671	63.150	33.865	4.073	4.984	5.971	0.92
230	1.589	0.708	2.421	1.062	4.065	1.733	30.314	16.962	40.012	22.671	63.150	33.894	4.073	4.985	5.977	0.92
231	1.590	0.709	2.423	1.063	4.071	1.735	30.323	16.988	40.061	22.672	63.150	33.918	4.073	4.986	5.984	0.92
232	1.596	0.710	2.425	1.063	4.073	1.743	30.325	17.072	40.116	22.673	63.150	33.944	4.074	4.987	5.990	0.93
233	1.598	0.710	2.427	1.063	4.075	1.749	30.368	17.094	40.249	22.673	63.150	33.985	4.074	4.988	5.997	0.93
234	1.604	0.711	2.429	1.064	4.077	1.753	30.411	17.184	40.253	22.673	63.153	34.014	4.075	4.989	6.004	0.93
235	1.610	0.712	2.430	1.064	4.079	1.757	30.416	17.187	40.290	22.674	63.159	34.032	4.075	4.990	6.012	0.93
236	1.612	0.712	2.431	1.066	4.081	1.762	30.428	17.188	40.385	22.675	63.173	34.051	4.076	4.991	6.024	0.94
237	1.613	0.712	2.432	1.069	4.083	1.767	30.430	17.189	40.488	22.675	63.193	34.067	4.076	4.992	6.037	0.94
238	1.614	0.713	2.433	1.072	4.084	1.772	30.452	17.241	40.720	22.675	63.214	34.079	4.076	4.993	6.049	0.94
239	1.615	0.716	2.434	1.075	4.085	1.776	30.488	17.370	40.763	22.677	63.233	34.085	4.076	4.994	6.060	0.94

Appendix B

Alternative Fast-Pass IM240 Standards

Appendix B

Alternative Fast-Pass IM240 Standards

Corresponding to Composite Start-up Emission Standards in §85.2205(a)(2)(i) and §85.2205(a)(2)(ii)

Light Duty Vehicles

	Low Altitude 1981-1982			Low Altitude 1983-1990			Low Altitude 1991-1995			High Altitude 1982		
Sec	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
30	0.330	4.189	0.250	0.330	1.941	0.251	0.174	1.307	0.222	0.330	7.391	0.250
31	0.342	4.278	0.267	0.342	1.983	0.268	0.179	1.329	0.246	0.342	7.667	0.267
32	0.353	4.366	0.283	0.353	2.025	0.285	0.184	1.350	0.270	0.353	7.944	0.283
33	0.364	4.455	0.300	0.365	2.067	0.302	0.189	1.372	0.294	0.364	8.220	0.300
34	0.375	4.544	0.316	0.376	2.108	0.320	0.194	1.394	0.318	0.375	8.497	0.316
35	0.386	4.633	0.333	0.388	2.150	0.337	0.199	1.416	0.342	0.386	8.773	0.333
36	0.398	4.728	0.336	0.399	2.230	0.339	0.201	1.453	0.345	0.398	9.011	0.336
37	0.409	4.823	0.339	0.410	2.310	0.342	0.203	1.490	0.348	0.409	9.249	0.339
38	0.420	4.917	0.342	0.420	2.390	0.344	0.205	1.527	0.350	0.420	9.488	0.342
39	0.431	5.012	0.345	0.431	2.471	0.347	0.207	1.565	0.353	0.431	9.726	0.345
40	0.443	5.107	0.348	0.442	2.551	0.349	0.209	1.602	0.356	0.443	9.964	0.348
41	0.458	5.429	0.371	0.458	2.738	0.373	0.214	1.642	0.373	0.458	10.527	0.371
42	0.474	5.751	0.394	0.473	2.926	0.397	0.219	1.682	0.390	0.474	11.090	0.394
43	0.489	6.073	0.418	0.489	3.114	0.422	0.224	1.722	0.407	0.489	11.652	0.418
44	0.505	6.395	0.441	0.505	3.302	0.446	0.228	1.763	0.425	0.505	12.215	0.441
45	0.521	6.717	0.465	0.520	3.489	0.470	0.233	1.803	0.442	0.521	12.778	0.465
46	0.535	6.985	0.480	0.536	3.589	0.486	0.238	1.867	0.465	0.535	13.265	0.480
47	0.550	7.254	0.496	0.552	3.688	0.501	0.244	1.932	0.487	0.550	13.751	0.496
48	0.565	7.522	0.512	0.568	3.787	0.517	0.250	1.997	0.510	0.565	14.238	0.512
49	0.580	7.791	0.527	0.584	3.887	0.533	0.255	2.061	0.533	0.580	14.724	0.527
50	0.594	8.060	0.543	0.600	3.986	0.549	0.261	2.126	0.555	0.594	15.211	0.543
51	0.611	8.511	0.567	0.617	4.029	0.571	0.268	2.152	0.573	0.611	15.550	0.567
52	0.628	8.962	0.590	0.633	4.072	0.594	0.275	2.179	0.590	0.628	15.889	0.590
53	0.644	9.413	0.613	0.649	4.115	0.616	0.282	2.205	0.608	0.644	16.228	0.613
54	0.661	9.865	0.637	0.665	4.157	0.638	0.290	2.232	0.625	0.661	16.567	0.637
55	0.678	10.316	0.660	0.681	4.200	0.661	0.297	2.258	0.643	0.678	16.907	0.660
56	0.691	10.818	0.675	0.696	4.263	0.676	0.302	2.348	0.654	0.691	17.199	0.675
57	0.705	11.320	0.689	0.710	4.326	0.691	0.306	2.437	0.666	0.705	17.492	0.689
58	0.718	11.822	0.703	0.725	4.388	0.707	0.311	2.526	0.677	0.718	17.785	0.703
59	0.731	12.325	0.718	0.740	4.451	0.722	0.316	2.616	0.688	0.731	18.078	0.718
60	0.745	12.827	0.732	0.754	4.514	0.737	0.320	2.705	0.700	0.745	18.371	0.732
61	0.758	13.228	0.743	0.767	4.589	0.748	0.323	2.726	0.707	0.758	18.609	0.743
62	0.772	13.629	0.754	0.780	4.664	0.758	0.326	2.746	0.714	0.772	18.847	0.754
63	0.786	14.029	0.764	0.794	4.740	0.769	0.329	2.767	0.722	0.786	19.085	0.764
64	0.799	14.430	0.775	0.807	4.815	0.780	0.332	2.787	0.729	0.799	19.323	0.775
65	0.813	14.831	0.786	0.820	4.891	0.790	0.335	2.808	0.736	0.813	19.562	0.786
66	0.827	15.046	0.794	0.833	4.945	0.799	0.340	2.812	0.742	0.827	19.887	0.794
67	0.841	15.261	0.803	0.846	4.999	0.808	0.345	2.816	0.747	0.841	20.213	0.803
68	0.855	15.476	0.811	0.859	5.053	0.817	0.350	2.820	0.753	0.855	20.539	0.811
69	0.869	15.692	0.820	0.872	5.107	0.826	0.355	2.825	0.758	0.869	20.865	0.820
70	0.883	15.907	0.828	0.885	5.162	0.835	0.360	2.829	0.764	0.883	21.191	0.828
71	0.894	16.118	0.838	0.896	5.226	0.846	0.364	2.847	0.783	0.894	21.396	0.838
72	0.905	16.330	0.848	0.906	5.291	0.857	0.367	2.865	0.802	0.905	21.602	0.848
73	0.917	16.542	0.858	0.917	5.356	0.868	0.371	2.884	0.822	0.917	21.808	0.858
74	0.928	16.753	0.868	0.928	5.421	0.878	0.375	2.902	0.841	0.928	22.013	0.868
75	0.939	16.965	0.878	0.939	5.486	0.889	0.378	2.921	0.860	0.939	22.219	0.878
76	0.953	17.199	0.891	0.952	5.553	0.900	0.387	2.982	0.874	0.953	22.685	0.891
77	0.967	17.432	0.904	0.965	5.620	0.911	0.396	3.044	0.888	0.967	23.151	0.904
78	0.981	17.666	0.917	0.978	5.687	0.922	0.405	3.106	0.902	0.981	23.617	0.917
79	0.994	17.900	0.930	0.991	5.754	0.933	0.414	3.167	0.916	0.994	24.083	0.930
80	1.008	18.133	0.944	1.004	5.821	0.944	0.423	3.229	0.930	1.008	24.549	0.944

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81	1.019	18.182	0.951	1.015	5.842	0.951	0.428	3.240	0.945	1.019	24.570	0.951
82	1.031	18.231	0.958	1.026	5.863	0.959	0.432	3.250	0.959	1.031	24.591	0.958
83	1.042	18.280	0.965	1.037	5.883	0.966	0.437	3.261	0.973	1.042	24.612	0.965
84	1.053	18.329	0.972	1.048	5.904	0.973	0.441	3.271	0.987	1.053	24.633	0.972
85	1.065	18.378	0.979	1.059	5.925	0.980	0.445	3.281	1.002	1.065	24.654	0.979
86	1.072	18.393	0.980	1.067	5.970	0.981	0.448	3.290	1.003	1.072	24.666	0.980
87	1.079	18.408	0.981	1.075	6.015	0.982	0.452	3.298	1.004	1.079	24.678	0.981
88	1.086	18.423	0.982	1.083	6.060	0.982	0.455	3.306	1.005	1.086	24.690	0.982
89	1.093	18.438	0.983	1.091	6.105	0.983	0.458	3.315	1.006	1.093	24.703	0.983
90	1.099	18.453	0.983	1.099	6.151	0.984	0.462	3.323	1.007	1.099	24.715	0.983
91	1.107	18.467	0.984	1.106	6.185	0.985	0.463	3.360	1.008	1.107	24.737	0.984
92	1.114	18.481	0.985	1.114	6.219	0.986	0.464	3.397	1.008	1.114	24.758	0.985
93	1.121	18.495	0.985	1.122	6.253	0.986	0.465	3.434	1.009	1.121	24.780	0.985
94	1.128	18.509	0.986	1.129	6.287	0.987	0.466	3.470	1.009	1.128	24.801	0.986
95	1.135	18.523	0.986	1.137	6.321	0.988	0.468	3.507	1.010	1.135	24.823	0.986
96	1.149	18.681	0.992	1.150	6.489	0.993	0.472	3.536	1.011	1.149	25.193	0.992
97	1.162	18.840	0.997	1.163	6.657	0.999	0.477	3.565	1.012	1.162	25.563	0.997
98	1.176	18.998	1.002	1.176	6.825	1.004	0.481	3.594	1.013	1.176	25.933	1.002
99	1.189	19.157	1.008	1.189	6.992	1.009	0.486	3.623	1.014	1.189	26.303	1.008
100	1.203	19.315	1.013	1.202	7.160	1.014	0.490	3.651	1.015	1.203	26.672	1.013
101	1.223	20.090	1.049	1.224	7.269	1.049	0.499	3.685	1.042	1.223	27.821	1.049
102	1.244	20.864	1.085	1.245	7.378	1.084	0.509	3.719	1.069	1.244	28.969	1.085
103	1.264	21.639	1.121	1.266	7.487	1.119	0.518	3.753	1.097	1.264	30.117	1.121
104	1.285	22.414	1.157	1.287	7.596	1.154	0.527	3.787	1.124	1.285	31.265	1.157
105	1.305	23.189	1.193	1.309	7.705	1.189	0.537	3.821	1.151	1.305	32.414	1.193
106	1.319	23.461	1.224	1.323	7.835	1.215	0.541	3.842	1.194	1.319	33.103	1.224
107	1.333	23.733	1.255	1.338	7.965	1.241	0.545	3.863	1.237	1.333	33.792	1.255
108	1.346	24.006	1.286	1.352	8.095	1.267	0.548	3.884	1.280	1.346	34.481	1.286
109	1.360	24.278	1.317	1.367	8.225	1.293	0.552	3.904	1.323	1.360	35.170	1.317
110	1.374	24.550	1.348	1.382	8.355	1.319	0.556	3.925	1.366	1.374	35.859	1.348
111	1.385	24.846	1.356	1.394	8.414	1.327	0.562	3.931	1.368	1.385	36.177	1.356
112	1.396	25.141	1.363	1.406	8.472	1.336	0.568	3.937	1.371	1.396	36.495	1.363
113	1.407	25.437	1.371	1.418	8.531	1.345	0.574	3.943	1.374	1.407	36.813	1.371
114	1.417	25.732	1.378	1.430	8.590	1.354	0.580	3.949	1.377	1.417	37.132	1.378
115	1.428	26.028	1.386	1.442	8.649	1.363	0.586	3.956	1.380	1.428	37.450	1.386
116	1.437	26.045	1.388	1.451	8.735	1.364	0.590	3.975	1.380	1.437	37.554	1.388
117	1.446	26.062	1.389	1.460	8.821	1.365	0.593	3.995	1.381	1.446	37.658	1.389
118	1.455	26.079	1.391	1.469	8.907	1.366	0.597	4.015	1.382	1.455	37.761	1.391
119	1.464	26.096	1.393	1.479	8.992	1.368	0.600	4.035	1.383	1.464	37.865	1.393
120	1.472	26.114	1.394	1.488	9.078	1.369	0.604	4.055	1.383	1.472	37.969	1.394
121	1.488	26.293	1.408	1.501	9.152	1.385	0.610	4.152	1.400	1.488	38.310	1.408
122	1.503	26.472	1.422	1.514	9.227	1.401	0.615	4.250	1.417	1.503	38.650	1.422
123	1.518	26.651	1.435	1.527	9.301	1.417	0.621	4.348	1.433	1.518	38.990	1.435
124	1.534	26.830	1.449	1.540	9.375	1.434	0.627	4.445	1.450	1.534	39.330	1.449
125	1.549	27.010	1.463	1.553	9.449	1.450	0.632	4.543	1.466	1.549	39.671	1.463
126	1.559	27.151	1.471	1.563	9.519	1.458	0.636	4.567	1.470	1.559	39.865	1.471
127	1.569	27.292	1.479	1.572	9.590	1.467	0.639	4.592	1.473	1.569	40.059	1.479
128	1.579	27.433	1.487	1.582	9.661	1.475	0.642	4.617	1.476	1.579	40.254	1.487
129	1.590	27.575	1.495	1.592	9.731	1.484	0.645	4.641	1.479	1.590	40.448	1.495
130	1.600	27.716	1.502	1.601	9.802	1.492	0.648	4.666	1.482	1.600	40.642	1.502
131	1.612	27.878	1.506	1.615	9.849	1.496	0.653	4.685	1.483	1.612	40.790	1.506
132	1.624	28.040	1.509	1.628	9.895	1.500	0.657	4.704	1.485	1.624	40.937	1.509
133	1.635	28.202	1.512	1.642	9.942	1.504	0.661	4.724	1.486	1.635	41.084	1.512
134	1.647	28.365	1.515	1.655	9.989	1.508	0.666	4.743	1.488	1.647	41.231	1.515
135	1.659	28.527	1.519	1.669	10.035	1.512	0.670	4.762	1.489	1.659	41.379	1.519
136	1.676	28.833	1.542	1.685	10.104	1.534	0.678	4.785	1.507	1.676	42.023	1.542
137	1.693	29.140	1.566	1.700	10.173	1.557	0.685	4.807	1.524	1.693	42.668	1.566
138	1.709	29.446	1.589	1.716	10.241	1.580	0.693	4.830	1.541	1.709	43.312	1.589
139	1.726	29.753	1.613	1.732	10.310	1.603	0.700	4.853	1.559	1.726	43.957	1.613
140	1.743	30.060	1.636	1.747	10.378	1.626	0.708	4.875	1.576	1.743	44.602	1.636
141	1.756	30.160	1.651	1.762	10.506	1.640	0.716	4.886	1.592	1.756	45.010	1.651

Appendix B

142	1.770	30.260	1.666	1.777	10.633	1.655	0.723	4.897	1.608	1.770	45.419	1.666
143	1.783	30.361	1.681	1.791	10.761	1.669	0.731	4.908	1.624	1.783	45.828	1.681
144	1.797	30.461	1.696	1.806	10.888	1.684	0.738	4.918	1.640	1.797	46.237	1.696
145	1.810	30.562	1.711	1.821	11.016	1.699	0.746	4.929	1.656	1.810	46.646	1.711
146	1.822	30.592	1.720	1.830	11.101	1.709	0.751	4.954	1.663	1.822	46.945	1.720
147	1.834	30.622	1.730	1.840	11.187	1.720	0.755	4.979	1.671	1.834	47.244	1.730
148	1.846	30.653	1.740	1.850	11.273	1.730	0.760	5.004	1.679	1.846	47.544	1.740
149	1.858	30.683	1.750	1.860	11.359	1.741	0.765	5.029	1.687	1.858	47.843	1.750
150	1.869	30.713	1.760	1.869	11.445	1.752	0.770	5.054	1.694	1.869	48.143	1.760
151	1.880	30.741	1.767	1.879	11.504	1.759	0.775	5.060	1.711	1.880	48.423	1.767
152	1.890	30.768	1.775	1.890	11.564	1.767	0.780	5.065	1.727	1.890	48.704	1.775
153	1.900	30.796	1.783	1.900	11.624	1.775	0.785	5.070	1.743	1.900	48.984	1.783
154	1.910	30.823	1.791	1.910	11.683	1.783	0.791	5.075	1.760	1.910	49.265	1.791
155	1.920	30.850	1.798	1.920	11.743	1.790	0.796	5.080	1.776	1.920	49.545	1.798
156	1.949	32.415	1.828	1.945	12.434	1.821	0.819	5.150	1.813	1.949	50.517	1.828
157	1.977	33.980	1.858	1.971	13.125	1.852	0.842	5.220	1.850	1.977	51.489	1.858
158	2.006	35.545	1.888	1.996	13.816	1.883	0.865	5.290	1.887	2.006	52.461	1.888
159	2.034	37.110	1.918	2.022	14.507	1.913	0.888	5.360	1.924	2.034	53.433	1.918
160	2.063	38.674	1.948	2.047	15.198	1.944	0.911	5.430	1.961	2.063	54.406	1.948
161	2.105	41.040	2.043	2.092	16.627	2.038	0.951	7.045	2.030	2.105	56.279	2.043
162	2.147	43.405	2.138	2.137	18.056	2.133	0.992	8.661	2.099	2.147	58.152	2.138
163	2.190	45.770	2.234	2.182	19.485	2.227	1.032	10.276	2.168	2.190	60.026	2.234
164	2.232	48.136	2.329	2.227	20.914	2.321	1.073	11.891	2.237	2.232	61.899	2.329
165	2.275	50.501	2.424	2.272	22.343	2.415	1.113	13.506	2.306	2.275	63.773	2.424
166	2.304	52.979	2.509	2.300	23.672	2.502	1.163	14.131	2.357	2.304	65.726	2.509
167	2.333	55.458	2.593	2.328	25.002	2.589	1.213	14.755	2.409	2.333	67.678	2.593
168	2.362	57.937	2.678	2.356	26.331	2.676	1.263	15.380	2.460	2.362	69.631	2.678
169	2.391	60.415	2.762	2.385	27.660	2.763	1.313	16.004	2.512	2.391	71.584	2.762
170	2.420	62.894	2.847	2.413	28.989	2.849	1.363	16.628	2.564	2.420	73.536	2.847
171	2.451	63.874	2.890	2.442	29.484	2.892	1.386	16.692	2.603	2.451	75.553	2.890
172	2.481	64.855	2.933	2.472	29.978	2.934	1.410	16.756	2.643	2.481	77.570	2.933
173	2.512	65.835	2.976	2.502	30.473	2.976	1.433	16.820	2.683	2.512	79.587	2.976
174	2.542	66.815	3.019	2.532	30.967	3.019	1.457	16.883	2.723	2.542	81.604	3.019
175	2.573	67.796	3.062	2.562	31.462	3.061	1.480	16.947	2.762	2.573	83.621	3.062
176	2.598	68.919	3.122	2.588	32.216	3.119	1.494	17.044	2.809	2.598	85.074	3.122
177	2.623	70.042	3.181	2.615	32.970	3.178	1.508	17.141	2.856	2.623	86.528	3.181
178	2.648	71.165	3.240	2.641	33.725	3.236	1.522	17.238	2.903	2.648	87.981	3.240
179	2.674	72.287	3.300	2.668	34.479	3.295	1.536	17.335	2.949	2.674	89.434	3.300
180	2.699	73.410	3.359	2.694	35.233	3.353	1.550	17.431	2.996	2.699	90.888	3.359
181	2.726	74.714	3.432	2.718	35.950	3.424	1.565	17.453	3.040	2.726	92.421	3.432
182	2.753	76.017	3.504	2.743	36.666	3.495	1.580	17.475	3.084	2.753	93.953	3.504
183	2.780	77.320	3.576	2.767	37.382	3.567	1.595	17.497	3.129	2.780	95.486	3.576
184	2.807	78.623	3.648	2.791	38.099	3.638	1.610	17.519	3.173	2.807	97.019	3.648
185	2.834	79.927	3.720	2.816	38.815	3.709	1.624	17.540	3.217	2.834	98.552	3.720
186	2.861	81.488	3.804	2.843	39.562	3.795	1.639	17.816	3.277	2.861	100.583	3.804
187	2.888	83.049	3.889	2.869	40.309	3.880	1.654	18.091	3.337	2.888	102.615	3.889
188	2.915	84.611	3.973	2.896	41.056	3.965	1.668	18.366	3.397	2.915	104.646	3.973
189	2.942	86.172	4.057	2.923	41.803	4.051	1.683	18.641	3.457	2.942	106.677	4.057
190	2.969	87.733	4.141	2.950	42.550	4.136	1.697	18.916	3.518	2.969	108.709	4.141
191	2.994	88.668	4.196	2.975	43.279	4.190	1.711	19.891	3.565	2.994	110.057	4.196
192	3.019	89.603	4.250	3.001	44.008	4.243	1.724	20.866	3.612	3.019	111.405	4.250
193	3.044	90.538	4.304	3.027	44.737	4.297	1.737	21.840	3.658	3.044	112.753	4.304
194	3.070	91.473	4.358	3.052	45.466	4.351	1.750	22.815	3.705	3.070	114.101	4.358
195	3.095	92.407	4.412	3.078	46.195	4.404	1.763	23.790	3.752	3.095	115.449	4.412
196	3.120	93.768	4.485	3.105	46.747	4.477	1.778	24.992	3.794	3.120	116.561	4.485
197	3.145	95.129	4.558	3.132	47.299	4.549	1.793	26.194	3.836	3.145	117.674	4.558
198	3.169	96.490	4.630	3.159	47.852	4.622	1.808	27.396	3.877	3.169	118.786	4.630
199	3.194	97.851	4.703	3.186	48.404	4.694	1.823	28.597	3.919	3.194	119.899	4.703
200	3.219	99.212	4.775	3.213	48.957	4.767	1.838	29.799	3.960	3.219	121.011	4.775
201	3.242	99.878	4.821	3.234	49.204	4.812	1.858	29.975	4.004	3.242	121.695	4.821
202	3.266	100.544	4.867	3.255	49.451	4.858	1.877	30.152	4.047	3.266	122.378	4.867

203	3.289	101.210	4.914	3.277	49.698	4.904	1.897	30.328	4.090	3.289	123.062	4.914
204	3.312	101.876	4.960	3.298	49.945	4.950	1.916	30.504	4.133	3.312	123.745	4.960
205	3.335	102.542	5.006	3.320	50.192	4.996	1.936	30.680	4.176	3.335	124.429	5.006
206	3.362	103.507	5.037	3.346	50.698	5.029	1.948	30.747	4.193	3.362	125.599	5.037
207	3.388	104.472	5.069	3.373	51.205	5.063	1.961	30.813	4.209	3.388	126.769	5.069
208	3.415	105.437	5.101	3.399	51.711	5.097	1.973	30.879	4.225	3.415	127.939	5.101
209	3.441	106.402	5.132	3.426	52.218	5.130	1.986	30.946	4.241	3.441	129.109	5.132
210	3.468	107.366	5.164	3.452	52.724	5.164	1.998	31.012	4.257	3.468	130.279	5.164
211	3.488	108.519	5.234	3.472	53.327	5.233	2.006	32.744	4.311	3.488	132.009	5.234
212	3.509	109.671	5.304	3.492	53.931	5.303	2.015	34.476	4.365	3.509	133.740	5.304
213	3.530	110.823	5.374	3.513	54.534	5.372	2.023	36.207	4.419	3.530	135.470	5.374
214	3.550	111.976	5.444	3.533	55.137	5.442	2.031	37.939	4.473	3.550	137.201	5.444
215	3.571	113.128	5.514	3.553	55.740	5.511	2.039	39.671	4.527	3.571	138.931	5.514
216	3.591	113.763	5.564	3.571	56.057	5.559	2.044	39.822	4.565	3.591	140.070	5.564
217	3.612	114.398	5.613	3.589	56.373	5.606	2.048	39.973	4.602	3.612	141.208	5.613
218	3.632	115.033	5.663	3.608	56.689	5.654	2.053	40.125	4.640	3.632	142.347	5.663
219	3.652	115.668	5.713	3.626	57.005	5.701	2.058	40.276	4.677	3.652	143.485	5.713
220	3.672	116.304	5.763	3.644	57.321	5.749	2.062	40.427	4.715	3.672	144.624	5.763
221	3.693	116.644	5.775	3.669	57.474	5.761	2.076	40.526	4.724	3.693	144.903	5.775
222	3.714	116.984	5.787	3.693	57.626	5.773	2.089	40.626	4.732	3.714	145.182	5.787
223	3.736	117.324	5.799	3.717	57.779	5.785	2.103	40.725	4.741	3.736	145.462	5.799
224	3.757	117.663	5.811	3.741	57.931	5.797	2.117	40.825	4.750	3.757	145.741	5.811
225	3.778	118.003	5.823	3.766	58.084	5.809	2.130	40.924	4.759	3.778	146.020	5.823
226	3.795	118.158	5.828	3.782	58.158	5.814	2.160	40.962	4.764	3.795	146.177	5.828
227	3.811	118.312	5.833	3.798	58.232	5.820	2.190	41.000	4.770	3.811	146.334	5.833
228	3.828	118.466	5.838	3.815	58.307	5.825	2.219	41.038	4.775	3.828	146.491	5.838
229	3.845	118.621	5.842	3.831	58.381	5.830	2.249	41.076	4.781	3.845	146.648	5.842
230	3.862	118.775	5.847	3.848	58.455	5.835	2.278	41.114	4.786	3.862	146.805	5.847
231	3.873	118.885	5.852	3.858	58.534	5.840	2.285	41.142	4.790	3.873	147.057	5.852
232	3.884	118.995	5.856	3.868	58.612	5.845	2.292	41.171	4.794	3.884	147.308	5.856
233	3.896	119.105	5.860	3.879	58.690	5.850	2.299	41.199	4.797	3.896	147.560	5.860
234	3.907	119.215	5.865	3.889	58.769	5.855	2.306	41.228	4.801	3.907	147.812	5.865
235	3.918	119.325	5.869	3.900	58.847	5.860	2.313	41.256	4.805	3.918	148.064	5.869
236	3.924	119.407	5.874	3.907	58.990	5.865	2.315	41.285	4.808	3.924	148.450	5.874
237	3.930	119.488	5.878	3.913	59.132	5.869	2.318	41.313	4.812	3.930	148.837	5.878
238	3.935	119.570	5.883	3.920	59.275	5.874	2.320	41.341	4.815	3.935	149.223	5.883
239	3.941	119.651	5.887	3.927	59.418	5.878	2.322	41.369	4.818	3.941	149.609	5.887
240	3.947	119.733	5.892	3.934	59.560	5.883	2.325	41.397	4.822	3.947	149.996	5.892

Alternative Fast-Pass IM240 Standards
Corresponding to Composite Start-up Emission Standards
in §85.2205(a)(2)(iv)

High Altitude, Light Duty Truck 1

	1982-1983			1984-1987			1988-1990			1991		
Sec	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
30	1.064	14.776	0.562	0.585	10.661	0.513	0.585	10.661	0.298	0.477	5.069	0.254
31	1.091	15.338	0.610	0.609	11.033	0.551	0.609	11.033	0.319	0.494	5.129	0.270
32	1.118	15.900	0.657	0.633	11.405	0.590	0.633	11.405	0.340	0.512	5.189	0.285
33	1.145	16.462	0.705	0.657	11.777	0.629	0.657	11.777	0.361	0.529	5.249	0.300
34	1.172	17.023	0.752	0.681	12.149	0.667	0.681	12.149	0.382	0.547	5.309	0.316
35	1.199	17.585	0.800	0.705	12.521	0.706	0.705	12.521	0.403	0.564	5.369	0.331
36	1.237	17.834	0.804	0.730	12.895	0.711	0.730	12.895	0.407	0.582	5.562	0.334
37	1.275	18.084	0.808	0.754	13.269	0.716	0.754	13.269	0.410	0.601	5.755	0.336
38	1.313	18.333	0.813	0.779	13.643	0.721	0.779	13.643	0.414	0.619	5.948	0.339
39	1.351	18.582	0.817	0.803	14.018	0.727	0.803	14.018	0.418	0.637	6.142	0.341
40	1.389	18.832	0.822	0.828	14.392	0.732	0.828	14.392	0.422	0.656	6.335	0.344
41	1.459	19.867	0.869	0.854	15.098	0.796	0.854	15.098	0.451	0.681	6.890	0.368
42	1.529	20.902	0.915	0.880	15.805	0.861	0.880	15.805	0.479	0.707	7.445	0.392
43	1.599	21.937	0.962	0.907	16.511	0.925	0.907	16.511	0.508	0.732	7.999	0.416
44	1.669	22.972	1.009	0.933	17.217	0.989	0.933	17.217	0.536	0.758	8.554	0.440
45	1.738	24.008	1.056	0.959	17.924	1.053	0.959	17.924	0.565	0.783	9.109	0.464
46	1.784	24.572	1.098	0.989	18.458	1.096	0.989	18.458	0.587	0.799	9.593	0.480
47	1.830	25.136	1.140	1.019	18.992	1.138	1.019	18.992	0.609	0.816	10.076	0.496
48	1.876	25.701	1.182	1.050	19.526	1.180	1.050	19.526	0.631	0.832	10.560	0.512
49	1.922	26.265	1.224	1.080	20.060	1.223	1.080	20.060	0.652	0.848	11.044	0.528
50	1.968	26.830	1.266	1.110	20.594	1.265	1.110	20.594	0.674	0.864	11.527	0.543
51	2.020	27.642	1.305	1.146	21.719	1.294	1.146	21.719	0.701	0.891	12.038	0.563
52	2.072	28.454	1.343	1.182	22.845	1.324	1.182	22.845	0.728	0.917	12.549	0.582
53	2.124	29.266	1.381	1.218	23.970	1.353	1.218	23.970	0.755	0.943	13.059	0.601
54	2.176	30.079	1.420	1.254	25.095	1.382	1.254	25.095	0.782	0.969	13.570	0.621
55	2.228	30.891	1.458	1.290	26.221	1.411	1.290	26.221	0.809	0.995	14.081	0.640
56	2.265	31.485	1.490	1.310	26.449	1.449	1.310	26.449	0.826	1.015	14.438	0.653
57	2.302	32.078	1.522	1.330	26.677	1.486	1.330	26.677	0.842	1.035	14.796	0.666
58	2.340	32.672	1.555	1.350	26.905	1.523	1.350	26.905	0.859	1.055	15.154	0.679
59	2.377	33.266	1.587	1.370	27.133	1.560	1.370	27.133	0.876	1.075	15.512	0.692
60	2.415	33.860	1.619	1.390	27.361	1.597	1.390	27.361	0.892	1.095	15.870	0.705
61	2.451	34.449	1.637	1.405	27.372	1.611	1.405	27.372	0.903	1.109	16.268	0.714
62	2.487	35.037	1.656	1.420	27.383	1.625	1.420	27.383	0.915	1.124	16.667	0.723
63	2.523	35.626	1.674	1.434	27.393	1.639	1.434	27.393	0.926	1.138	17.066	0.732
64	2.559	36.215	1.693	1.449	27.404	1.653	1.449	27.404	0.938	1.153	17.465	0.741
65	2.595	36.804	1.711	1.464	27.415	1.667	1.464	27.415	0.949	1.167	17.863	0.750
66	2.639	37.463	1.737	1.497	28.054	1.699	1.497	28.054	0.960	1.182	18.249	0.759
67	2.683	38.122	1.763	1.530	28.694	1.732	1.530	28.694	0.972	1.196	18.635	0.768
68	2.728	38.782	1.789	1.563	29.333	1.765	1.563	29.333	0.983	1.211	19.020	0.777
69	2.772	39.441	1.815	1.596	29.972	1.797	1.596	29.972	0.994	1.225	19.406	0.786
70	2.817	40.100	1.841	1.629	30.612	1.830	1.629	30.612	1.005	1.239	19.792	0.795
71	2.859	40.631	1.862	1.650	31.097	1.854	1.650	31.097	1.016	1.255	19.906	0.805
72	2.901	41.161	1.884	1.672	31.583	1.878	1.672	31.583	1.028	1.271	20.020	0.815
73	2.943	41.692	1.906	1.694	32.068	1.902	1.694	32.068	1.039	1.287	20.134	0.825
74	2.985	42.222	1.928	1.715	32.554	1.925	1.715	32.554	1.051	1.303	20.248	0.835
75	3.027	42.753	1.950	1.737	33.039	1.949	1.737	33.039	1.062	1.318	20.362	0.845
76	3.061	43.694	1.978	1.760	33.193	1.977	1.760	33.193	1.074	1.331	20.782	0.859
77	3.096	44.636	2.007	1.782	33.347	2.005	1.782	33.347	1.085	1.344	21.202	0.874
78	3.130	45.577	2.035	1.805	33.501	2.033	1.805	33.501	1.096	1.357	21.623	0.888
79	3.165	46.519	2.063	1.828	33.655	2.061	1.828	33.655	1.108	1.370	22.043	0.902
80	3.200	47.461	2.092	1.851	33.809	2.089	1.851	33.809	1.119	1.382	22.463	0.916
81	3.237	47.831	2.111	1.872	34.035	2.111	1.872	34.035	1.131	1.407	22.571	0.925
82	3.275	48.201	2.130	1.894	34.261	2.132	1.894	34.261	1.144	1.431	22.678	0.934
83	3.313	48.571	2.149	1.915	34.488	2.154	1.915	34.488	1.156	1.455	22.786	0.942

84	3.351	48.941	2.168	1.937	34.714	2.175	1.937	34.714	1.169	1.480	22.894	0.951
85	3.389	49.311	2.187	1.958	34.941	2.197	1.958	34.941	1.181	1.504	23.001	0.960
86	3.432	49.503	2.189	1.973	35.115	2.200	1.973	35.115	1.182	1.531	23.112	0.961
87	3.475	49.694	2.192	1.988	35.289	2.203	1.988	35.289	1.182	1.558	23.223	0.963
88	3.518	49.886	2.194	2.002	35.463	2.206	2.002	35.463	1.183	1.586	23.334	0.964
89	3.562	50.077	2.197	2.017	35.637	2.209	2.017	35.637	1.184	1.613	23.445	0.966
90	3.605	50.269	2.199	2.032	35.811	2.212	2.032	35.811	1.185	1.640	23.556	0.967
91	3.645	50.447	2.200	2.044	35.968	2.213	2.044	35.968	1.186	1.654	23.558	0.968
92	3.686	50.626	2.201	2.056	36.125	2.214	2.056	36.125	1.187	1.668	23.560	0.968
93	3.727	50.805	2.202	2.068	36.282	2.215	2.068	36.282	1.188	1.682	23.562	0.968
94	3.767	50.984	2.203	2.081	36.440	2.216	2.081	36.440	1.189	1.696	23.564	0.969
95	3.808	51.162	2.204	2.093	36.597	2.217	2.093	36.597	1.190	1.710	23.567	0.969
96	3.853	51.779	2.212	2.111	36.968	2.227	2.111	36.968	1.195	1.727	23.924	0.978
97	3.898	52.395	2.219	2.129	37.339	2.236	2.129	37.339	1.201	1.744	24.282	0.987
98	3.943	53.012	2.227	2.147	37.710	2.245	2.147	37.710	1.207	1.762	24.639	0.996
99	3.988	53.628	2.234	2.165	38.081	2.254	2.165	38.081	1.213	1.779	24.997	1.004
100	4.033	54.245	2.242	2.183	38.453	2.263	2.183	38.453	1.218	1.796	25.355	1.013
101	4.081	55.131	2.322	2.221	40.429	2.342	2.221	40.429	1.259	1.819	25.871	1.045
102	4.128	56.016	2.403	2.258	42.405	2.420	2.258	42.405	1.299	1.842	26.387	1.076
103	4.175	56.902	2.484	2.295	44.382	2.498	2.295	44.382	1.340	1.865	26.903	1.107
104	4.223	57.788	2.565	2.333	46.358	2.576	2.333	46.358	1.380	1.887	27.419	1.139
105	4.270	58.674	2.646	2.370	48.335	2.654	2.370	48.335	1.421	1.910	27.935	1.170
106	4.300	59.222	2.721	2.404	49.060	2.740	2.404	49.060	1.458	1.936	28.221	1.201
107	4.331	59.771	2.797	2.437	49.785	2.826	2.437	49.785	1.495	1.962	28.506	1.232
108	4.361	60.319	2.872	2.471	50.511	2.912	2.471	50.511	1.531	1.988	28.792	1.263
109	4.391	60.868	2.948	2.504	51.236	2.998	2.504	51.236	1.568	2.014	29.077	1.294
110	4.421	61.416	3.023	2.538	51.962	3.084	2.538	51.962	1.605	2.040	29.363	1.325
111	4.449	61.935	3.038	2.560	52.113	3.101	2.560	52.113	1.615	2.057	29.405	1.332
112	4.476	62.455	3.053	2.582	52.265	3.118	2.582	52.265	1.624	2.074	29.447	1.338
113	4.503	62.974	3.067	2.604	52.417	3.136	2.604	52.417	1.634	2.090	29.489	1.344
114	4.531	63.493	3.082	2.625	52.569	3.153	2.625	52.569	1.644	2.107	29.531	1.350
115	4.558	64.013	3.097	2.647	52.721	3.170	2.647	52.721	1.653	2.124	29.573	1.357
116	4.600	64.559	3.099	2.673	52.723	3.173	2.673	52.723	1.656	2.152	29.865	1.359
117	4.642	65.105	3.102	2.698	52.724	3.175	2.698	52.724	1.658	2.179	30.157	1.361
118	4.684	65.651	3.105	2.723	52.726	3.178	2.723	52.726	1.661	2.207	30.449	1.363
119	4.726	66.197	3.108	2.749	52.728	3.181	2.749	52.728	1.663	2.234	30.741	1.365
120	4.768	66.743	3.111	2.774	52.729	3.184	2.774	52.729	1.666	2.262	31.033	1.368
121	4.804	67.600	3.134	2.799	53.168	3.206	2.799	53.168	1.684	2.276	31.230	1.383
122	4.840	68.458	3.156	2.824	53.606	3.229	2.824	53.606	1.703	2.290	31.428	1.399
123	4.876	69.315	3.179	2.850	54.044	3.251	2.850	54.044	1.722	2.304	31.625	1.415
124	4.911	70.173	3.202	2.875	54.483	3.274	2.875	54.483	1.741	2.318	31.823	1.431
125	4.947	71.030	3.224	2.900	54.921	3.296	2.900	54.921	1.759	2.332	32.020	1.446
126	4.983	71.729	3.241	2.920	55.078	3.310	2.920	55.078	1.770	2.355	32.099	1.453
127	5.019	72.427	3.257	2.941	55.236	3.323	2.941	55.236	1.780	2.377	32.178	1.460
128	5.055	73.126	3.274	2.961	55.393	3.337	2.961	55.393	1.790	2.399	32.256	1.468
129	5.091	73.825	3.290	2.981	55.551	3.350	2.981	55.551	1.800	2.422	32.335	1.475
130	5.126	74.523	3.307	3.001	55.708	3.364	3.001	55.708	1.811	2.444	32.413	1.482
131	5.178	75.331	3.311	3.027	55.921	3.370	3.027	55.921	1.813	2.464	32.638	1.484
132	5.230	76.139	3.316	3.052	56.134	3.376	3.052	56.134	1.816	2.485	32.862	1.487
133	5.282	76.947	3.321	3.078	56.346	3.382	3.078	56.346	1.819	2.505	33.086	1.490
134	5.334	77.755	3.326	3.103	56.559	3.388	3.103	56.559	1.822	2.525	33.310	1.492
135	5.386	78.563	3.331	3.129	56.771	3.394	3.129	56.771	1.825	2.545	33.534	1.495
136	5.468	79.372	3.365	3.167	57.854	3.432	3.167	57.854	1.851	2.573	34.147	1.520
137	5.549	80.181	3.398	3.206	58.937	3.469	3.206	58.937	1.877	2.600	34.760	1.546
138	5.630	80.990	3.431	3.244	60.020	3.507	3.244	60.020	1.903	2.628	35.373	1.571
139	5.712	81.798	3.464	3.283	61.102	3.544	3.283	61.102	1.929	2.655	35.985	1.596
140	5.793	82.607	3.498	3.322	62.185	3.582	3.322	62.185	1.955	2.682	36.598	1.622
141	5.825	83.486	3.536	3.342	62.366	3.639	3.342	62.366	1.977	2.702	36.880	1.639
142	5.856	84.365	3.575	3.363	62.548	3.697	3.363	62.548	1.999	2.722	37.162	1.656
143	5.888	85.245	3.613	3.383	62.729	3.754	3.383	62.729	2.021	2.742	37.444	1.673
144	5.920	86.124	3.652	3.404	62.910	3.811	3.404	62.910	2.043	2.762	37.727	1.691
145	5.951	87.003	3.690	3.425	63.091	3.869	3.425	63.091	2.065	2.782	38.009	1.708

Appendix B

146	5.975	87.915	3.718	3.453	63.539	3.892	3.453	63.539	2.074	2.797	38.632	1.717
147	5.998	88.827	3.745	3.482	63.987	3.916	3.482	63.987	2.082	2.811	39.255	1.726
148	6.022	89.739	3.772	3.510	64.435	3.939	3.510	64.435	2.090	2.825	39.878	1.735
149	6.046	90.652	3.800	3.539	64.883	3.963	3.539	64.883	2.098	2.839	40.501	1.743
150	6.069	91.564	3.827	3.568	65.331	3.986	3.568	65.331	2.106	2.853	41.124	1.752
151	6.099	92.475	3.852	3.595	65.704	4.000	3.595	65.704	2.117	2.868	41.450	1.765
152	6.129	93.387	3.877	3.623	66.077	4.014	3.623	66.077	2.129	2.883	41.776	1.778
153	6.159	94.298	3.901	3.650	66.450	4.029	3.650	66.450	2.141	2.898	42.102	1.791
154	6.189	95.209	3.926	3.677	66.823	4.043	3.677	66.823	2.152	2.913	42.428	1.803
155	6.219	96.121	3.951	3.705	67.197	4.057	3.705	67.197	2.164	2.927	42.754	1.816
156	6.313	97.599	4.030	3.767	69.206	4.117	3.767	69.206	2.205	2.969	44.233	1.849
157	6.407	99.077	4.110	3.829	71.215	4.176	3.829	71.215	2.247	3.011	45.712	1.882
158	6.501	100.555	4.190	3.891	73.225	4.236	3.891	73.225	2.289	3.053	47.191	1.915
159	6.595	102.033	4.269	3.953	75.234	4.295	3.953	75.234	2.330	3.095	48.670	1.948
160	6.689	103.511	4.349	4.015	77.243	4.355	4.015	77.243	2.372	3.136	50.149	1.981
161	7.010	107.552	4.542	4.078	79.985	4.551	4.078	79.985	2.472	3.182	51.569	2.071
162	7.331	111.593	4.736	4.142	82.727	4.747	4.142	82.727	2.571	3.227	52.988	2.162
163	7.652	115.634	4.930	4.205	85.469	4.943	4.205	85.469	2.671	3.272	54.408	2.252
164	7.972	119.676	5.123	4.268	88.211	5.139	4.268	88.211	2.770	3.318	55.828	2.343
165	8.293	123.717	5.317	4.332	90.953	5.335	4.332	90.953	2.870	3.363	57.247	2.434
166	8.576	125.252	5.496	4.380	93.266	5.516	4.380	93.266	2.961	3.410	58.958	2.509
167	8.859	126.786	5.676	4.428	95.579	5.696	4.428	95.579	3.053	3.458	60.670	2.584
168	9.142	128.321	5.855	4.477	97.892	5.876	4.477	97.892	3.144	3.505	62.381	2.659
169	9.425	129.855	6.034	4.525	100.205	6.056	4.525	100.205	3.235	3.552	64.092	2.735
170	9.708	131.390	6.213	4.573	102.517	6.237	4.573	102.517	3.327	3.600	65.804	2.810
171	9.788	132.095	6.318	4.618	103.813	6.345	4.618	103.813	3.373	3.644	66.939	2.863
172	9.868	132.801	6.422	4.664	105.109	6.452	4.664	105.109	3.420	3.688	68.075	2.916
173	9.948	133.506	6.527	4.709	106.404	6.560	4.709	106.404	3.467	3.732	69.210	2.969
174	10.028	134.211	6.632	4.754	107.700	6.668	4.754	107.700	3.513	3.776	70.345	3.022
175	10.107	134.917	6.736	4.799	108.995	6.776	4.799	108.995	3.560	3.821	71.481	3.075
176	10.174	137.703	6.876	4.858	110.733	6.910	4.858	110.733	3.626	3.856	73.077	3.130
177	10.242	140.490	7.016	4.917	112.471	7.045	4.917	112.471	3.692	3.891	74.674	3.185
178	10.309	143.276	7.155	4.977	114.209	7.179	4.977	114.209	3.758	3.927	76.271	3.240
179	10.376	146.063	7.295	5.036	115.946	7.313	5.036	115.946	3.824	3.962	77.867	3.295
180	10.443	148.849	7.435	5.095	117.684	7.447	5.095	117.684	3.889	3.997	79.464	3.350
181	10.506	152.900	7.603	5.158	119.775	7.621	5.158	119.775	3.979	4.024	81.282	3.430
182	10.570	156.950	7.772	5.221	121.866	7.795	5.221	121.866	4.069	4.050	83.100	3.509
183	10.634	161.001	7.941	5.284	123.956	7.969	5.284	123.956	4.159	4.077	84.919	3.589
184	10.698	165.051	8.110	5.347	126.047	8.143	5.347	126.047	4.248	4.104	86.737	3.668
185	10.761	169.102	8.279	5.411	128.138	8.318	5.411	128.138	4.338	4.131	88.555	3.748
186	10.836	171.850	8.477	5.428	129.673	8.499	5.428	129.673	4.443	4.154	90.333	3.841
187	10.911	174.598	8.675	5.446	131.209	8.681	5.446	131.209	4.547	4.178	92.110	3.934
188	10.986	177.345	8.873	5.463	132.745	8.862	5.463	132.745	4.652	4.202	93.888	4.026
189	11.061	180.093	9.071	5.481	134.281	9.043	5.481	134.281	4.756	4.225	95.665	4.119
190	11.136	182.841	9.269	5.499	135.816	9.225	5.499	135.816	4.861	4.249	97.442	4.212
191	11.307	184.591	9.422	5.561	137.198	9.386	5.561	137.198	4.932	4.285	98.856	4.274
192	11.477	186.341	9.576	5.623	138.580	9.547	5.623	138.580	5.003	4.321	100.271	4.336
193	11.648	188.091	9.730	5.686	139.961	9.708	5.686	139.961	5.074	4.357	101.685	4.398
194	11.819	189.841	9.884	5.748	141.343	9.869	5.748	141.343	5.146	4.393	103.099	4.459
195	11.990	191.591	10.038	5.810	142.724	10.030	5.810	142.724	5.217	4.430	104.513	4.521
196	12.067	194.037	10.193	5.828	144.052	10.188	5.828	144.052	5.301	4.460	106.134	4.589
197	12.144	196.482	10.348	5.845	145.381	10.346	5.845	145.381	5.385	4.490	107.755	4.658
198	12.221	198.927	10.503	5.863	146.709	10.504	5.863	146.709	5.469	4.520	109.376	4.726
199	12.298	201.373	10.658	5.880	148.037	10.662	5.880	148.037	5.553	4.550	110.997	4.795
200	12.376	203.818	10.813	5.898	149.365	10.820	5.898	149.365	5.637	4.580	112.617	4.863
201	12.463	204.868	10.912	5.942	150.214	10.948	5.942	150.214	5.692	4.623	113.207	4.906
202	12.551	205.918	11.012	5.986	151.063	11.075	5.986	151.063	5.746	4.666	113.796	4.949
203	12.639	206.967	11.111	6.029	151.912	11.203	6.029	151.912	5.801	4.709	114.385	4.993
204	12.726	208.017	11.211	6.073	152.760	11.330	6.073	152.760	5.856	4.752	114.974	5.036
205	12.814	209.067	11.310	6.117	153.609	11.458	6.117	153.609	5.911	4.795	115.563	5.079
206	12.891	211.915	11.381	6.174	154.888	11.530	6.174	154.888	5.951	4.848	116.847	5.119
207	12.969	214.764	11.452	6.231	156.166	11.601	6.231	156.166	5.990	4.901	118.131	5.160

208	13.046	217.612	11.523	6.288	157.445	11.673	6.288	157.445	6.030	4.955	119.415	5.201
209	13.124	220.460	11.594	6.345	158.724	11.745	6.345	158.724	6.070	5.008	120.699	5.241
210	13.201	223.309	11.665	6.401	160.002	11.817	6.401	160.002	6.110	5.061	121.983	5.282
211	13.243	226.365	11.862	6.451	161.606	11.984	6.451	161.606	6.194	5.090	123.498	5.355
212	13.285	229.421	12.060	6.500	163.210	12.152	6.500	163.210	6.278	5.119	125.012	5.429
213	13.327	232.478	12.257	6.550	164.814	12.319	6.550	164.814	6.362	5.147	126.526	5.502
214	13.370	235.534	12.455	6.599	166.418	12.486	6.599	166.418	6.446	5.176	128.040	5.576
215	13.412	238.591	12.653	6.649	168.022	12.653	6.649	168.022	6.530	5.204	129.554	5.649
216	13.470	240.891	12.778	6.693	168.948	12.780	6.693	168.948	6.585	5.240	130.345	5.695
217	13.528	243.191	12.904	6.737	169.874	12.906	6.737	169.874	6.640	5.275	131.136	5.741
218	13.586	245.492	13.030	6.782	170.800	13.032	6.782	170.800	6.695	5.310	131.928	5.787
219	13.645	247.792	13.156	6.826	171.726	13.159	6.826	171.726	6.750	5.345	132.719	5.833
220	13.703	250.092	13.282	6.870	172.653	13.285	6.870	172.653	6.804	5.380	133.510	5.879
221	13.896	250.710	13.307	6.946	173.200	13.314	6.946	173.200	6.818	5.436	133.899	5.888
222	14.088	251.329	13.332	7.022	173.748	13.343	7.022	173.748	6.831	5.492	134.287	5.896
223	14.281	251.947	13.358	7.098	174.295	13.371	7.098	174.295	6.844	5.548	134.676	5.905
224	14.474	252.565	13.383	7.173	174.843	13.400	7.173	174.843	6.857	5.604	135.064	5.913
225	14.667	253.184	13.409	7.249	175.391	13.429	7.249	175.391	6.870	5.660	135.453	5.922
226	14.845	253.888	13.422	7.334	175.611	13.440	7.334	175.611	6.877	5.699	135.633	5.927
227	15.023	254.593	13.436	7.419	175.831	13.452	7.419	175.831	6.884	5.738	135.814	5.931
228	15.201	255.297	13.450	7.504	176.051	13.464	7.504	176.051	6.891	5.776	135.995	5.936
229	15.379	256.002	13.464	7.589	176.271	13.475	7.589	176.271	6.897	5.815	136.176	5.941
230	15.557	256.706	13.478	7.674	176.491	13.487	7.674	176.491	6.904	5.854	136.356	5.946
231	15.658	257.286	13.488	7.710	176.612	13.498	7.710	176.612	6.910	5.875	136.581	5.951
232	15.759	257.866	13.499	7.746	176.732	13.508	7.746	176.732	6.916	5.897	136.806	5.956
233	15.861	258.445	13.510	7.782	176.853	13.519	7.782	176.853	6.922	5.918	137.031	5.962
234	15.962	259.025	13.521	7.818	176.974	13.530	7.818	176.974	6.928	5.940	137.256	5.967
235	16.063	259.605	13.531	7.853	177.095	13.540	7.853	177.095	6.934	5.961	137.482	5.972
236	16.104	259.940	13.543	7.867	177.463	13.551	7.867	177.463	6.940	5.977	137.680	5.978
237	16.144	260.276	13.554	7.881	177.830	13.561	7.881	177.830	6.946	5.994	137.879	5.983
238	16.185	260.612	13.566	7.894	178.198	13.572	7.894	178.198	6.951	6.010	138.078	5.989
239	16.225	260.947	13.577	7.908	178.566	13.582	7.908	178.566	6.957	6.026	138.277	5.994
240	16.265	261.283	13.589	7.922	178.933	13.592	7.922	178.933	6.962	6.042	138.476	6.000

Appendix B

Alternative Fast-Pass IM240 Standards
Corresponding to Composite Start-up Emission Standards
in §85.2205(a)(2)(vi)

High Altitude, Light Duty Truck 2

	1982-1983			1984-1987			1988-1990			1991		
Sec	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
30	1.064	14.776	0.513	0.585	10.661	0.513	0.585	10.661	0.436	0.477	5.069	0.395
31	1.091	15.338	0.551	0.609	11.033	0.551	0.609	11.033	0.463	0.494	5.129	0.420
32	1.118	15.900	0.590	0.633	11.405	0.590	0.633	11.405	0.490	0.512	5.189	0.445
33	1.145	16.462	0.629	0.657	11.777	0.629	0.657	11.777	0.517	0.529	5.249	0.470
34	1.172	17.023	0.667	0.681	12.149	0.667	0.681	12.149	0.544	0.547	5.309	0.495
35	1.199	17.585	0.706	0.705	12.521	0.706	0.705	12.521	0.572	0.564	5.369	0.520
36	1.237	17.834	0.711	0.730	12.895	0.711	0.730	12.895	0.576	0.582	5.562	0.524
37	1.275	18.084	0.716	0.754	13.269	0.716	0.754	13.269	0.580	0.601	5.755	0.527
38	1.313	18.333	0.721	0.779	13.643	0.721	0.779	13.643	0.584	0.619	5.948	0.531
39	1.351	18.582	0.727	0.803	14.018	0.727	0.803	14.018	0.588	0.637	6.142	0.535
40	1.389	18.832	0.732	0.828	14.392	0.732	0.828	14.392	0.592	0.656	6.335	0.539
41	1.459	19.867	0.796	0.854	15.098	0.796	0.854	15.098	0.636	0.681	6.890	0.578
42	1.529	20.902	0.861	0.880	15.805	0.861	0.880	15.805	0.681	0.707	7.445	0.617
43	1.599	21.937	0.925	0.907	16.511	0.925	0.907	16.511	0.726	0.732	7.999	0.657
44	1.669	22.972	0.989	0.933	17.217	0.989	0.933	17.217	0.771	0.758	8.554	0.696
45	1.738	24.008	1.053	0.959	17.924	1.053	0.959	17.924	0.815	0.783	9.109	0.735
46	1.784	24.572	1.096	0.989	18.458	1.096	0.989	18.458	0.840	0.799	9.593	0.760
47	1.830	25.136	1.138	1.019	18.992	1.138	1.019	18.992	0.866	0.816	10.076	0.785
48	1.876	25.701	1.180	1.050	19.526	1.180	1.050	19.526	0.891	0.832	10.560	0.810
49	1.922	26.265	1.223	1.080	20.060	1.223	1.080	20.060	0.916	0.848	11.044	0.835
50	1.968	26.830	1.265	1.110	20.594	1.265	1.110	20.594	0.941	0.864	11.527	0.860
51	2.020	27.642	1.294	1.146	21.719	1.294	1.146	21.719	0.978	0.891	12.038	0.893
52	2.072	28.454	1.324	1.182	22.845	1.324	1.182	22.845	1.016	0.917	12.549	0.926
53	2.124	29.266	1.353	1.218	23.970	1.353	1.218	23.970	1.053	0.943	13.059	0.959
54	2.176	30.079	1.382	1.254	25.095	1.382	1.254	25.095	1.090	0.969	13.570	0.992
55	2.228	30.891	1.411	1.290	26.221	1.411	1.290	26.221	1.128	0.995	14.081	1.026
56	2.265	31.485	1.449	1.310	26.449	1.449	1.310	26.449	1.160	1.015	14.438	1.051
57	2.302	32.078	1.486	1.330	26.677	1.486	1.330	26.677	1.192	1.035	14.796	1.077
58	2.340	32.672	1.523	1.350	26.905	1.523	1.350	26.905	1.224	1.055	15.154	1.103
59	2.377	33.266	1.560	1.370	27.133	1.560	1.370	27.133	1.256	1.075	15.512	1.129
60	2.415	33.860	1.597	1.390	27.361	1.597	1.390	27.361	1.288	1.095	15.870	1.155
61	2.451	34.487	1.611	1.405	27.372	1.611	1.405	27.372	1.301	1.109	16.268	1.166
62	2.487	35.113	1.625	1.420	27.383	1.625	1.420	27.383	1.313	1.124	16.667	1.177
63	2.523	35.740	1.639	1.434	27.393	1.639	1.434	27.393	1.326	1.138	17.066	1.188
64	2.559	36.367	1.653	1.449	27.404	1.653	1.449	27.404	1.338	1.153	17.465	1.200
65	2.595	36.994	1.667	1.464	27.415	1.667	1.464	27.415	1.351	1.167	17.863	1.211
66	2.639	37.728	1.699	1.497	28.054	1.699	1.497	28.054	1.366	1.182	18.249	1.230
67	2.683	38.462	1.732	1.530	28.694	1.732	1.530	28.694	1.382	1.196	18.635	1.250
68	2.728	39.197	1.765	1.563	29.333	1.765	1.563	29.333	1.397	1.211	19.020	1.269
69	2.772	39.931	1.797	1.596	29.972	1.797	1.596	29.972	1.412	1.225	19.406	1.289
70	2.817	40.666	1.830	1.629	30.612	1.830	1.629	30.612	1.427	1.239	19.792	1.308
71	2.859	41.083	1.854	1.650	31.097	1.854	1.650	31.097	1.443	1.255	19.906	1.321
72	2.901	41.500	1.878	1.672	31.583	1.878	1.672	31.583	1.459	1.271	20.020	1.334
73	2.943	41.918	1.902	1.694	32.068	1.902	1.694	32.068	1.475	1.287	20.134	1.347
74	2.985	42.335	1.925	1.715	32.554	1.925	1.715	32.554	1.491	1.303	20.248	1.361
75	3.027	42.753	1.949	1.737	33.039	1.949	1.737	33.039	1.507	1.318	20.362	1.374
76	3.061	43.705	1.977	1.760	33.193	1.977	1.760	33.193	1.528	1.331	20.782	1.391
77	3.096	44.657	2.005	1.782	33.347	2.005	1.782	33.347	1.550	1.344	21.202	1.409
78	3.130	45.609	2.033	1.805	33.501	2.033	1.805	33.501	1.571	1.357	21.623	1.426
79	3.165	46.562	2.061	1.828	33.655	2.061	1.828	33.655	1.593	1.370	22.043	1.444
80	3.200	47.514	2.089	1.851	33.809	2.089	1.851	33.809	1.615	1.382	22.463	1.461
81	3.237	47.873	2.111	1.872	34.035	2.111	1.872	34.035	1.623	1.407	22.571	1.475
82	3.275	48.233	2.132	1.894	34.261	2.132	1.894	34.261	1.632	1.431	22.678	1.489

 Appendix B

83	3.313	48.592	2.154	1.915	34.488	2.154	1.915	34.488	1.640	1.455	22.786	1.503
84	3.351	48.952	2.175	1.937	34.714	2.175	1.937	34.714	1.648	1.480	22.894	1.517
85	3.389	49.311	2.197	1.958	34.941	2.197	1.958	34.941	1.657	1.504	23.001	1.531
86	3.432	49.503	2.200	1.973	35.115	2.200	1.973	35.115	1.659	1.531	23.112	1.531
87	3.475	49.694	2.203	1.988	35.289	2.203	1.988	35.289	1.661	1.558	23.223	1.532
88	3.518	49.886	2.206	2.002	35.463	2.206	2.002	35.463	1.663	1.586	23.334	1.533
89	3.562	50.077	2.209	2.017	35.637	2.209	2.017	35.637	1.665	1.613	23.445	1.533
90	3.605	50.269	2.212	2.032	35.811	2.212	2.032	35.811	1.667	1.640	23.556	1.534
91	3.645	50.447	2.213	2.044	35.968	2.213	2.044	35.968	1.668	1.654	23.558	1.534
92	3.686	50.626	2.214	2.056	36.125	2.214	2.056	36.125	1.669	1.668	23.560	1.534
93	3.727	50.805	2.215	2.068	36.282	2.215	2.068	36.282	1.671	1.682	23.562	1.535
94	3.767	50.984	2.216	2.081	36.440	2.216	2.081	36.440	1.672	1.696	23.564	1.535
95	3.808	51.162	2.217	2.093	36.597	2.217	2.093	36.597	1.674	1.710	23.567	1.535
96	3.853	51.779	2.227	2.111	36.968	2.227	2.111	36.968	1.680	1.727	23.924	1.547
97	3.898	52.395	2.236	2.129	37.339	2.236	2.129	37.339	1.686	1.744	24.282	1.558
98	3.943	53.012	2.245	2.147	37.710	2.245	2.147	37.710	1.692	1.762	24.639	1.570
99	3.988	53.628	2.254	2.165	38.081	2.254	2.165	38.081	1.698	1.779	24.997	1.581
100	4.033	54.245	2.263	2.183	38.453	2.263	2.183	38.453	1.704	1.796	25.355	1.593
101	4.081	55.131	2.342	2.221	40.429	2.342	2.221	40.429	1.779	1.819	25.871	1.636
102	4.128	56.016	2.420	2.258	42.405	2.420	2.258	42.405	1.854	1.842	26.387	1.678
103	4.175	56.902	2.498	2.295	44.382	2.498	2.295	44.382	1.928	1.865	26.903	1.721
104	4.223	57.788	2.576	2.333	46.358	2.576	2.333	46.358	2.003	1.887	27.419	1.764
105	4.270	58.674	2.654	2.370	48.335	2.654	2.370	48.335	2.078	1.910	27.935	1.807
106	4.300	59.222	2.740	2.404	49.060	2.740	2.404	49.060	2.132	1.936	28.221	1.864
107	4.331	59.771	2.826	2.437	49.785	2.826	2.437	49.785	2.187	1.962	28.506	1.921
108	4.361	60.319	2.912	2.471	50.511	2.912	2.471	50.511	2.241	1.988	28.792	1.978
109	4.391	60.868	2.998	2.504	51.236	2.998	2.504	51.236	2.296	2.014	29.077	2.035
110	4.421	61.416	3.084	2.538	51.962	3.084	2.538	51.962	2.350	2.040	29.363	2.092
111	4.449	61.935	3.101	2.560	52.113	3.101	2.560	52.113	2.365	2.057	29.405	2.107
112	4.476	62.455	3.118	2.582	52.265	3.118	2.582	52.265	2.381	2.074	29.447	2.121
113	4.503	62.974	3.136	2.604	52.417	3.136	2.604	52.417	2.396	2.090	29.489	2.135
114	4.531	63.493	3.153	2.625	52.569	3.153	2.625	52.569	2.411	2.107	29.531	2.149
115	4.558	64.013	3.170	2.647	52.721	3.170	2.647	52.721	2.426	2.124	29.573	2.163
116	4.600	64.559	3.173	2.673	52.723	3.173	2.673	52.723	2.430	2.152	29.865	2.166
117	4.642	65.105	3.175	2.698	52.724	3.175	2.698	52.724	2.433	2.179	30.157	2.169
118	4.684	65.651	3.178	2.723	52.726	3.178	2.723	52.726	2.437	2.207	30.449	2.173
119	4.726	66.197	3.181	2.749	52.728	3.181	2.749	52.728	2.441	2.234	30.741	2.176
120	4.768	66.743	3.184	2.774	52.729	3.184	2.774	52.729	2.445	2.262	31.033	2.179
121	4.804	67.600	3.206	2.799	53.168	3.206	2.799	53.168	2.467	2.276	31.230	2.200
122	4.840	68.458	3.229	2.824	53.606	3.229	2.824	53.606	2.489	2.290	31.428	2.222
123	4.876	69.315	3.251	2.850	54.044	3.251	2.850	54.044	2.512	2.304	31.625	2.243
124	4.911	70.173	3.274	2.875	54.483	3.274	2.875	54.483	2.534	2.318	31.823	2.265
125	4.947	71.030	3.296	2.900	54.921	3.296	2.900	54.921	2.557	2.332	32.020	2.286
126	4.983	71.729	3.310	2.920	55.078	3.310	2.920	55.078	2.569	2.355	32.099	2.297
127	5.019	72.427	3.323	2.941	55.236	3.323	2.941	55.236	2.580	2.377	32.178	2.307
128	5.055	73.126	3.337	2.961	55.393	3.337	2.961	55.393	2.592	2.399	32.256	2.318
129	5.091	73.825	3.350	2.981	55.551	3.350	2.981	55.551	2.604	2.422	32.335	2.329
130	5.126	74.523	3.364	3.001	55.708	3.364	3.001	55.708	2.616	2.444	32.413	2.339
131	5.178	75.331	3.370	3.027	55.921	3.370	3.027	55.921	2.619	2.464	32.638	2.343
132	5.230	76.139	3.376	3.052	56.134	3.376	3.052	56.134	2.623	2.485	32.862	2.347
133	5.282	76.947	3.382	3.078	56.346	3.382	3.078	56.346	2.627	2.505	33.086	2.350
134	5.334	77.755	3.388	3.103	56.559	3.388	3.103	56.559	2.630	2.525	33.310	2.354
135	5.386	78.563	3.394	3.129	56.771	3.394	3.129	56.771	2.634	2.545	33.534	2.358
136	5.468	79.372	3.432	3.167	57.854	3.432	3.167	57.854	2.672	2.573	34.147	2.395
137	5.549	80.181	3.469	3.206	58.937	3.469	3.206	58.937	2.711	2.600	34.760	2.431
138	5.630	80.990	3.507	3.244	60.020	3.507	3.244	60.020	2.749	2.628	35.373	2.468
139	5.712	81.798	3.544	3.283	61.102	3.544	3.283	61.102	2.787	2.655	35.985	2.505
140	5.793	82.607	3.582	3.322	62.185	3.582	3.322	62.185	2.826	2.682	36.598	2.542
141	5.825	83.486	3.639	3.342	62.366	3.639	3.342	62.366	2.851	2.702	36.880	2.574
142	5.856	84.365	3.697	3.363	62.548	3.697	3.363	62.548	2.875	2.722	37.162	2.606
143	5.888	85.245	3.754	3.383	62.729	3.754	3.383	62.729	2.900	2.742	37.444	2.638

144	5.920	86.124	3.811	3.404	62.910	3.811	3.404	62.910	2.925	2.762	37.727	2.671
145	5.951	87.003	3.869	3.425	63.091	3.869	3.425	63.091	2.949	2.782	38.009	2.703
146	5.975	87.915	3.892	3.453	63.539	3.892	3.453	63.539	2.959	2.797	38.632	2.715
147	5.998	88.827	3.916	3.482	63.987	3.916	3.482	63.987	2.968	2.811	39.255	2.726
148	6.022	89.739	3.939	3.510	64.435	3.939	3.510	64.435	2.978	2.825	39.878	2.738
149	6.046	90.652	3.963	3.539	64.883	3.963	3.539	64.883	2.987	2.839	40.501	2.750
150	6.069	91.564	3.986	3.568	65.331	3.986	3.568	65.331	2.997	2.853	41.124	2.762
151	6.099	92.475	4.000	3.595	65.704	4.000	3.595	65.704	3.007	2.868	41.450	2.774
152	6.129	93.387	4.014	3.623	66.077	4.014	3.623	66.077	3.017	2.883	41.776	2.786
153	6.159	94.298	4.029	3.650	66.450	4.029	3.650	66.450	3.028	2.898	42.102	2.799
154	6.189	95.209	4.043	3.677	66.823	4.043	3.677	66.823	3.038	2.913	42.428	2.811
155	6.219	96.121	4.057	3.705	67.197	4.057	3.705	67.197	3.049	2.927	42.754	2.823
156	6.313	97.599	4.117	3.767	69.206	4.117	3.767	69.206	3.113	2.969	44.233	2.870
157	6.407	99.077	4.176	3.829	71.215	4.176	3.829	71.215	3.178	3.011	45.712	2.917
158	6.501	100.555	4.236	3.891	73.225	4.236	3.891	73.225	3.242	3.053	47.191	2.964
159	6.595	102.033	4.295	3.953	75.234	4.295	3.953	75.234	3.307	3.095	48.670	3.011
160	6.689	103.511	4.355	4.015	77.243	4.355	4.015	77.243	3.371	3.136	50.149	3.057
161	7.010	107.552	4.551	4.078	79.985	4.551	4.078	79.985	3.503	3.182	51.569	3.181
162	7.331	111.593	4.747	4.142	82.727	4.747	4.142	82.727	3.635	3.227	52.988	3.306
163	7.652	115.634	4.943	4.205	85.469	4.943	4.205	85.469	3.767	3.272	54.408	3.430
164	7.972	119.676	5.139	4.268	88.211	5.139	4.268	88.211	3.899	3.318	55.828	3.554
165	8.293	123.717	5.335	4.332	90.953	5.335	4.332	90.953	4.030	3.363	57.247	3.678
166	8.671	125.252	5.516	4.380	93.266	5.516	4.380	93.266	4.145	3.410	58.958	3.796
167	9.050	126.786	5.696	4.428	95.579	5.696	4.428	95.579	4.260	3.458	60.670	3.914
168	9.428	128.321	5.876	4.477	97.892	5.876	4.477	97.892	4.375	3.505	62.381	4.033
169	9.806	129.855	6.056	4.525	100.205	6.056	4.525	100.205	4.490	3.552	64.092	4.151
170	10.184	131.390	6.237	4.573	102.517	6.237	4.573	102.517	4.605	3.600	65.804	4.269
171	10.426	132.095	6.345	4.618	103.813	6.345	4.618	103.813	4.673	3.644	66.939	4.322
172	10.667	132.801	6.452	4.664	105.109	6.452	4.664	105.109	4.741	3.688	68.075	4.374
173	10.909	133.506	6.560	4.709	106.404	6.560	4.709	106.404	4.808	3.732	69.210	4.426
174	11.150	134.211	6.668	4.754	107.700	6.668	4.754	107.700	4.876	3.776	70.345	4.479
175	11.392	134.917	6.776	4.799	108.995	6.776	4.799	108.995	4.944	3.821	71.481	4.531
176	11.439	137.703	6.910	4.858	110.733	6.910	4.858	110.733	5.057	3.856	73.077	4.626
177	11.486	140.490	7.045	4.917	112.471	7.045	4.917	112.471	5.171	3.891	74.674	4.722
178	11.533	143.276	7.179	4.977	114.209	7.179	4.977	114.209	5.284	3.927	76.271	4.817
179	11.581	146.063	7.313	5.036	115.946	7.313	5.036	115.946	5.398	3.962	77.867	4.912
180	11.628	148.849	7.447	5.095	117.684	7.447	5.095	117.684	5.511	3.997	79.464	5.008
181	11.671	154.282	7.621	5.158	119.775	7.621	5.158	119.775	5.641	4.024	81.282	5.111
182	11.715	159.715	7.795	5.221	121.866	7.795	5.221	121.866	5.770	4.050	83.100	5.214
183	11.759	165.147	7.969	5.284	123.956	7.969	5.284	123.956	5.900	4.077	84.919	5.318
184	11.803	170.580	8.143	5.347	126.047	8.143	5.347	126.047	6.029	4.104	86.737	5.421
185	11.846	176.013	8.318	5.411	128.138	8.318	5.411	128.138	6.159	4.131	88.555	5.524
186	11.887	179.970	8.499	5.428	129.673	8.499	5.428	129.673	6.285	4.154	90.333	5.656
187	11.928	183.927	8.681	5.446	131.209	8.681	5.446	131.209	6.411	4.178	92.110	5.787
188	11.969	187.884	8.862	5.463	132.745	8.862	5.463	132.745	6.537	4.202	93.888	5.919
189	12.010	191.841	9.043	5.481	134.281	9.043	5.481	134.281	6.663	4.225	95.665	6.050
190	12.051	195.798	9.225	5.499	135.816	9.225	5.499	135.816	6.789	4.249	97.442	6.182
191	12.090	197.691	9.386	5.561	137.198	9.386	5.561	137.198	6.875	4.285	98.856	6.266
192	12.128	199.584	9.547	5.623	138.580	9.547	5.623	138.580	6.961	4.321	100.271	6.350
193	12.166	201.476	9.708	5.686	139.961	9.708	5.686	139.961	7.047	4.357	101.685	6.435
194	12.205	203.369	9.869	5.748	141.343	9.869	5.748	141.343	7.133	4.393	103.099	6.519
195	12.243	205.262	10.030	5.810	142.724	10.030	5.810	142.724	7.219	4.430	104.513	6.603
196	12.281	208.341	10.188	5.828	144.052	10.188	5.828	144.052	7.346	4.460	106.134	6.706
197	12.319	211.419	10.346	5.845	145.381	10.346	5.845	145.381	7.473	4.490	107.755	6.810
198	12.357	214.498	10.504	5.863	146.709	10.504	5.863	146.709	7.600	4.520	109.376	6.913
199	12.395	217.577	10.662	5.880	148.037	10.662	5.880	148.037	7.727	4.550	110.997	7.017
200	12.433	220.656	10.820	5.898	149.365	10.820	5.898	149.365	7.853	4.580	112.617	7.120
201	12.509	221.810	10.948	5.942	150.214	10.948	5.942	150.214	7.929	4.623	113.207	7.195
202	12.585	222.965	11.075	5.986	151.063	11.075	5.986	151.063	8.005	4.666	113.796	7.270
203	12.661	224.119	11.203	6.029	151.912	11.203	6.029	151.912	8.080	4.709	114.385	7.345
204	12.738	225.274	11.330	6.073	152.760	11.330	6.073	152.760	8.156	4.752	114.974	7.419

APPENDIX C
ANALYTIC PROCEDURES

The following procedure shall be adhered to for the analysis of gas samples once they have been drawn from the CVS.

1. The samples shall be stored in an insulated ice chest which will be free from UV light contamination.

2. The samples shall be removed from the Tedlar bag using a gas tight syringe.

3. 200 microliters of gas sample shall be removed the bag.

4. The sample shall be injected into the sample port of the GC/MS.

Analysis of CO and CO_2 by GC

Instrument:	Perkin Elmer Autosystem GC
Analytical column:	60/80 Carbosieve G, 10 ft. x 1/8" SS
Carrier gas:	Helium @ 25 ml/min.
Detector:	TCD
Injector temperature:	200°C
Detector temperature:	200°C
Temperature program:	Initial: 40°C Initial hold: 5 min. Ramp: 30°C/min. to 195°C, hold for 15 min.

Analysis of Hydrocarbons by GC/MS

Instrument:	Perkin Elmer Autosystem GC
Analytical column:	Econo-Cap (SE-30), 30m x 0.32mm fused silica
Carrier gas:	Helium @ 1.5 ml/min.
Detector:	PE QMASS 910 Mass Spectrometer
Injector temperature:	150°C
Detector temperature:	150°C
Temperature program:	Initial: 0°C Hold: 25 min.

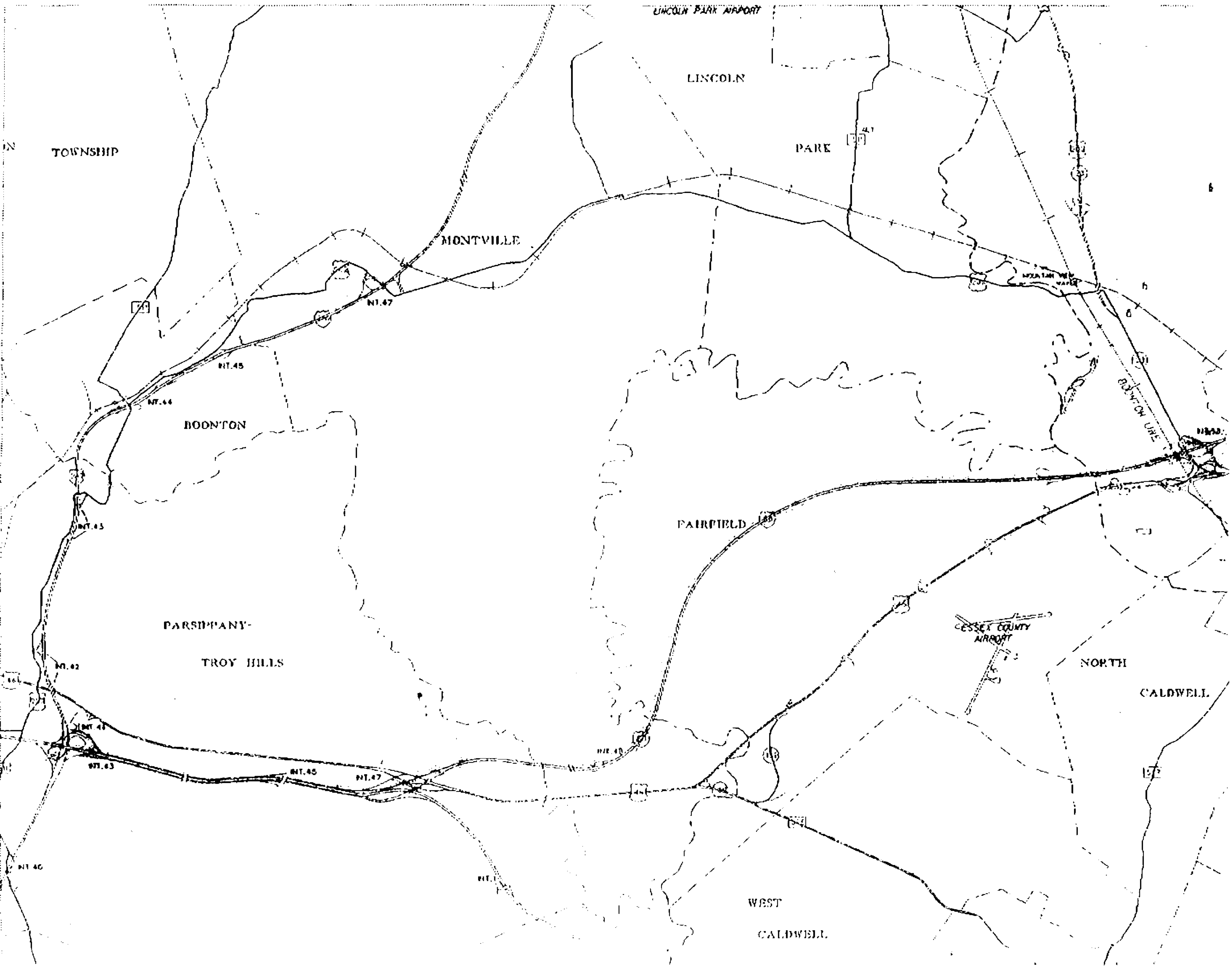
4. Road Conditioning Course

ROAD CONDITIONING COURSE

The road conditioning course used is as described below and as shown on the accompanying map.

Starting at the Wayne DMV Inspection Station, exit onto Route 46 West. From Route 46 West, enter Route 80 West and proceed to the Route 287 exit in Parsippany-Troy Hills. Go north on Route 287 to the first exit (Inverness Road) and make a U-turn to Route 287 South. Take Route 287 South to the Route 80 split. Take Route 80 East to the Route 23 / Route 46 exit in Wayne and exit to Route 46 East. Take Route 46 East to first exit. Take the Route 46 overpass to Route 46 West and return to the DMV Inspection Station.

The above route is approximately 25 miles, and was used by all vehicles as a conditioning course before undertaking the ASM 2525/IM 240 test regimen with and without the device/procedure installed. Actual odometer readings may vary because of calibration, and were recorded. All vehicles were driven at as close to the posted speed limit as possible.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PARSIPPANY-
TROY HILLS
INT.42
INT.45
INT.47
ESSEX COUNTY
AIRPORT
NORTH
CALDWELL
INT.40
WEST
CALDWELL

5. Emissions Analysis Test Schedule

EMISSIONS ANALYSIS TEST SCHEDULE

Once the vehicle returned from the conditioning drive, it was driven onto the dynamometer by the DMV inspector, the Constant Volume Sampler (CVS) was attached to the vehicle exhaust pipe, its Vehicle Identification Number (VIN) was recorded and tested according to the following schedule: ASM 2525, IM 240, ASM 2525, IM 240, ASM 2525, IM 240, ASM 2525, IM 240. These test protocols, with the following exceptions, are detailed in AppendixC3.

Exceptions to test protocols:

-- (a) General Requirements (4) and (6) do not apply

-- (b) Vehicle Pre Inspection and Preparation (3) does not apply

-- (10) Vehicle Conditioning (i) does not apply, (ii) discretionary precondition - an ASM 2525 shall be performed

On the fourth ASM 2525 for each vehicle, a Tedlar sample bag was hooked up to the exhaust of the CVS and an exhaust sample was drawn. This sample was placed in a UV protected cooler and transported back to TACOM-ARDEC for analysis using gas chromatography/mass spectrometry (GC/MS) procedures described below. All sampling and analysis were performed by trained and experienced TACOM-ARDEC personnel, in accordance with the sampler and equipment manufacturer's instructions. The fourth ASM 2525 data was not used for statistical analysis.

Environmental conditions (ambient temperature, relative humidity and barometric pressure) were recorded at the beginning and end of each vehicle emissions test.

GC/MS test procedure

The following procedure was adhered to for the analysis of the gas samples once they were drawn from the CVS.

1. The samples were stored in an insulated ice chest which was protected from UV light contamination.

2. The samples were removed from the Tedlar bag using a gas-tight syringe.

3. 200 microliters of gas sample were removed from the bag.

4. The sample was injected into the sample port of the GC/MS.

ANALYSIS OF CO AND CO_2 BY GC

Instrument:	Perkin Elmer Autosystem GC
Analytical column:	60/80 Carbosieve G, 10 ft. x 1/8' SS
Carrier gas:	Helium @ 25 ml/min.
Detector:	TCD
Injector temperature:	200°C
Detector temperature:	200°C
Temperature program:	Initial: 40°C Initial hold: 5 min. Ramp: 30°C/min. to 195°C, hold for 15 min.

ANALYSIS OF HYDROCARBONS BY GC/MS

Instrument:	Perkin Elmer Autosystem GC
Analytical column:	Econo-Cap (SE-30), 30m x 0.32mm fused silica
Carrier gas:	Helium @ 1.5 ml/min.
Detector:	PE QMASS 910 Mass Spectrometer
Injector temperature:	150°C
Detector temperature:	150°C
Temperature program:	Initial: 0°C Hold: 25 min.

APPENDIX D
Emissions Test Data

1. Environmental Conditions on Test Dates

2. Raw Emissions Test Data

   a. IM 240 / ASM 2525
   b. Individual GCMS Analyses (TACOM-ARDEC)

3. Calculated Emissions Test Data

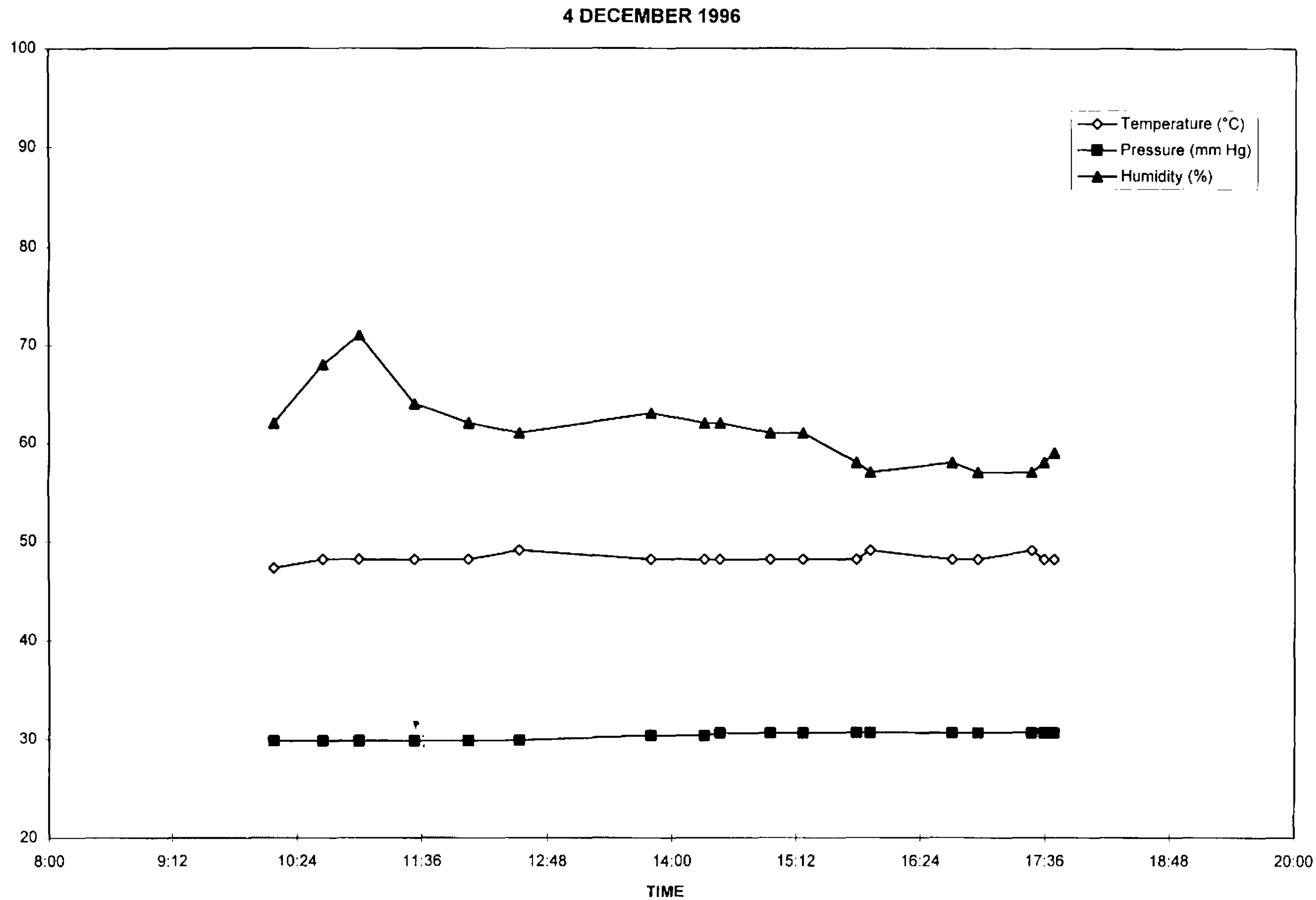
   a. Data Roll-Up / Summary
      (1) Control Car
      (2) ASM 2525
      (3) IM 240

   b. Individual Statistical Data
      (1) Two way ANOVA for Control Car, Run x Day
      (2) Student t tests for the Control Car
      (3) Multi-factor regression of Control Car versus Environmental Factors
      (4) Box and Whisker Plots, Range of Control Car Data
      (5) Two way ANOVA, Device x Car
      (6) Least Significant Different Tests for Devices

4. Emissions Gas Analysis Data

   a. Data Roll-Up / Summary
   b. Individual Statistical Data

1. Environmental Conditions on Test Dates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Pressure (mm Hg)
Humidity (%)
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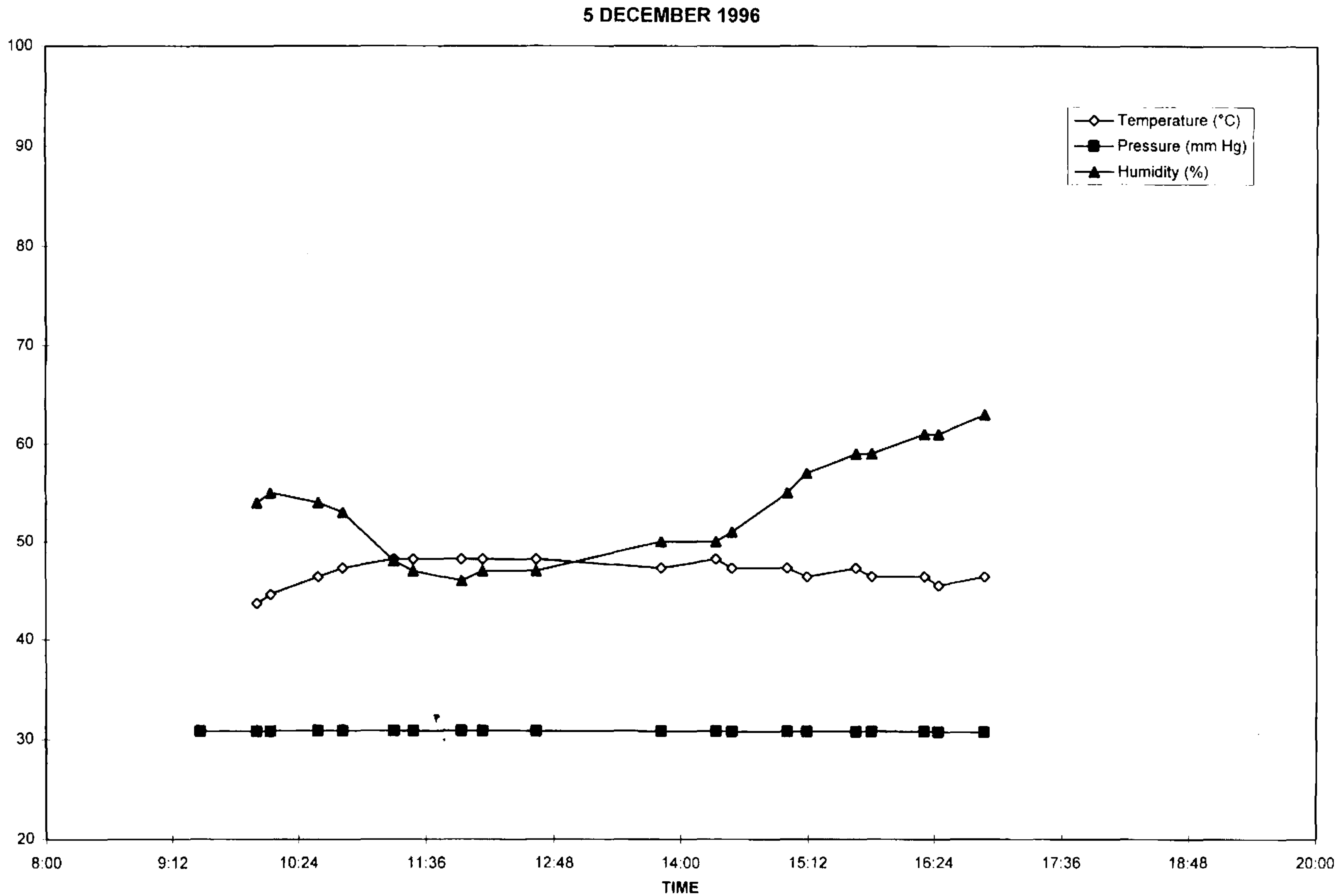
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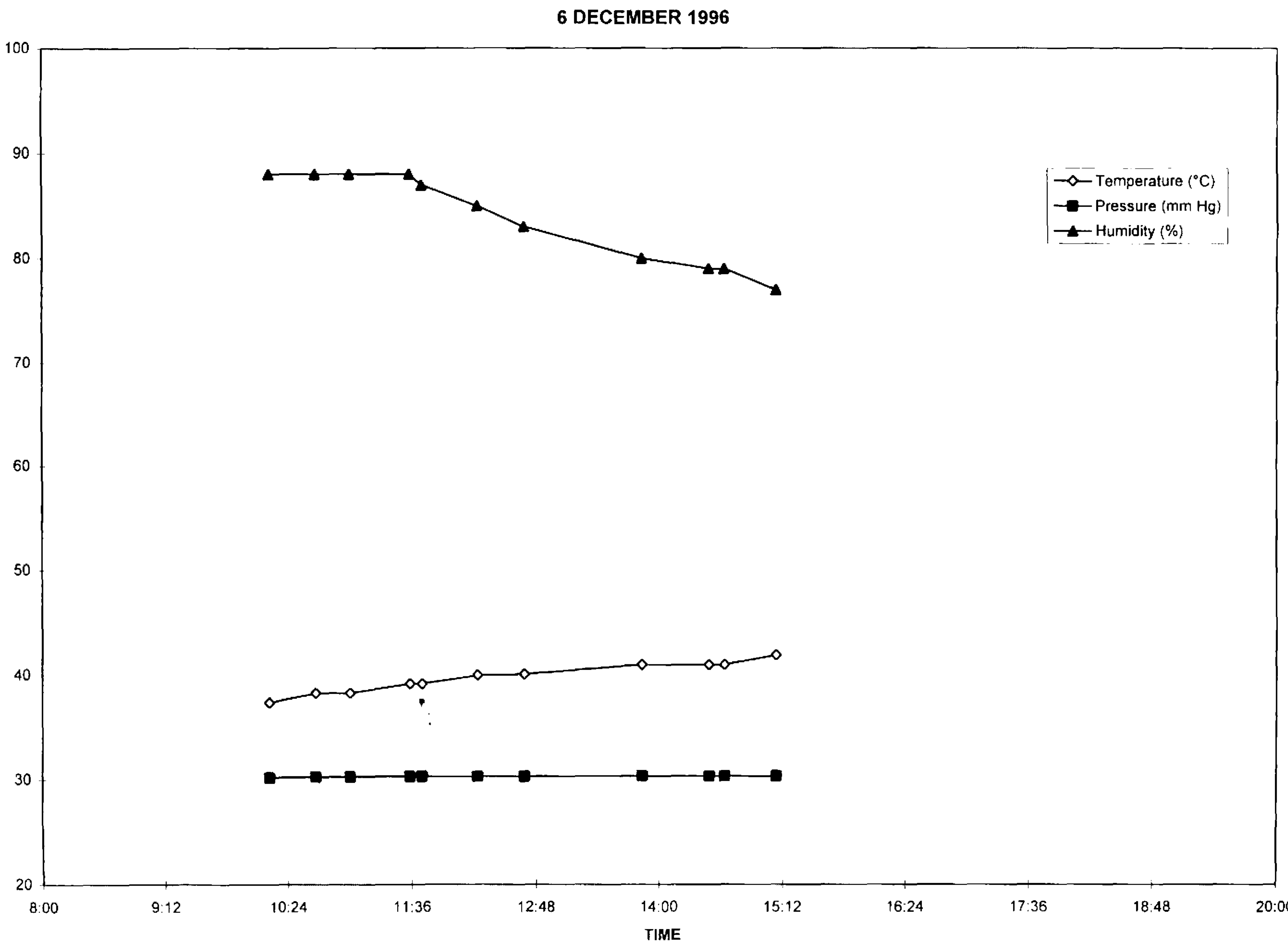

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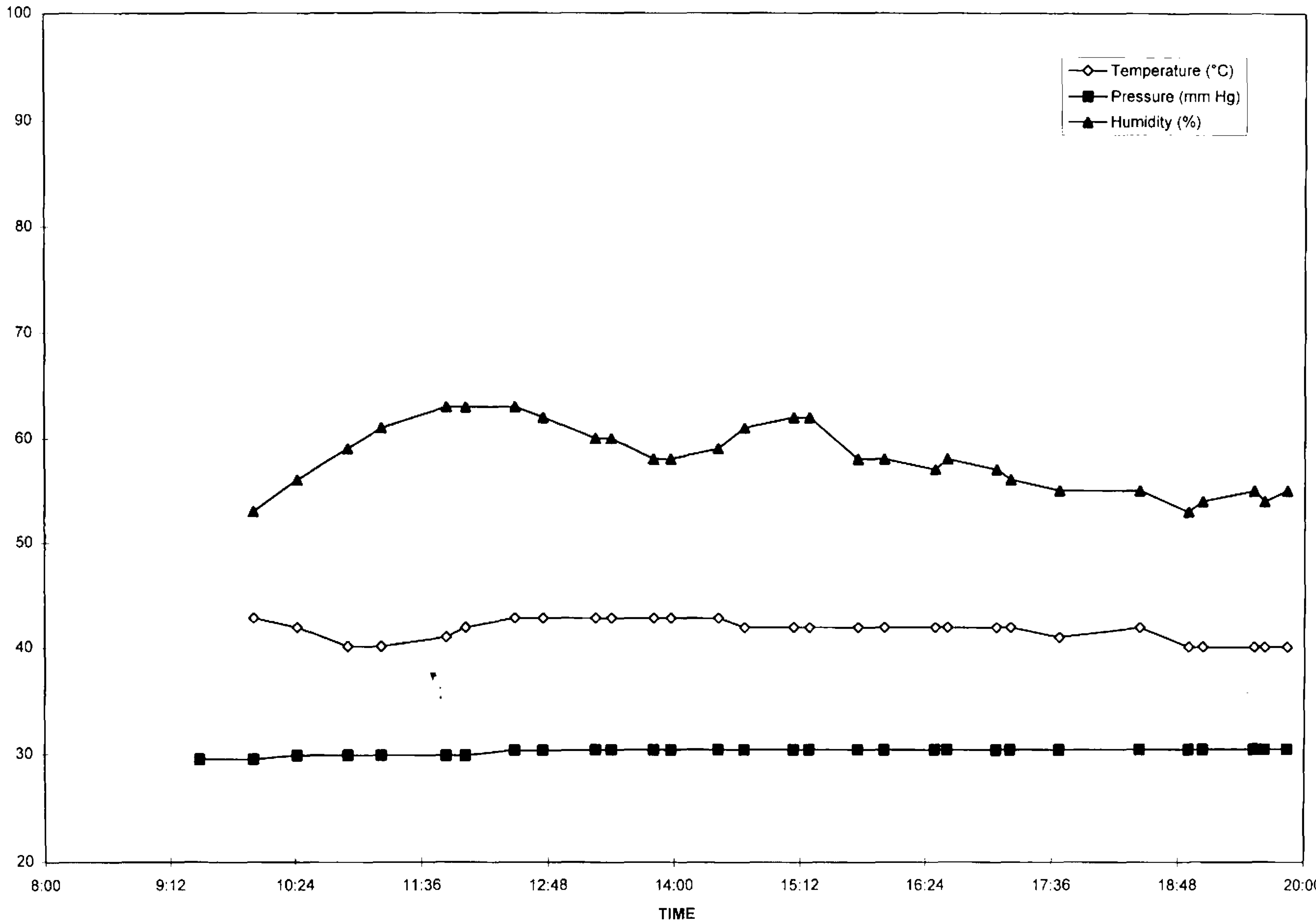
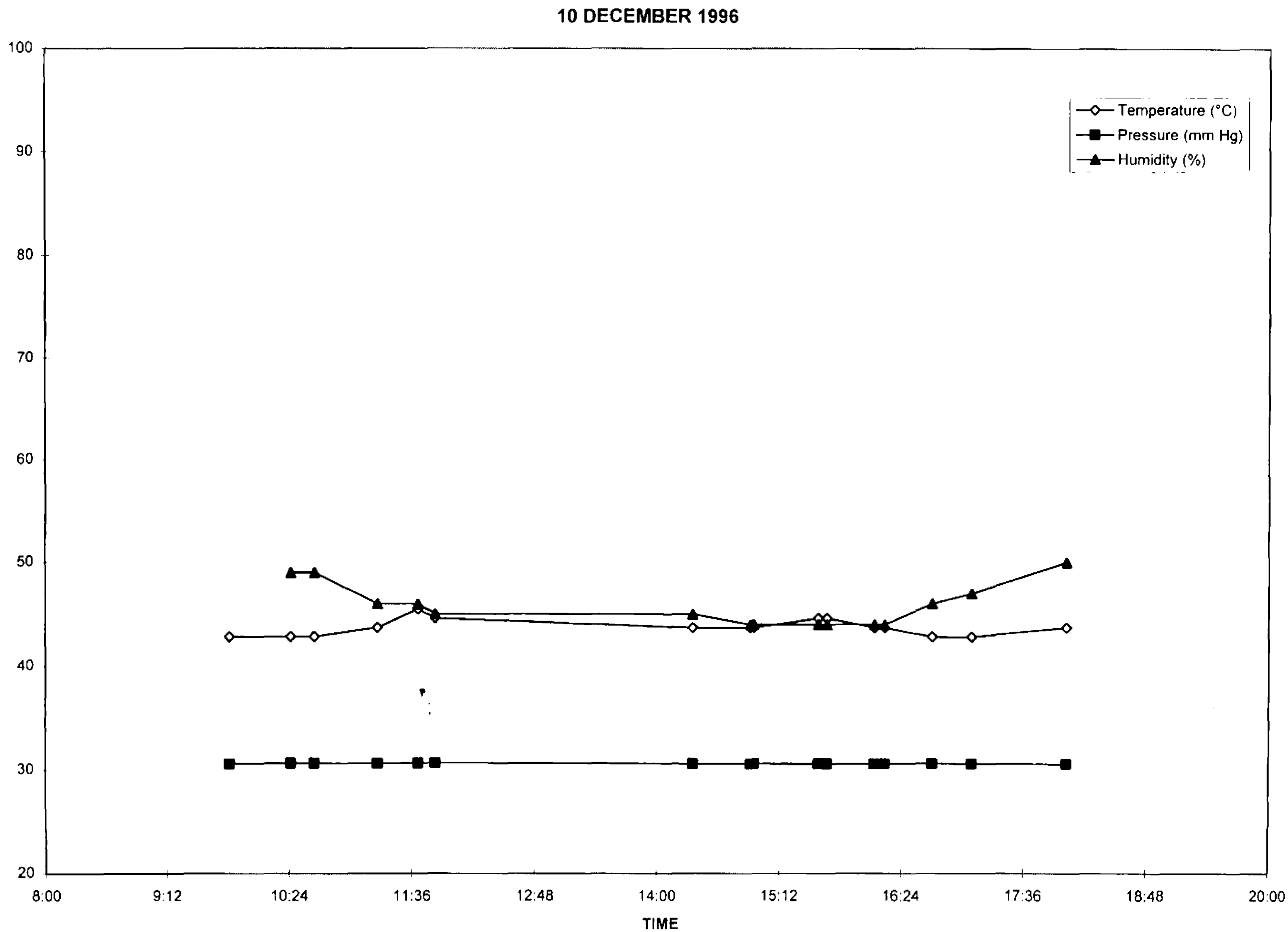
Pressure (mm Hg)
Humidity (%)

9 DECEMBER 1996

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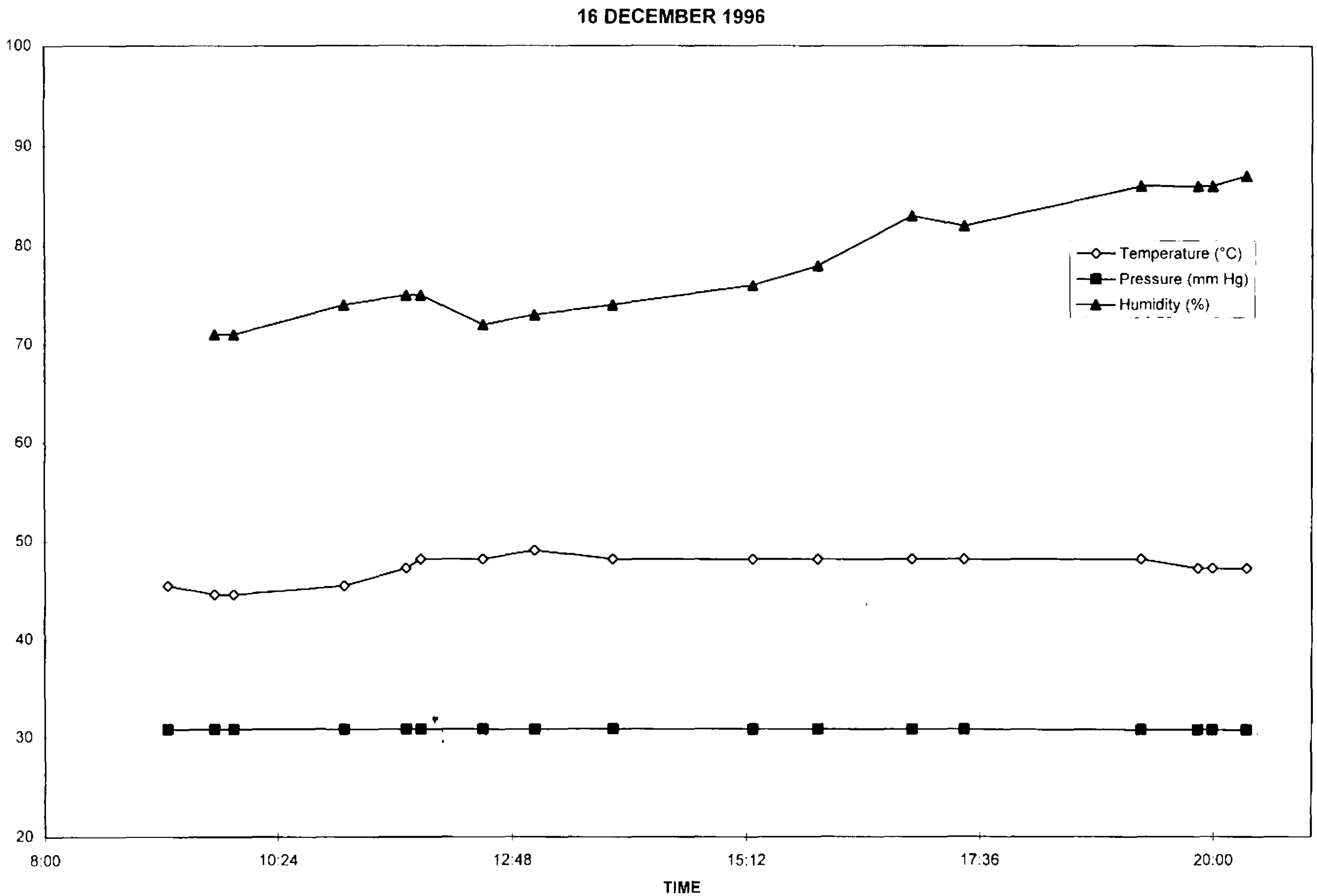
Humidity (%)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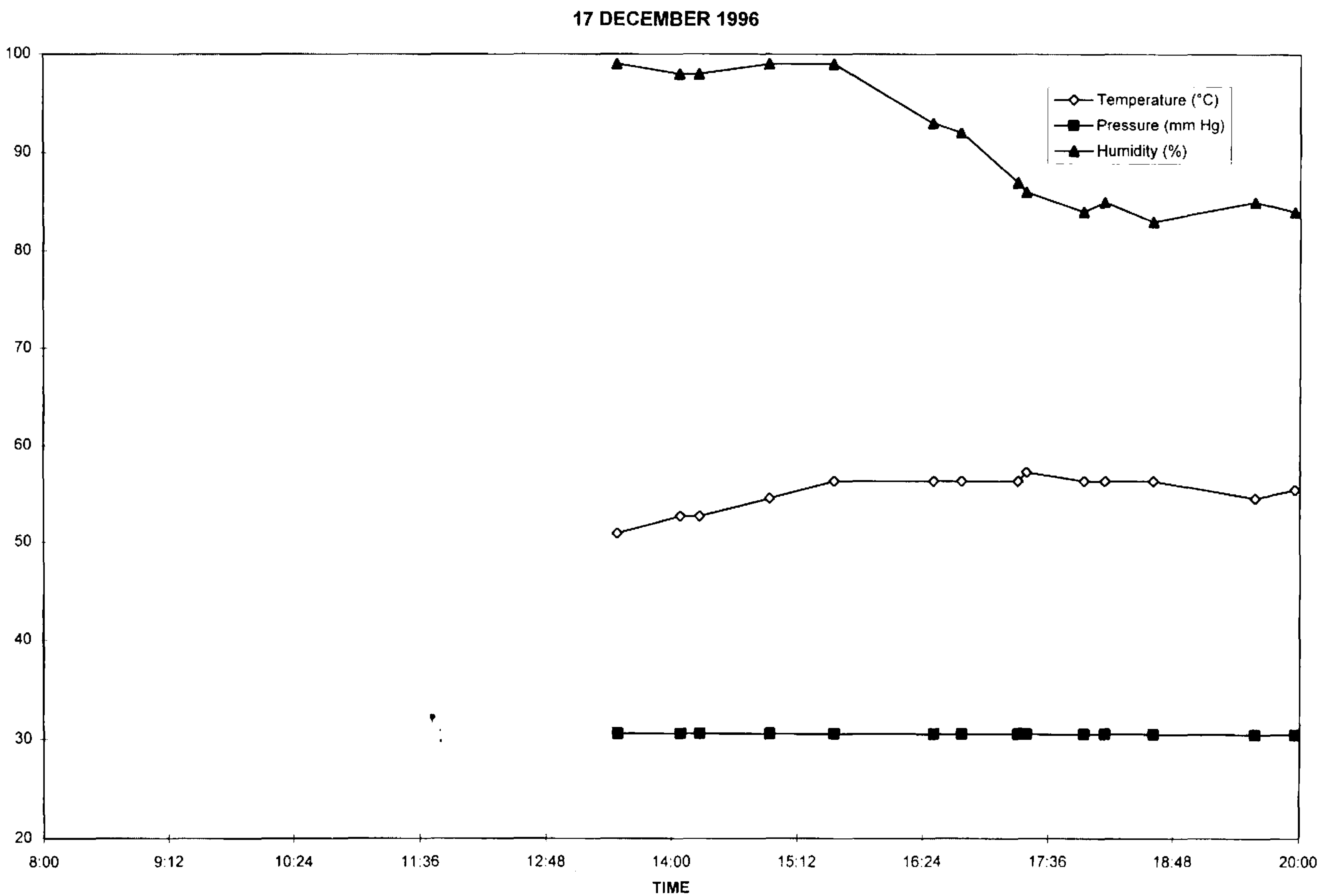
Pressure (mm Hg)
Humidity (%)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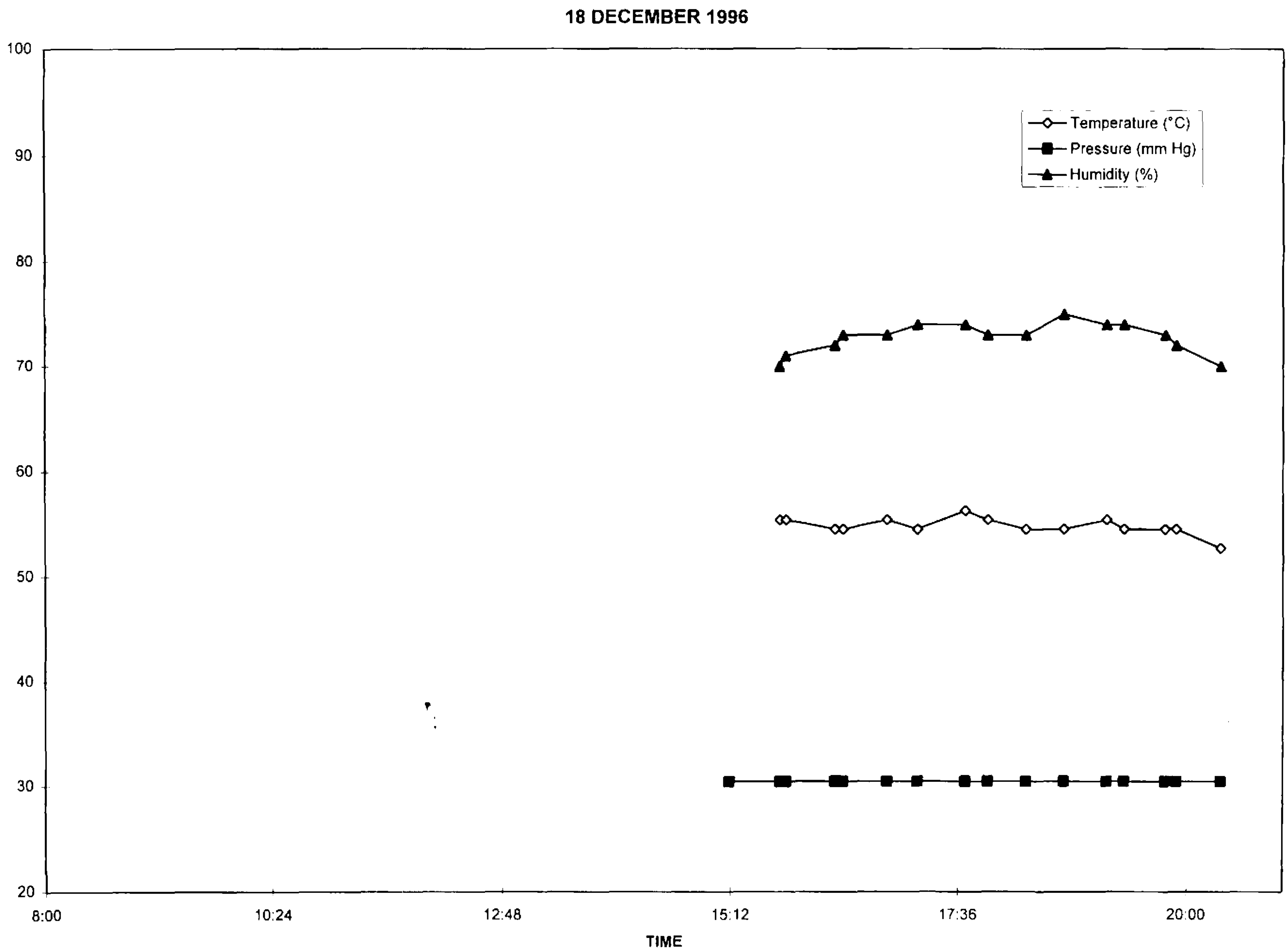
Temperature (°C)
Pressure (mm Hg)
Humidity (%)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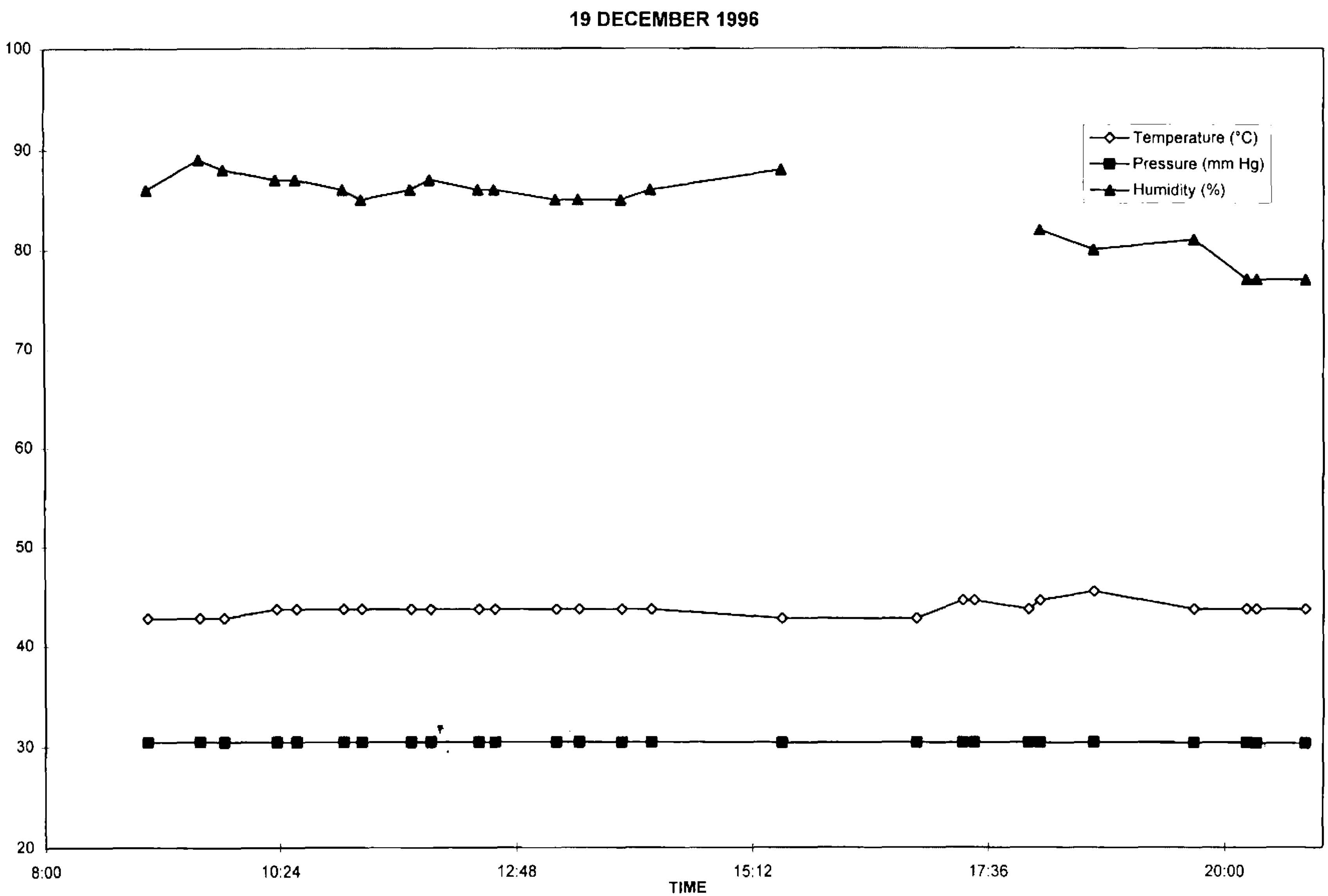
Pressure (mm Hg)
Humidity (%)



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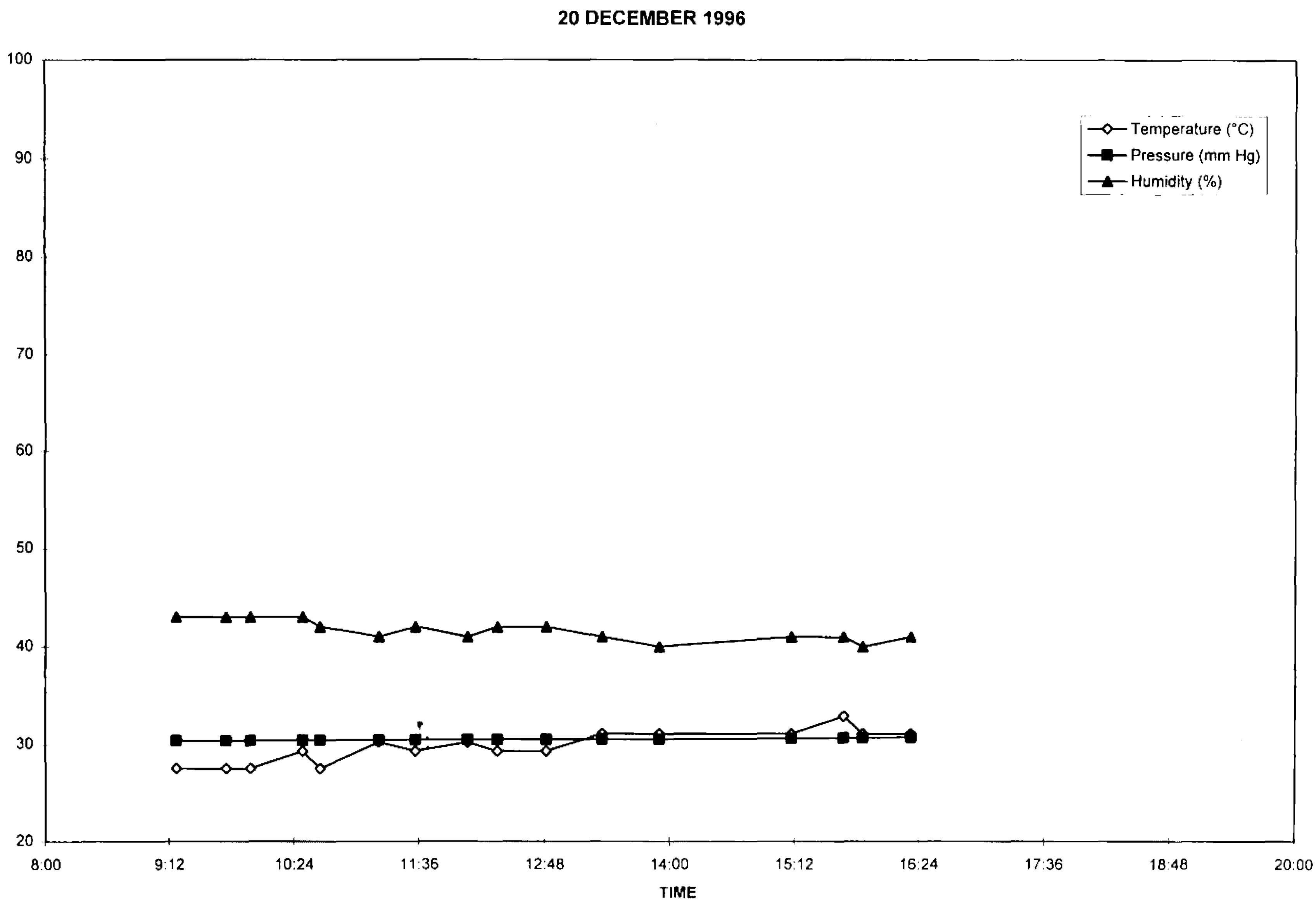
Pressure (mm Hg)
Humidity (%)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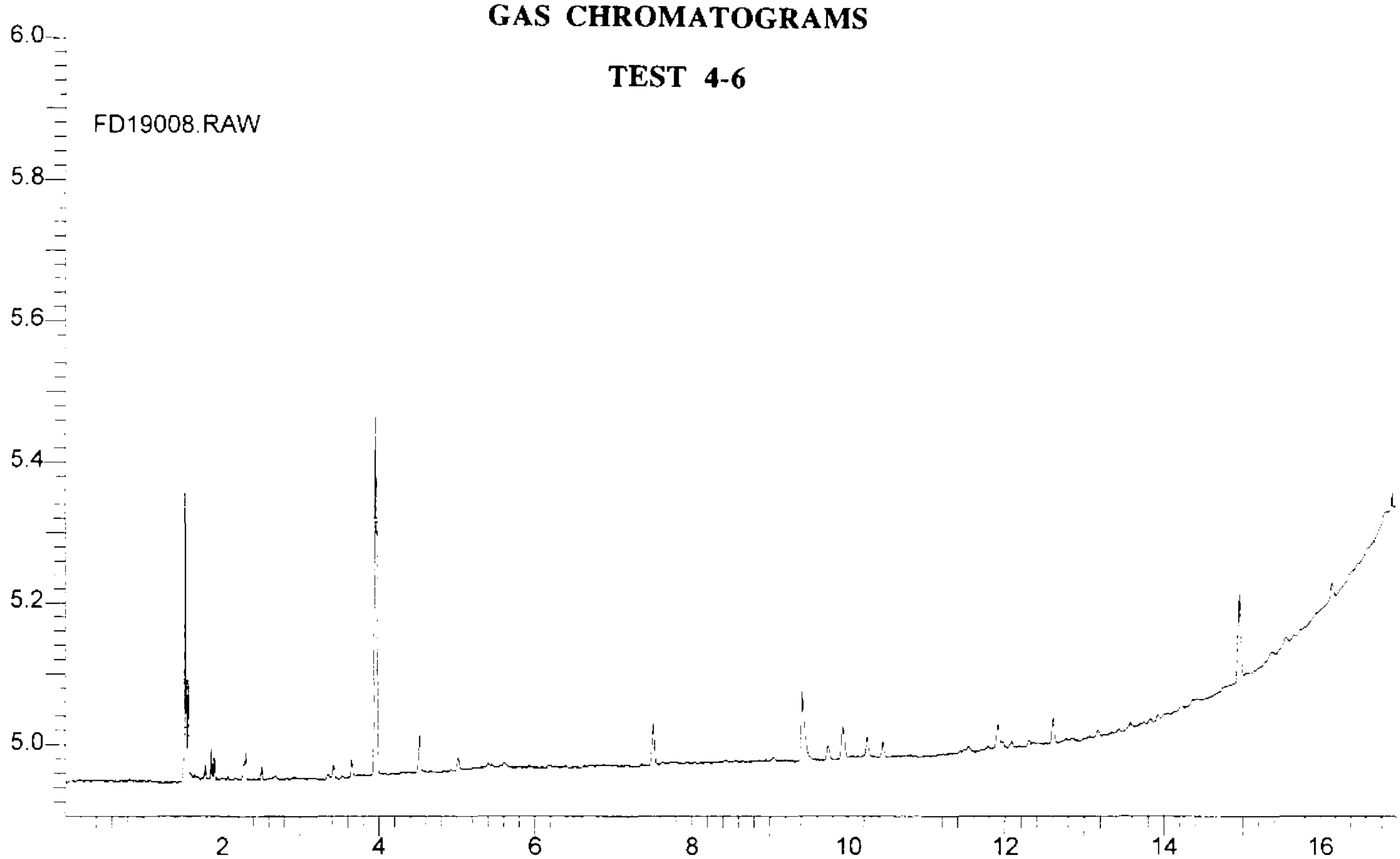
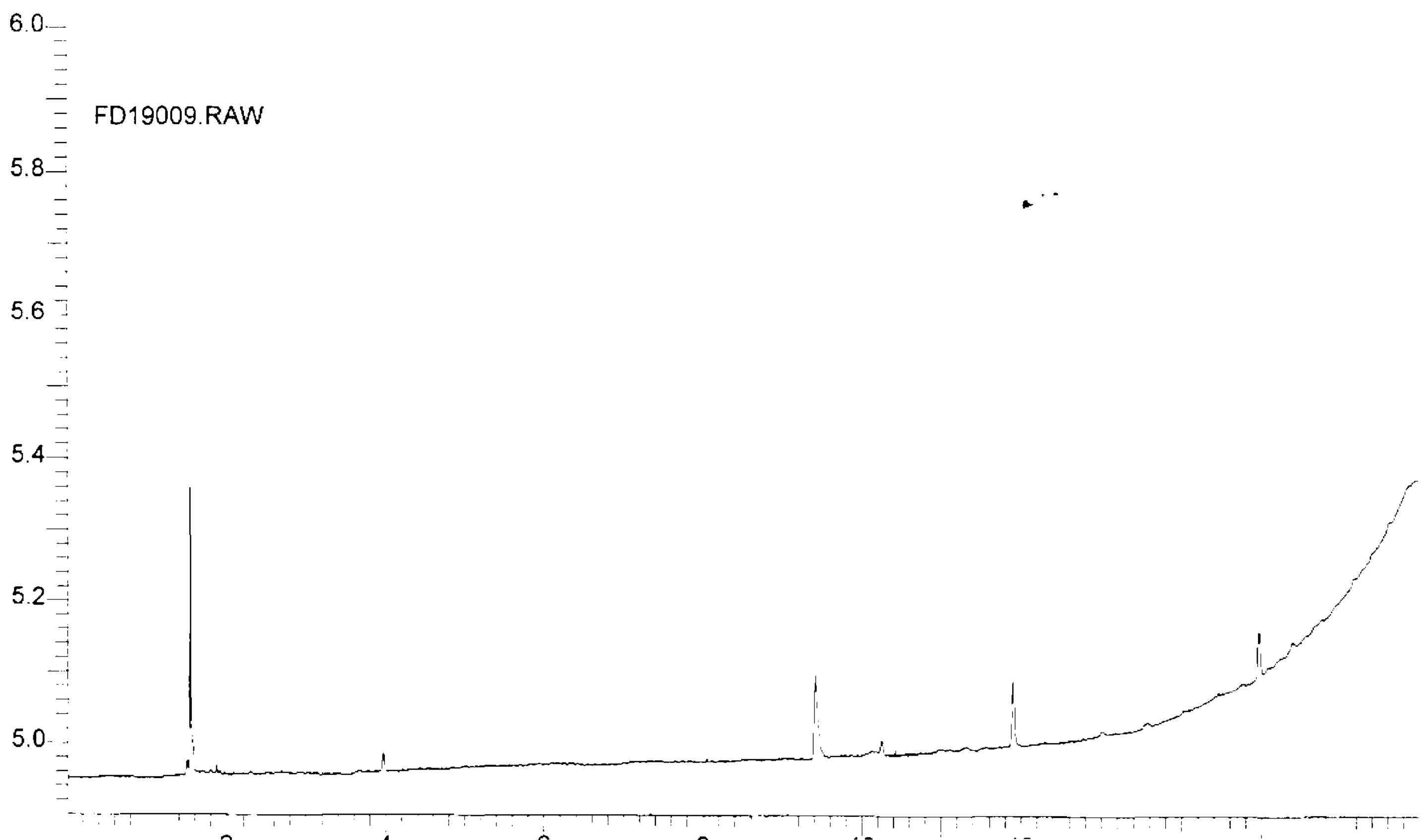
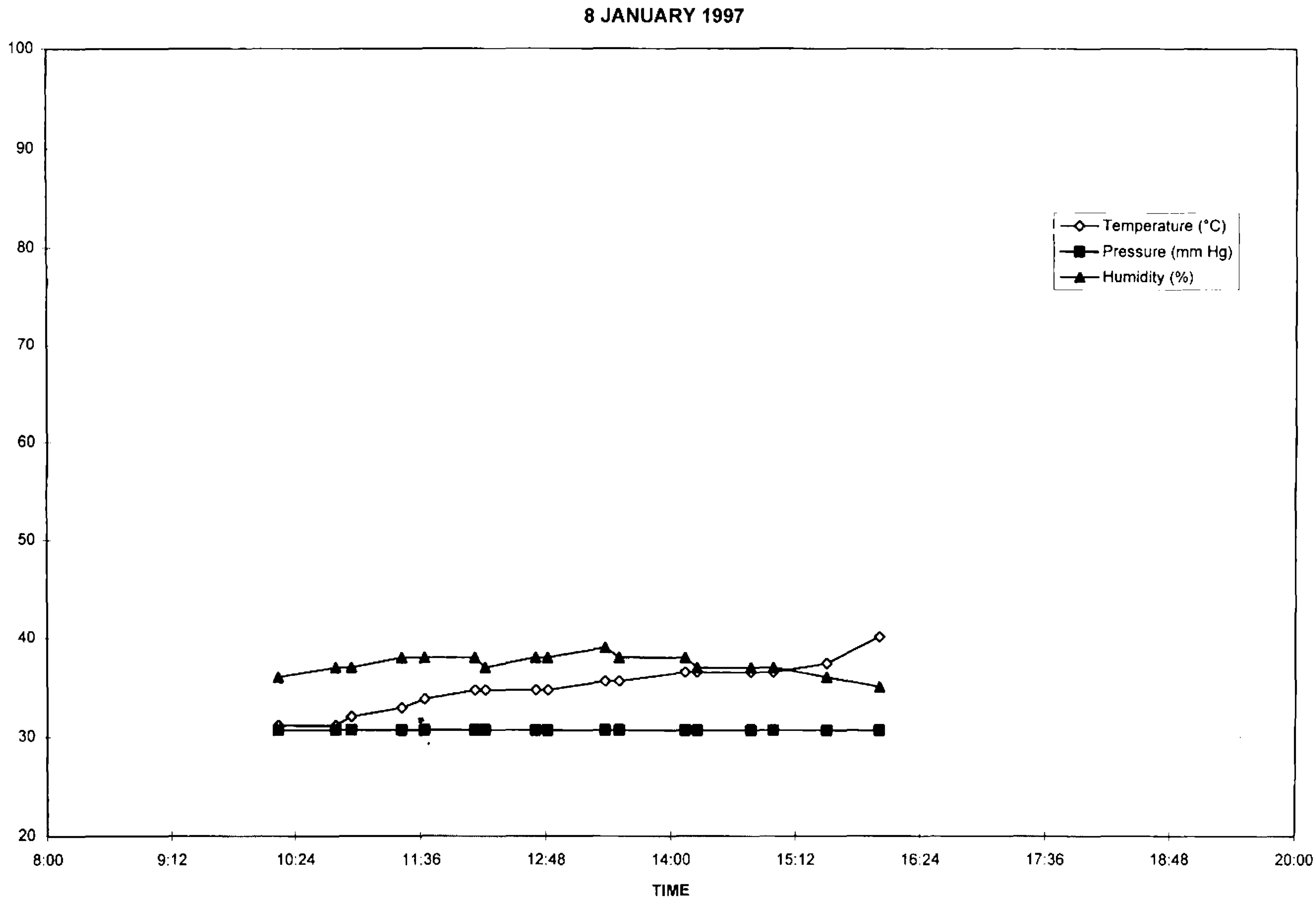
TIME
Temperature (°C)
Pressure (mm Hg)
Humidity (%)

GAS CHROMATOGRAMS

TEST 4-6



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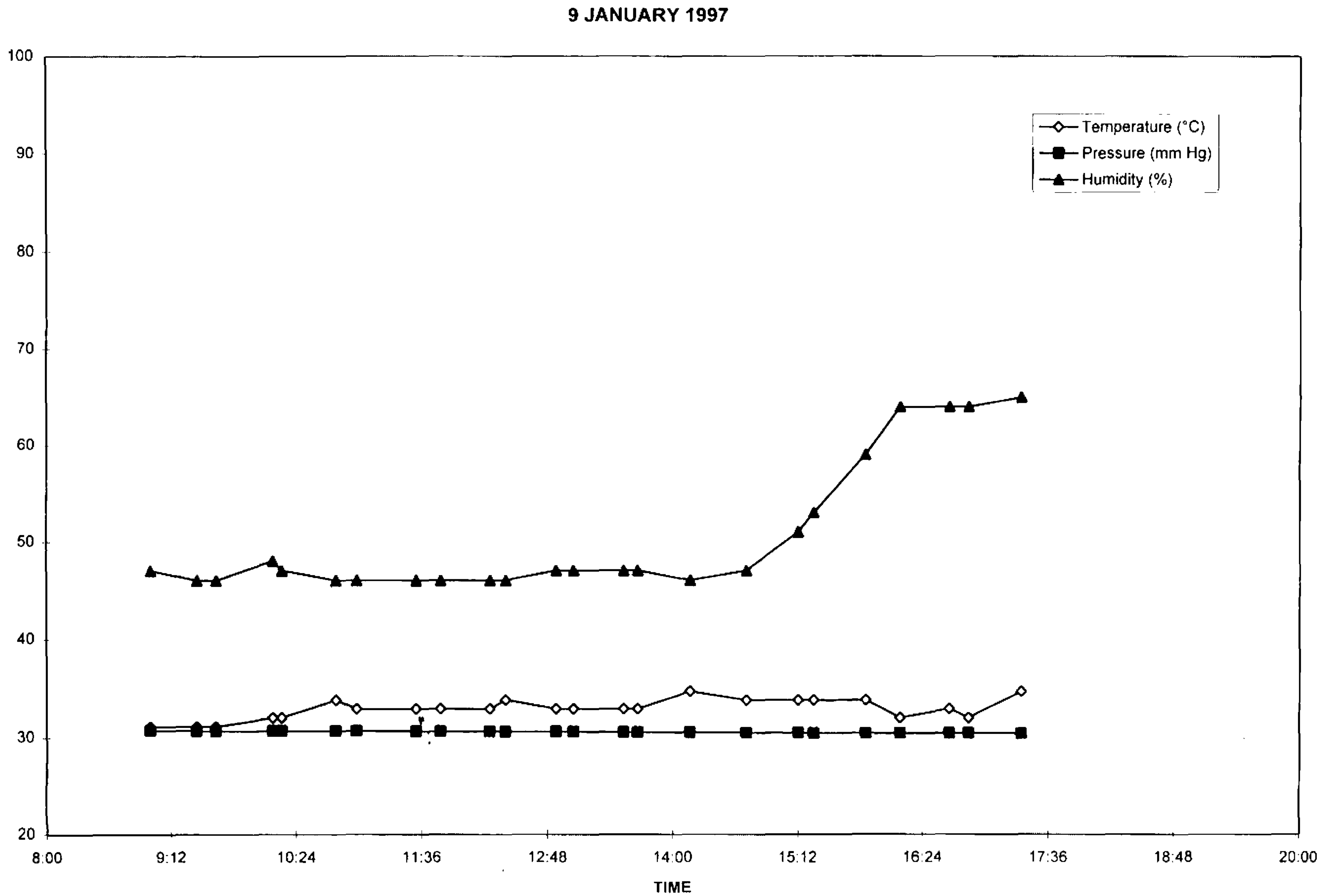
Humidity (%)



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TIME

2. Raw Emissions Test Data

a. IM 240 / ASM 2525

b. Individual GCMS Analyses (TACOM-ARDEC)

2. Raw Emissions Test Data

a. IM 240 / ASM 2525

Raw Emissions Test Data
IM 240 / ASM 2525

Metal Reaction, Inc.
Vitalizer
4 Dec 96

DOT Emission Testing Program

Date: 12/4/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1 & 9

	RL 25/25: NO_x	HC	CO	CO_2	RL 25/25: NO_x	HC	CO	CO_2
	39	0	0.07	14.90	139	6	0.13	14.7
	75	3	0.05	14.90				
	41	1	0.03	14.90				
Average:	51.7	1.3	0.05	14.90	139	6	0.13	14.7
σ:	20.2	1.5	0.02	0.00				

	IM240: NO_x	HC	CO	CO_2	IM240: NO_x	HC	CO	CO_2
	0.67	0.37	11.14	309.5	0.81	0.19	7.38	323.1
	0.58	0.28	10.60	315.5				
	0.61	0.22	9.95	319.6				
	0.62	0.15	7.11	321.6				
Average:	0.62	0.26	9.70	316.6	0.81	0.19	7.38	323.1
σ:	0.037	0.093	1.79	5.34				

DOT Emission Testing Program

Date: 12/4/96 Test #: 1-1

VIN: 12948 Description: Van - Dodge

Runs: 2 & 4

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	817	19	0.00	10.90		780	20	0	10.8
	808	20	0.00	10.80		819	20	0	10.8
	811	18	0.01	11.00		834	21	0.12	10.9
Average:	812.0	19.0	0.00	10.90		811	20.3	0.04	10.83
σ:	4.6	1.0	0.01	0.10		27.9	0.6	0.07	0.06

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	2.89	0.24	5.99	532.9		2.89	0.23	6.51	512.9
	2.95	0.26	6.08	540.3		2.76	0.24	5.93	520.9
	2.92	0.24	7.17	538.0		2.91	0.24	6.86	519.6
	2.92	0.24	6.50	535.2		2.73	0.27	7.75	531.9
Average:	2.92	0.25	6.44	536.6		2.82	0.25	6.76	521.3
σ:	0.024	0.010	0.54	3.23		0.091	0.017	0.76	7.87

Vitalizer

DOT Emission Testing Program

Date: 12/4/96 Test #: 1-2

VIN: 29823 Description: K-Car

Runs: 3 & 6

RL 25/25:

	NO_x	HC	CO	CO_2
	55	21	0.18	14.90
	75	25	0.19	14.90
	73	33	0.20	15.00
Average:	67.67	26.33	0.19	14.93
σ:	11.02	6.11	0.01	0.06

RL 25/25:

	NO_x	HC	CO	CO_2
	253	81	0.86	24.8
	174	60	0.73	14.3
	90	32	0.22	14.8
Average:	172.33	57.67	0.6	17.97
σ:	81.51	24.58	0.34	5.92

IM240:

	NO_x	HC	CO	CO_2
	0.71	0.41	11.96	302.0
	0.69	0.40	11.32	302.9
	0.64	0.42	11.22	307.6
	0.79	0.37	14.35	307.9
Average:	0.71	0.40	12.21	305.1
σ:	0.062	0.022	1.46	3.08

IM240:

	NO_x	HC	CO	CO_2
	0.74	0.34	13.25	309.8
	0.77	0.33	10.82	317
	0.81	0.37	8.14	314.7
	0.66	0.26	7.56	316.7
Average:	0.75	0.33	9.94	314.6
σ:	0.064	0.047	2.62	3.33

DOT Emission Testing Program

Date: 12/4/96 Test #: 1-3

VIN: 68742 Description: K-Car

Runs: 5 & 8

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	55	21	0.18	14.90	98	39	0.2	14.6
	75	25	0.19	14.90	98	36	0.17	14.7
	73	33	0.20	15.00	103	37	0.17	14.2
Average:	67.67	26.33	0.19	14.93	99.67	37.33	0.18	14.5
σ:	11.02	6.11	0.01	0.06	2.89	1.53	0.02	0.26

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	0.71	0.41	11.96	302.0	0.84	0.23	7.82	316.5
	0.69	0.40	11.32	302.9	0.74	0.29	7.12	315.8
	0.64	0.42	11.22	307.6	0.91	0.31	8.61	314.1
	0.79	0.37	14.35	307.9	0.78	0.25	6.16	320.2
Average:	0.71	0.40	12.21	305.1	0.82	0.27	7.43	316.7
σ:	0.062	0.022	1.46	3.08	0.074	0.037	1.04	2.57

Vitalizer

Raw Emissions Test Data
IM 240 / ASM 2525

Metal Reaction, Inc.
Vitalizer
5 Dec 96

DOT Emission Testing Program

Date: 12/5/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1 & 10

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	140	6	0.10	15.00	44	8	0.06	15
	66	5	0.05	14.90	99	7	0.11	14.9
	85	4	0.04	15.00	42	6	0.07	15.1
Average:	97.00	5.00	0.06	14.97	61.67	7	0.08	15
σ:	38.43	1.00	0.03	0.06	32.35	1	0.03	0.1

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	0.57	0.13	8.46	315.2	0.67	0.17	6.61	304.4
	0.51	0.10	6.10	319.9	0.6	0.15	6.9	300.9
	0.65	0.12	8.59	315.7	0.74	0.17	7.68	307.4
	0.63	0.12	8.44	323.0	0.68	0.13	7.27	303.7
Average:	0.59	0.12	7.90	318.5	0.67	0.16	7.12	304.1
σ:	0.063	0.013	1.20	3.69	0.057	0.019	0.46	2.67

DOT Emission Testing Program

Date: 12/5/96 Test #: 1-4

VIN: 08399 Description: Chevy

Runs: 3 & 7

RL 25/25:

	NO_x	HC	CO	CO_2
	158	10	0.07	14.90
	127	17	0.09	14.50
	151	17	0.12	14.80
Average:	145.33	14.67	0.09	14.73
σ:	16.26	4.04	0.03	0.21

RL 25/25:

	NO_x	HC	CO	CO_2
	361	23	0.01	13.1
	369	20	0	13
	457	23	0	13.2
Average:	395.67	22	0	13.1
σ:	53.27	1.73	0.01	0.1

IM240:

	NO_x	HC	CO	CO_2
	0.81	0.12	7.97	305.1
	0.85	0.12	8.42	304.0
	0.89	0.18	11.12	307.8
	0.78	0.12	9.03	307.2
Average:	0.83	0.14	9.14	306.0
σ:	0.048	0.030	1.39	1.78

IM240:

	NO_x	HC	CO	CO_2
	1.62	0.13	1.51	450.8
	1.69	0.13	1.62	457.7
	1.6	0.12	1.49	453.3
	1.61	0.14	4.14	456.9
Average:	1.63	0.13	2.19	454.7
σ:	0.041	0.008	1.3	3.21

Vitalizer

DOT Emission Testing Program

Date: 12/5/96 Test #: 1-5

VIN: 32760 Description: K-Car

Runs: 2 & 5

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	132	33	0.24	15.00		98	27	0.19	15
	129	30	0.25	14.90		86	30	0.23	14.9
	104	30	0.22	14.90		53	20	0.16	15.1
Average:	121.67	31.00	0.24	14.93		79	25.67	0.19	15
σ:	15.37	1.73	0.02	0.06		23.3	5.13	0.04	0.1

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	0.60	0.22	13.16	304.1		0.52	0.17	8.64	292.8
	0.54	0.27	13.21	308.8		0.49	0.22	9.1	292.7
	0.51	0.25	11.08	314.2		0.5	0.14	7.76	293.5
	0.51	0.25	11.88	312.1		0.57	0.19	9.1	297.1
Average:	0.54	0.25	12.33	309.8		0.52	0.18	8.65	294
σ:	0.042	0.021	1.04	4.40		0.036	0.034	0.63	2.08

Vitalizer

DOT Emission Testing Program

Date: 12/5/96 Test #: 1-6

VIN 28983 Description: K-Car

Runs 4 & 8

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	158	10	0.07	14.90	168	14	0.11	14.9
	127	17	0.09	14.50	134	12	0.11	14.9
	151	17	0.12	14.80	153	11	0.08	14.9
Average:	145.33	14.67	0.09	14.73	151.67	12.33	0.1	14.9
σ:	16.26	4.04	0.03	0.21	17.04	1.53	0.02	0

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	0.81	0.12	7.97	305.1	0.78	0.09	6.88	293.8
	0.85	0.12	8.42	304.0	0.76	0.14	10.06	293.1
	0.89	0.18	11.12	307.8	0.81	0.16	9.31	296.2
	0.78	0.12	9.03	307.2	0.9	0.17	7.79	305.9
Average:	0.83	0.14	9.14	306.0	0.81	0.14	8.51	297.3
σ:	0.048	0.030	1.39	1.78	0.062	0.036	1.44	5.92

Vitalizer

DOT Emission Testing Program

Date: 12/5/96 Test #: 1-7

VIN: 27311 Description: State Police Chevy Caprice

Runs: 6 & 9

RL 25/25:

	NO_x	HC	CO	CO_2
	442	1	0.00	14.70
	127	3	0.00	14.80
	453	1	0.00	15.00
Average:	340.67	1.67	0.00	14.83
σ:	185.12	1.15	0.00	0.15

RL 25/25:

	NO_x	HC	CO	CO_2
	610	8	0	14.9
	143	0	0	15
	144	2	0	15
Average:	299	3.33	0	14.97
σ:	269.33	4.16	0	0.06

IM240:

	NO_x	HC	CO	CO_2
	1.10	0.22	4.31	463.5
	1.11	0.10	1.84	462.4
	1.05	0.11	1.56	443.7
	1.12	0.07	1.02	444.4
Average:	1.10	0.13	2.18	453.5
σ:	0.031	0.066	1.46	10.92

IM240:

	NO_x	HC	CO	CO_2
	1.12	0.19	2.84	427.2
	1.28	0.1	1.12	441.5
	1.32	0.2	4.07	438.9
	1.24	0.08	1.49	445.9
Average:	1.24	0.14	2.38	438.4
σ:	0.086	0.061	1.35	7.99

Vitalizer

Raw Emissions Test Data
IM 240 / ASM 2525

Metal Reaction, Inc.
Vitalizer
6 Dec 96

DOT Emission Testing Program

Date: 12/6/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1 & 6

RL 25/25:

	NO_x	HC	CO	CO_2
	54	2	0.09	14.90
	36	2	0.11	14.90
	84	7	0.02	14.90
Average:	58.00	3.67	0.07	14.90
σ:	24.25	2.89	0.05	0.00

RL 25/25:

	NO_x	HC	CO	CO_2
	61	8	0.03	14.9
	30	1	0.01	14.3
	176	4	0.15	14.7
Average:	89	4.33	0.06	14.63
σ:	76.92	3.51	0.08	0.31

IM240:

	NO_x	HC	CO	CO_2
	0.68	0.16	8.09	309.4
	0.63	0.10	6.34	327.4
	0.71	0.14	6.70	325.8
	0.79	0.18	9.31	335.2
Average:	0.70	0.15	7.61	324.5
σ:	0.067	0.034	1.36	10.84

IM240:

	NO_x	HC	CO	CO_2
	0.62	0.14	5.97	313.2
	0.6	0.11	5.3	314.4
	0.68	0.13	5.68	319.8
	0.63	0.17	7.11	315.5
Average:	0.63	0.14	6.02	315.7
σ:	0.034	0.025	0.78	2.87

DOT Emission Testing Program

Date: 12/6/96 Test #: 1-8

VIN: 86665 Description: Buick

Runs 2 & 4

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	112	10	0.08	15.00		106	12	0.04	15
	18	10	0.04	25.40		114	12	0.05	14.9
	72	11	0.05	14.90		114	11	0.06	14.4
Average:	67.33	10.33	0.06	18.43		111.33	11.67	0.05	14.77
σ:	47.17	0.58	0.02	6.03		4.62	0.58	0.01	0.32

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	0.22	0.03	0.65	399.4		0.38	0.04	0.95	384.5
	0.24	0.04	4.35	385.0		0.34	0.04	1.2	388.8
	0.33	0.06	5.54	399.8		0.28	0.03	0.64	392.8
	0.22	0.07	5.58	439.5		0.3	0.04	2.73	405.9
Average:	0.25	0.05	4.03	405.9		0.33	0.04	1.38	393
σ:	0.053	0.018	2.32	23.42		0.044	0.005	0.93	9.24

Vitalizer

DOT Emission Testing Program

Date: 12/6/96 Test #: 1-9

VIN: 86770 Description: K-Car

Runs: 3 & 5

RL 25/25:

	NO_x	HC	CO	CO_2
	96	10	0.35	14.50
	47	26	1.17	13.90
	45	55	1.87	13.10
Average:	62.67	30.33	1.13	13.83
σ:	28.88	22.81	0.76	0.70

RL 25/25:

	NO_x	HC	CO	CO_2
	50	104	2.91	13
	64	43	1.96	13.2
	63	179	4.14	12
Average:	59	108.67	3	12.73
σ:	7.81	68.12	1.09	0.64

IM240:

	NO_x	HC	CO	CO_2
	0.59	0.41	23.47	319.1
	0.56	0.35	22.71	313.1
	0.51	0.42	26.23	311.8
	0.44	0.46	26.18	314.3
Average:	0.53	0.41	24.65	314.6
σ:	0.066	0.045	1.83	3.18

IM240:

	NO_x	HC	CO	CO_2
	0.36	0.66	38.43	259.8
	0.49	0.71	32.44	280.9
	0.45	0.79	40.72	275.7
	0.56	0.66	34.01	287.8
Average:	0.47	0.71	36.4	276.1
σ:	0.083	0.061	3.84	11.91

Vitalizer

Raw Emissions Test Data
IM 240 / ASM 2525

EnviroSource of NJ
Fuel-Cat
9 Dec 96

DOT Emission Testing Program

Date: 12/9/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1 & 15

RL 25/25:

	NO_x	HC	CO	CO_2
	159	1	0.02	15.00
	94	4	0.08	14.80
	64	5	0.03	14.50
Average:	105.67	3.33	0.04	14.77
σ:	48.56	2.08	0.03	0.25

RL 25/25:

	NO_x	HC	CO	CO_2
	93	3	0.01	15
	60	4	0.03	15.1
Average:	76.5	3.5	0.02	15.05
σ:	23.3	0.7	0.01	0.07

IM240:

	NO_x	HC	CO	CO_2
	0.81	0.14	7.28	308.4
	0.65	0.16	7.78	328.8
	0.65	0.18	7.24	321.8
	0.67	0.11	6.10	326.8
Average:	0.70	0.15	7.10	321.5
σ:	0.077	0.030	0.71	9.18

IM240:

	NO_x	HC	CO	CO_2
	0.8	0.15	3.28	318.9
	0.7	0.1	3.04	294.2
Average:	0.75	0.13	3.16	306.6
σ:	0.071	0.035	0.17	17.47

DOT Emission Testing Program

Date: 12/9/96 Test #: 2-1

VIN: 37166 Description: Red K-Car

Runs: 2 & 5

RL 25/25:

	NO_x	HC	CO	CO_2
	227	52	0.27	14.70
	231	59	0.33	14.70
	214	50	0.33	14.70
Average:	224.00	53.67	0.31	14.70
σ:	8.89	4.73	0.03	0.00

RL 25/25:

	NO_x	HC	CO	CO_2
	119	64	0.28	15.1
	202	63	0.32	14.9
	197	68	0.35	14.9
Average:	172.67	65	0.32	14.97
σ:	46.54	2.65	0.04	0.12

IM240:

	NO_x	HC	CO	CO_2
	0.84	0.34	9.33	301.6
	0.82	0.28	7.36	305.6
	0.92	0.26	8.01	314.3
	0.92	0.26	8.80	313.6
Average:	0.88	0.29	8.38	308.8
σ:	0.053	0.038	0.87	6.20

IM240:

	NO_x	HC	CO	CO_2
	0.96	0.34	9.78	300.4
	1.04	0.31	11.12	309.7
	1.07	0.38	10.34	312.7
	0.92	0.30	8.47	312.2
Average:	1	0.33	9.93	308.8
σ:	0.069	0.036	1.12	5.72

DOT Emission Testing Program

Date: 12/9/96 Test #: 2-2

VIN: 54002 Description: St Police White Chevy Caprice

Runs: 3 & 9

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	3108	155	0.66	14.20	3009	154	0.54	14.20
	3197	160	0.68	14.00	3036	149	0.52	14.10
	3144	156	0.64	14.10	3065	153	0.59	14.20
Average:	3149.67	157.00	0.66	14.10	3036.67	152.00	0.55	14.17
σ:	44.77	2.65	0.02	0.10	28.01	2.65	0.04	0.06

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	4.63	1.29	17.72	438.1	4.88	1.13	11.84	443.0
	4.67	1.17	14.64	444.5	4.84	1.16	10.99	439.1
	4.50	1.23	18.02	444.6	4.78	1.18	11.06	442.7
	4.87	1.24	14.99	449.1	4.75	1.18	11.63	449.3
Average:	4.67	1.23	16.34	444.1	4.81	1.16	11.38	443.5
σ:	0.153	0.049	1.77	4.52	0.059	0.024	0.42	4.24

DOT Emission Testing Program

Date: 12/9/96 Test #: 2-3

VIN: 86582 Description: White Van, RAM

Runs: 4 & 8

RL 25/25:

	NO_x	HC	CO	CO_2
	1089	21	0.01	11.30
	1219	24	0.01	11.40
	1135	20	0.01	11.40
Average:	1147.67	21.67	0.01	11.37
σ:	65.92	2.08	0.00	0.06

RL 25/25:

	NO_x	HC	CO	CO_2
	1090	20	0.01	11.40
	1141	21	0.01	11.40
	1217	20	0.01	11.50
Average:	1149.33	20.33	0.01	11.43
σ:	63.91	0.58	0.00	0.06

IM240:

	NO_x	HC	CO	CO_2
	2.90	0.27	5.22	536.5
	2.98	0.28	6.15	530.5
	3.11	0.35	13.66	530.3
	2.91	0.27	7.21	536.0
Average:	2.98	0.29	8.06	533.3
σ:	0.097	0.039	3.82	3.38

IM240:

	NO_x	HC	CO	CO_2
	3.13	0.29	9.42	517.0
	2.95	0.33	8.99	519.9
	2.84	0.23	5.40	518.1
	2.77	0.27	9.09	531.4
Average:	2.92	0.28	8.23	521.6
σ:	0.157	0.042	1.89	6.64

DOT Emission Testing Program

Date: 12/9/96 Test #: 2-4

VIN: 10406 Description: White K-Car

Runs: 7 & 10

RL 25/25:

	NO_x	HC	CO	CO_2
	283	20	0.01	14.30
	396	39	0.03	22.70
	228	23	0.00	14.20
Average:	302.33	27.33	0.01	17.07
σ:	85.65	10.21	0.02	4.88

RL 25/25:

	NO_x	HC	CO	CO_2
	198	20	0.00	14.10
	198	20	0.00	14.10
	200	21	0.00	14.10
Average:	198.67	20.33	0.00	14.10
σ:	1.15	0.58	0.00	0.00

IM240:

	NO_x	HC	CO	CO_2
	1.14	0.24	7.28	331.2
	1.24	0.27	6.94	334.5
	1.10	0.28	9.93	325.7
	1.19	0.30	8.48	333.0
Average:	1.17	0.27	8.16	331.1
σ:	0.061	0.025	1.35	3.84

IM240:

	NO_x	HC	CO	CO_2
	1.27	0.22	4.81	350.3
	1.16	0.17	3.84	325.7
	1.23	0.17	3.83	327.1
	1.19	0.20	5.28	329.6
Average:	1.21	0.19	4.44	333.2
σ:	0.048	0.024	0.72	11.53

DOT Emission Testing Program

Date: 12/9/96 Test #: 2-5

VIN: 49016 Description: Blue Chevy Caprice

Runs: 11 & 13

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	375	22	0.00	12.40	714	35	0.01	22.50
	449	32	0.01	12.80	386	25	0.01	12.60
	208	19	0.01	12.50	194	19	0.00	12.50
Average:	344.00	24.33	0.01	12.57	431.33	26.33	0.01	15.87
σ:	123.45	6.81	0.01	0.21	262.95	8.08	0.01	5.74

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	1.38	0.15	3.57	421.5	1.44	0.10	0.37	425.8
	1.36	0.11	0.45	414.2	1.28	0.09	0.10	388.7
	1.37	0.11	0.70	426.6	1.42	0.10	0.39	434.1
	1.39	0.11	0.76	424.3	1.36	0.12	0.37	426.6
Average:	1.38	0.12	1.37	421.7	1.38	0.10	0.31	418.8
σ:	0.013	0.020	1.47	5.39	0.072	0.013	0.14	20.41

DOT Emission Testing Program

Date: 12/9/96 Test #: 2-6

VIN: 25036 Description: St Police White Chevy Caprice

Runs: 12 & 14

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	1083	40	0.14	15.10	1072	44	0.25	15.00
	1296	40	0.19	14.80	1032	37	0.20	15.10
	1216	42	0.27	14.80	1000	39	0.16	15.10
Average:	1198.33	40.67	0.20	14.90	1034.67	40.00	0.20	15.07
σ:	107.59	1.15	0.07	0.17	36.07	3.61	0.05	0.06

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	2.47	0.36	3.48	445.4	1.68	0.31	1.17	341.0
	2.35	0.40	2.70	449.8	2.38	0.41	2.22	445.2
	2.35	0.42	2.52	451.9	2.41	0.39	1.76	446.8
	2.32	0.36	2.07	454.6	2.45	0.59	1.60	425.8
Average:	2.37	0.39	2.69	450.4	2.23	0.43	1.69	414.7
σ:	0.067	0.030	0.59	3.88	0.368	0.118	0.43	50.05

Raw Emissions Test Data
IM 240 / ASM 2525

EnviroSource of NJ
Fuel-Cat
10 Dec 96

DOT Emission Testing Program

Date: 12/10/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1 & 9

	RL 25/25: NO_x	HC	CO	CO_2	RL 25/25: NO_x	HC	CO	CO_2
	111	16	0.01	15.10	82	7	0.18	14.90
	48	3	0.02	14.70	53	2	0.03	15.10
	134	4	0.05	14.90				
Average:	97.67	7.67	0.03	14.90	67.5	4.5	0.11	15.00
σ:	44.52	7.23	0.02	0.20	20.5	3.5	0.11	0.14

	IM240: NO_x	HC	CO	CO_2	IM240: NO_x	HC	CO	CO_2
	0.79	0.10	6.86	331.4	0.71	0.13	4.70	308.7
	0.80	0.14	8.55	334.0	0.69	0.09	4.78	308.6
	0.73	0.11	8.14	342.3				
	0.78	0.13	8.25	341.2				
Average:	0.78	0.12	7.95	337.2	0.70	0.11	4.74	308.7
σ:	0.031	0.018	0.75	5.35	0.014	0.028	0.06	0.07

DOT Emission Testing Program

Date: 12/10/96 Test #: 2-7

VIN: 68774 Description: K-Car

Runs: 2 & 6

RL 25/25:

	NO_x	HC	CO	CO_2
	387	9	0.02	15.00
	419	10	0.03	14.90
	550	8	0.00	14.90
Average:	452.00	9.00	0.02	14.93
σ:	86.37	1.00	0.02	0.06

RL 25/25:

	NO_x	HC	CO	CO_2
	598	33	0.42	14.60
	644	9	0.00	14.90
	582	13	0.02	15.00
Average:	608.00	18.33	0.15	14.83
σ:	32.19	12.86	0.24	0.21

IM240:

	NO_x	HC	CO	CO_2
	1.31	0.25	8.35	329.1
	1.30	0.30	8.42	320.2
	1.25	0.42	9.52	328.8
	1.38	0.41	10.94	326.0
Average:	1.31	0.35	9.31	326.0
σ:	0.054	0.083	1.21	4.13

IM240:

	NO_x	HC	CO	CO_2
	1.44	0.35	9.29	321.9
	1.37	0.34	7.97	313.5
	1.43	0.32	8.34	316.4
	1.41	0.35	7.30	314.8
Average:	1.41	0.34	8.23	316.7
σ:	0.031	0.014	0.83	3.70

DOT Emission Testing Program

Date: 12/10/96 Test #: 2-8

VIN: 99843 Description: K-Car

Runs: 4 & 7

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	293	55	0.02	14.10		355	59	0.02	14.10
	298	57	0.01	13.80		296	55	0.02	13.90
	322	53	0.01	14.10		345	51	0.02	14.10
Average:	304.33	55.00	0.01	14.00		332.00	55.00	0.02	14.03
σ:	15.50	2.00	0.01	0.17		31.58	4.00	0.00	0.12

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
***	9.74	4.38	119.30	1589.0		1.29	0.51	13.04	275.8
	1.34	0.49	10.31	300.9		1.30	0.40	9.15	301.1
	1.31	0.38	8.48	304.3		1.35	0.42	11.43	302.6
	1.28	0.36	7.98	298.8		1.44	0.41	11.81	301.1
Average:	1.31	0.41	8.92	301.33		1.35	0.44	11.36	295.2
σ:	4.215	1.986	55.20	643.84		0.069	0.051	1.62	12.92

***Exhaust not on ignore data.

DOT Emission Testing Program

Date: 12/10/96 Test #: 2-9

VIN: 26275 Description: K-Car

Runs: 5 & 8

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	270	32	0.03	14.20	296	27	0.02	14.20
	272	28	0.02	14.20	284	33	0.02	14.20
	229	34	0.02	14.20	266	32	0.02	14.20
Average:	257.00	31.33	0.02	14.20	282.00	30.67	0.02	14.20
σ:	24.27	3.06	0.01	0.00	15.10	3.21	0.00	0.00

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	1.48	0.34	9.45	336.4	1.56	0.28	7.27	319.5
	1.51	0.40	11.41	337.5	1.51	0.42	10.08	325.4
	1.44	0.30	8.25	345.4	1.86	0.38	10.81	354.6
	1.44	0.29	8.73	353.6	1.57	0.41	11.09	332.0
Average:	1.47	0.33	9.46	343.2	1.63	0.37	9.81	332.9
σ:	0.034	0.050	1.39	7.99	0.159	0.064	1.75	15.36

Fuel Cat

Raw Emissions Test Data
IM 240 / ASM 2525

Compliance & Research Services, Inc.
Tailpipe Catalytic Converter
16 Dec 96

DOT Emission Testing Program

Date: 12/16/96　　Test #: Control

VIN: 31996　　Description: Control Car - 1988 Dodge

Runs: 1 & 10

	RL 25/25: NO_x	HC	CO	CO_2	RL 25/25: NO_x	HC	CO	CO_2
	52	5	0.02	15.00	102	1	0.09	14.8
	39	3	0.03	14.90	103	7	0.03	14.9
	56	4	0.02	14.90	34	3	0.02	14.8
Average:	49.00	4.00	0.02	14.93	79.67	3.67	0.05	14.83
σ:	8.89	1.00	0.01	0.06	39.55	3.06	0.04	0.06

	IM240: NO_x	HC	CO	CO_2	IM240: NO_x	HC	CO	CO_2
	0.69	0.12	6.23	317.4	0.88	0.11	6.28	352
	0.63	0.08	5.70	323.0	0.8	0.11	5.07	348.2
	0.64	0.11	6.34	335.1	0.84	0.11	5.92	341.8
	0.67	0.11	6.04	333.5				
Average:	0.66	0.11	6.08	327.3	0.84	0.11	5.76	347.3
σ:	0.028	0.017	0.28	8.48	0.04	0	0.62	5.15

DOT Emission Testing Program

Date: 12/16/96 Test #: 4-1

VIN: 29662 Description: Chevy Wagon

Runs: 3 & 6

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	388	36	0.14	14.90		174	14	0.02	14.9
	209	15	0.06	14.90		92	14	0.02	14.9
	692	44	0.09	14.90		127	12	0.02	14.9
Average:	429.67	31.67	0.10	14.90		131	13.3	0.02	14.9
σ:	244.18	14.98	0.04	0.00		41.1	1.2	0	0

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	1.16	0.12	1.94	388.4		1.1	0.09	1.21	331.7
	1.32	0.09	2.12	397.4		1.17	0.09	0.95	337.9
	1.40	0.10	1.84	371.5		1.05	0.1	2.65	349.1
						1.18	0.08	0.93	345.9
Average:	1.29	0.10	1.97	385.77		1.11	0.09	1.6	339.57
σ:	0.122	0.015	0.14	13.15		0.06	0.006	0.92	8.82

DOT Emission Testing Program

Date: 12/16/96 Test #: 4-2

VIN: 53039 Description: Police Cruiser

Runs: 9 & 8

RL 25/25:

	NO_x	HC	CO	CO_2
	1847	143	0.64	12.70
	2035	141	0.77	12.80
	1880	145	0.64	12.60
Average:	1920.7	143.0	0.68	12.70
σ:	100.4	2.0	0.08	0.10

RL 25/25:

	NO_x	HC	CO	CO_2
	1367	136	0.65	12.9
	912	127	0.48	13.1
	1154	133	0.59	13
Average:	1144.3	132	0.57	13
σ:	227.7	4.6	0.09	0.1

IM240:

	NO_x	HC	CO	CO_2
	3.71	1.10	16.79	432.5
	3.70	1.02	14.46	437.1
	3.65	1.20	18.24	447.8
	3.63	1.11	17.90	444.1
Average:	3.69	1.11	16.50	439.13
σ:	0.032	0.090	1.91	7.85

IM240:

	NO_x	HC	CO	CO_2
	2.06	0.85	6.5	457
	2.04	0.68	5.14	462.4
	2.11	0.74	5.72	467
Average:	2.07	0.76	5.79	462.13
σ:	0.036	0.086	0.68	5.01

DOT Emission Testing Program

Date: 12/16/96 Test #: 4-3

VIN: 32063 Description: Dodge Ram K-Car

Runs: 5 & 7

RL 25/25:

	NO_x	HC	CO	CO_2
	2771	79	0.48	10.80
	2786	82	0.62	10.90
	2879	91	0.74	10.90
Average:	2812.0	84.0	0.61	10.87
σ:	58.5	6.2	0.13	0.06

RL 25/25:

	NO_x	HC	CO	CO_2
	2631	55	0.07	11.4
	2565	53	0.08	11.6
	2632	48	0.06	11.8
Average:	2609.3	52	0.07	11.6
σ:	38.4	3.6	0.01	0.2

IM240:

	NO_x	HC	CO	CO_2
	5.13	0.96	33.88	553.6
	5.05	0.95	35.95	548.9
	5.21	0.96	35.84	547.1
	5.28	0.91	33.83	550.3
Average:	5.13	0.96	35.22	549.87
σ:	0.080	0.006	1.16	3.36

IM240:

	NO_x	HC	CO	CO_2
	4.73	0.44	6.09	581.9
	4.9	0.36	4.17	588.2
	4.6	0.38	4.62	591.6
	4.48	0.4	5.48	580.5
Average:	4.74	0.39	4.96	587.23
σ:	0.15	0.042	1	4.92

Raw Emissions Test Data
IM 240 / ASM 2525

Compliance & Research Services, Inc.
Tailpipe Catalytic Converter
17 Dec 96

DOT Emission Testing Program

Date: 12/17/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1

RL 25/25:

	NO_x	HC	CO	CO_2
	79	2	0.01	14.80
	59	3	0.01	14.70
	101	0	0.02	24.90
Average:	79.7	1.7	0.01	18.13
σ:	21.0	1.5	0.01	5.86

IM240:

	NO_x	HC	CO	CO_2
	0.78	0.18	7.48	308.8
	0.69	0.21	6.66	313.9
	0.73	0.17	8.23	317.9
	0.82	0.20	9.63	320.8
Average:	0.76	0.19	8.00	315.4
σ:	0.057	0.018	1.26	5.20

DOT Emission Testing Program

Date: 12/17/96 Test #: 4-4

VIN: 52548 Description: Chevy Police Cruiser

Runs: 2 & 5

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	229	9	0.08	14.80	25	7	0.07	14.8
	127	13	0.28	14.80	71	0	0.06	15
	100	17	0.30	14.80	21	9	0.09	14.8
Average:	152.0	13.0	0.22	14.80	39	5.3	0.07	14.87
σ:	68.0	4.0	0.12	0.00	27.8	4.7	0.02	0.12

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	0.96	0.38	4.18	486.2	0.85	0.62	0.97	436.6
	0.99	0.28	3.55	486.9	0.99	0.79	1.1	436.2
	1.41	0.54	6.46	662.1	1	0.62	0.9	431.9
	1.61	0.54	9.59	670.4	0.92	0.54	1.03	432.6
Average:	1.24	0.44	5.95	576.4	0.94	0.64	1	434.3
σ:	0.320	0.128	2.73	103.81	0.068	0.105	0.09	2.42

DOT Emission Testing Program

Date: 12/17/96 Test #: 4-5

VIN: 27954 Description: K-Car

Runs 3 & 6

RL 25/25:

	NO_x	HC	CO	CO_2
	131	5	0.17	14.50
	116	13	0.14	14.60
	273	14	0.11	14.70
Average:	173.3	10.7	0.14	14.60
σ:	86.6	4.9	0.03	0.10

RL 25/25:

	NO_x	HC	CO	CO_2
	34	4	0	14.4
	76	9	0	14.6
	29	2	0.02	14.6
Average:	46.3	5	0.01	14.53
σ:	25.8	3.6	0.01	0.12

IM240:

	NO_x	HC	CO	CO_2
	0.99	0.18	6.11	305.7
	1.12	0.23	8.52	312.4
	1.21	0.25	9.57	330.6
	1.24	0.22	7.68	339.0
Average:	1.14	0.22	7.97	321.9
σ:	0.112	0.029	1.46	15.50

IM240:

	NO_x	HC	CO	CO_2
	0.65	0.09	2.72	293.7
	0.72	0.07	1.82	295.3
	0.65	0.07	1.96	294
	0.64	0.09	4.45	308.6
Average:	0.67	0.08	2.74	297.9
σ:	0.037	0.012	1.21	7.17

DOT Emission Testing Program

Date: 12/17/96 Test #: 4-6

VIN: 05237 Description: Plymouth

Runs: 4 & 7

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	214	9	0.00	14.00	144	6	0	13.8
	203	10	0.00	14.00	141	0	0	13.9
	194	8	0.00	14.00	158	0	0	14.2
Average:	203.7	9.0	0.00	14.00	142.5	3	0	13.85
σ:	10.0	1.0	0.00	0.00	2.1	4.2	0	0.07

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	1.19	0.15	7.97	286.1	0.59	0.08	4.08	272.4
	1.02	0.12	4.81	285.9	0.57	0.07	2.54	279.6
	1.17	0.14	6.75	286.5	0.62	0.07	3.49	293.9
	1.01	0.09	5.09	289.6				
Average:	1.10	0.13	6.16	287.0	0.59	0.07	3.37	282
σ:	0.096	0.026	1.48	1.73	0.025	0.006	0.78	10.94

Raw Emissions Test Data
IM 240 / ASM 2525

Compliance & Research Services, Inc.
Tailpipe Catalytic Converter
18 Dec 96

DOT Emission Testing Program

Date: 12/18/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1 & 8

RL 25/25:

	NO_x	HC	CO	CO_2
	82	4	0.02	14.10
	95	5	0.02	14.80
	67	4	0.01	14.80
Average:	81.3	4.3	0.02	14.57
σ:	14.0	0.6	0.01	0.40

RL 25/25:

	NO_x	HC	CO	CO_2
	99	8	0.01	14.7
	115	2	0.15	14.5
	136	3	0.01	15
Average:	116.7	4.3	0.06	14.73
σ:	18.6	3.2	0.08	0.25

IM240:

	NO_x	HC	CO	CO_2
	0.71	0.16	7.43	300.2
	0.64	0.18	8.06	298.2
	0.55	0.17	6.82	301.7
	0.72	0.17	7.55	304.7
Average:	0.66	0.17	7.47	301.2
σ:	0.079	0.008	0.51	2.74

IM240:

	NO_x	HC	CO	CO_2
	1	0.18	5.65	299.9
	0.96	0.11	4.79	302.9
	1.03	0.11	4.76	299.8
	0.99	0.13	5.82	305.9
Average:	1	0.13	5.26	302.1
σ:	0.029	0.033	0.56	2.9

DOT Emission Testing Program

Date: 12/18/96 Test #: 4-7

VIN: 39746 Description: K-Car

Runs: 2 & 5

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	71	29	0.09	14.60	61	80	0.21	14.9
	18	38	0.26	14.50	51	88	0.28	14.9
	57	60	0.19	14.60	35	57	0.2	14.8
Average:	48.7	42.3	0.18	14.57	49	75	0.23	14.87
σ:	27.5	15.9	0.09	0.06	13.1	16.1	0.04	0.06

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	0.27	0.20	5.81	322.7	0.43	0.21	5.19	301.8
	0.37	0.20	6.09	321.2	0.46	0.19	4.31	300.7
	0.38	0.17	5.81	327.4	0.47	0.19	3.63	299.5
	0.38	0.20	4.97	334.3	0.46	0.15	4.74	300.8
Average:	0.35	0.19	5.67	326.4	0.46	0.19	4.47	300.7
σ:	0.054	0.015	0.48	5.89	0.017	0.025	0.66	0.94

DOT Emission Testing Program

Date: 12/18/96 Test #: 4-8

VIN: 09261 Description: Blue Ram Van

Runs: 3 & 6

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	1403	32	0.04	9.00		1260	15	0.01	8.8
	1410	32	0.04	9.10		1414	9	0.01	8.9
	1378	35	0.04	9.10		1335	16	0.01	8.9
Average:	1397.0	33.0	0.04	9.07		1336.3	13.3	0.01	8.87
σ:	16.8	1.7	0.00	0.06		77	3.8	0	0.06

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	5.45	0.50	8.71	653.3		5.52	0.21	0.08	608.9
	5.91	0.47	5.18	631.5		5.52	0.22	0.02	651.1
	5.87	0.55	5.18	618.7		5.72	0.25	0.23	613.9
	5.83	0.69	6.65	618.6		5.79	0.2	0.18	617.4
Average:	5.77	0.55	6.43	630.5		5.64	0.22	0.13	622.8
σ:	0.213	0.097	1.67	16.35		0.139	0.022	0.1	19.17

DOT Emission Testing Program

Date: 12/18/96 Test #: 4-9

VIN: 42293 Description: Ram Pick-Up

Runs: 4 & 7

RL 25/25:

	NO_x	HC	CO	CO_2
	293	12	0.00	10.50
	305	13	0.01	10.50
	314	14	0.01	10.50
Average:	304.0	13.0	0.01	10.50
σ:	10.5	1.0	0.01	0.00

RL 25/25:

	NO_x	HC	CO	CO_2
	261	0	0.01	10.3
	263	13	0	10.3
	296	0	0.01	10.3
Average:	273.3	4.3	0.01	10.3
σ:	19.7	7.5	0.01	0

IM240:

	NO_x	HC	CO	CO_2
	1.92	0.17	1.14	506.2
	1.98	0.19	1.80	500.4
	2.12	0.18	2.12	504.8
	2.35	0.23	1.12	508.5
Average:	2.09	0.19	1.55	505.0
σ:	0.191	0.026	0.50	3.41

IM240:

	NO_x	HC	CO	CO_2
	1.91	0.15	0.15	496.6
	2.07	0.14	0.01	496.1
	1.9	0.14	0.16	454.5
Average:	1.96	0.14	0.11	482.4
σ:	0.095	0.006	0.08	24.16

Raw Emissions Test Data
IM 240 / ASM 2525

INSET Industries, Inc.
INSET Fuel Stabilizer
19 Dec 96

DOT Emission Testing Program

Date: 12/19/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1&14

RL 25/25:

	NO_x	HC	CO	CO_2
	70	3	0.02	14.90
	52	0	0.02	14.80
	100	4	0.01	14.90
Average:	74.0	2.3	0.02	14.87
σ:	24.2	2.1	0.01	0.06

RL 25/25:

	NO_x	HC	CO	CO_2
	127	4	0.07	15.00
	94	5	0.03	15.00
	210	11	0.13	23.00
Average:	143.7	6.7	0.08	17.67
σ:	59.8	3.8	0.05	4.62

IM240:

	NO_x	HC	CO	CO_2
	0.69	0.07	5.02	318.3
	0.65	0.10	5.06	319.6
	0.62	0.09	5.63	318.7
	0.66	0.10	6.21	317.7
Average:	0.66	0.09	5.48	318.6
σ:	0.03	0.01	0.56	0.8

IM240:

	NO_x	HC	CO	CO_2
	0.84	0.08	3.97	333.7
	0.83	0.09	4.53	335.4
	0.74	0.10	4.39	335.8
	0.77	0.09	6.41	335.3
Average:	0.80	0.09	4.83	335.1
σ:	0.05	0.01	1.08	0.9

Inset

DOT Emission Testing Program

Date: 12/19/96 Test #: 5-1

VIN: 04759 Description: K-Car

Runs: 2&5

RL 25/25:

	NO_x	HC	CO	CO_2
	329	14	0.02	13.60
	317	14	0.03	13.60
	311	15	0.02	13.50
Average:	319.0	14.3	0.02	13.57
σ:	9.2	0.6	0.01	0.06

RL 25/25:

	NO_x	HC	CO	CO_2
	340	12	0.02	13.90
	361	18	0.02	13.80
	317	22	0.02	13.80
Average:	339.3	17.3	0.02	13.83
σ:	22.0	5.0	0.00	0.06

IM240:

	NO_x	HC	CO	CO_2
	1.22	0.29	10.62	313.9
	1.18	0.43	15.82	310.9
	1.04	0.37	14.81	313.3
	1.20	0.36	13.22	314.4
Average:	1.16	0.36	13.62	313.1
σ:	0.08	0.06	2.27	1.5

IM240:

	NO_x	HC	CO	CO_2
	1.22	0.30	8.78	318.1
	1.32	0.44	15.45	316.9
	1.35	0.35	11.70	338.4
	1.37	0.44	18.20	314.8
Average:	1.32	0.38	13.53	322.1
σ:	0.07	0.07	4.14	11.0

Inset

DOT Emission Testing Program

Date: 12/19/96 Test #: 5-2

VIN: 18650 Description: Pick-up

Runs: 3&6

RL 25/25:

	NO_x	HC	CO	CO_2
	2056	19	0.00	11.30
	1980	29	0.00	11.30
	1866	18	0.00	11.40
Average:	1967.3	22.0	0.00	11.33
σ:	95.6	6.1	0.00	0.06

RL 25/25:

	NO_x	HC	CO	CO_2
	2530	21	0.00	10.90
	2321	20	0.00	11.10
	2253	14	0.00	11.20
Average:	2368.0	18.3	0.00	11.07
σ:	144.4	3.8	0.00	0.15

IM240:

	NO_x	HC	CO	CO_2
	3.52	0.13	0.41	502.1
	3.51	0.13	0.58	499.2
	3.74	0.13	0.09	515.3
	3.83	0.12	0.00	494.3
Average:	3.65	0.13	0.27	502.7
σ:	0.16	0.01	0.27	9.0

IM240:

	NO_x	HC	CO	CO_2
	3.26	0.14	0.42	491.8
	2.99	0.14	0.60	488.8
	3.16	0.13	0.30	495.8
	2.89	0.14	0.67	513.1
Average:	3.08	0.14	0.50	497.4
σ:	0.17	0.01	0.17	10.9

Inset

DOT Emission Testing Program

Date: 12/19/96 Test #: 5-3

VIN: 13440 Description: K-Car

Runs: 4&7

	RL 25/25: NO_x	HC	CO	CO_2		RL 25/25: NO_x	HC	CO	CO_2
	623	13	0.00	14.30		837	6	0.00	13.50
	608	2	0.00	14.30		574	2	0.00	13.90
	436	2	0.00	14.30		1003	7	0.00	13.80
Average:	555.7	5.7	0.00	14.30		804.7	5.0	0.00	13.73
σ:	103.9	6.4	0.00	0.00		216.3	2.6	0.00	0.21

	IM240: NO_x	HC	CO	CO_2		IM240: NO_x	HC	CO	CO_2
	1.39	0.10	6.54	334.3		1.37	0.09	3.98	333.9
	1.48	0.10	7.68	336.9		1.56	0.06	1.94	340.0
	1.58	0.15	8.96	342.7		1.56	0.06	1.76	339.4
	1.49	0.10	9.09	343.1		1.71	0.07	3.40	339.5
Average:	1.49	0.11	8.07	339.3		1.55	0.07	2.77	338.2
σ:	0.08	0.03	1.20	4.3		0.14	0.01	1.09	2.9

Inset

DOT Emission Testing Program

Date: 12/19/96 Test #: 5-4

VIN: 85054 Description: Police Cruiser

Runs: 8&10

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	222	12	0.09	14.60	375	18	0.08	14.90
	206	11	0.06	14.50	454	22	0.05	14.30
	224	10	0.07	14.90	359	15	0.04	14.40
Average:	217.3	11.0	0.07	14.67	396.0	18.3	0.06	14.53
σ:	9.9	1.0	0.02	0.21	50.9	3.5	0.02	0.32

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	1.31	0.25	10.29	487.1	1.27	0.16	3.83	491.1
	1.20	0.25	9.39	483.6	1.32	0.17	3.61	496.8
	1.27	0.25	11.27	488.1	1.18	0.19	4.16	561.5
	1.23	0.30	13.77	492.2	1.40	0.16	3.53	505.9
Average:	1.25	0.26	11.18	487.8	1.29	0.17	3.78	513.8
σ:	0.05	0.02	1.89	3.5	0.09	0.01	0.28	32.4

Inset

DOT Emission Testing Program

Date: 12/19/96 Test #: 5-5

VIN: 26487 Description: K-Car

Runs: 9&11

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	272	9	0.00	13.90		253	7	0.00	13.90
	215	9	0.00	14.00		312	12	0.00	13.50
	171	9	0.00	14.00		279	12	0.00	13.90
Average:	219.3	9.0	0.00	13.97		281.3	10.3	0.00	13.77
σ:	50.6	0.0	0.00	0.06		29.6	2.9	0.00	0.23

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	1.17	0.11	4.30	322.4		1.19	0.10	3.52	323.2
	1.14	0.11	5.14	329.1		1.25	0.14	7.51	320.2
	1.19	0.13	6.35	330.3		1.24	0.11	3.89	323.3
	1.20	0.10	4.36	335.9		1.30	0.11	3.69	329.4
Average:	1.18	0.11	5.04	329.4		1.25	0.12	4.65	324.0
σ:	0.03	0.01	0.96	5.5		0.05	0.02	1.91	3.9

Inset

DOT Emission Testing Program

Date: 12/19/96 Test #: 5-6

VIN: 51429 Description: Police Cruiser

Runs: 12&13

	RL 25/25: NO_x	HC	CO	CO_2	RL 25/25: NO_x	HC	CO	CO_2
	95	2	0.00	14.80	496	18	0.00	15.20
	150	1	0.00	14.70	548	3	0.00	14.90
	244	1	0.00	14.80	554	4	0.00	15.10
Average:	163.0	1.3	0.00	14.77	532.7	8.3	0.00	15.07
σ:	75.3	0.6	0.00	0.06	31.9	8.4	0.00	0.15

	IM240: NO_x	HC	CO	CO_2	IM240: NO_x	HC	CO	CO_2
	0.77	0.09	0.15	445.4	0.74	0.06	1.77	449.7
	0.80	0.07	0.02	457.0	0.76	0.06	0.08	462.4
	0.67	0.07	0.09	465.2	0.75	0.08	0.10	453.2
	0.79	0.07	0.14	457.2	0.78	0.07	0.00	450.4
Average:	0.76	0.08	0.10	456.2	0.76	0.07	0.49	453.9
σ:	0.06	0.01	0.06	8.2	0.02	0.01	0.86	5.8

Inset

Raw Emissions Test Data
IM 240 / ASM 2525

INSET Industries, Inc.
INSET Fuel Stabilizer
20 Dec 96

DOT Emission Testing Program

Date: 12/20/96 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1&8

RL 25/25:

	NO_x	HC	CO	CO_2
	117	6	0.10	14.90
	229	3	0.06	15.10
	292	3	0.06	15.00
Average:	212.7	4.0	0.07	15.00
σ:	88.6	1.7	0.02	0.10

RL 25/25:

	NO_x	HC	CO	CO_2
	84	7	0.03	15.20
	60	3	0.02	15.30
	235	4	0.05	15.20
Average:	126.3	4.7	0.03	15.23
σ:	94.9	2.1	0.02	0.06

IM240:

	NO_x	HC	CO	CO_2
	0.75	0.12	10.53	316.2
	0.65	0.08	7.44	334.7
	0.68	0.11	8.53	342.6
	0.70	0.10	7.16	339.0
Average:	0.70	0.10	8.42	333.1
σ:	0.04	0.02	1.53	11.7

IM240:

	NO_x	HC	CO	CO_2
	0.80	0.12	7.27	330.5
	0.61	0.11	8.15	339.7
	0.74	0.12	8.75	332.1
	0.81	0.13	11.31	371.1
Average:	0.74	0.12	8.87	343.4
σ:	0.09	0.01	1.74	18.9

Inset

DOT Emission Testing Program

Date: 12/20/96 Test #: 5-7

VIN: 03825 Description: Van

Runs: 2&4

RL 25/25:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	2908	16	0.00	10.20	2676	15	0.00	10.20
	3504	20	0.00	10.30	2838	19	0.00	10.20
	3498	22	0.00	10.40	3169	13	0.00	10.50
Average:	3303.3	19.3	0.00	10.30	2894.3	15.7	0.00	10.30
σ:	342.4	3.1	0.00	0.10	251.3	3.1	0.00	0.17

IM240:

	NO_x	HC	CO	CO_2	NO_x	HC	CO	CO_2
	5.53	0.12	1.90	467.6	4.63	0.12	1.91	456.7
	5.81	0.11	1.93	456.3	4.79	0.10	1.84	449.6
	5.78	0.11	1.83	472.4	4.87	0.11	1.82	459.8
	5.33	0.10	1.96	464.2	5.08	0.10	1.81	456.3
Average:	5.61	0.11	1.91	465.1	4.84	0.11	1.85	455.6
σ:	0.23	0.01	0.06	6.8	0.19	0.01	0.05	4.3

Inset

DOT Emission Testing Program

Date: 12/20/96 Test #: 5-8

VIN: 91881 Description: Pick-up

Runs: 3&5

RL 25/25:

	NO_x	HC	CO	CO_2
	2321	45	0.04	11.40
	2090	71	0.16	11.90
	4037	102	0.19	22.60
Average:	2816.0	72.7	0.13	15.30
σ:	1063.7	28.5	0.08	6.33

RL 25/25:

	NO_x	HC	CO	CO_2
	2055	42	0.02	10.91
	2165	44	0.03	11.10
	2183	47	0.05	11.40
Average:	2134.3	44.3	0.03	11.14
σ:	69.3	2.5	0.02	0.25

IM240:

	NO_x	HC	CO	CO_2
	2.40	0.46	22.10	528.6
	2.61	0.51	25.89	514.2
	2.71	0.51	26.18	507.4
	2.67	0.46	23.10	513.8
Average:	2.60	0.49	24.32	516.0
σ:	0.14	0.03	2.03	9.0

IM240:

	NO_x	HC	CO	CO_2
	2.78	0.45	15.51	544.8
	2.79	0.47	16.79	550.5
	2.94	0.48	19.17	533.7
	2.89	0.43	17.09	508.7
Average:	2.85	0.46	17.14	534.4
σ:	0.08	0.02	1.52	18.5

Inset

DOT Emission Testing Program

Date: 12/20/96 Test #: 5-9

VIN: 99768 Description: K-Car

Runs: 6&7

RL 25/25:

	NO_x	HC	CO	CO_2
	270	11	0.02	14.00
	268	19	0.03	14.00
	236	18	0.02	13.60
Average:	258.0	16.0	0.02	13.87
σ:	19.1	4.4	0.01	0.23

RL 25/25:

	NO_x	HC	CO	CO_2
	262	15	0.03	14.20
	337	19	0.02	14.00
	266	18	0.02	14.10
Average:	288.3	17.3	0.02	14.10
σ:	42.2	2.1	0.01	0.10

IM240:

	NO_x	HC	CO	CO_2
	1.13	0.17	8.45	364.3
	1.05	0.16	7.95	323.0
	1.12	0.21	12.49	323.6
	1.40	0.24	11.99	333.9
Average:	1.18	0.20	10.22	336.2
σ:	0.15	0.04	2.35	19.4

IM240:

	NO_x	HC	CO	CO_2
	1.18	0.19	11.13	322.5
	1.19	0.19	10.05	327.1
	1.16	0.21	9.62	338.4
Average:	1.18	0.20	10.27	329.3
σ:	0.02	0.01	0.78	8.2

Inset

Raw Emissions Test Data
IM 240 / ASM 2525

Enginewity Systems, Inc.
Engine Cleaning
8 Jan 97

DOT Emission Testing Program

Date: 1/8/97 Test #: Control

VIN: 31996 Description: Control Car - 1988 Dodge

Runs: 1

RL 25/25:

	NO_x	HC	CO	CO_2
	107	1	0.01	15.00
	56	1	0.02	14.90
	50	0	0.02	14.30
Average:	71.0	0.7	0.02	14.73
σ:	31.3	0.6	0.01	0.38

IM240:

	NO_x	HC	CO	CO_2
	0.72	0.12	8.75	315.5
	0.70	0.17	8.82	320.7
	0.70	0.10	7.64	317.9
	0.76	0.10	6.91	330.0
Average:	0.72	0.12	8.03	321.0
σ:	0.03	0.03	0.92	6.3

DOT Emission Testing Program

Date: 1/8/97 Test #: 3-1

VIN: 82021 Description: Caprice

Runs: 2&5

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	390	13	0.06	12.60		269	15	0.05	12.70
	189	16	0.03	12.20		322	21	0.05	12.80
	258	21	0.13	13.30		337	10	0.05	12.60
Average:	279.0	16.7	0.07	12.70		309.3	15.3	0.05	12.70
σ:	102.1	4.0	0.05	0.56		35.7	5.5	0.00	0.10

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	1.23	0.15	5.52	461.5		1.25	0.18	7.14	452.6
	1.39	0.17	6.89	473.9		1.26	0.18	6.82	444.3
	1.17	0.18	7.99	440.8		1.24	0.16	6.86	448.3
	1.14	0.16	6.36	457.7		9.12	1.42	63.32	1614.0
Average:	1.23	0.17	6.69	458.5		3.22	0.49	21.04	739.8
σ:	0.11	0.01	1.03	13.7		3.94	0.62	28.19	582.8

DOT Emission Testing Program

Date: 1/8/97 Test #: 3-2

VIN: 33113 Description: K-Car Wagon

Runs: 3&7

RL 25/25:

	NO_x	HC	CO	CO_2
	301	17	0.05	14.20
	379	22	0.02	14.20
	316	24	0.02	14.30
Average:	332.0	21.0	0.03	14.23
σ:	41.4	3.6	0.02	0.06

RL 25/25:

	NO_x	HC	CO	CO_2
	408	23	0.04	14.10
	440	25	0.04	14.30
	453	27	0.05	14.20
Average:	433.7	25.0	0.04	14.20
σ:	23.2	2.0	0.01	0.10

IM240:

	NO_x	HC	CO	CO_2
	0.86	0.15	8.81	301.3
	0.81	0.17	9.22	301.7
	0.82	0.15	8.59	307.5
	0.78	0.18	11.25	305.9
Average:	0.82	0.16	9.47	304.1
σ:	0.03	0.02	1.22	3.1

IM240:

	NO_x	HC	CO	CO_2
	0.94	0.15	6.17	304.4
	0.87	0.16	7.84	309.0
	0.87	0.15	7.33	301.6
	0.97	0.16	6.97	300.8
Average:	0.91	0.16	7.08	304.0
σ:	0.05	0.01	0.70	3.7

DOT Emission Testing Program

Date: 1/8/97 Test #: 3-3

VIN: 50733 Description: Cruiser

Runs: 4&8

RL 25/25:

	NO_x	HC	CO	CO_2
	12	11	0.03	14.80
	10	3	0.03	14.70
	10	14	0.04	14.90
Average:	10.7	9.3	0.03	14.80
σ:	1.2	5.7	0.01	0.10

RL 25/25:

	NO_x	HC	CO	CO_2
	339	2	0.00	14.90
	347	5	0.00	15.00
	332	4	0.00	14.80
Average:	339.3	3.7	0.00	14.90
σ:	7.5	1.5	0.00	0.10

IM240:

	NO_x	HC	CO	CO_2
	0.48	0.22	3.14	463.4
	0.48	0.20	2.54	466.3
	0.47	0.24	2.45	460.1
	0.54	0.23	3.45	467.6
Average:	0.49	0.22	2.90	464.4
σ:	0.03	0.02	0.48	3.3

IM240:

	NO_x	HC	CO	CO_2
	0.53	0.22	3.09	441.9
	0.50	0.22	6.08	448.2
	0.56	0.22	2.50	455.1
	0.65	0.23	6.37	457.8
Average:	0.56	0.22	4.51	450.8
σ:	0.06	0.00	2.00	7.2

DOT Emission Testing Program

Date: 1/8/97 Test #: 3-4

VIN: 03369 Description: Van

Runs: 6&9

RL 25/25:

NO_x	HC	CO	CO_2
1154	20	0.18	12.80
1206	19	0.20	12.90
827	2	0.10	12.70
Average: 1062.3	13.7	0.16	12.80
σ: 205.5	10.1	0.05	0.10

RL 25/25:

NO_x	HC	CO	CO_2
1435	22	0.17	13.00
837	8	0.09	12.60
825	8	0.12	12.70
1032.3	12.7	0.13	12.77
348.8	8.1	0.04	0.21

IM240:

NO_x	HC	CO	CO_2
3.99	0.47	17.86	625.4
3.80	0.38	15.56	618.5
4.64	0.37	16.61	659.8
5.11	0.35	14.55	700.4
Average: 4.39	0.39	16.15	651.0
σ: 0.60	0.05	1.42	37.5

IM240:

NO_x	HC	CO	CO_2
4.40	0.43	13.82	632.3
4.15	0.32	9.57	636.0
4.35	0.31	9.85	641.4
4.30	0.35	11.08	636.6
0.13	0.07	2.38	4.6

Raw Emissions Test Data
IM 240 / ASM 2525

Enginewity Systems, Inc.
Engine Cleaning
9 Jan 97

DOT Emission Testing Program

Date: 1/9/97 Test #: Control

VIN: 31996 Description: Control - 1988 Dodge

Runs: 1&12

RL 25/25:

	NO_x	HC	CO	CO_2
	174	2	0.02	14.80
	118	3	0.01	14.80
	320	19	0.11	31.00
Average:	204.0	8.0	0.05	20.20
σ:	104.3	9.5	0.06	9.35

RL 25/25:

	NO_x	HC	CO	CO_2
	138	0	0.01	14.90
	58	4	0.06	14.90
	121	6	0.09	14.90
Average:	105.7	3.3	0.05	14.90
σ:	42.1	3.1	0.04	0.00

IM240:

	NO_x	HC	CO	CO_2
	0.72	0.13	10.63	316.8
	0.62	0.12	6.71	327.5
	0.72	0.15	10.29	328.7
	0.68	0.20	11.57	330.8
Average:	0.69	0.15	9.80	326.0
σ:	0.05	0.04	2.13	6.3

IM240:

	NO_x	HC	CO	CO_2
	0.48	0.09	6.30	303.8
	0.63	0.11	6.82	336.2
	0.78	0.10	7.58	337.1
	0.69	0.11	9.99	336.1
Average:	0.65	0.10	7.67	328.3
σ:	0.13	0.01	1.63	16.3

DOT Emission Testing Program

Date: 1/9/97 Test #: 3-5

VIN: 04758 Description: K-Car

Runs: 2&6

RL 25/25:

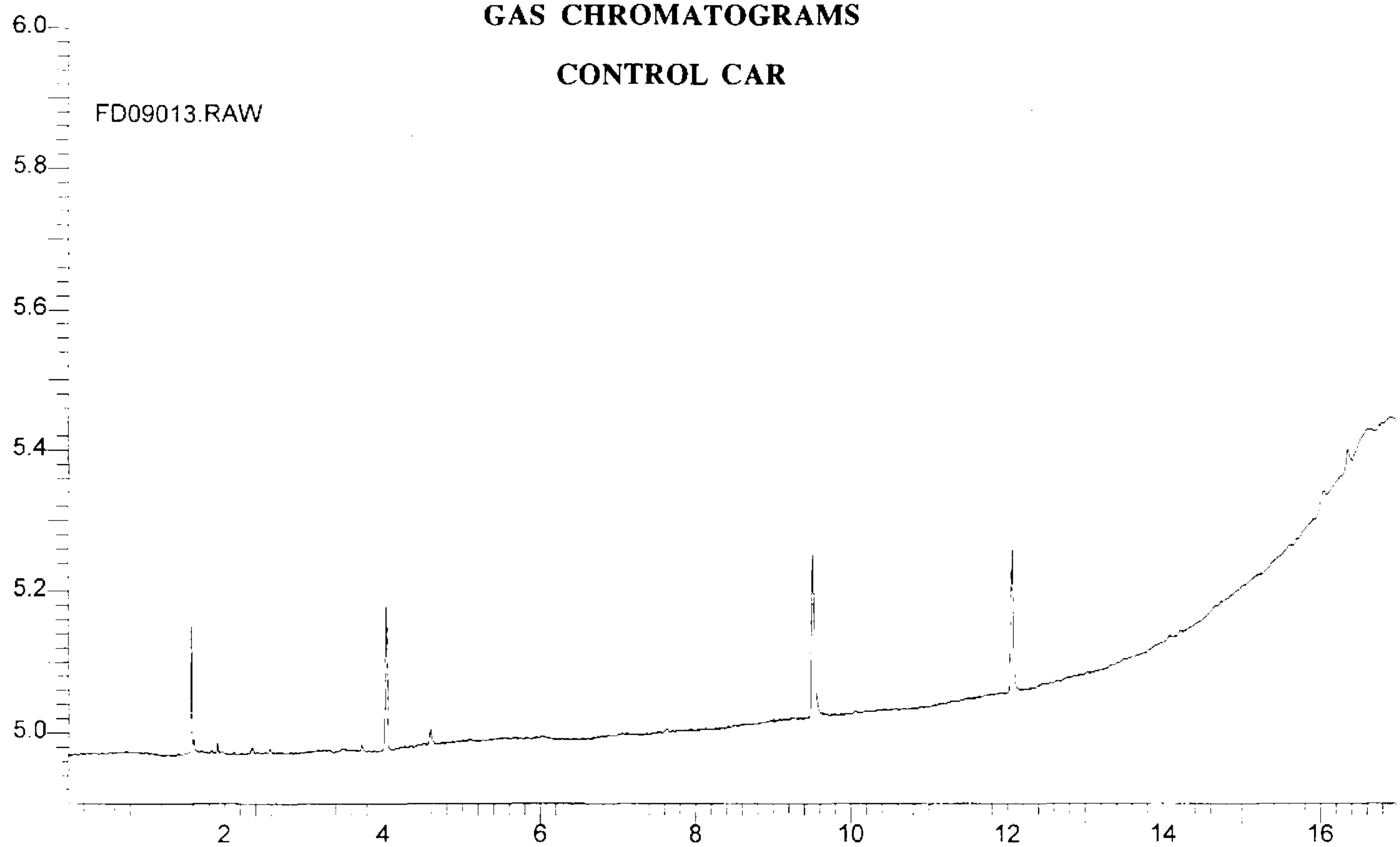
	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	157	3	0.00	13.70		153	212	6.05	10.70
	129	6	0.00	13.70		135	243	6.48	10.50
	300	7	0.00	13.70		173	845	9.99	6.20
Average:	195.3	5.3	0.00	13.70		153.7	433.3	7.51	9.13
σ:	91.7	2.1	0.00	0.00		19.0	356.9	2.16	2.54

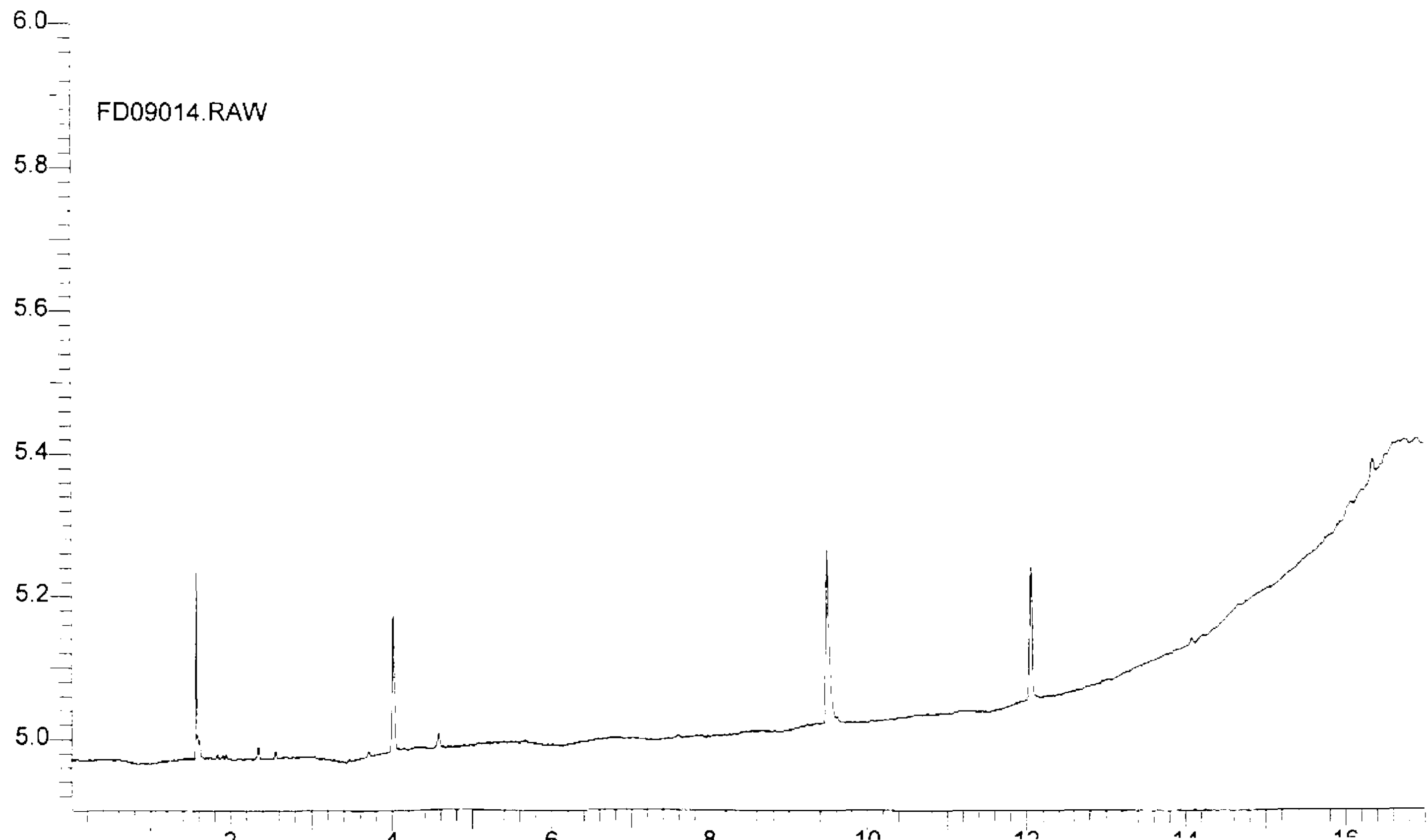
IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	0.76	0.16	6.88	324.6		0.57	1.70	74.32	259.7
	0.84	0.12	5.92	330.4		0.48	2.51	107.20	236.4
	0.76	0.10	5.55	330.2		0.10	3.48	153.10	204.9
	0.89	0.10	6.26	348.7		0.10	3.83	163.50	202.8
Average:	0.81	0.12	6.15	333.5		0.31	2.88	124.53	226.0
σ:	0.06	0.03	0.57	10.5		0.25	0.96	41.46	27.2

GAS CHROMATOGRAMS

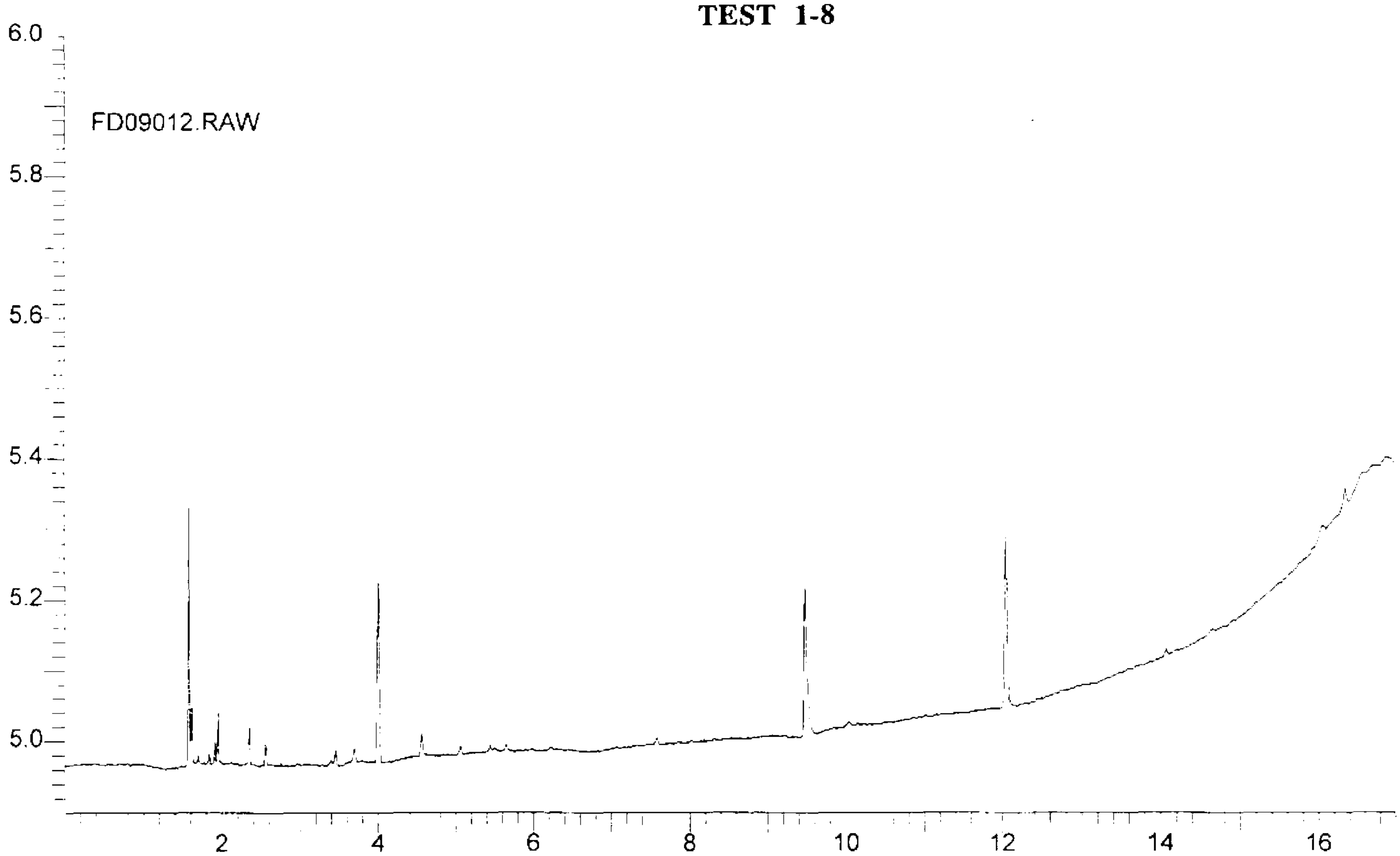
CONTROL CAR

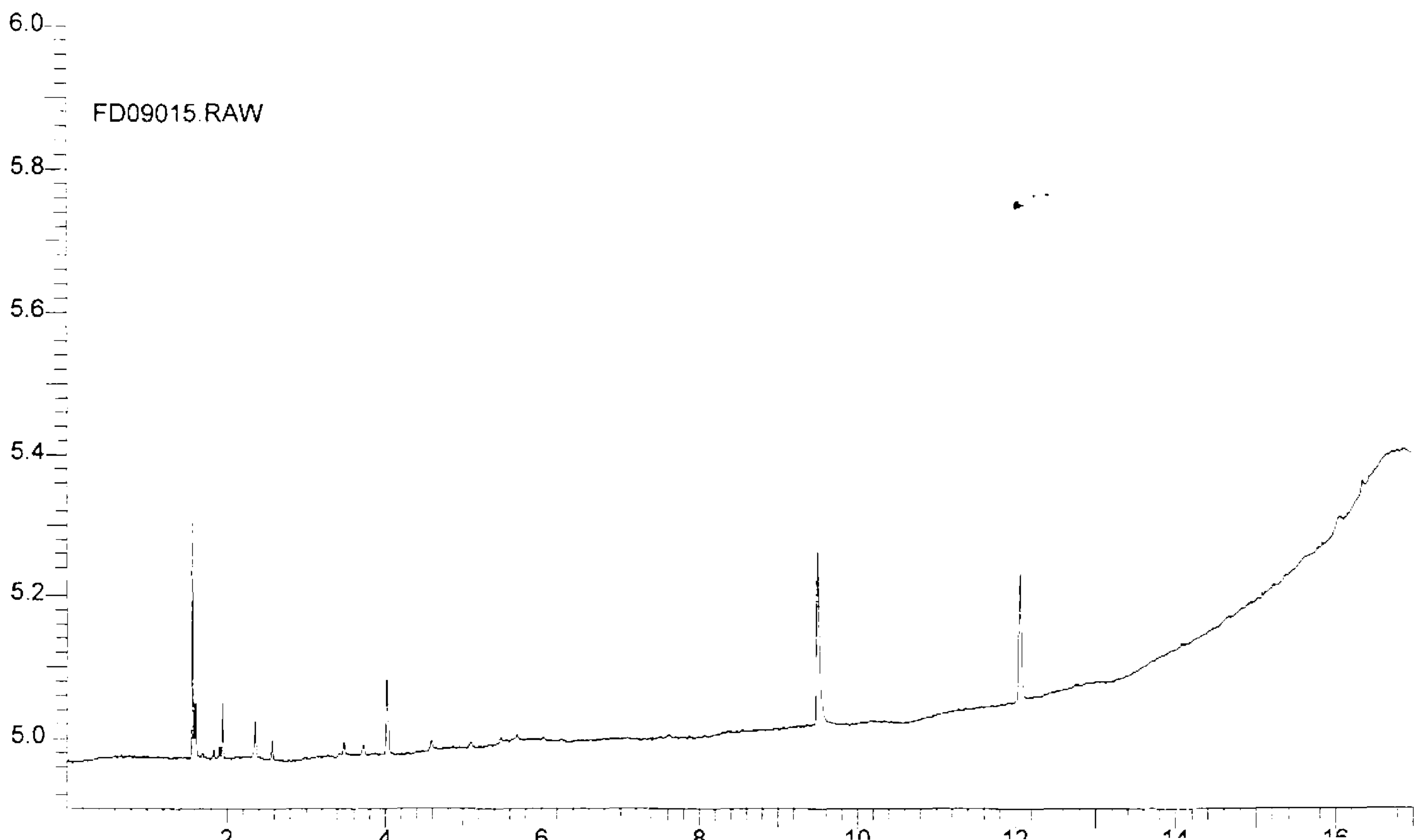




GAS CHROMATOGRAMS

TEST 1-8





DOT Emission Testing Program

Date: 1/9/97 Test #: 3-6

VIN: 00871 Description: K-Car

Runs: 3&7

RL 25/25:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	1499	21	0.22	14.70		1719	8	0.12	14.90
	1623	21	0.15	14.60		1454	15	0.15	14.80
	1641	19	0.28	14.50		1519	17	0.15	14.80
Average:	1587.7	20.3	0.22	14.60		1564.0	13.3	0.14	14.83
σ:	77.3	1.2	0.07	0.10		138.1	4.7	0.02	0.06

IM240:

	NO_x	HC	CO	CO_2		NO_x	HC	CO	CO_2
	3.68	0.46	15.46	373.9		2.65	0.30	15.53	316.8
	2.73	0.24	11.29	333.3		2.84	0.39	16.81	356.3
	2.73	0.20	9.39	334.7		2.69	0.22	12.23	327.1
	2.65	0.24	12.34	335.0		2.68	0.33	15.14	337.2
Average:	2.95	0.29	12.12	344.2		2.72	0.31	14.93	334.4
σ:	0.49	0.12	2.54	19.8		0.09	0.07	1.93	16.8

DOT Emission Testing Program

Date: 1/9/97 Test #: 3-7

VIN: 03824 Description: Van

Runs: 4&9

RL 25/25:

	NO_x	HC	CO	CO_2
	478	149	0.17	11.50
	487	143	0.15	11.50
	510	121	0.14	11.70
Average:	491.7	137.7	0.15	11.57
σ:	16.5	14.7	0.02	0.12

RL 25/25:

	NO_x	HC	CO	CO_2
	259	208	0.25	12.40
	313	196	0.20	12.10
	313	200	0.20	12.30
Average:	295.0	201.3	0.22	12.27
σ:	31.2	6.1	0.03	0.15

IM240:

	NO_x	HC	CO	CO_2
	1.14	1.47	24.16	485.1
	1.06	1.25	17.87	490.4
	1.07	1.54	27.57	473.6
	1.09	1.42	18.75	486.1
Average:	1.09	1.42	22.09	483.8
σ:	0.04	0.12	4.59	7.2

IM240:

	NO_x	HC	CO	CO_2
	0.75	1.95	47.07	472.0
	0.81	1.73	40.30	471.8
	0.83	1.78	41.27	472.0
	0.86	1.68	38.73	474.1
Average:	0.81	1.79	41.84	472.5
σ:	0.05	0.12	3.64	1.1

DOT Emission Testing Program

Date: 1/9/97 Test #: 3-8

VIN: 25575 Description: Police Cruiser

Runs: 5&10

RL 25/25:

NO_x	HC	CO	CO_2
837	27	0.04	14.90
627	27	0.10	14.80
723	26	0.06	14.90
Average: 729.0	26.7	0.07	14.87
σ: 105.1	0.6	0.03	0.06

RL 25/25:

NO_x	HC	CO	CO_2
964	29	0.02	14.90
850	29	0.03	14.70
709	26	0.14	14.70
841.0	28.0	0.06	14.77
127.7	1.7	0.07	0.12

IM240:

NO_x	HC	CO	CO_2
1.67	0.31	6.44	443.6
1.61	0.28	5.57	444.2
1.56	0.26	4.67	449.7
1.62	0.24	3.75	456.0
Average: 1.62	0.27	5.11	448.4
σ: 0.05	0.03	1.16	5.8

IM240:

NO_x	HC	CO	CO_2
1.72	0.28	4.30	467.8
1.63	0.25	3.92	471.4
1.75	0.26	4.53	464.9
1.82	0.26	4.07	473.5
1.73	0.26	4.21	469.4
0.08	0.01	0.27	3.8

DOT Emission Testing Program

Date: 1/9/97 Test #: 3-9

VIN: 27580 Description: Police Cruiser

Runs: 8&11

RL 25/25:

	NO_x	HC	CO	CO_2
	831	3	0.00	14.60
	1235	0	0.00	14.00
	914	4	0.00	14.40
Average:	993.3	2.3	0.00	14.33
σ:	213.4	2.1	0.00	0.31

RL 25/25:

	NO_x	HC	CO	CO_2
	344	1	0.03	14.30
	799	7	0.00	14.70
	683	3	0.00	14.60
Average:	608.7	3.7	0.01	14.53
σ:	236.4	3.1	0.02	0.21

IM240:

	NO_x	HC	CO	CO_2
	1.46	0.08	4.07	474.7
	1.77	0.08	0.78	471.7
	1.79	0.08	0.68	466.1
	1.58	0.07	0.58	467.6
Average:	1.65	0.08	1.53	470.0
σ:	0.16	0.01	1.70	3.9

IM240:

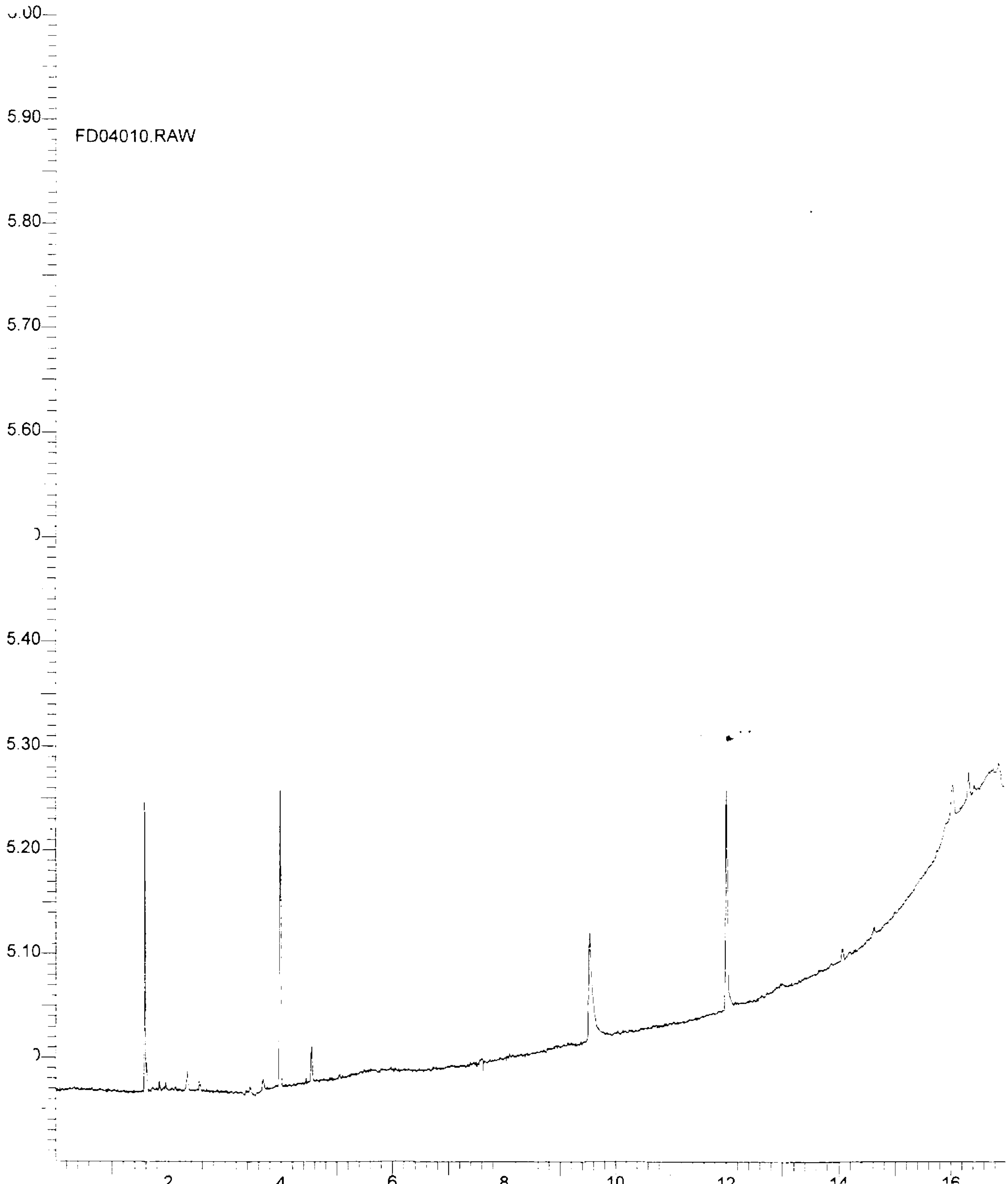
	NO_x	HC	CO	CO_2
	0.92	0.06	1.33	448.4
	1.28	0.07	0.77	450.2
	1.04	0.08	1.49	458.7
	1.20	0.09	0.62	464.6
Average:	1.11	0.08	1.05	455.5
σ:	0.16	0.01	0.42	7.6

2. Raw Emissions Test Data

b. Individual GCMS Analyses (TACOM-ARDEC)

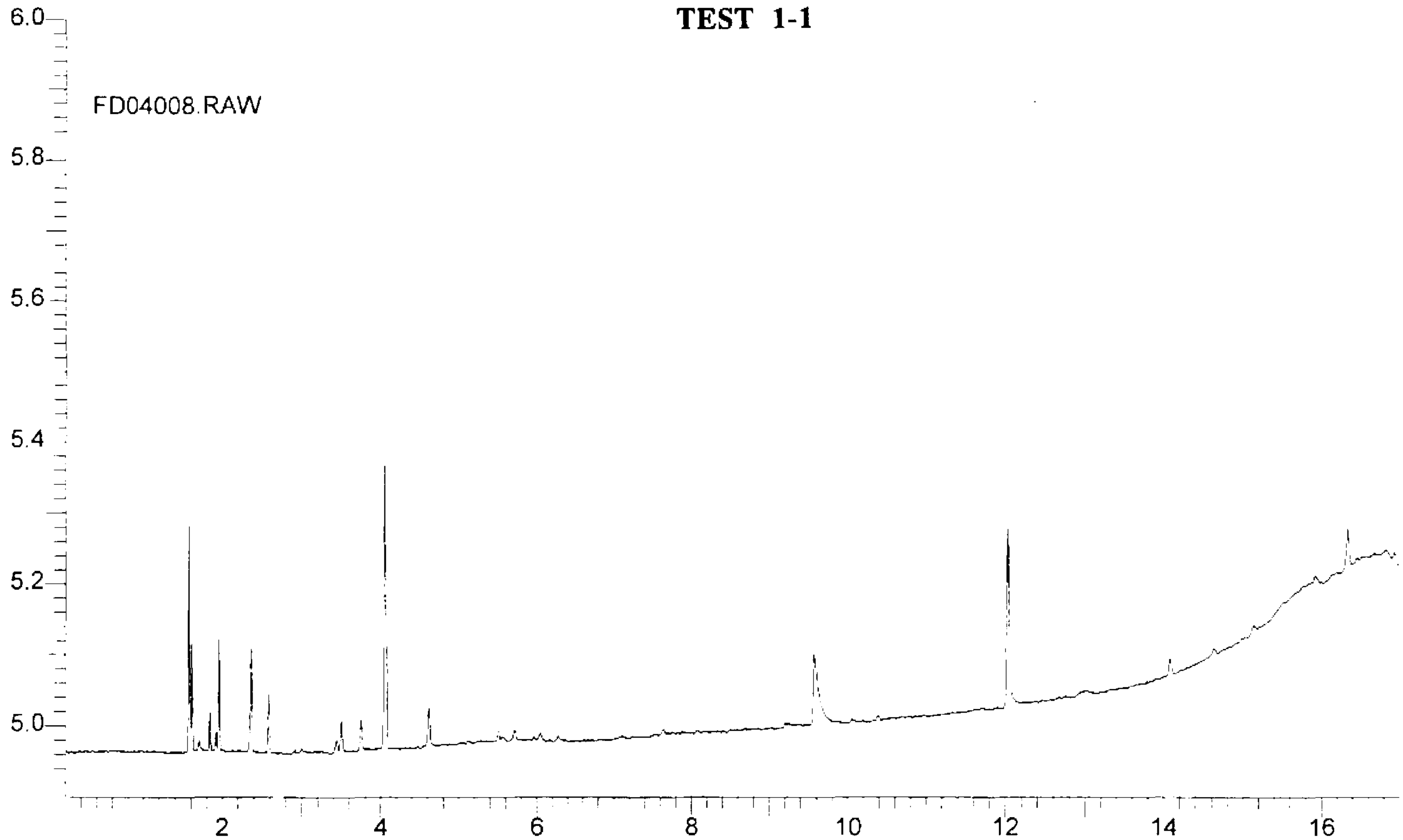
GAS CHROMATOGRAMS

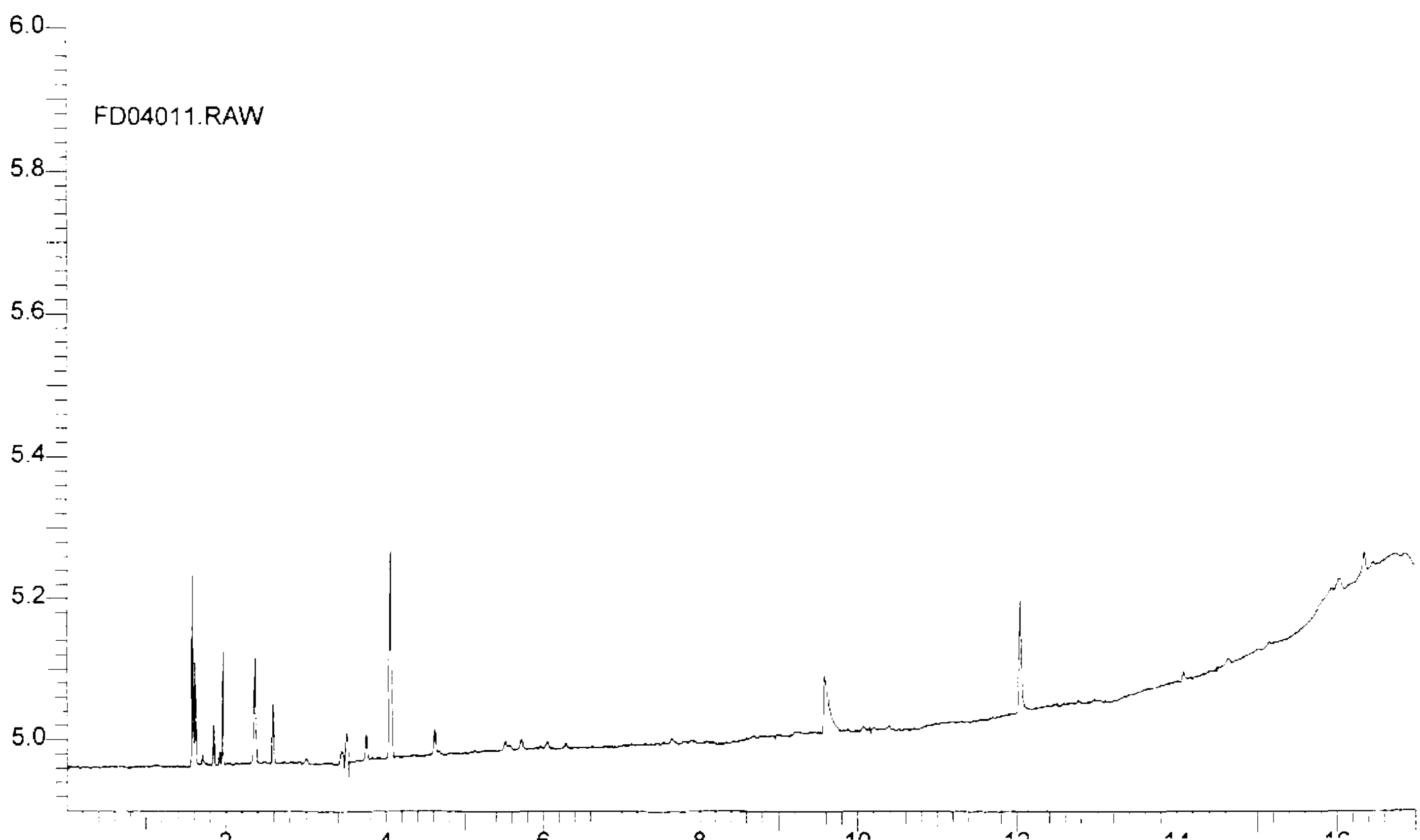
CONTROL CAR



GAS CHROMATOGRAMS

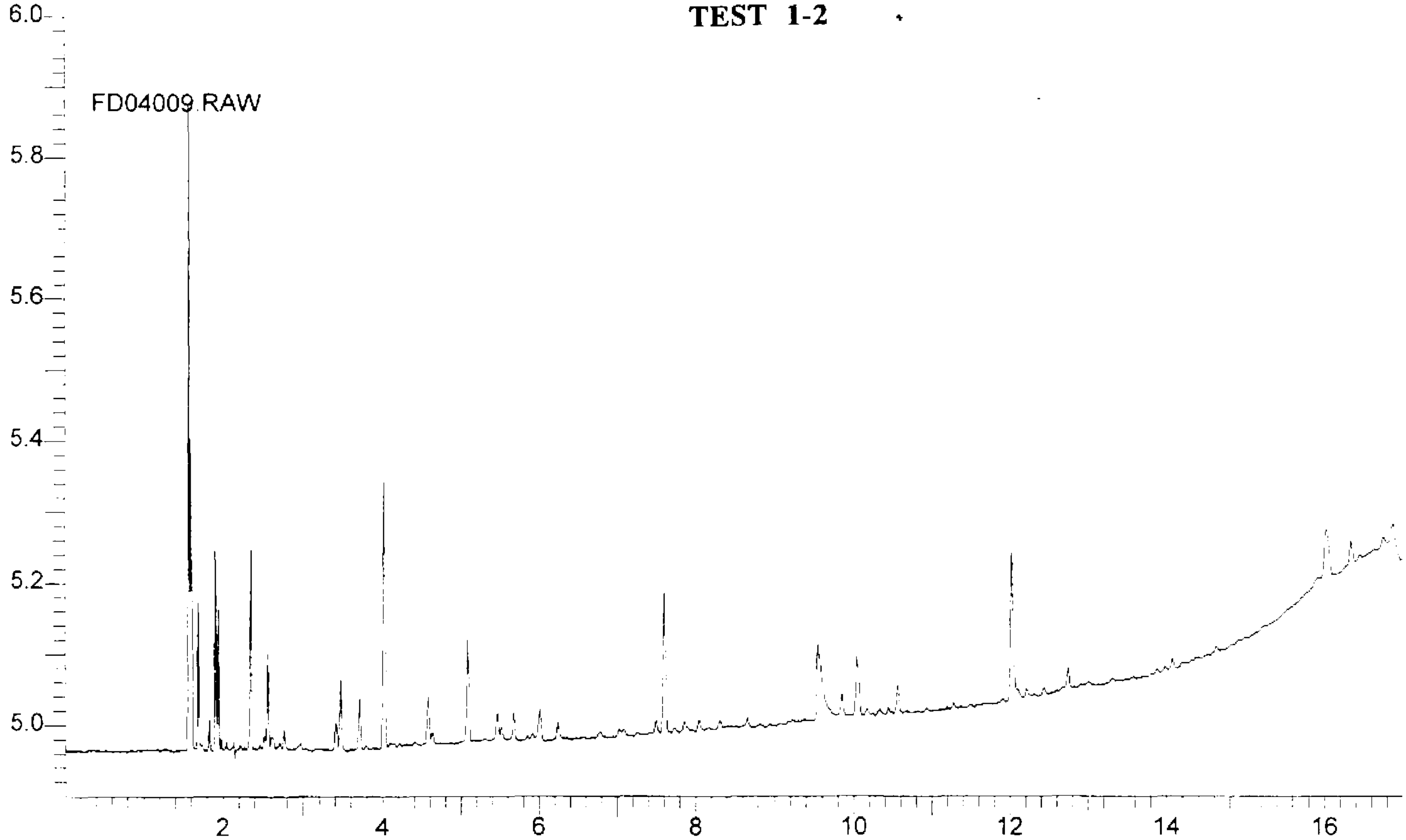
TEST 1-1

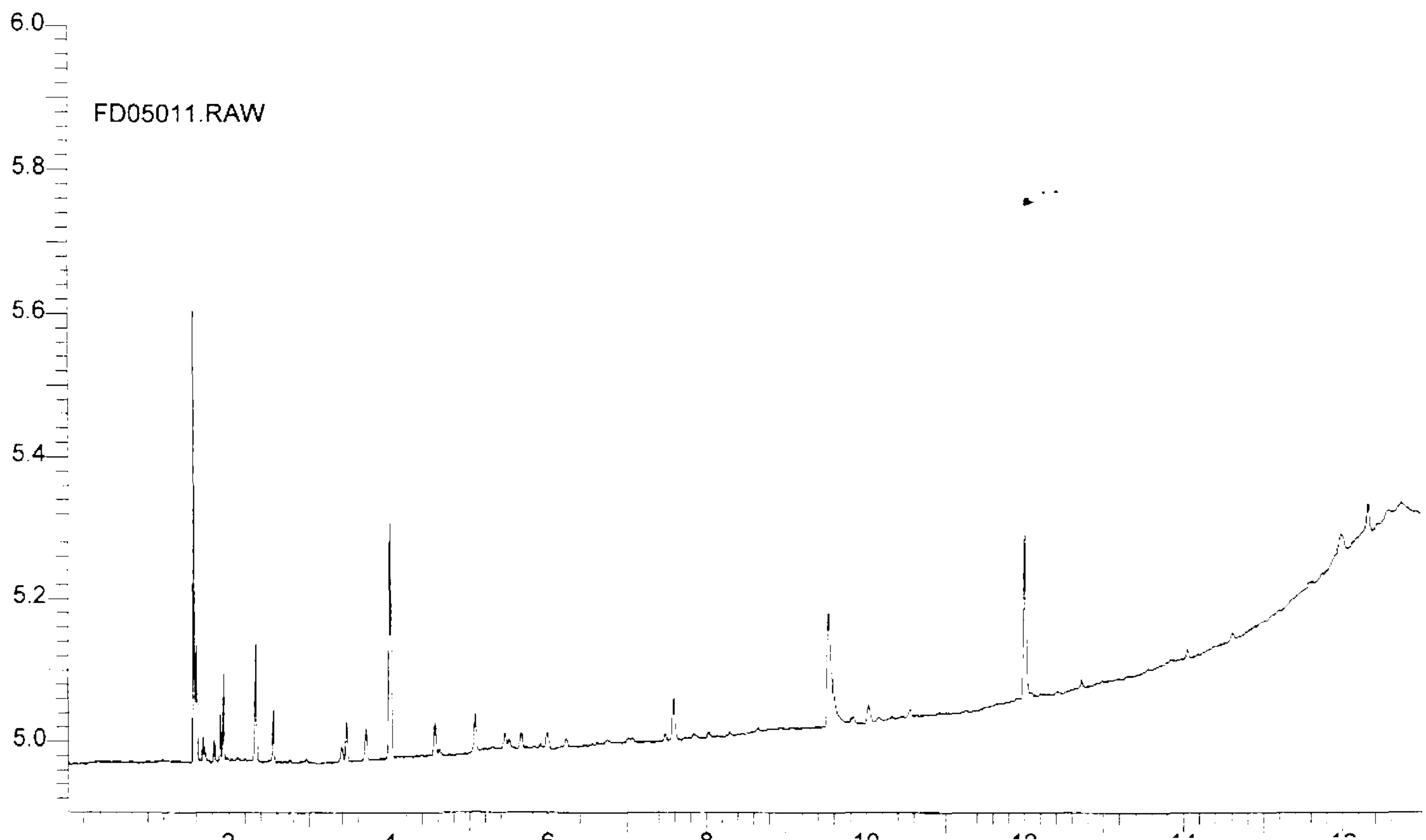




GAS CHROMATOGRAMS

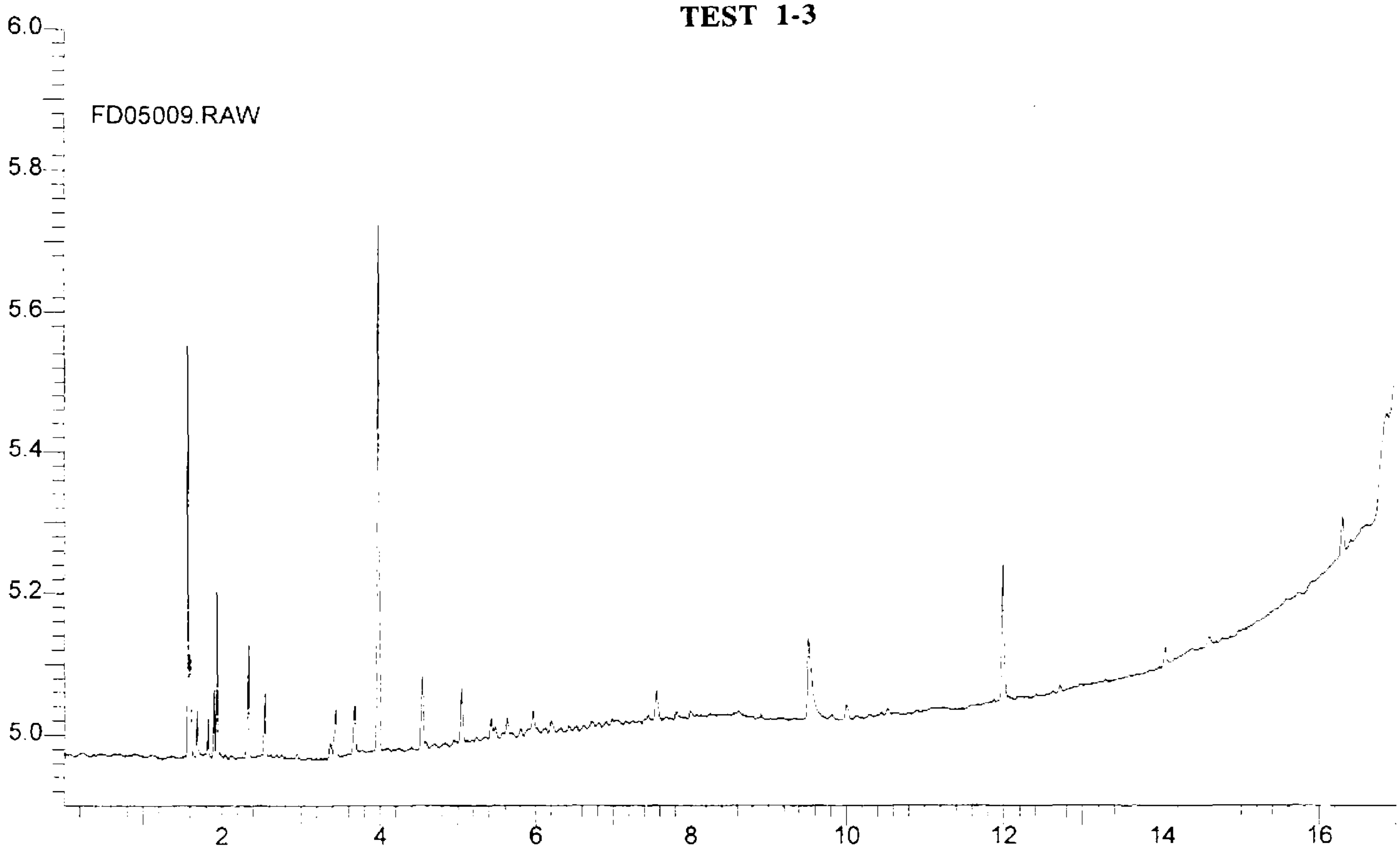
TEST 1-2

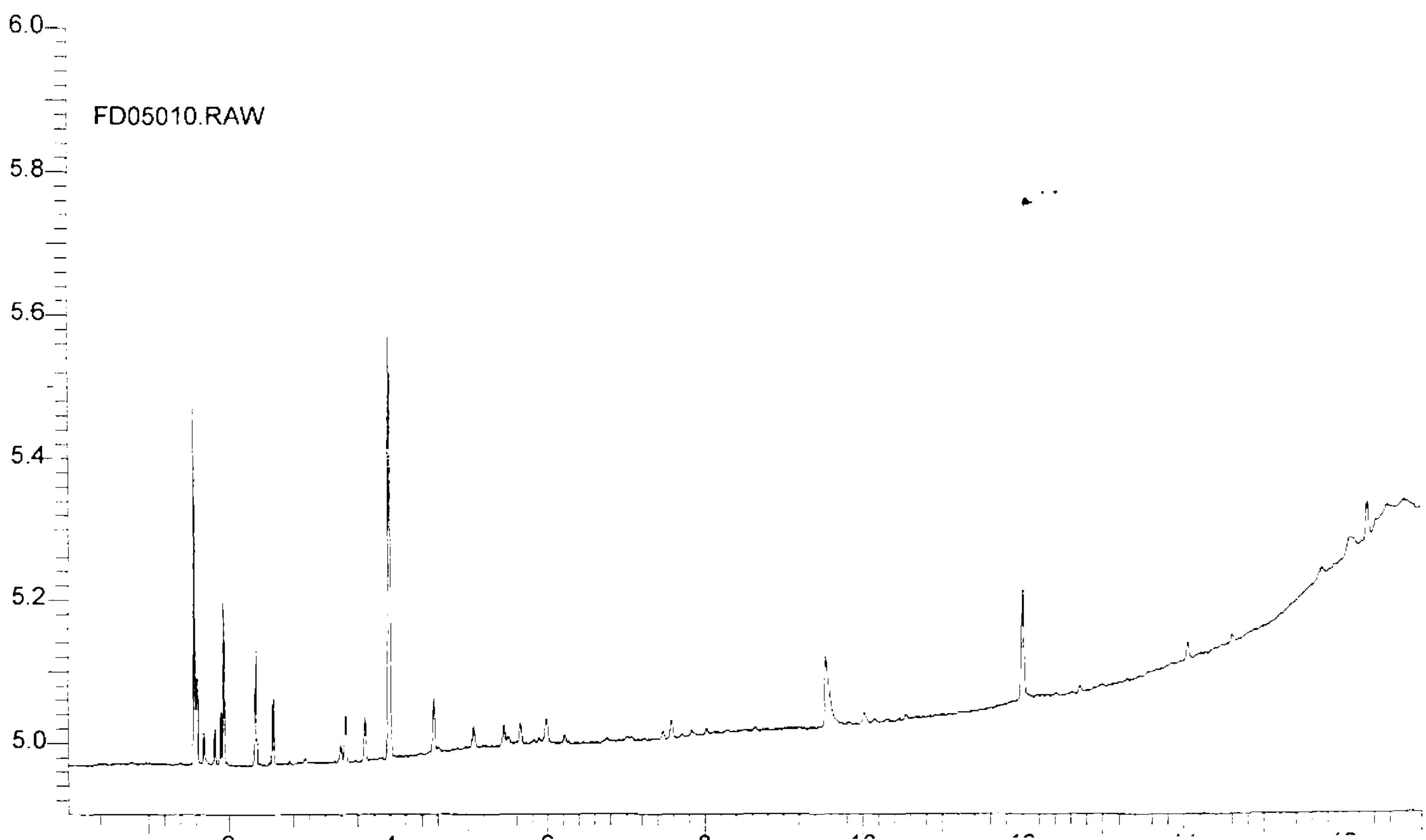




GAS CHROMATOGRAMS

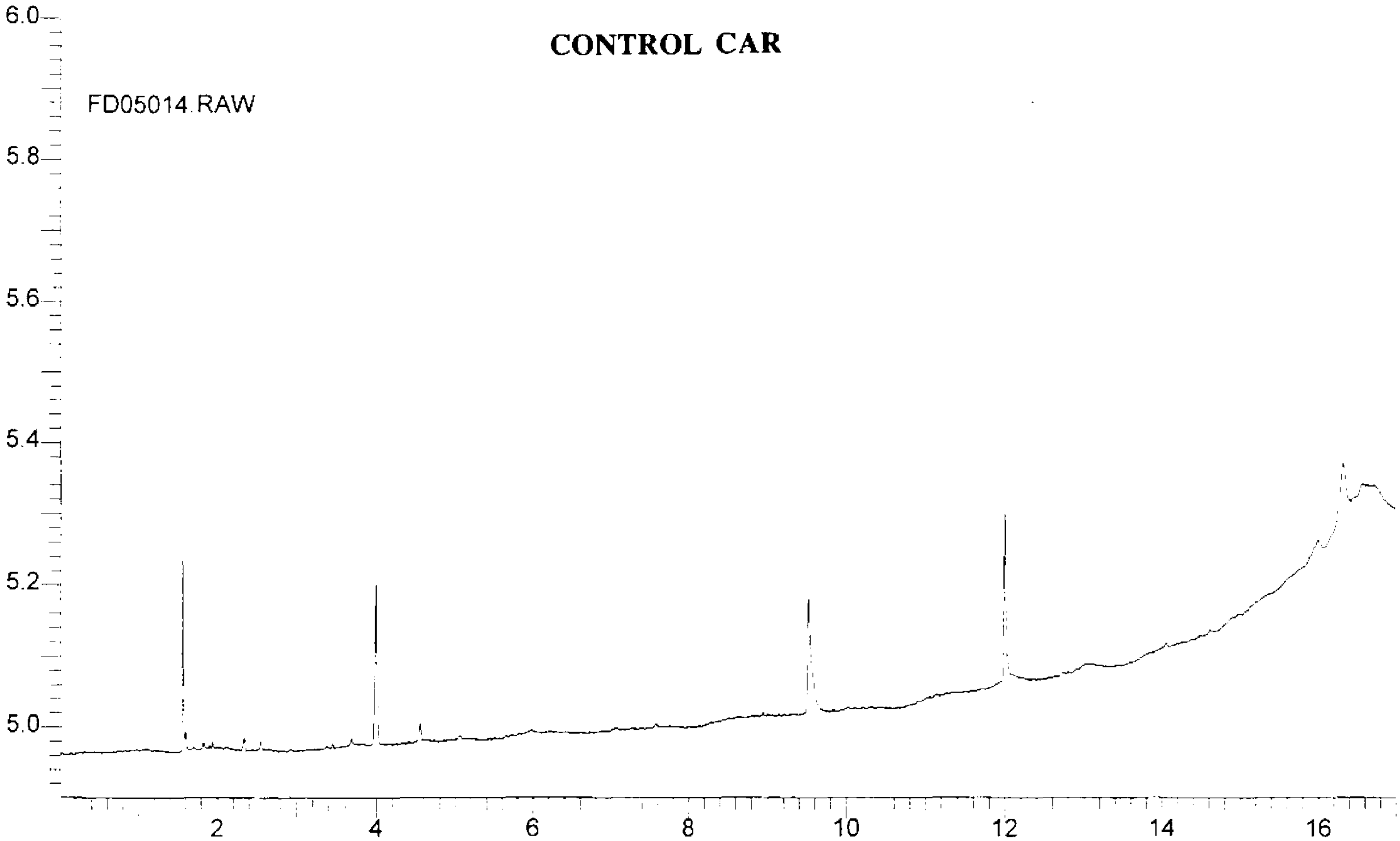
TEST 1-3

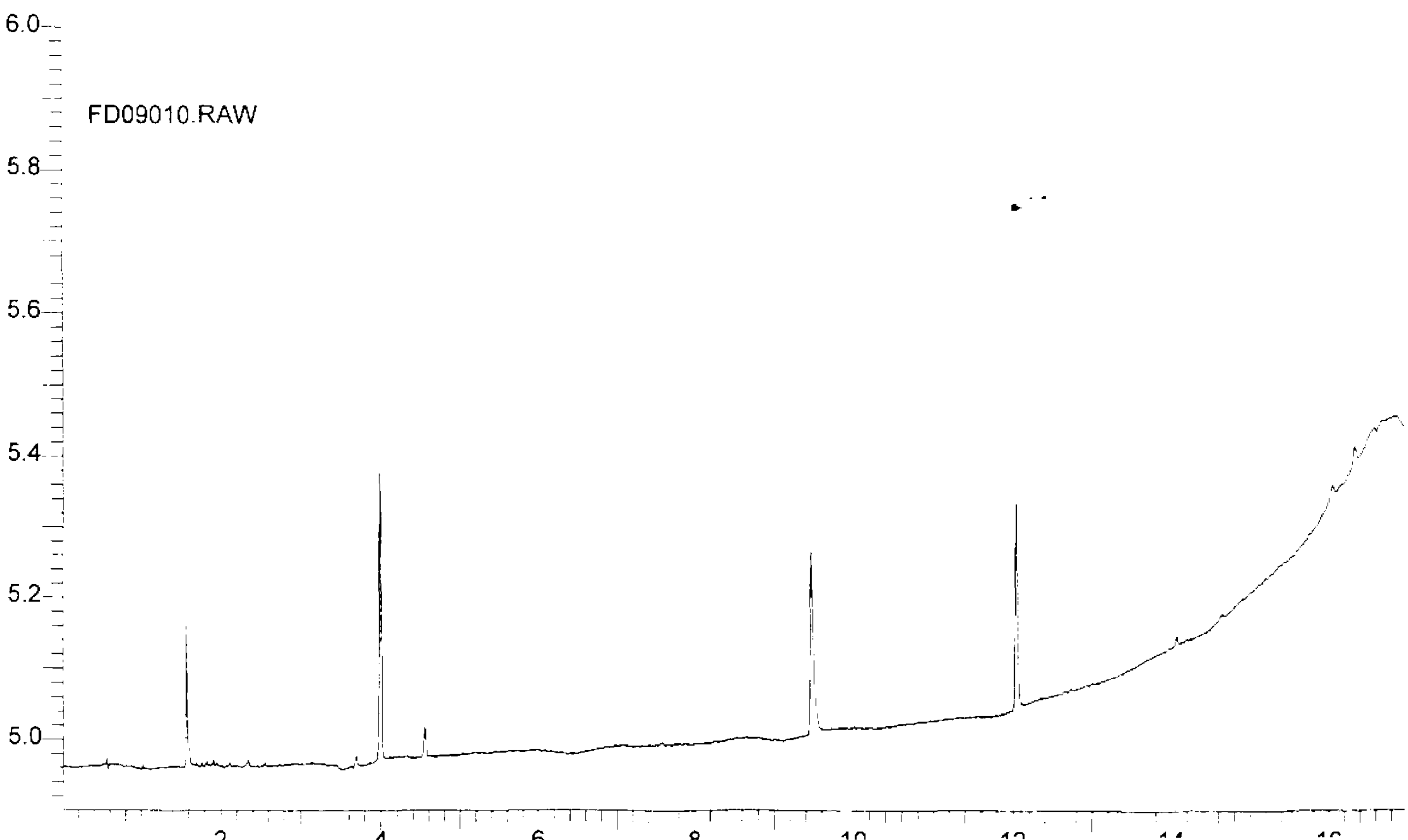




GAS CHROMATOGRAMS

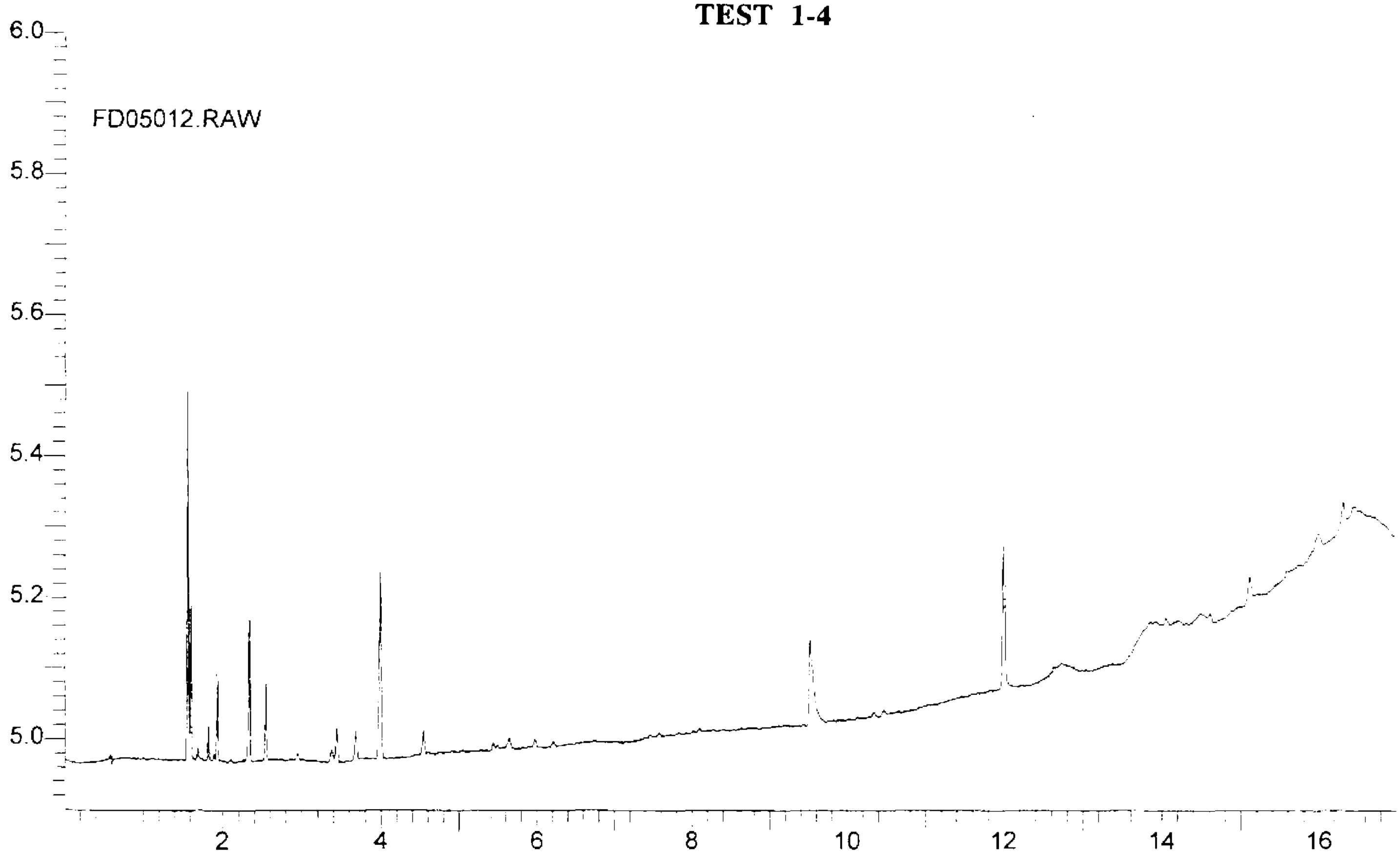
CONTROL CAR

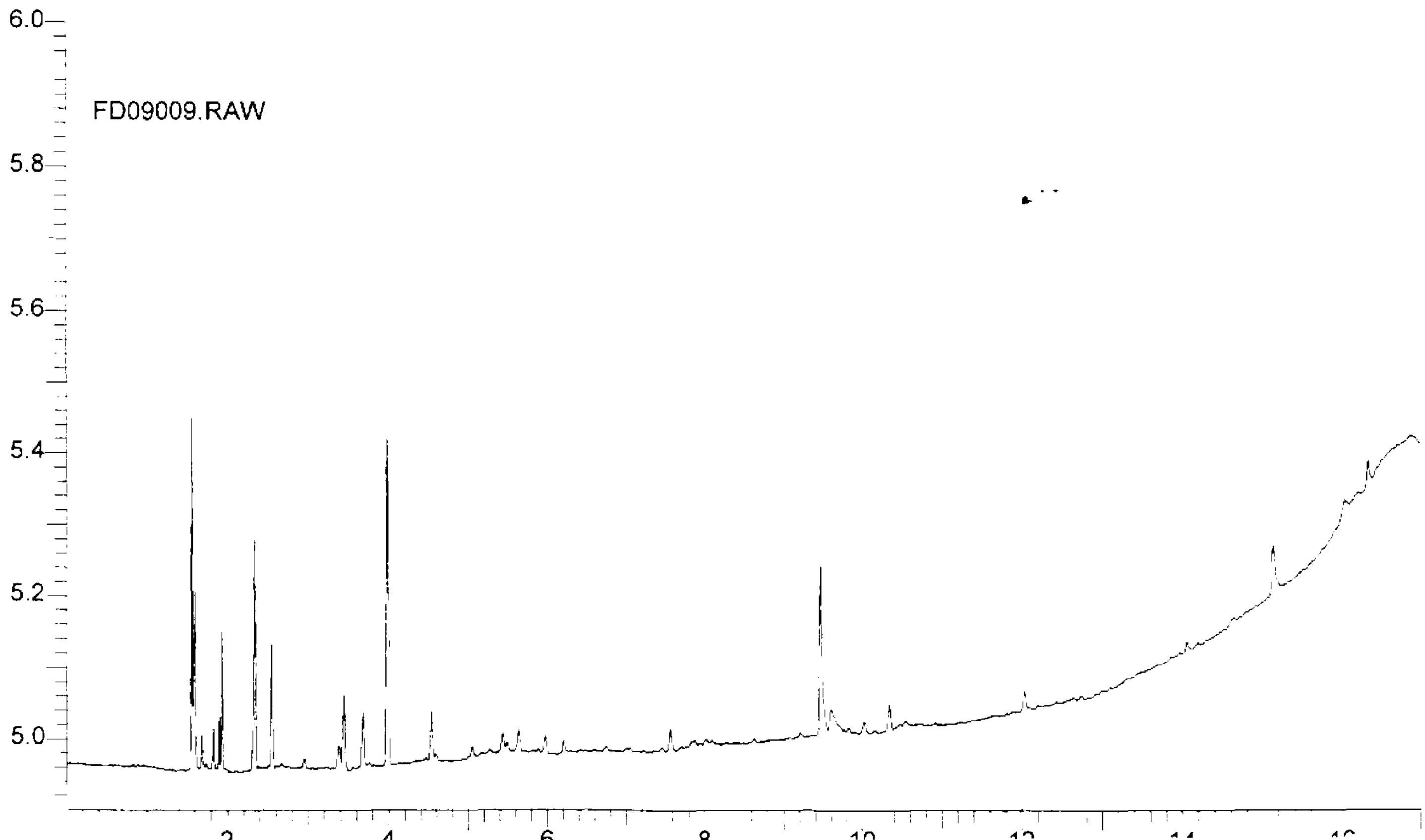




GAS CHROMATOGRAMS

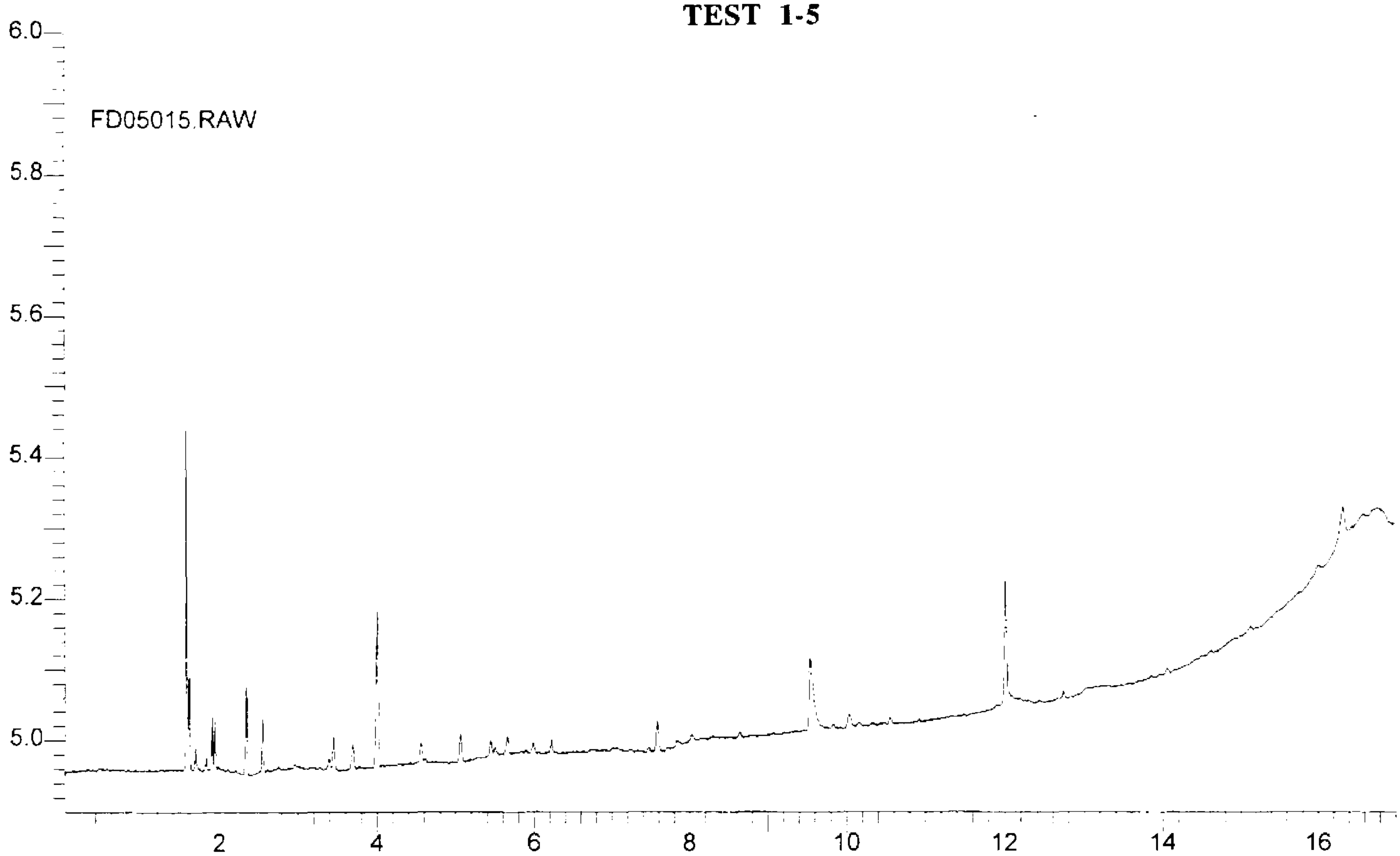
TEST 1-4

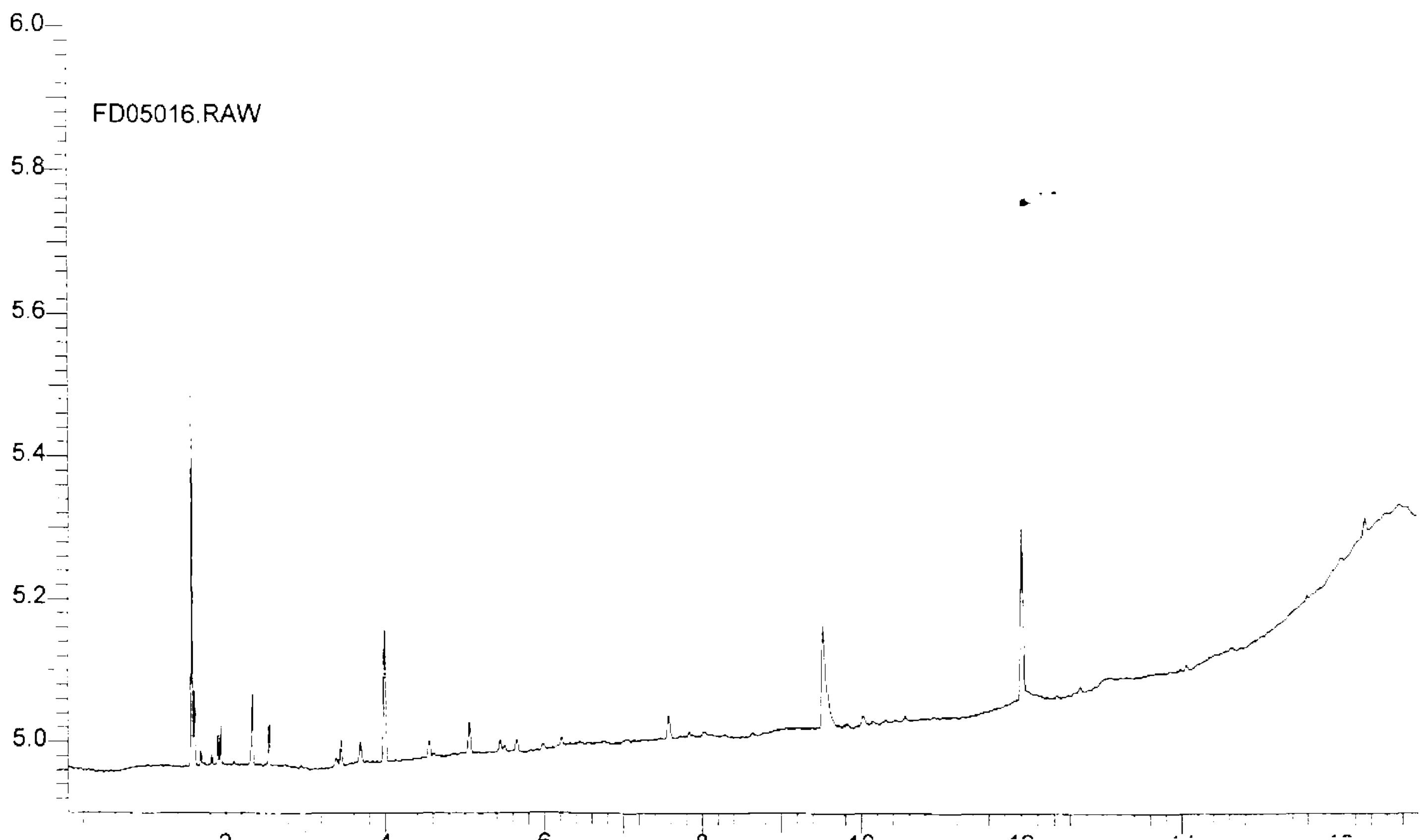




GAS CHROMATOGRAMS

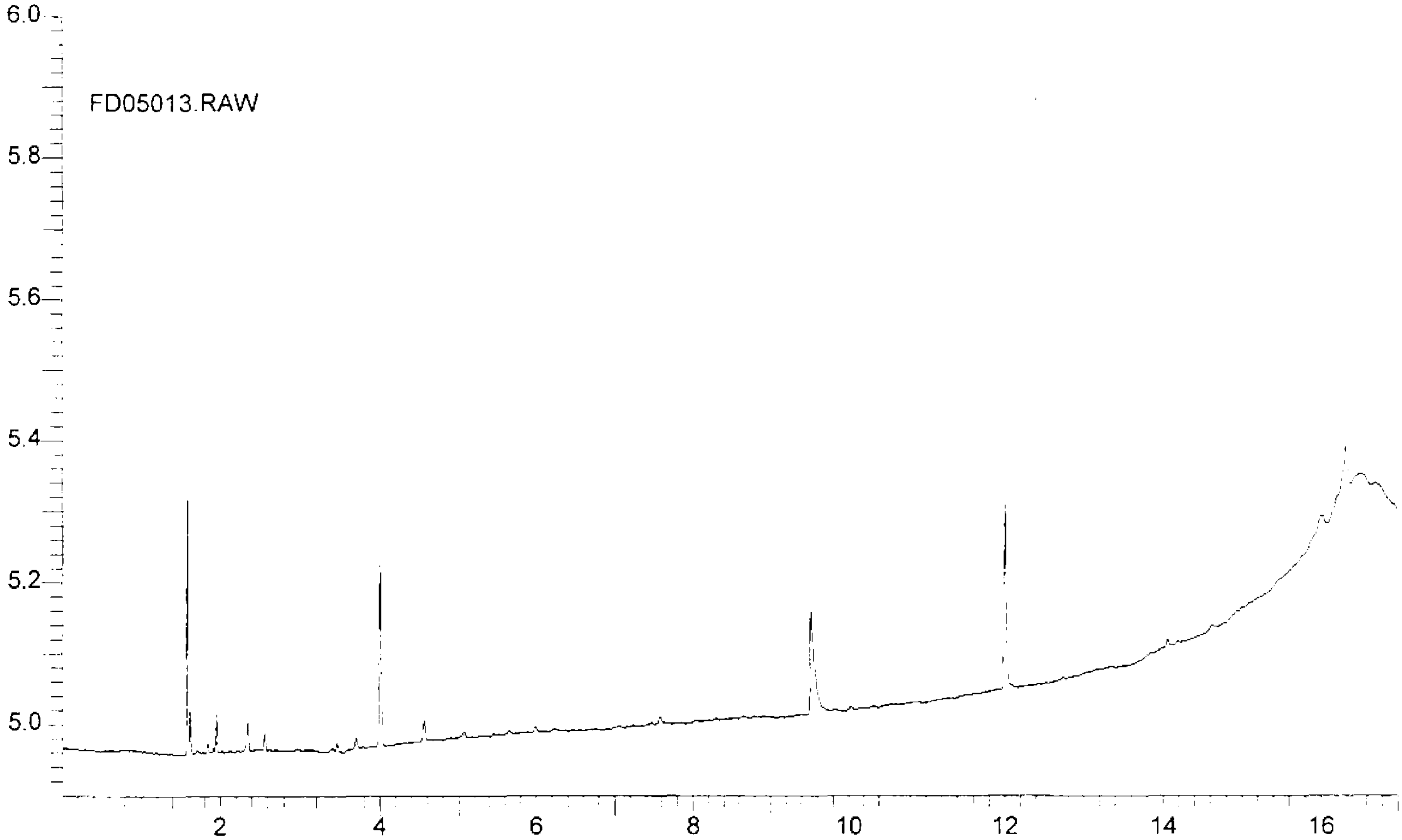
TEST 1-5

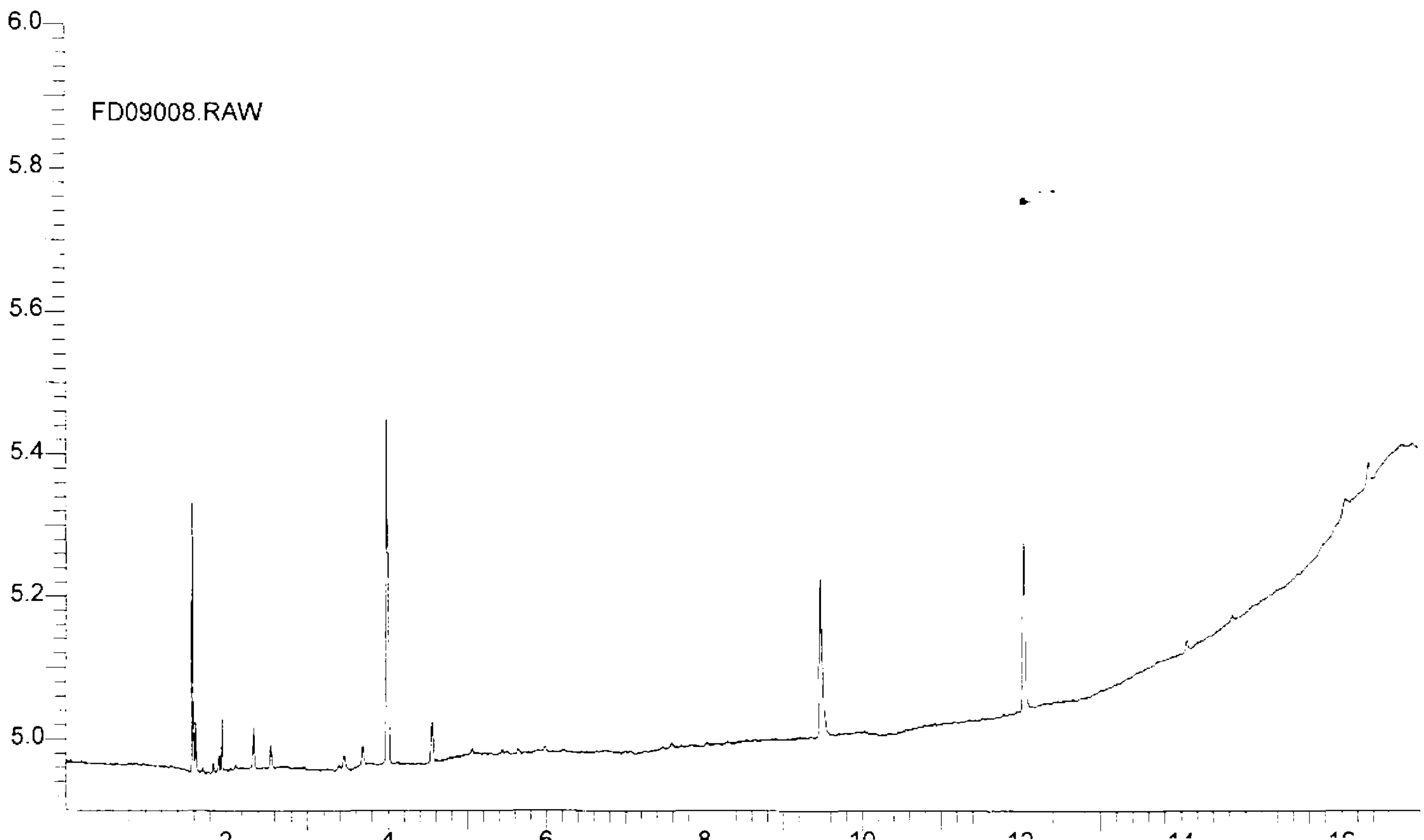




GAS CHROMATOGRAMS

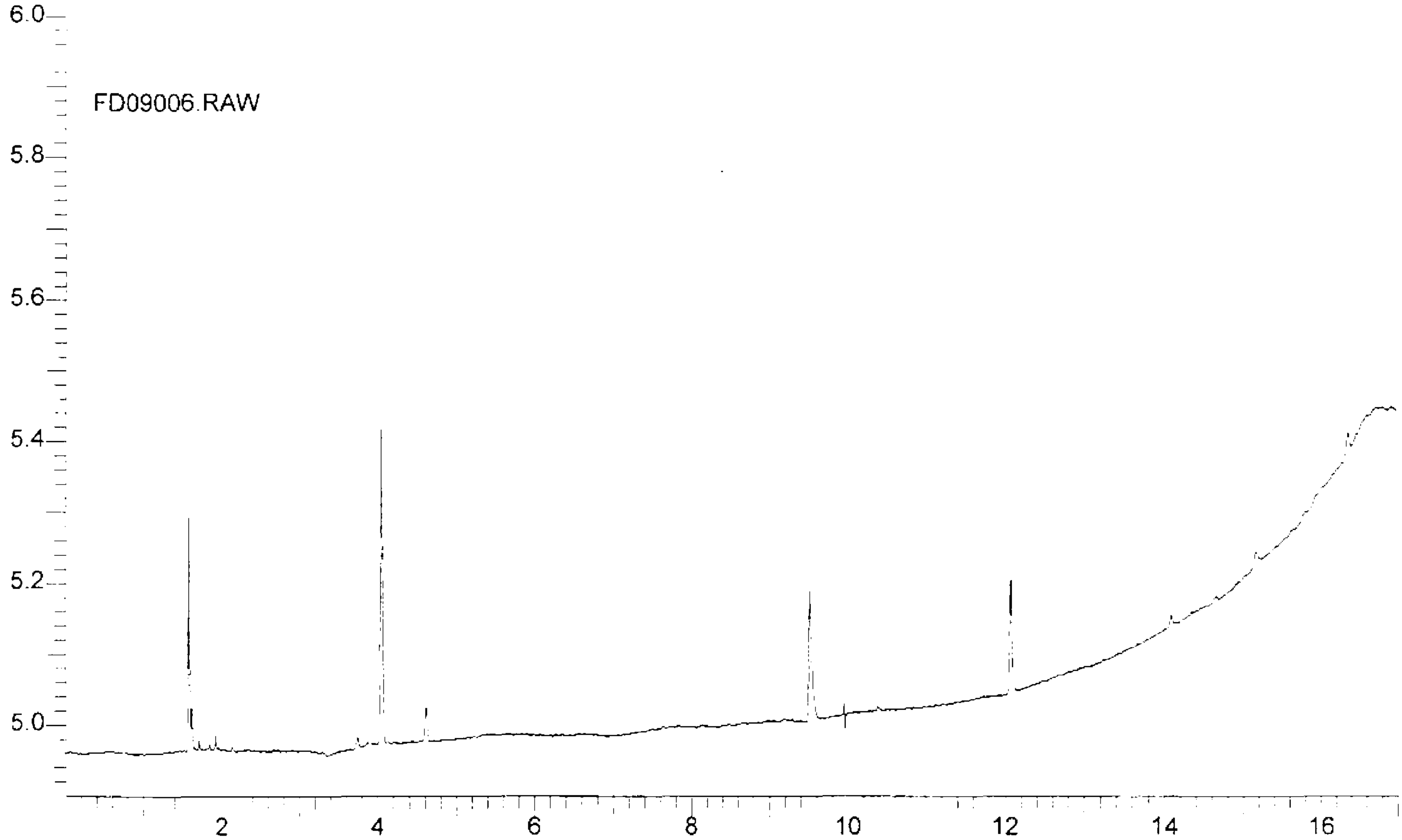
TEST 1-6

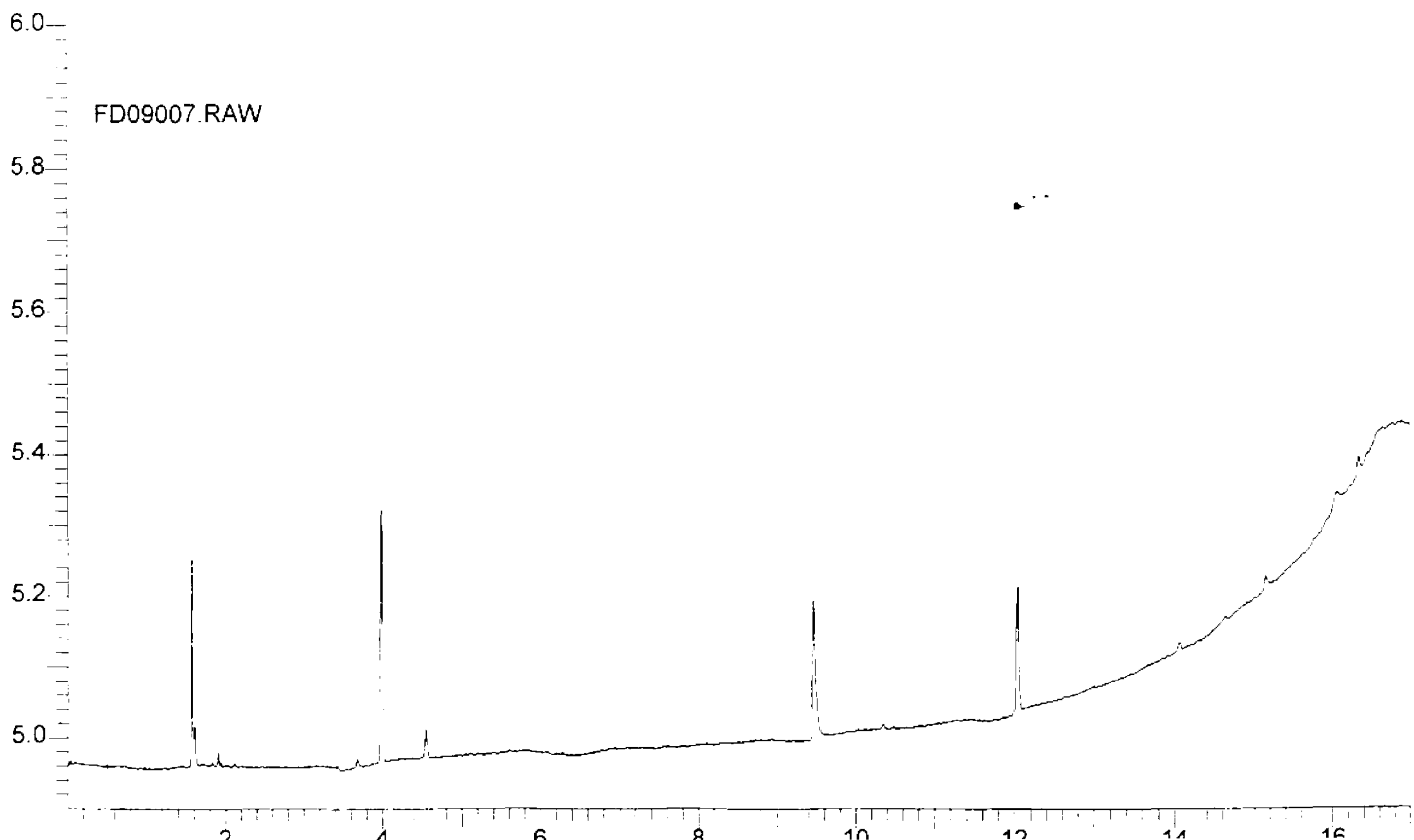




GAS CHROMATOGRAMS

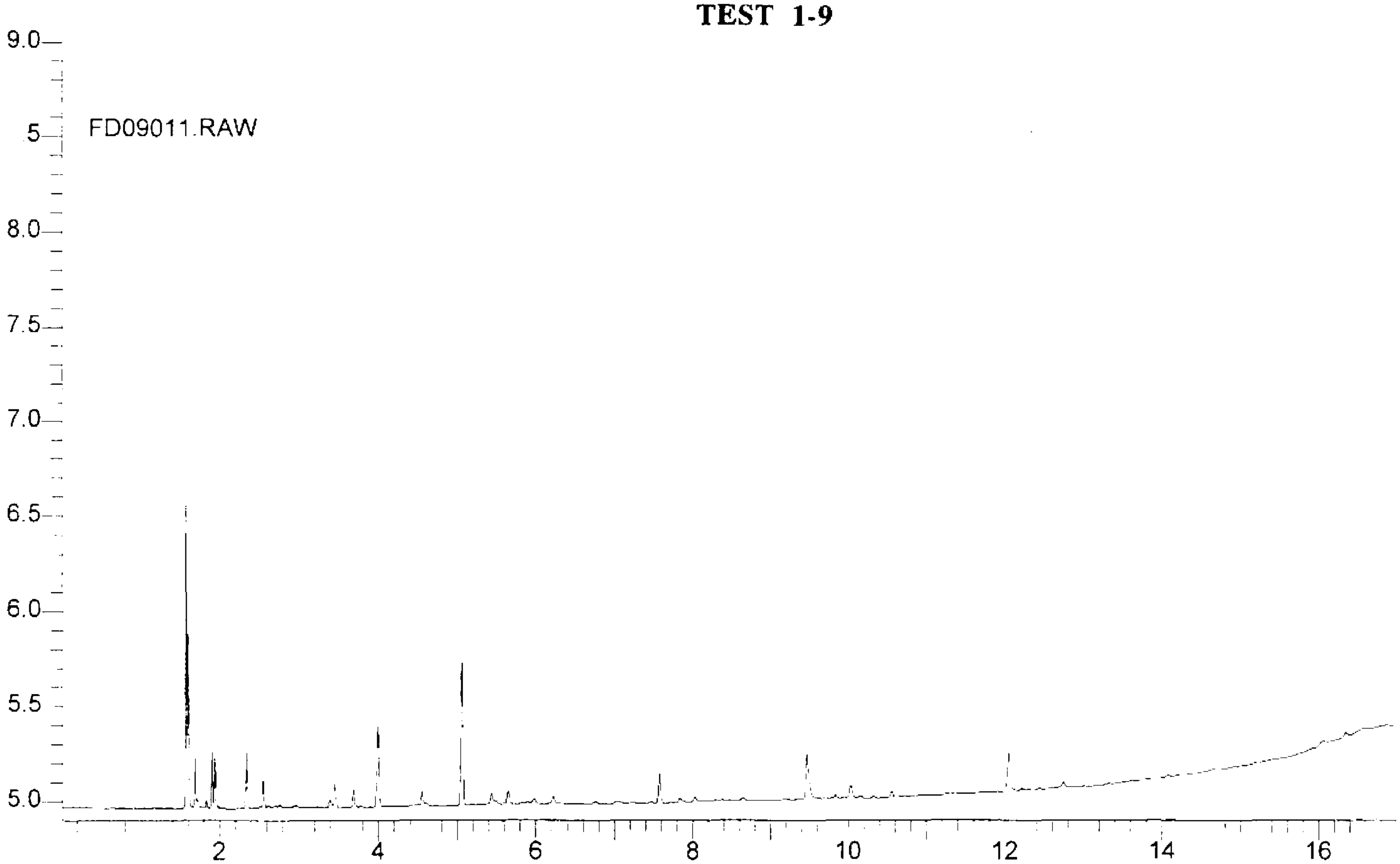
TEST 1-7

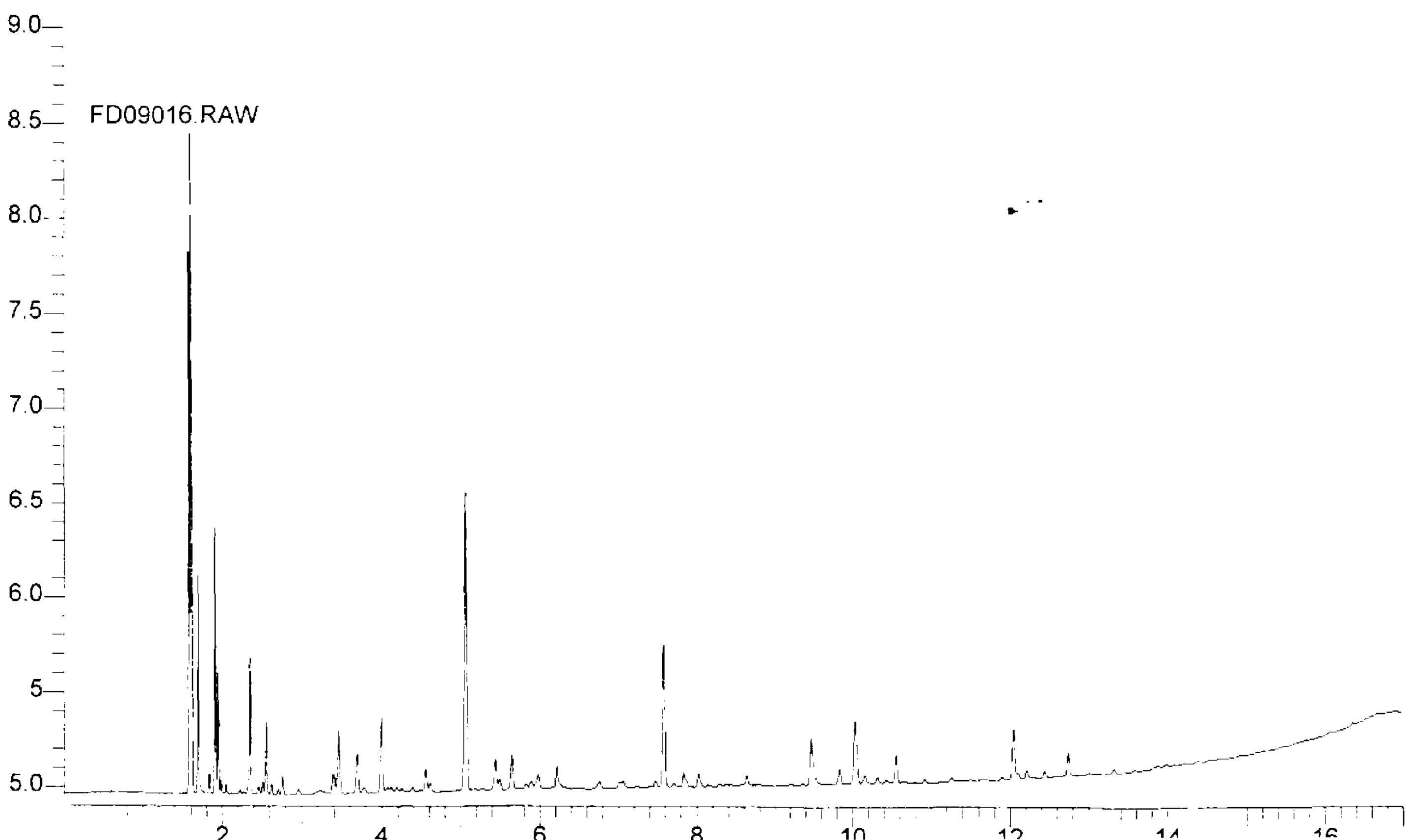




GAS CHROMATOGRAMS

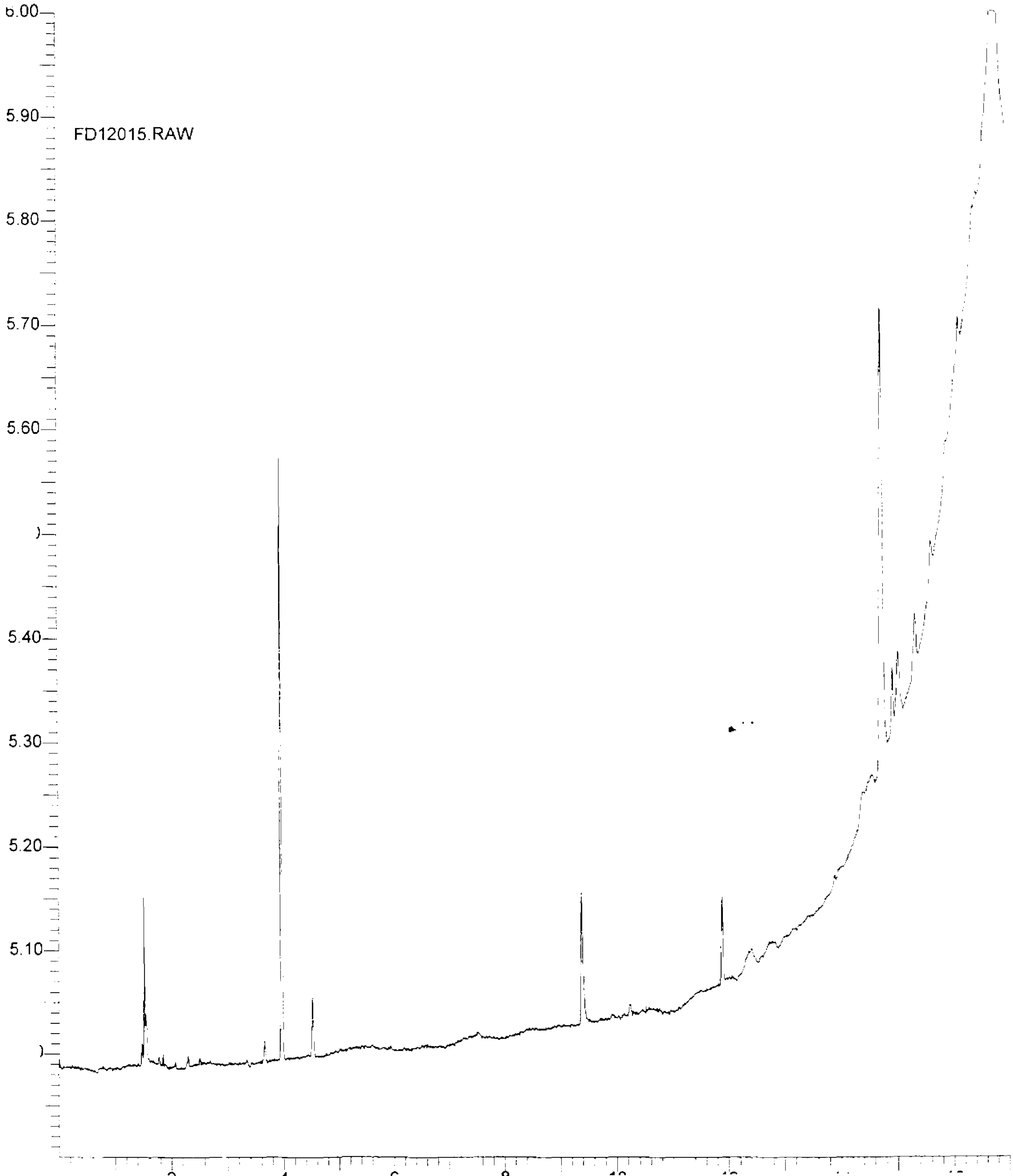
TEST 1-9





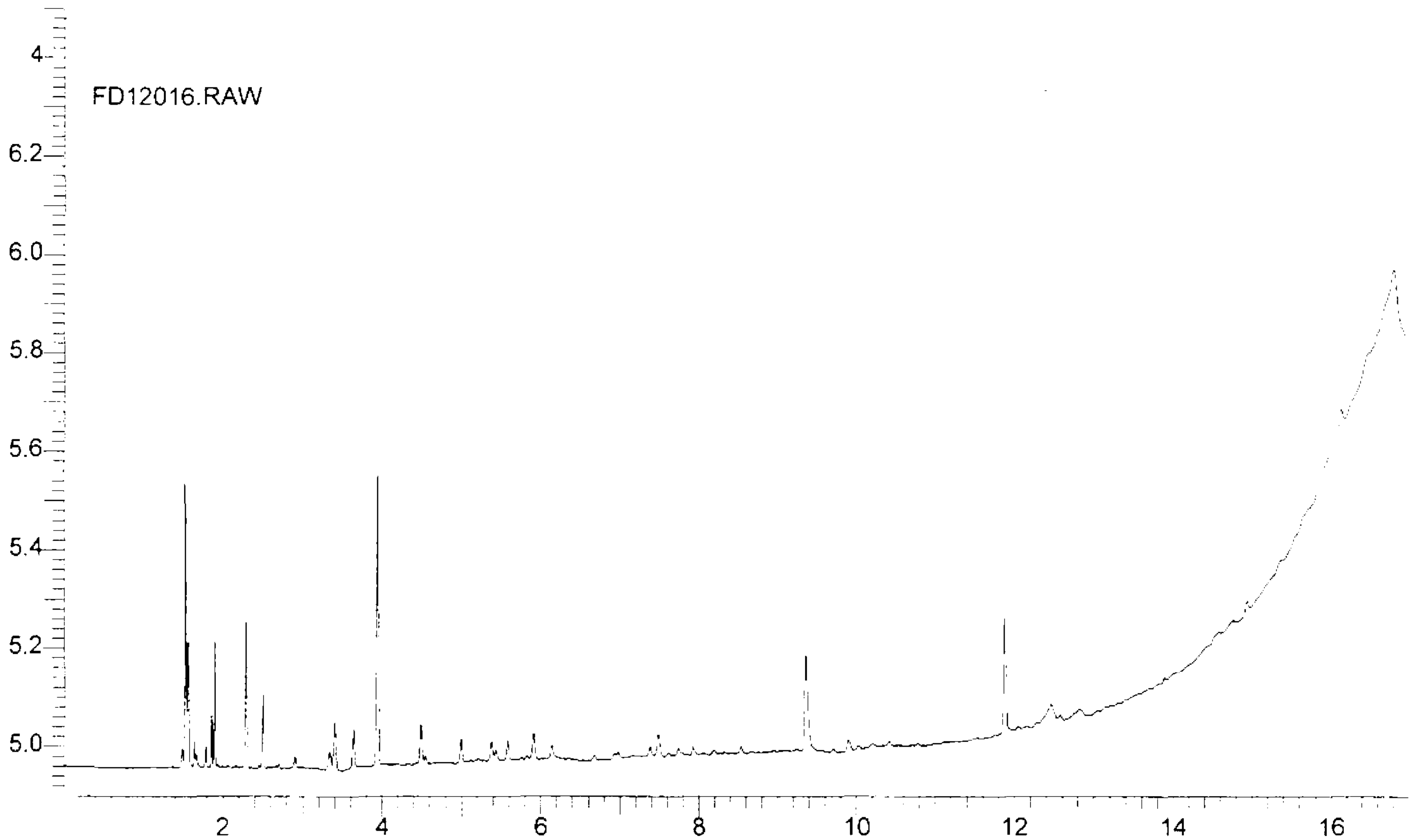
GAS CHROMATOGRAMS

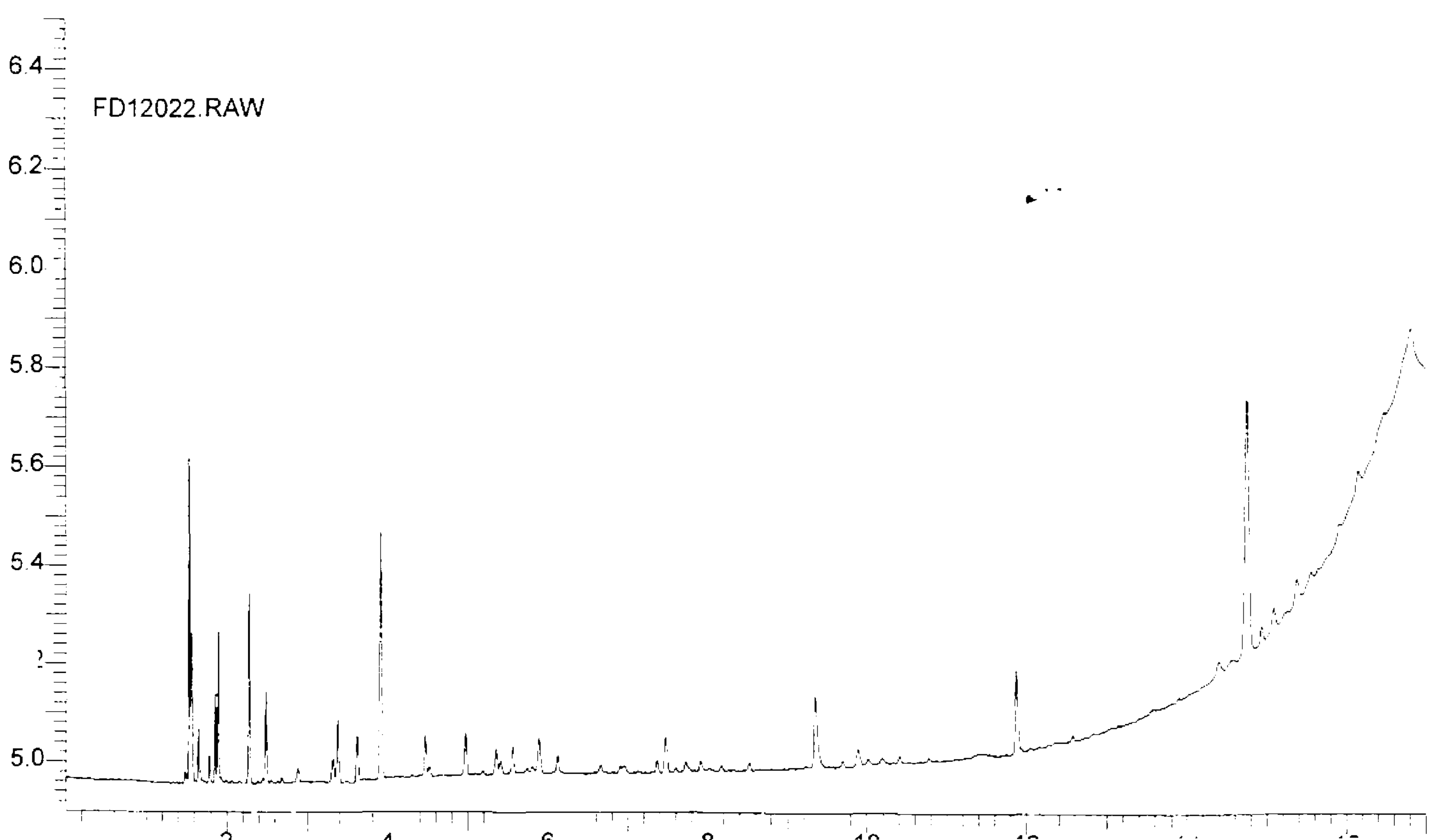
CONTROL CAR



GAS CHROMATOGRAMS

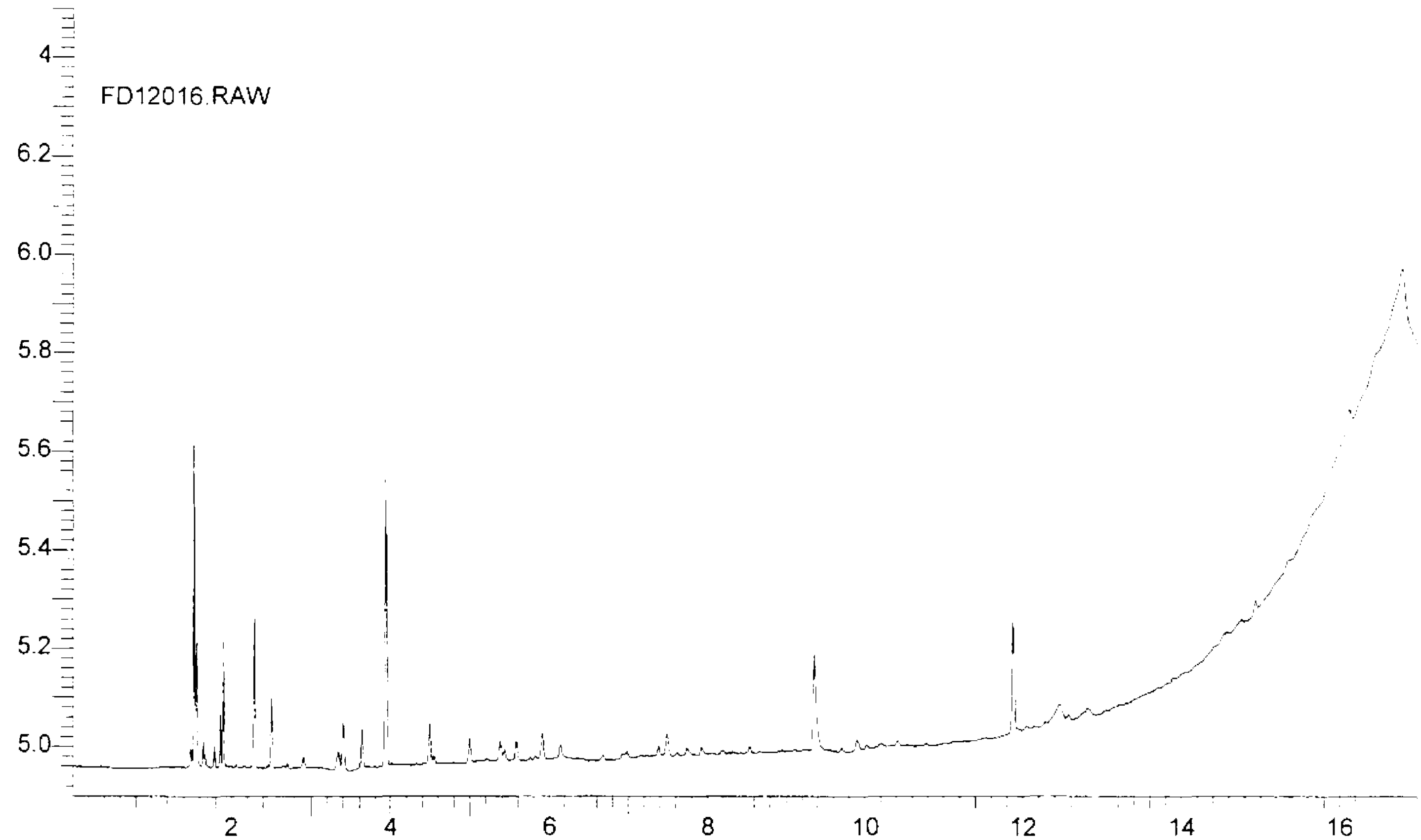
TEST 2-1

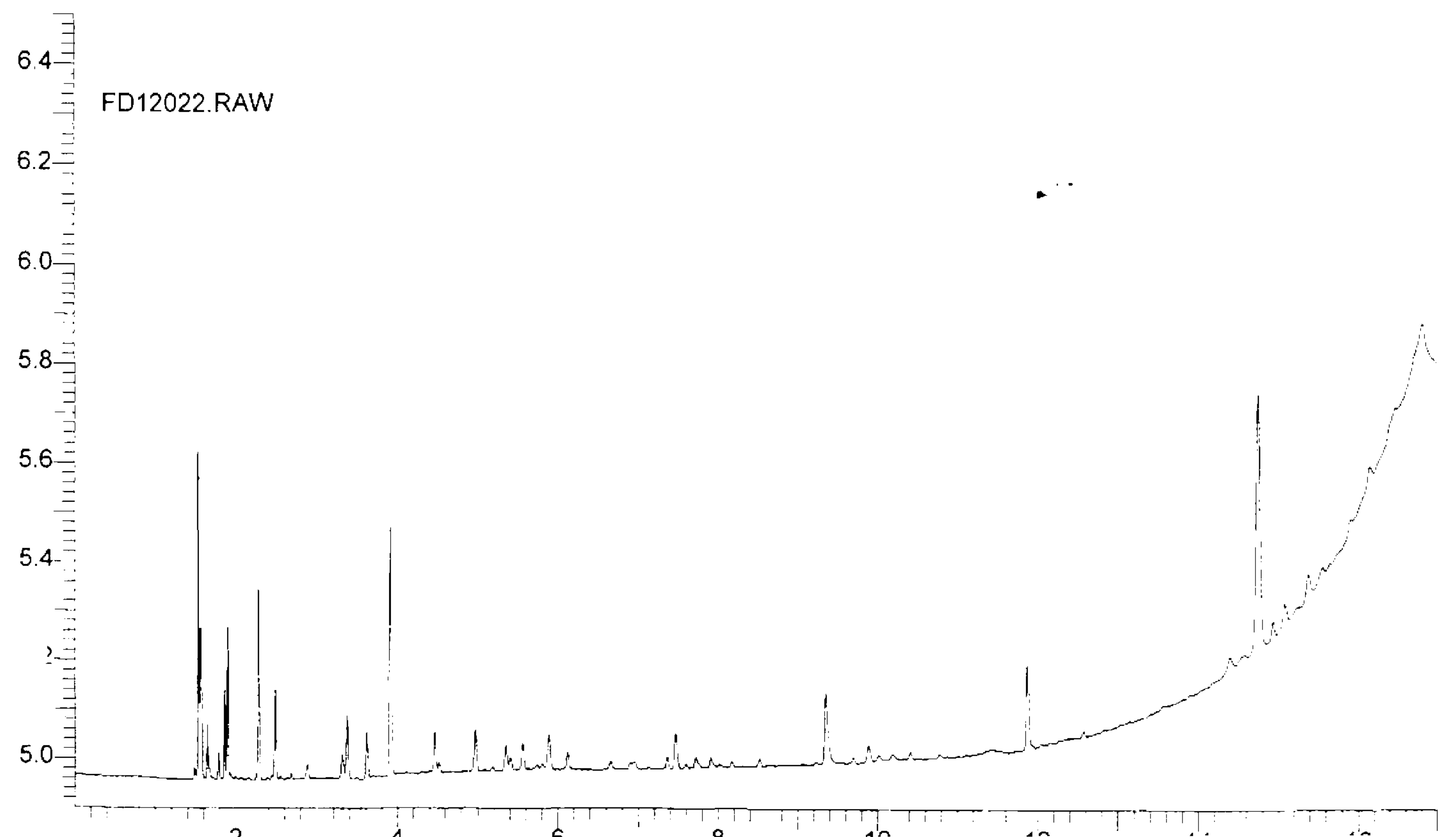




GAS CHROMATOGRAMS

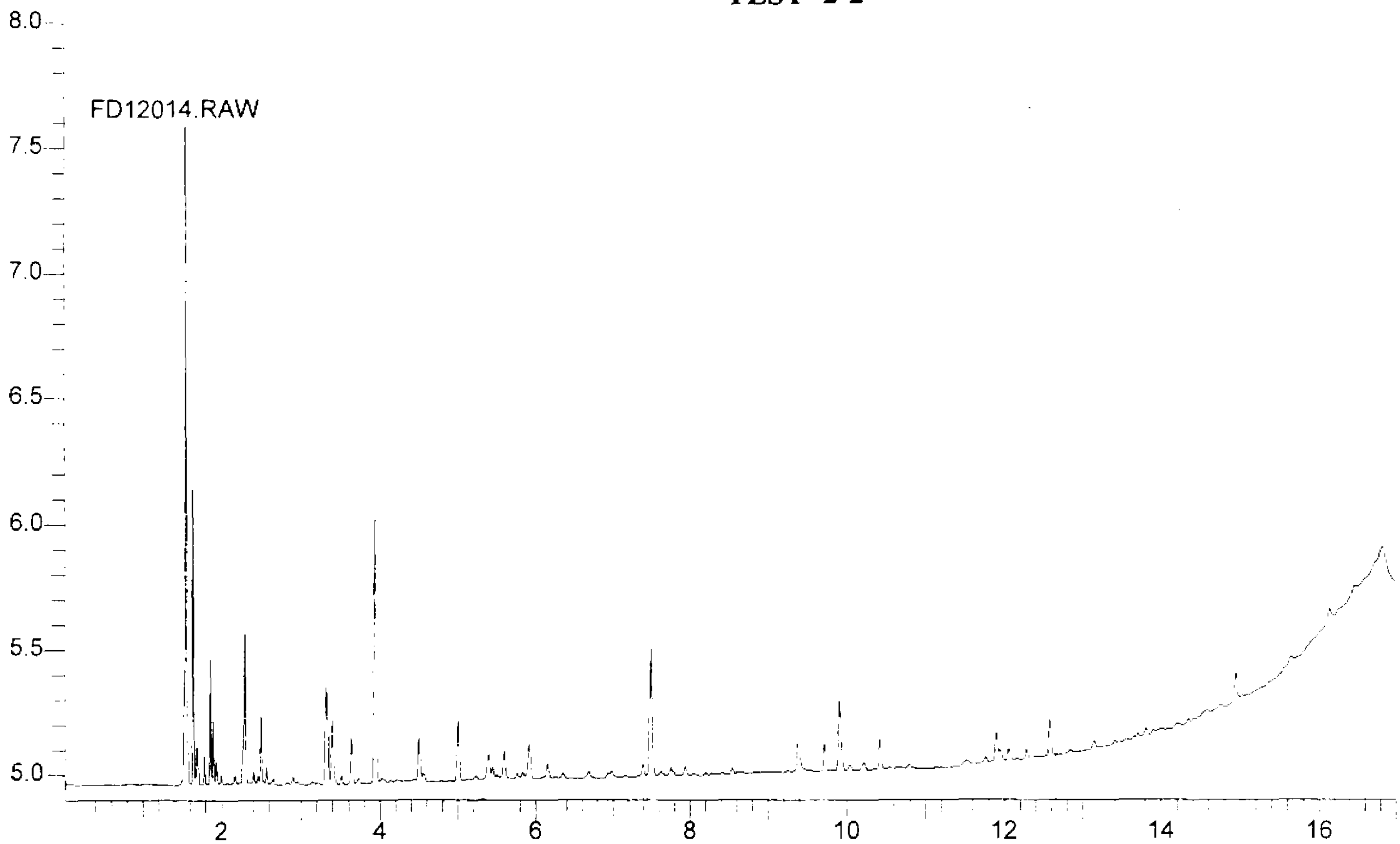
TEST 2-1

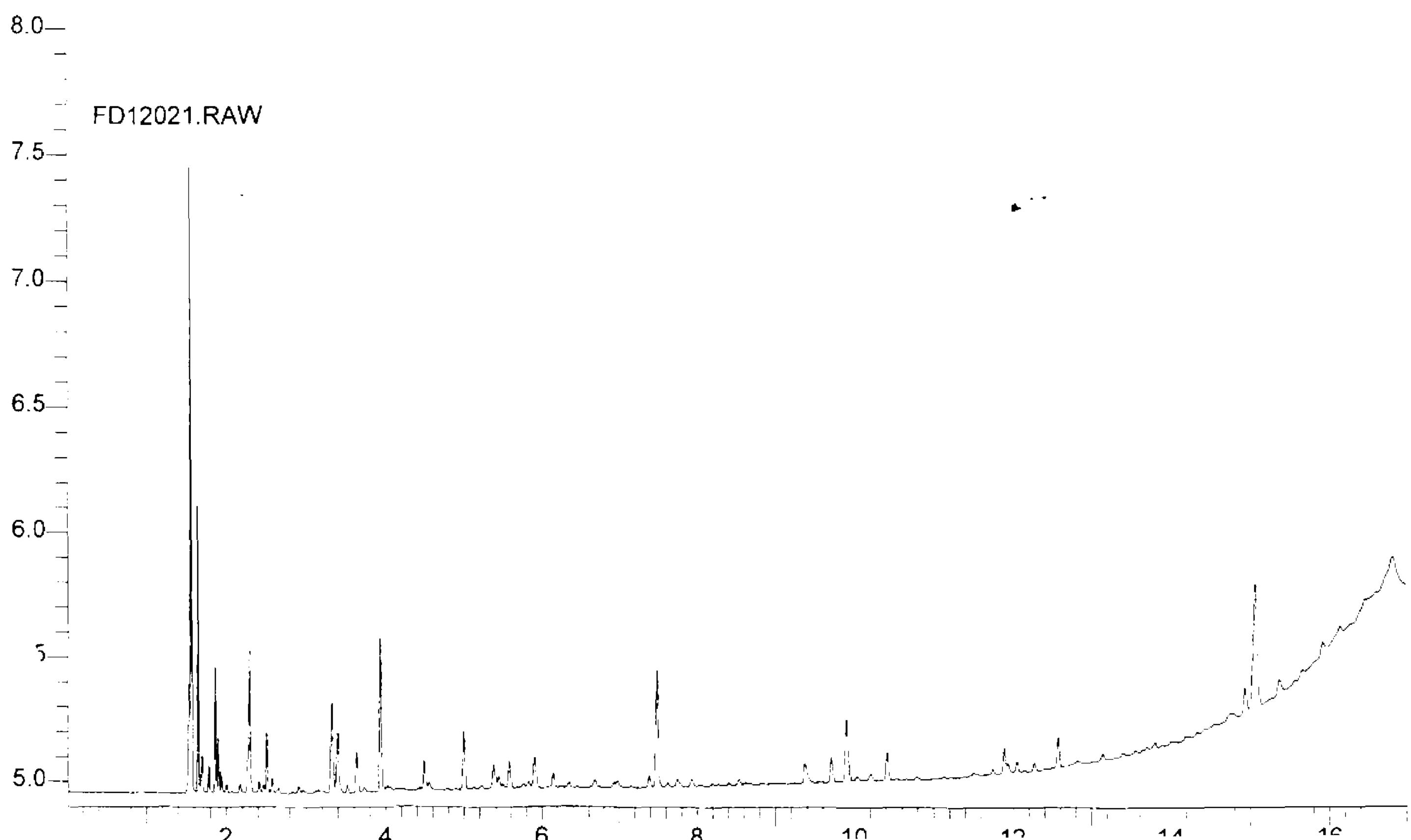




GAS CHROMATOGRAMS

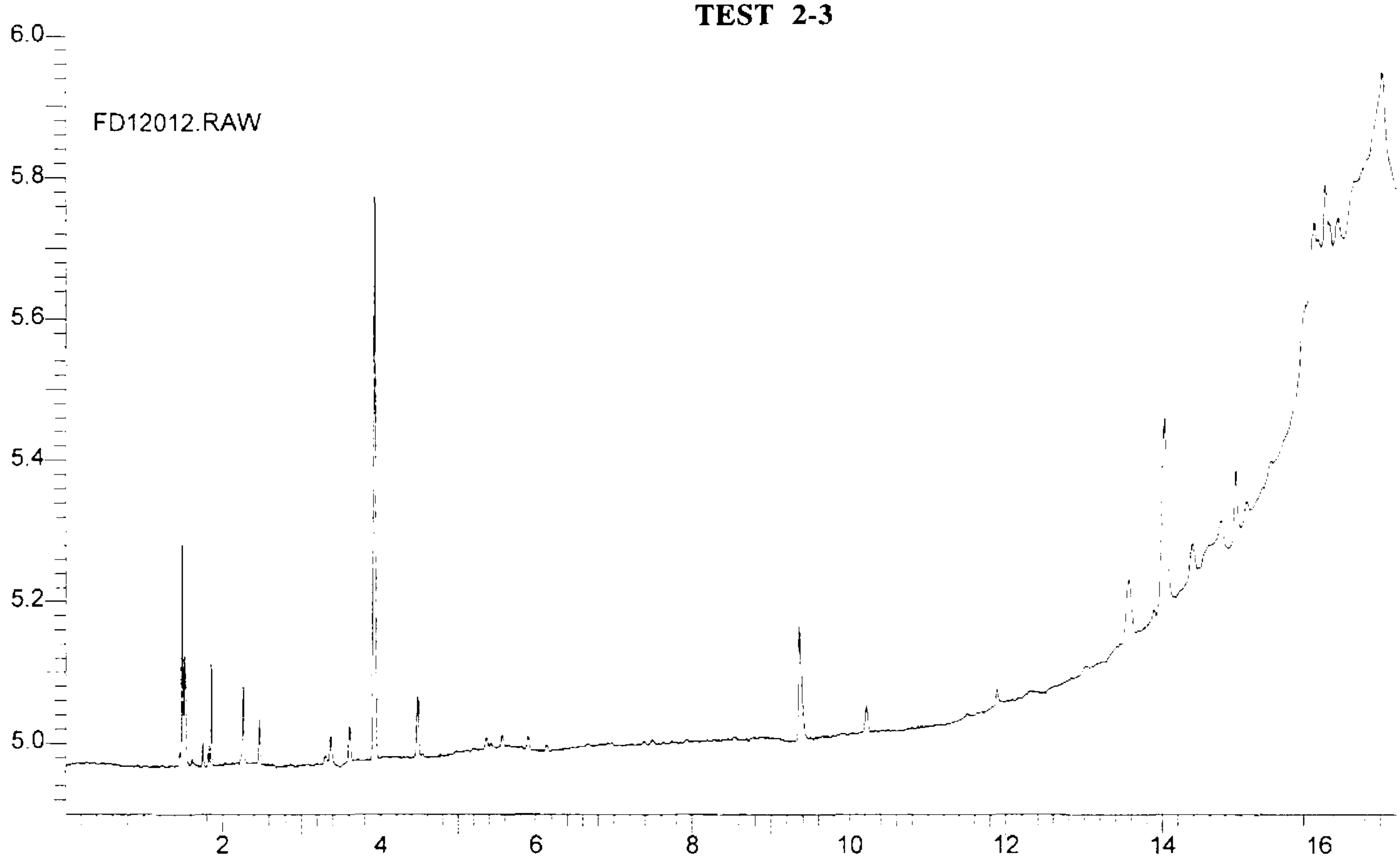
TEST 2-2

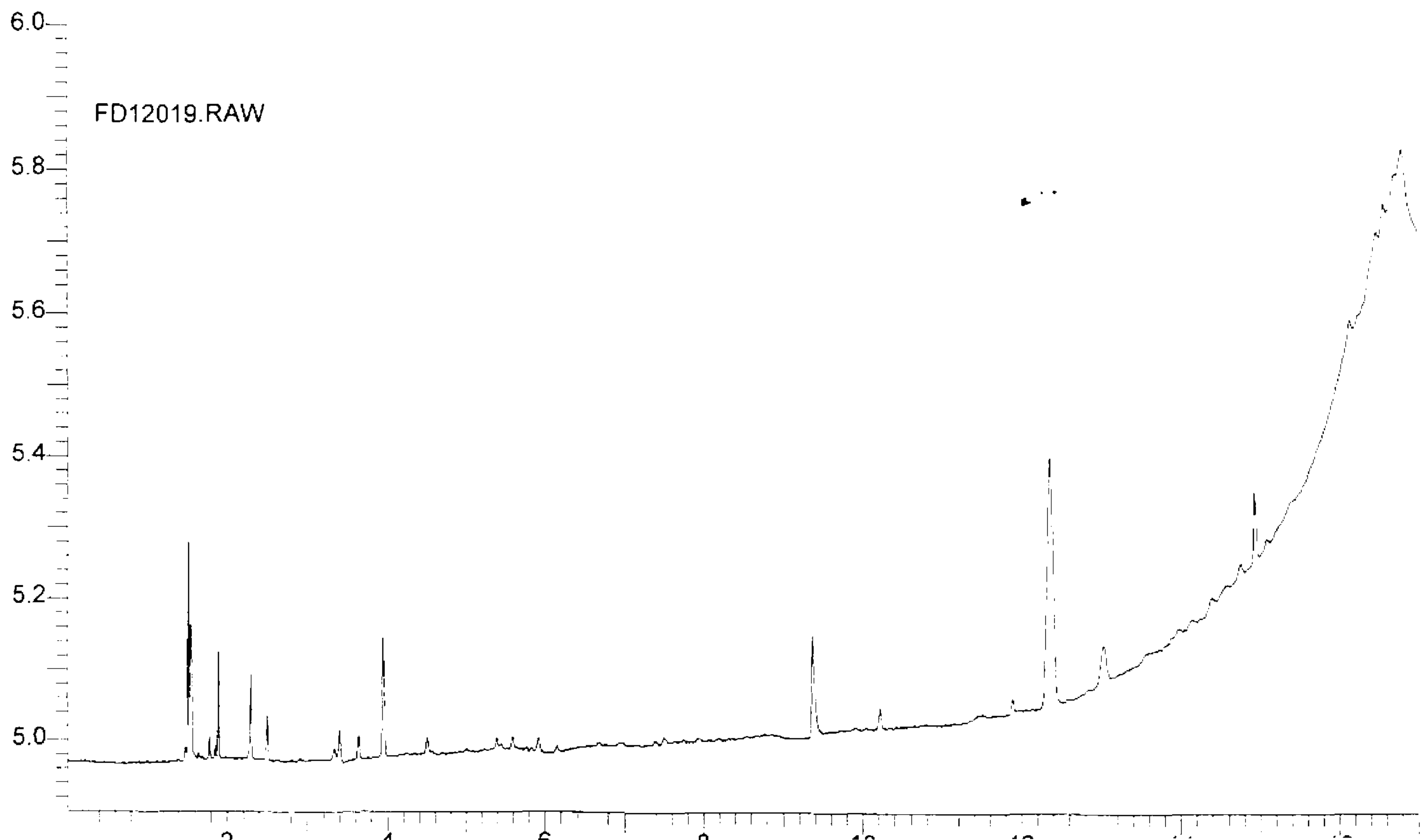




GAS CHROMATOGRAMS

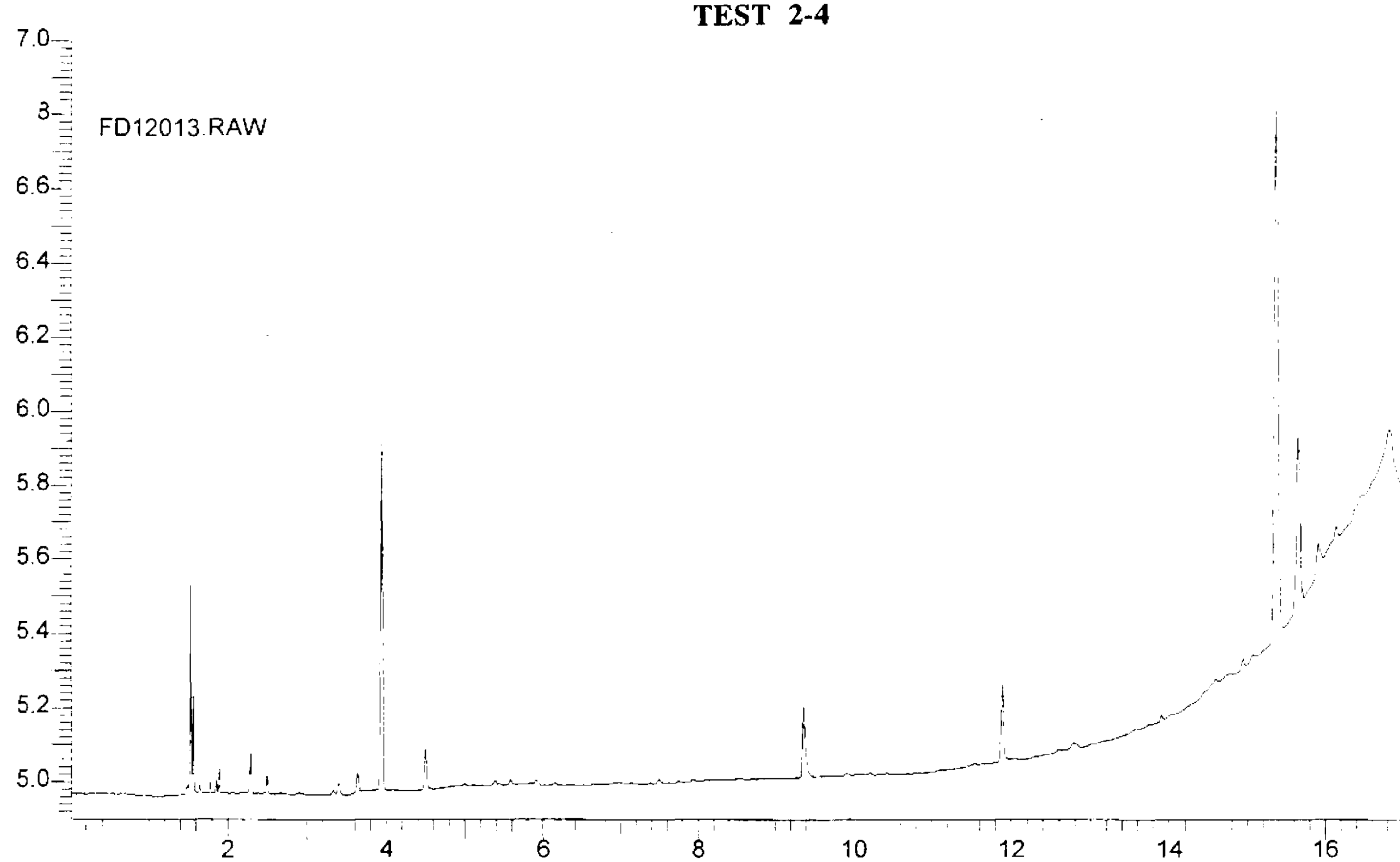
TEST 2-3

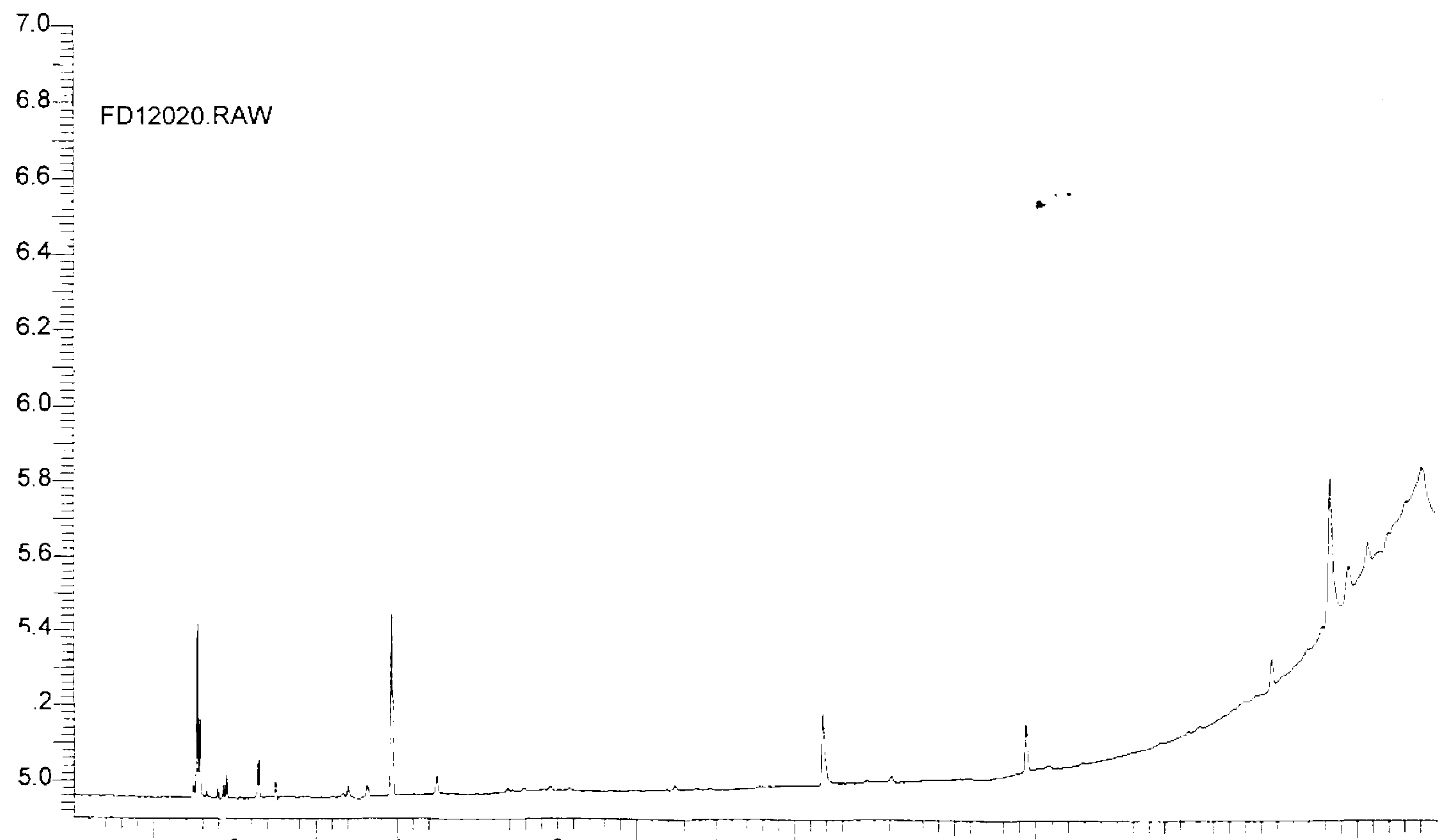




GAS CHROMATOGRAMS

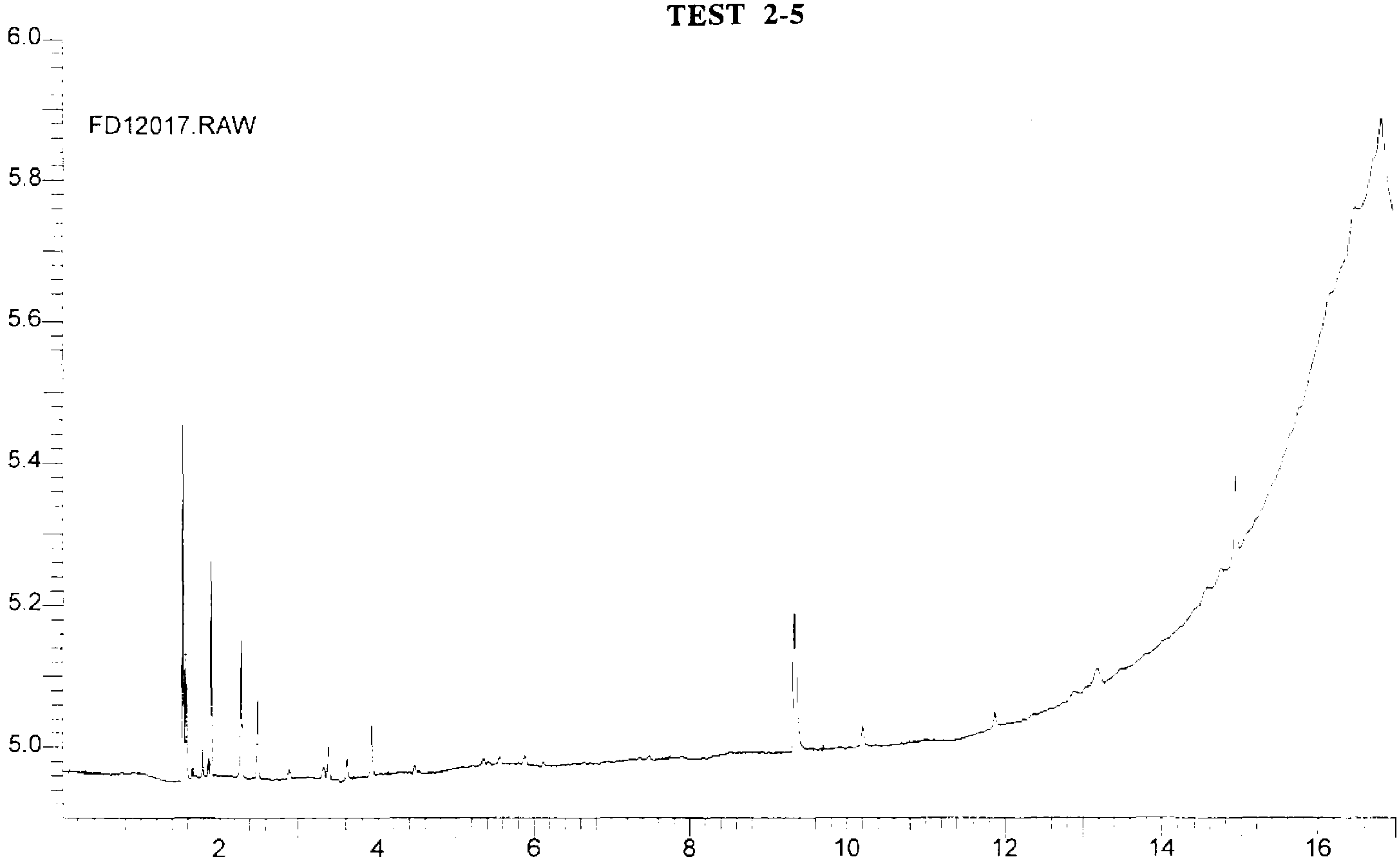
TEST 2-4

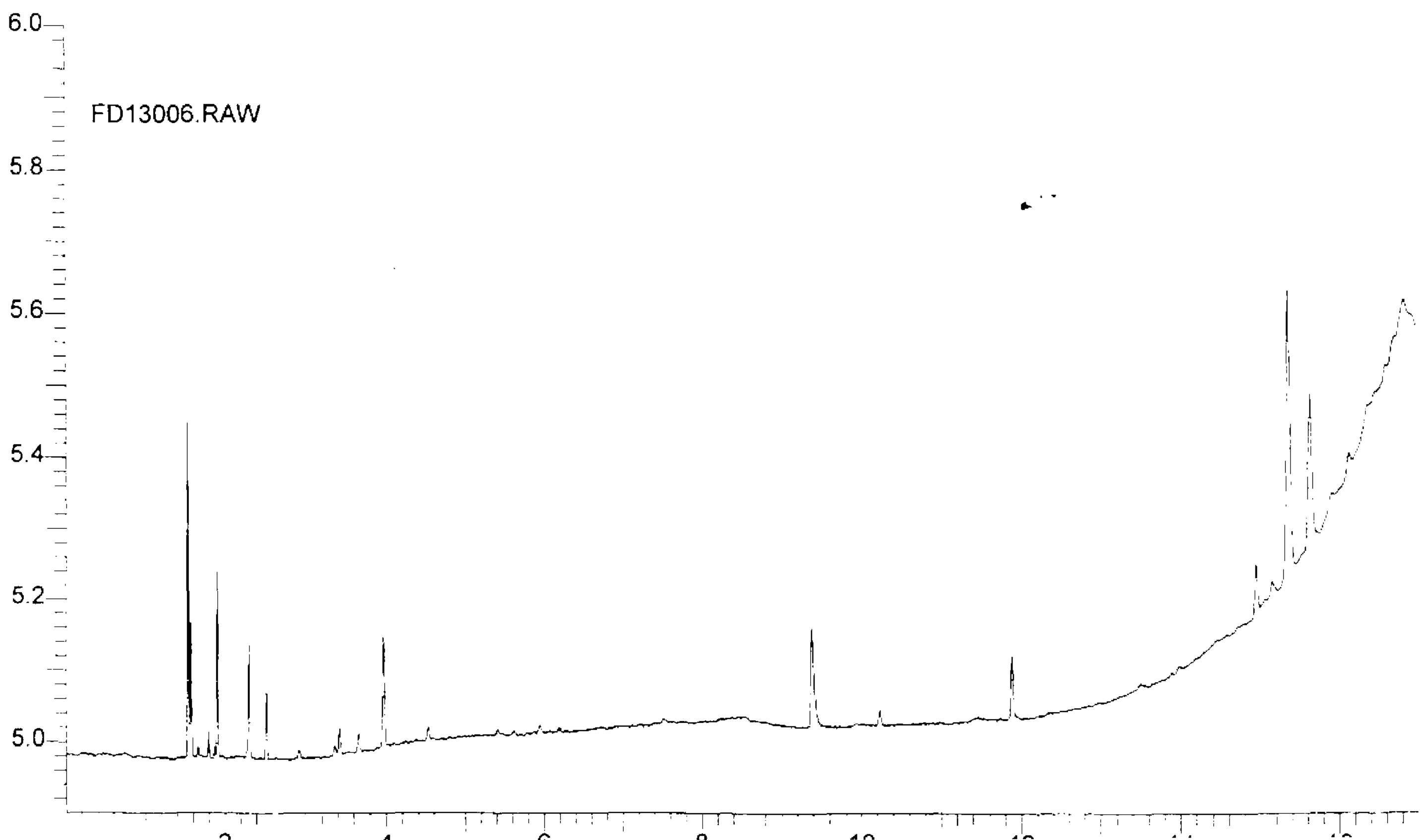




GAS CHROMATOGRAMS

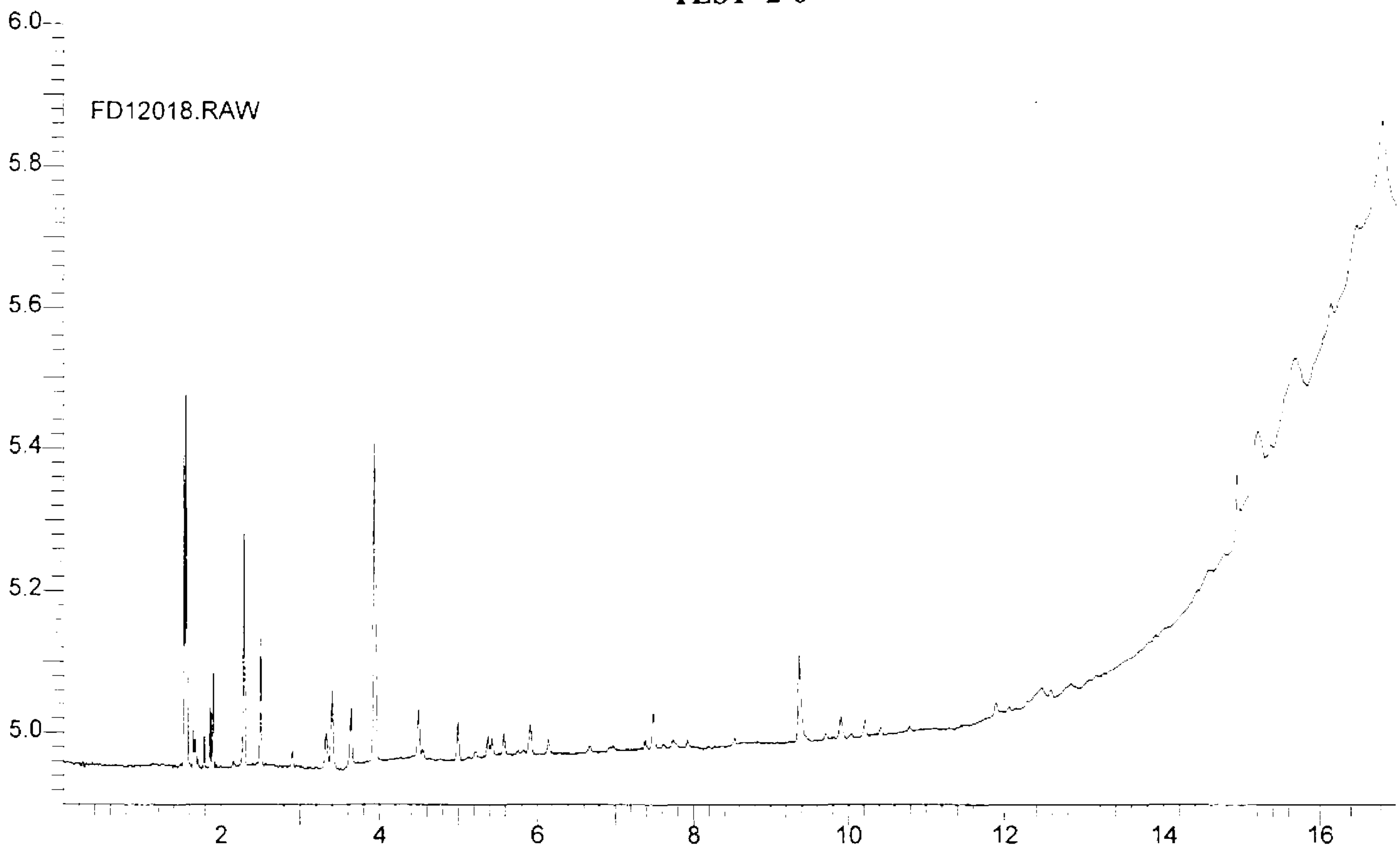
TEST 2-5

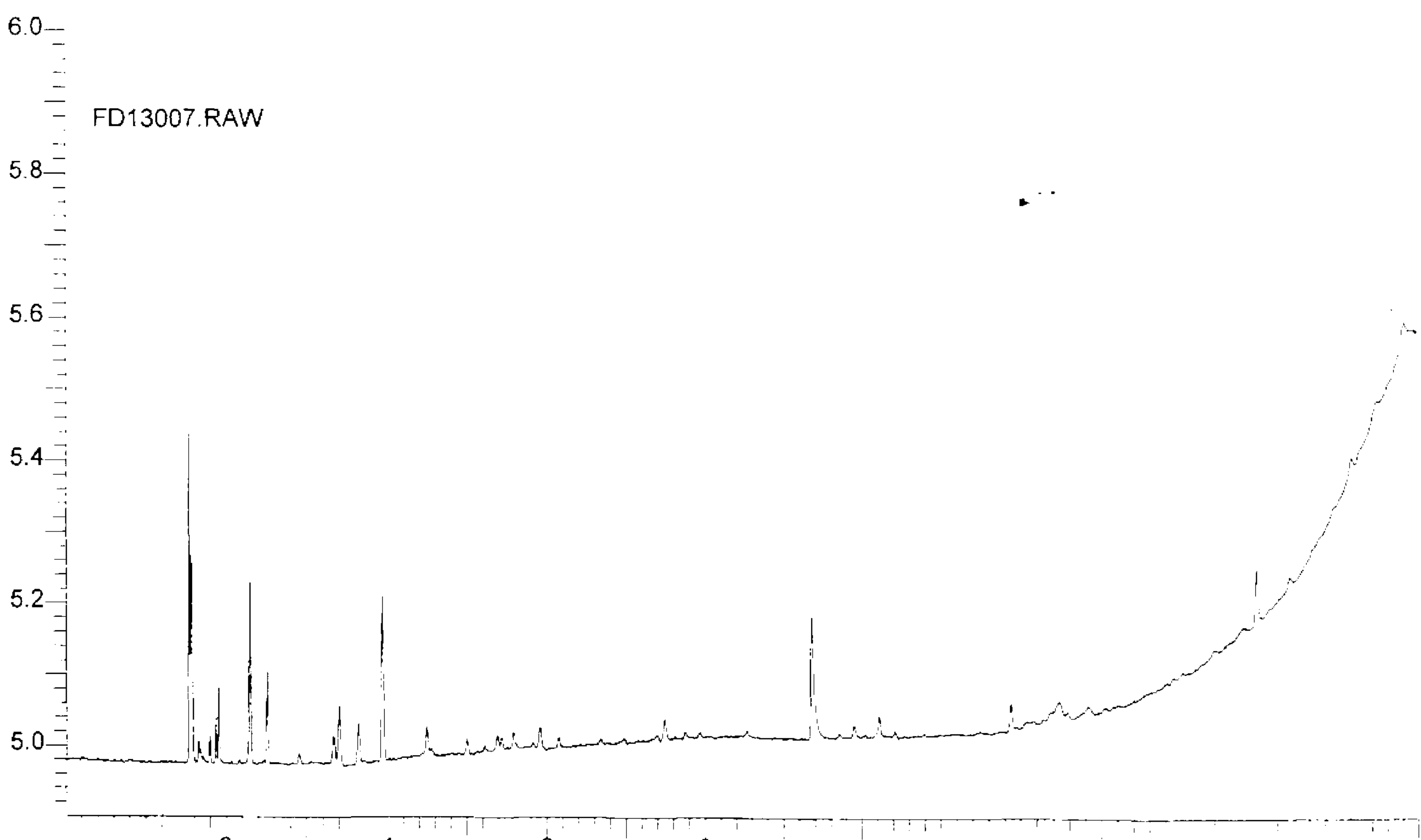




GAS CHROMATOGRAMS

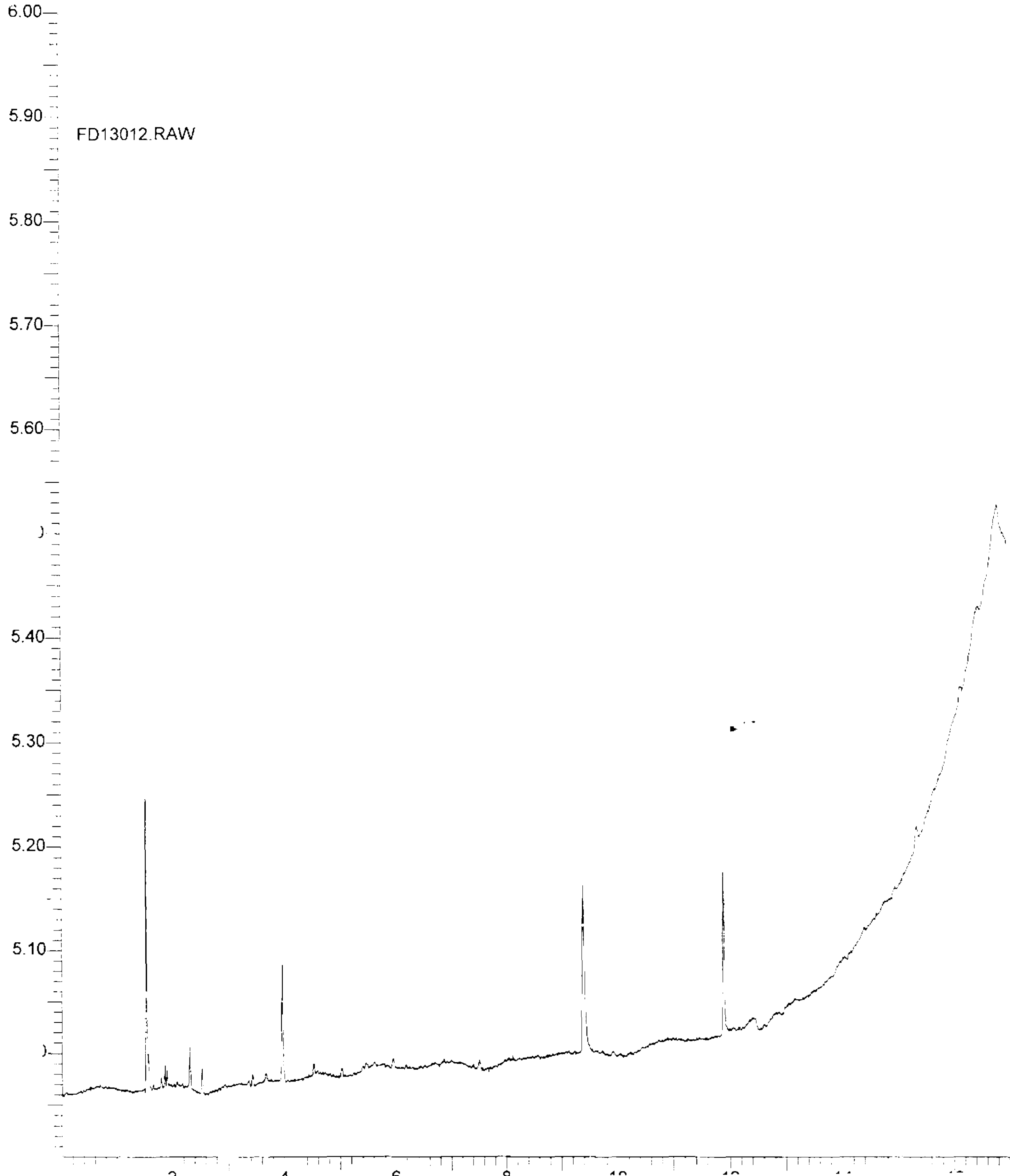
TEST 2-6





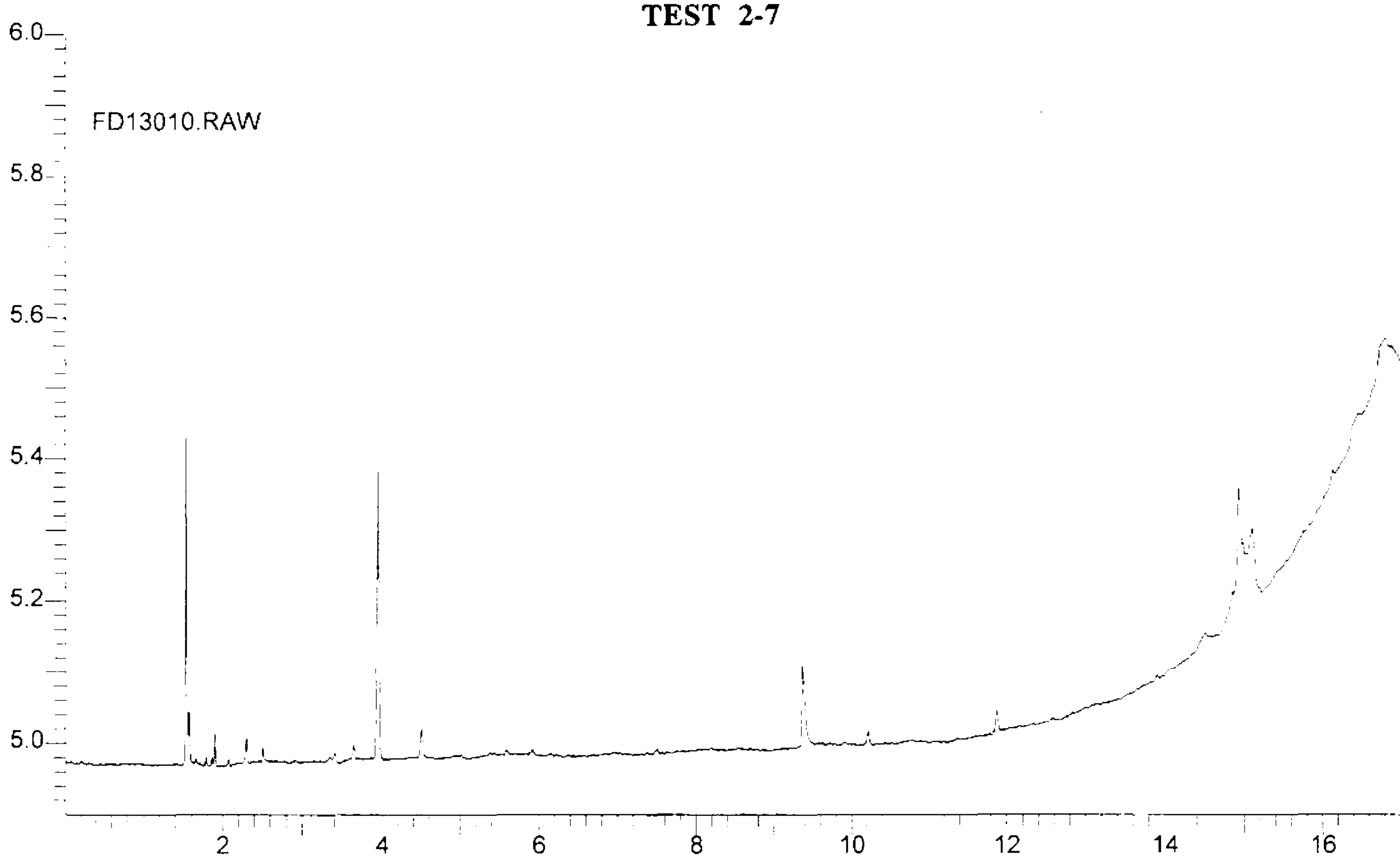
GAS CHROMATOGRAMS

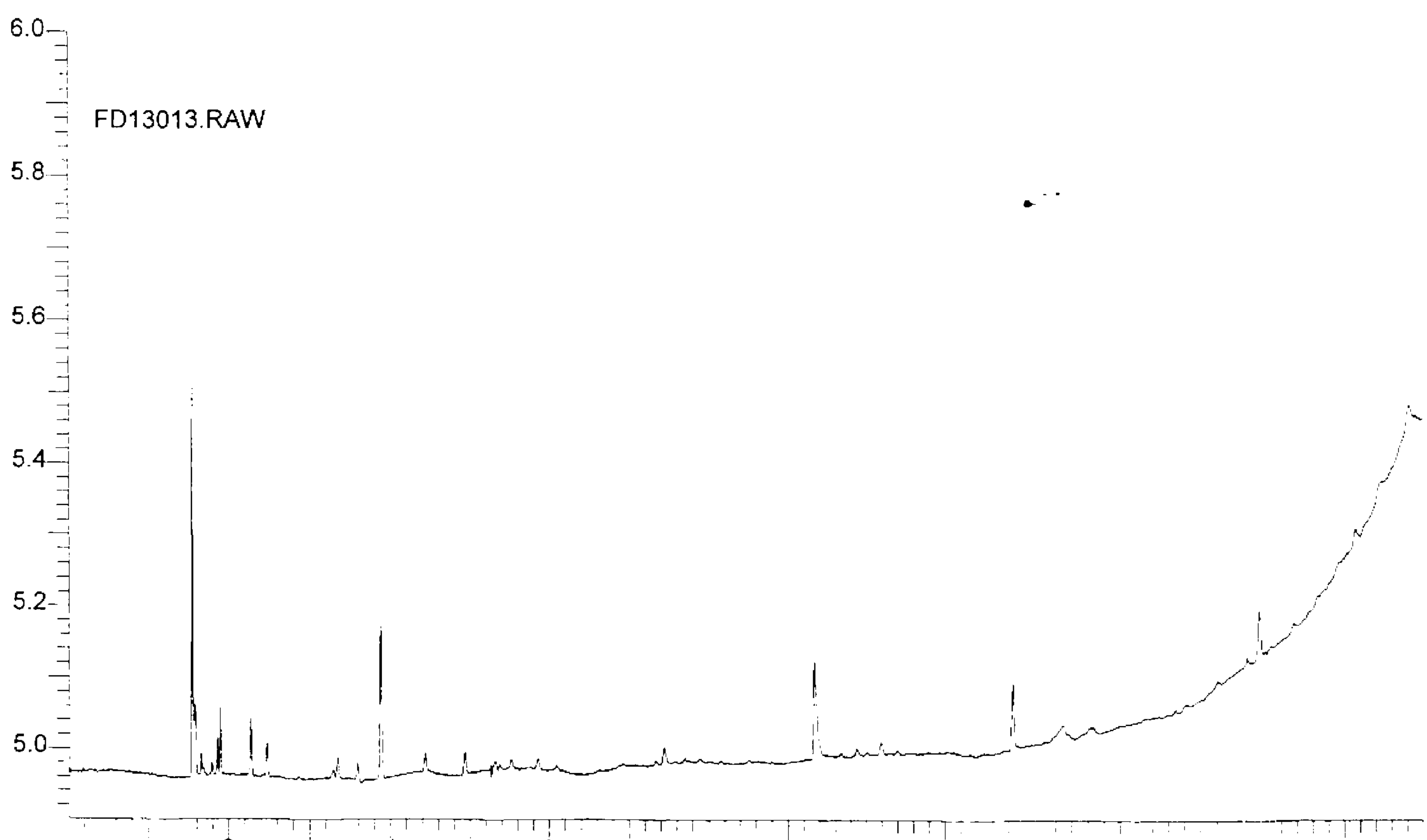
CONTROL CAR



GAS CHROMATOGRAMS

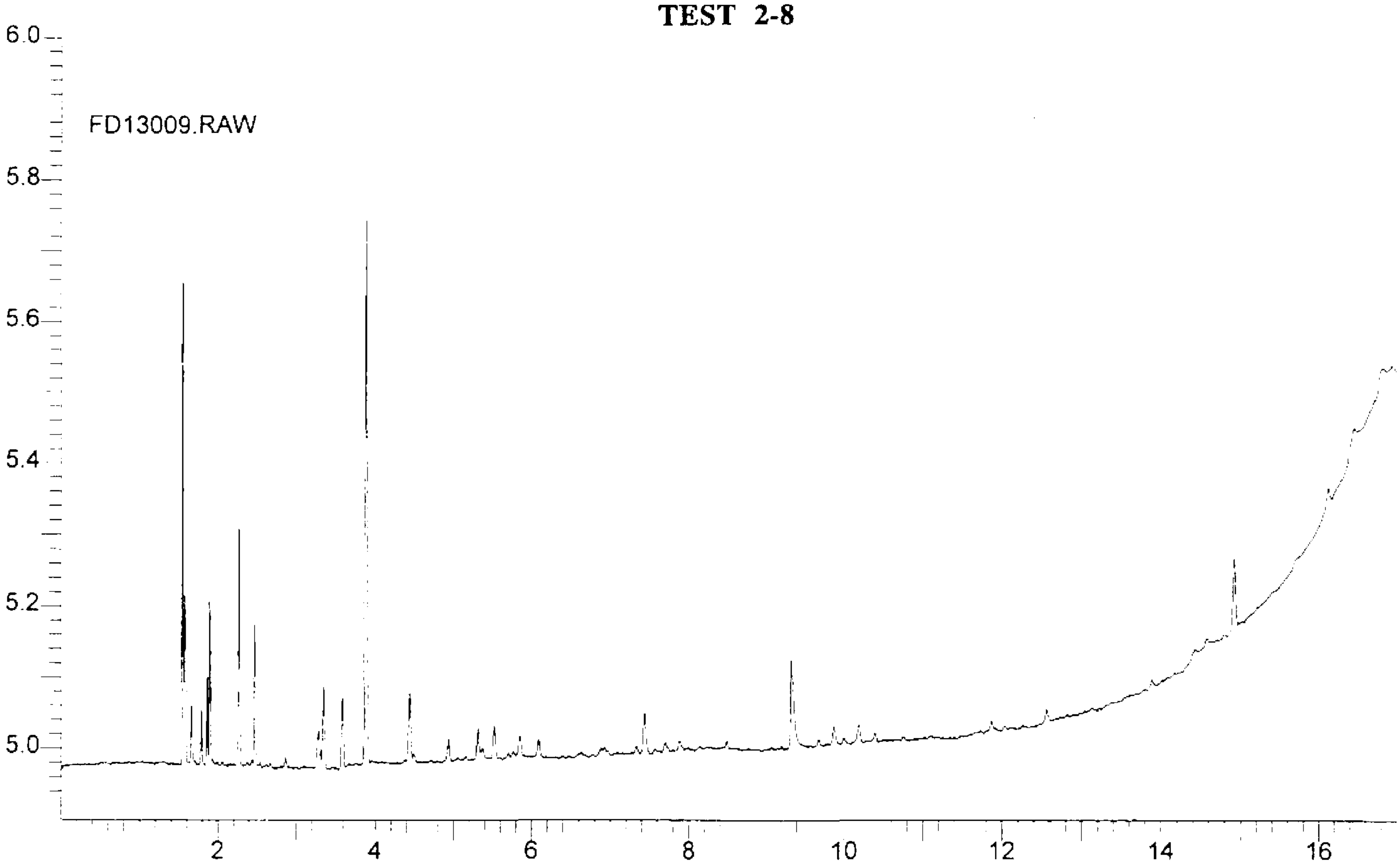
TEST 2-7

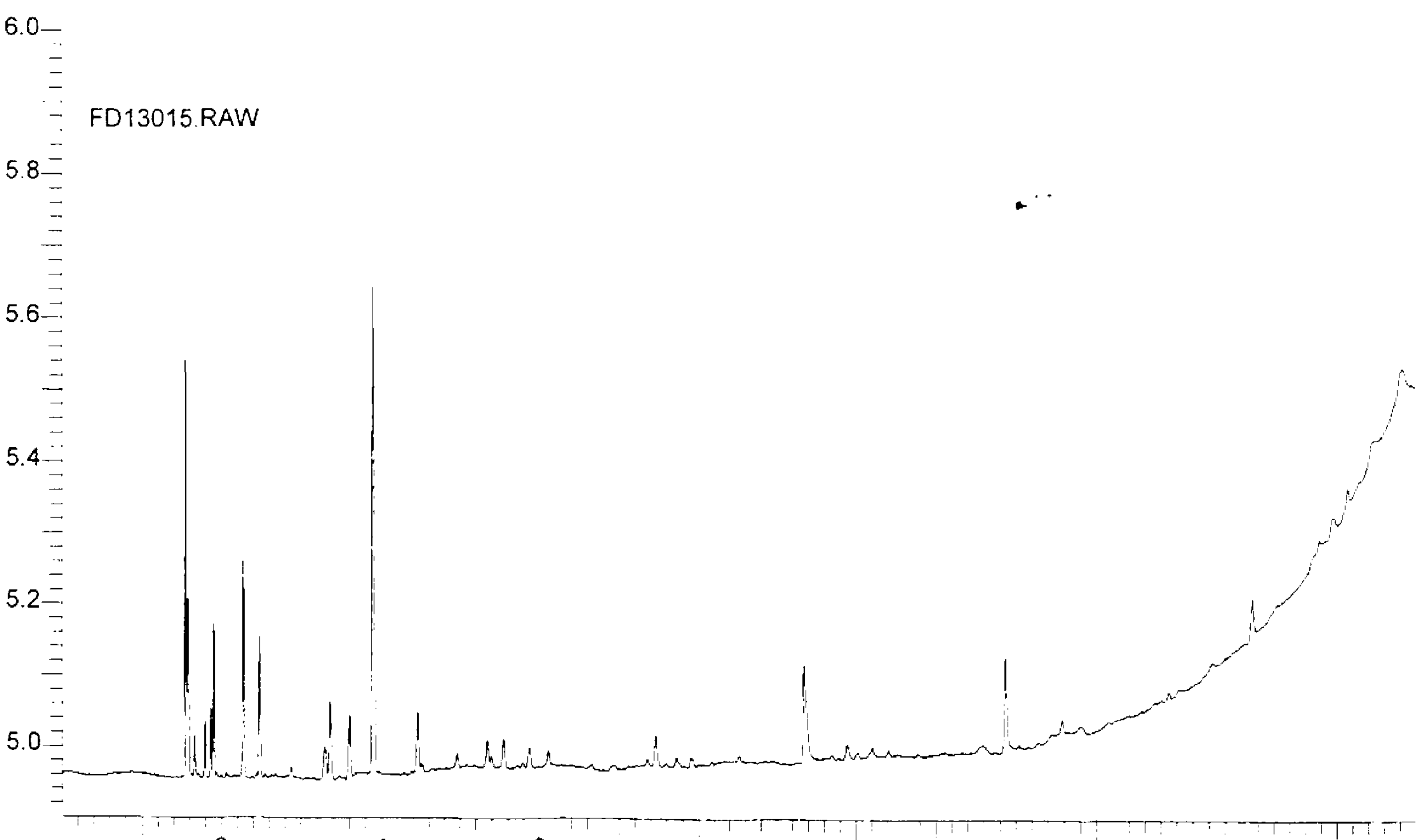




GAS CHROMATOGRAMS

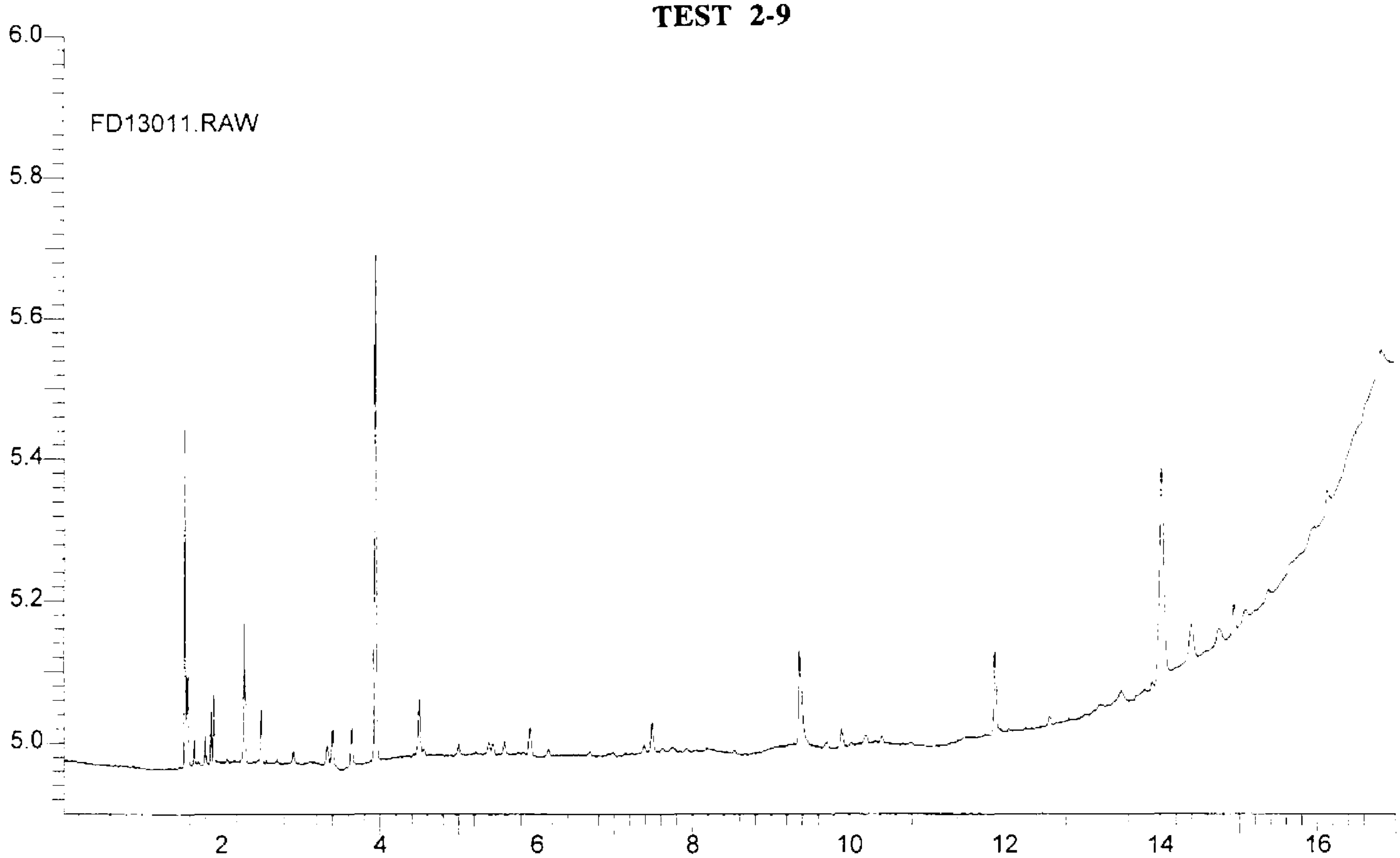
TEST 2-8

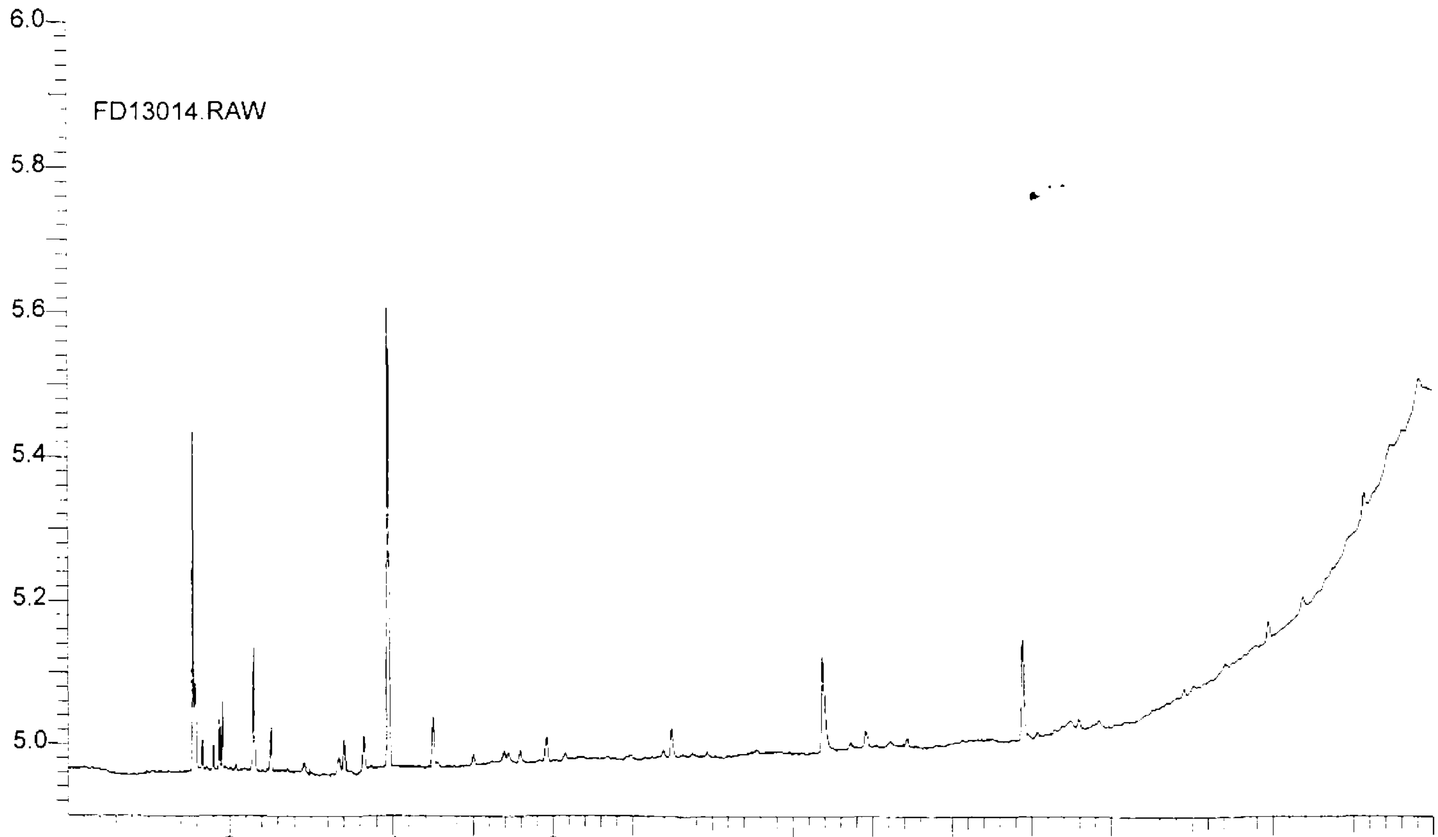




GAS CHROMATOGRAMS

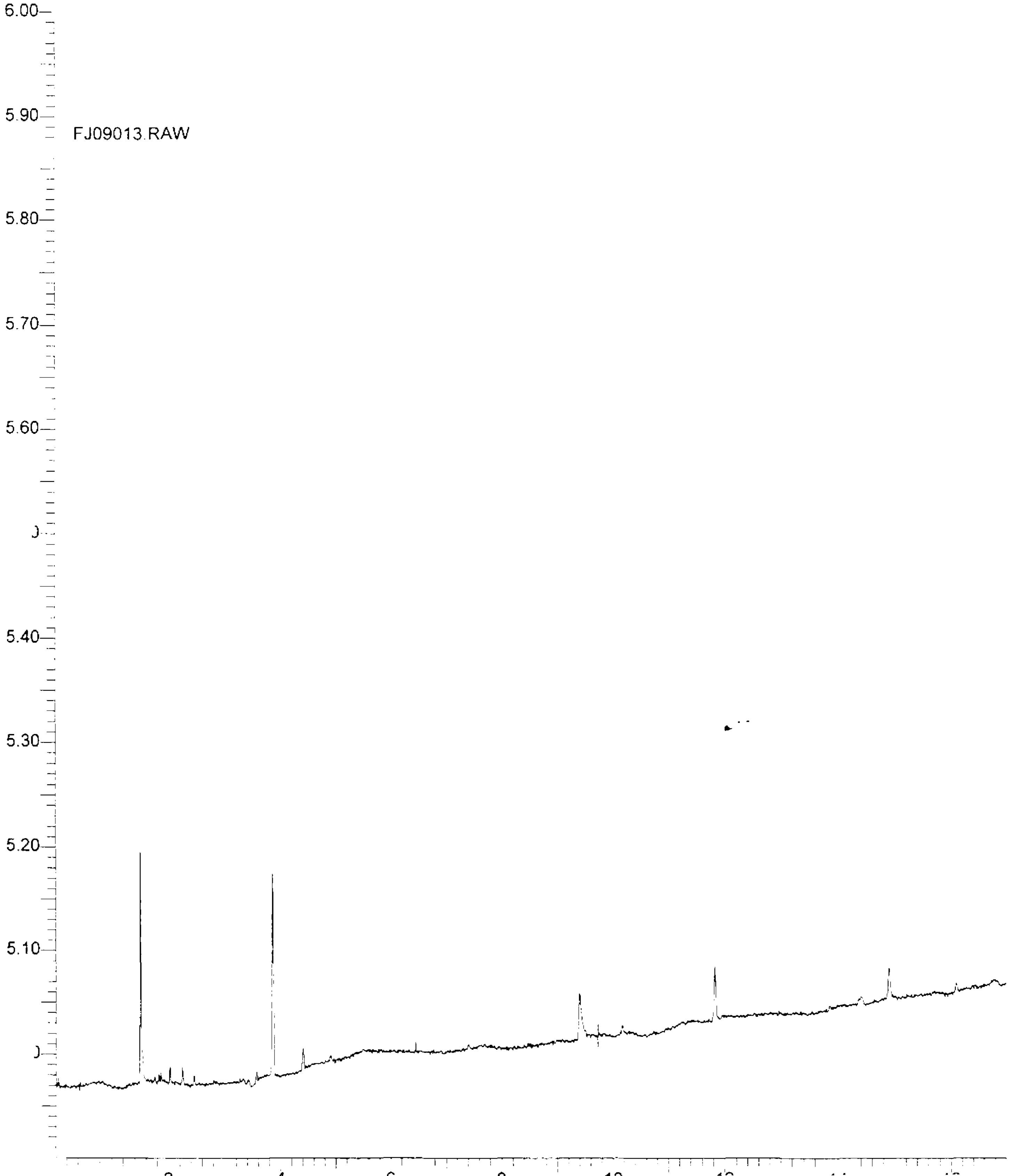
TEST 2-9





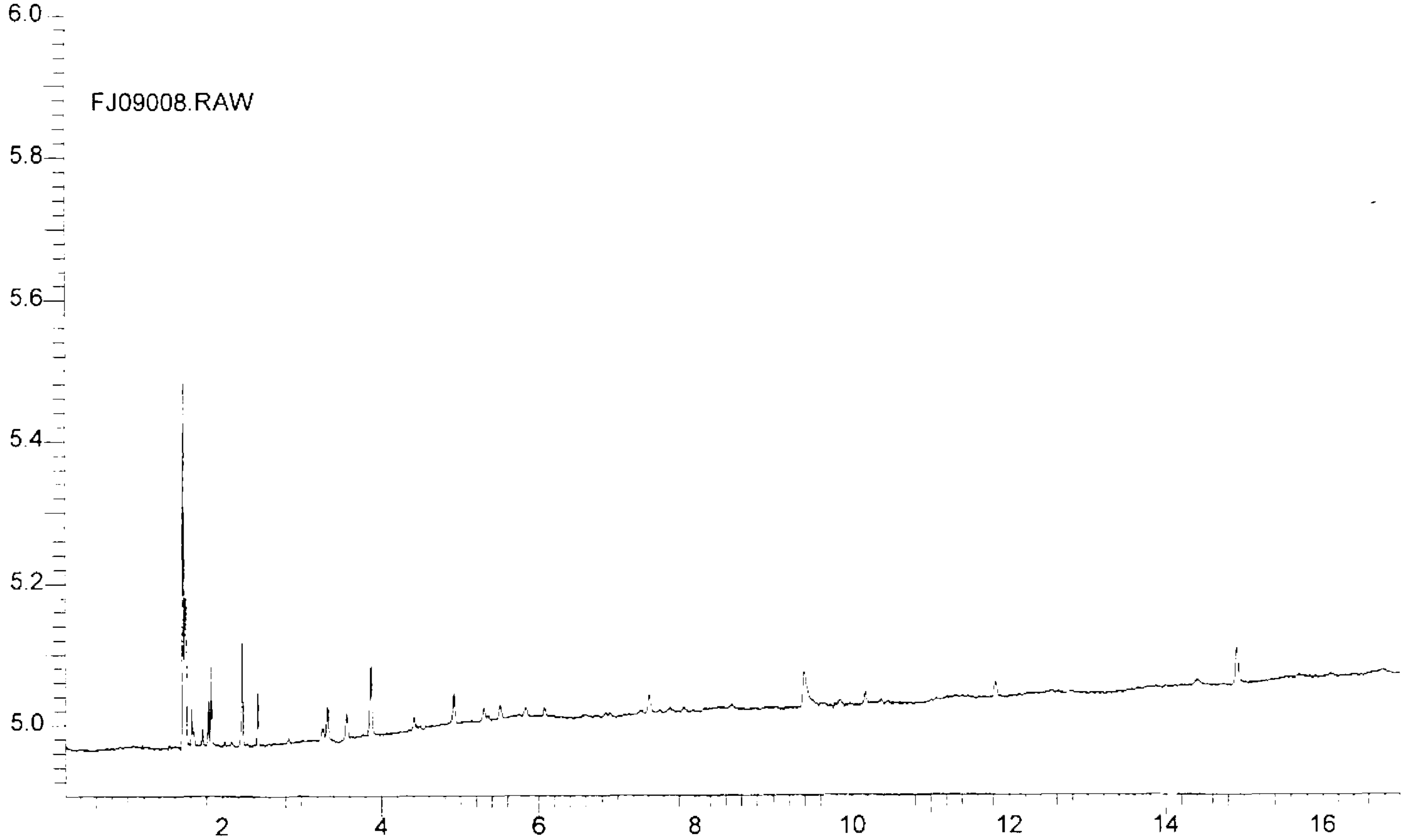
GAS CHROMATOGRAMS

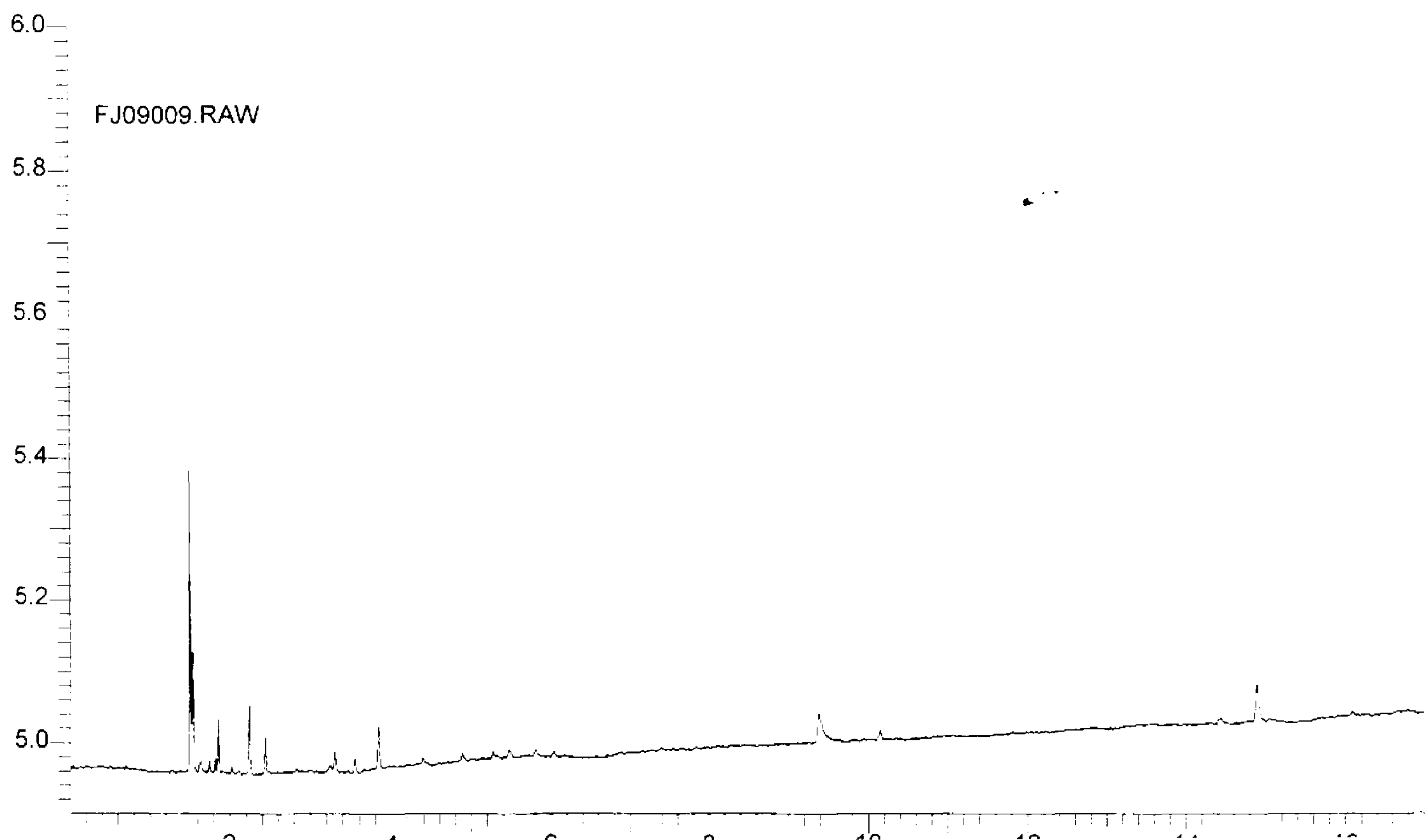
CONTROL CAR



GAS CHROMATOGRAMS

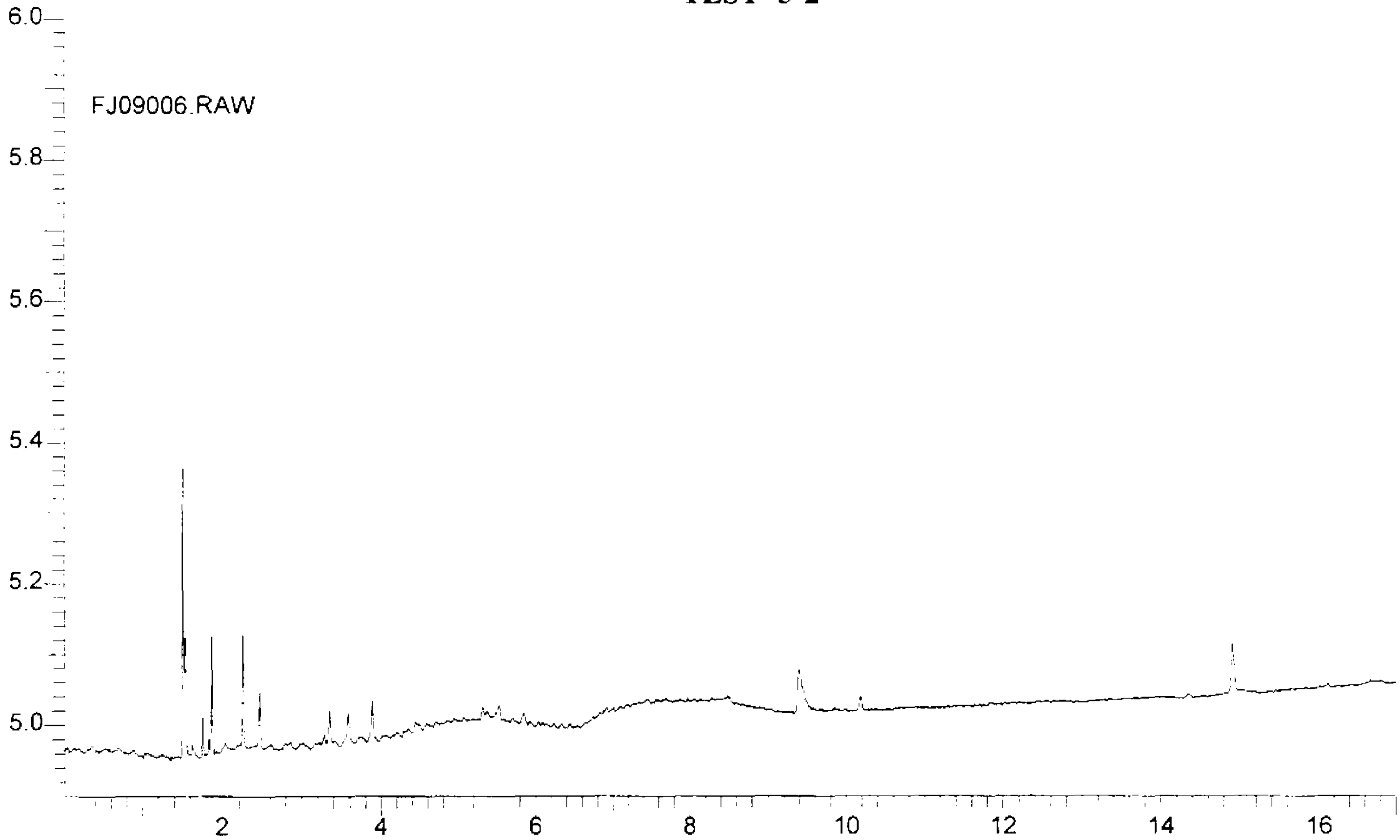
TEST 3-1

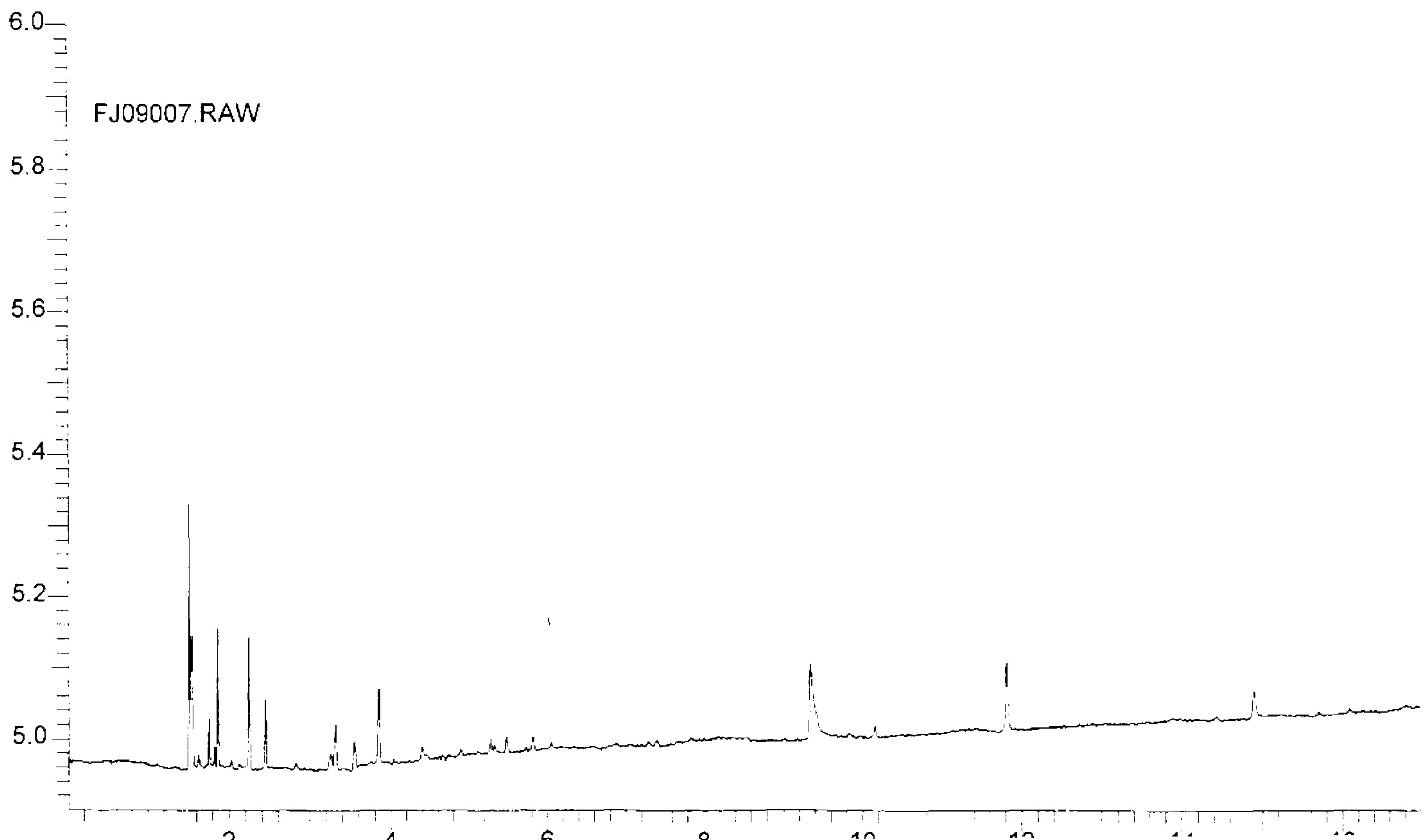




GAS CHROMATOGRAMS

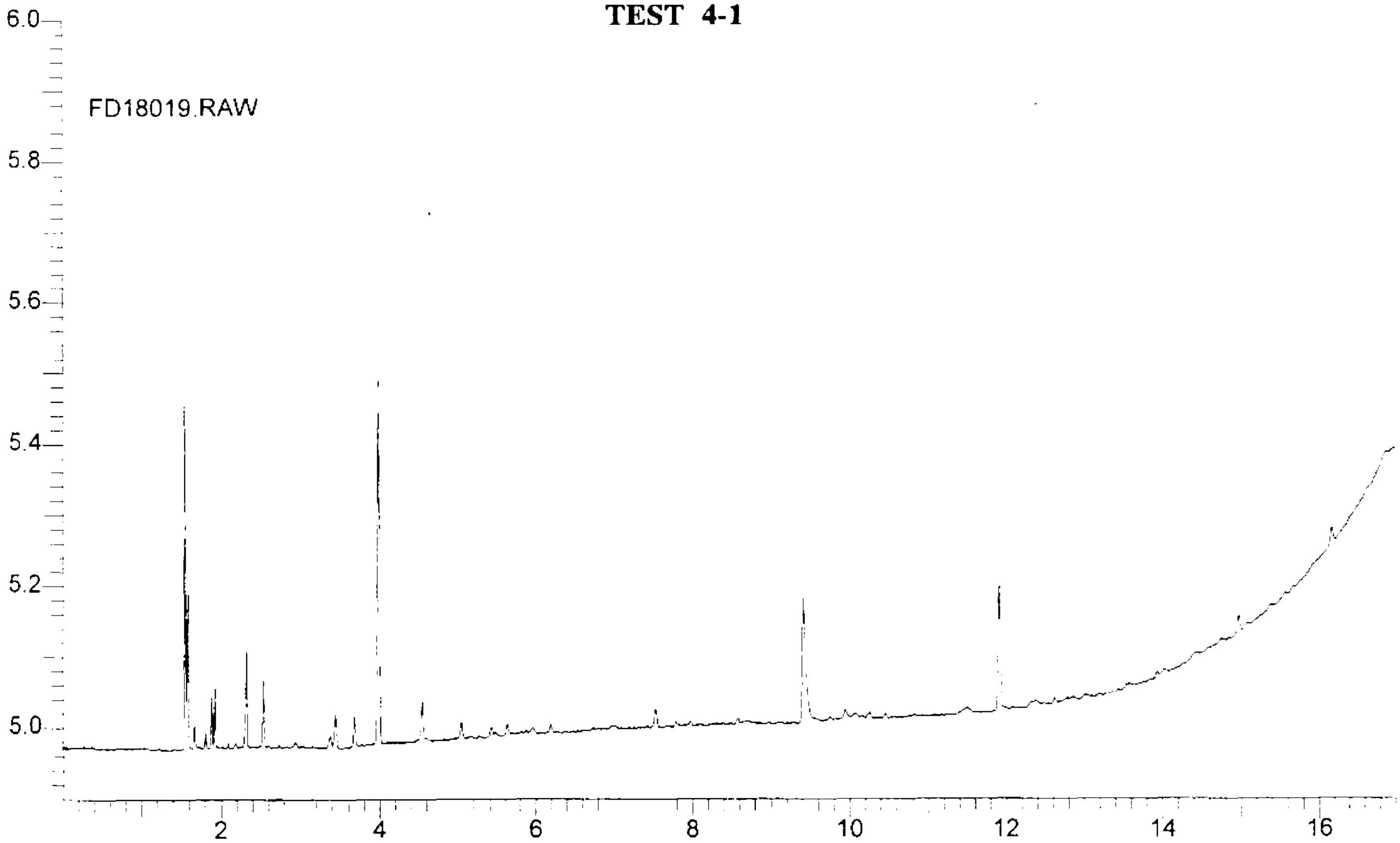
TEST 3-2

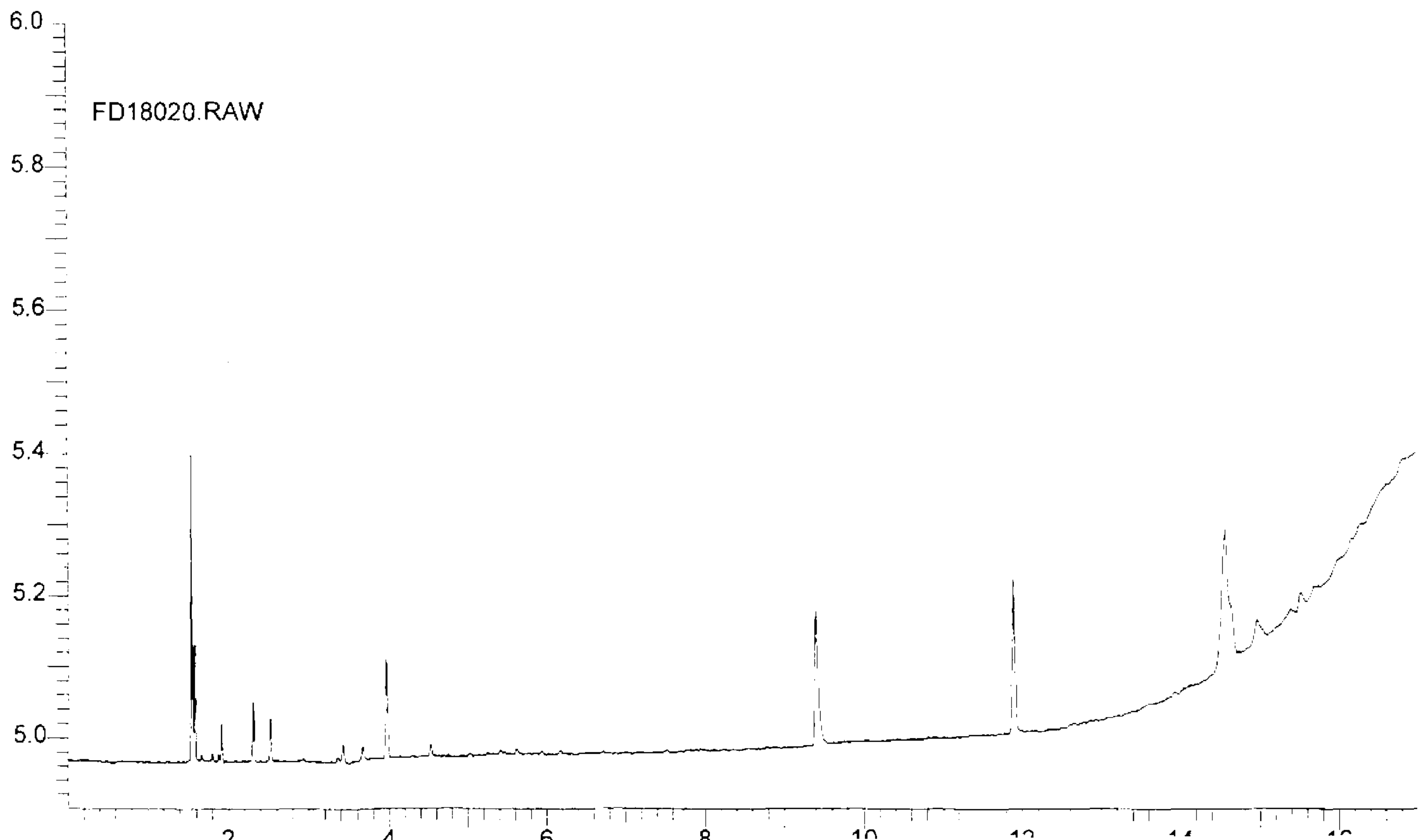




GAS CHROMATOGRAMS

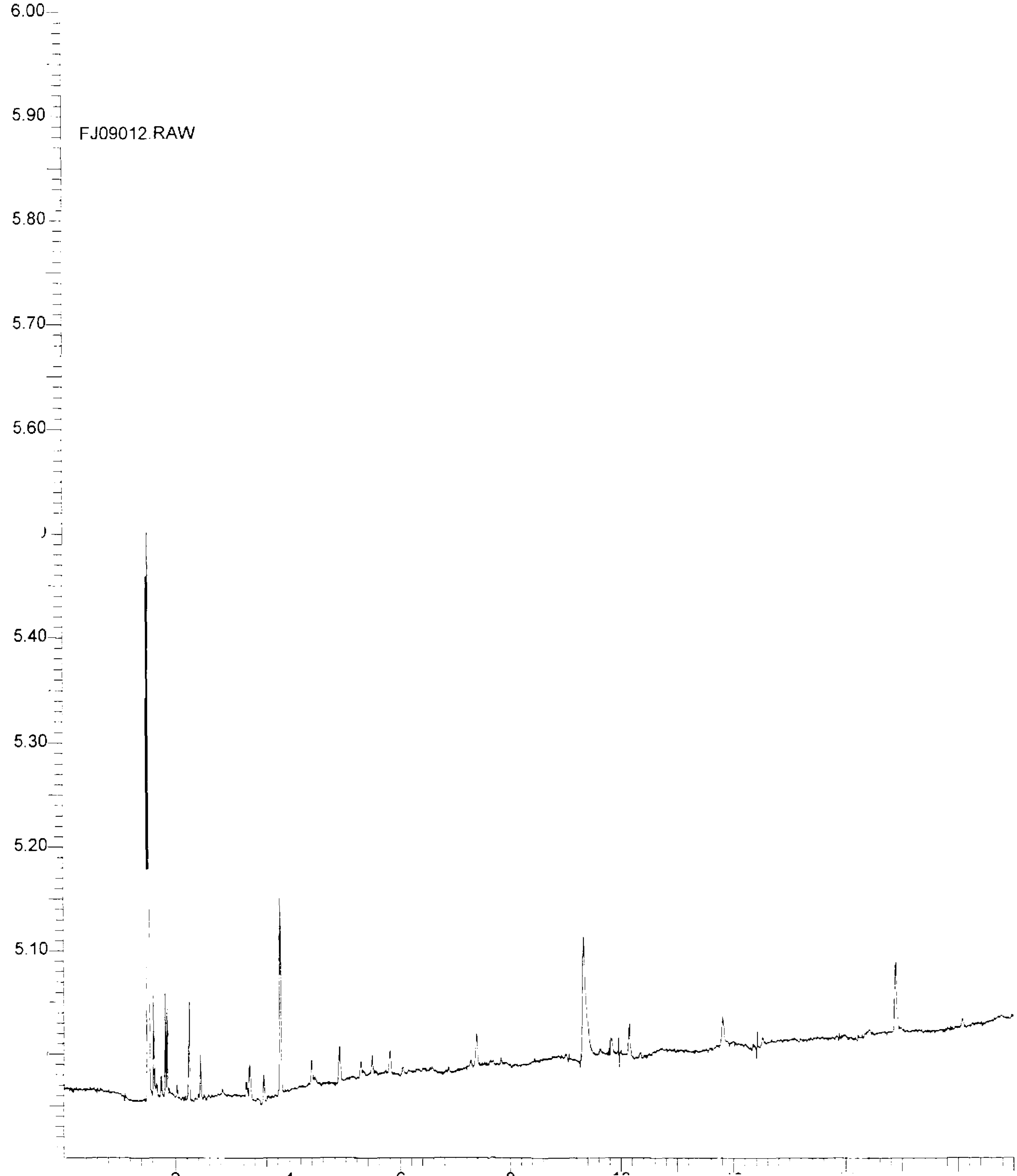
TEST 4-1





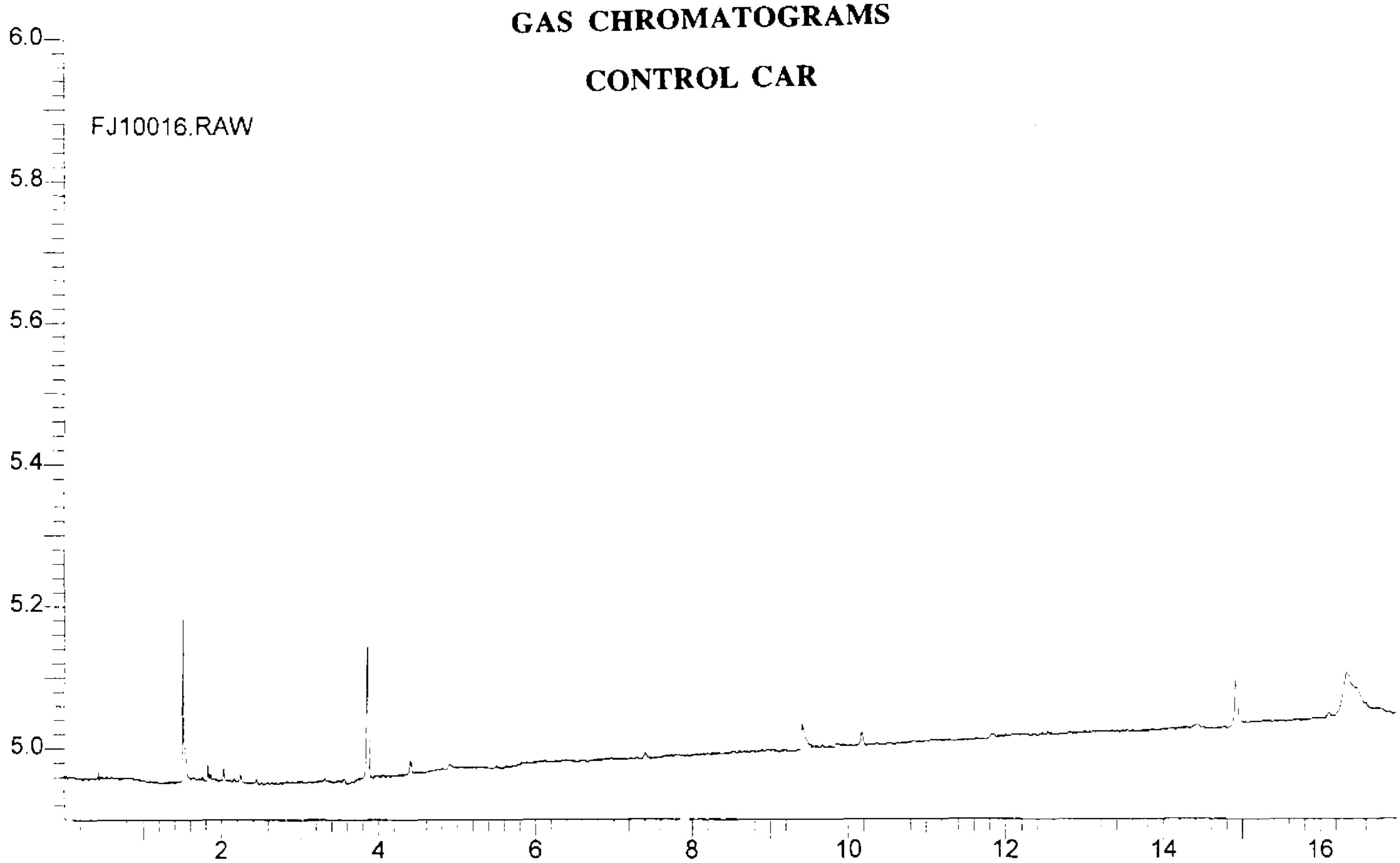
GAS CHROMATOGRAMS

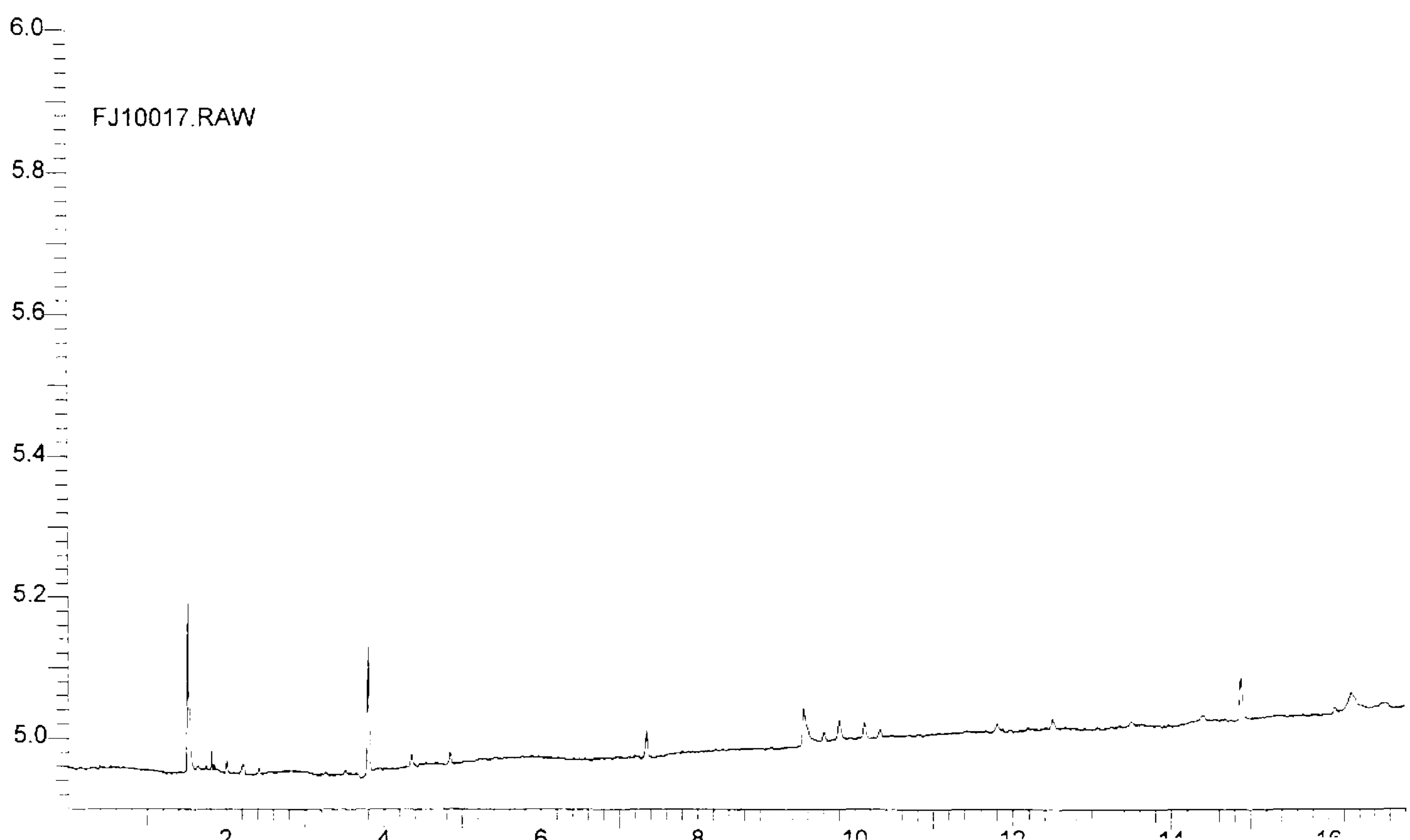
TEST 3-4



GAS CHROMATOGRAMS

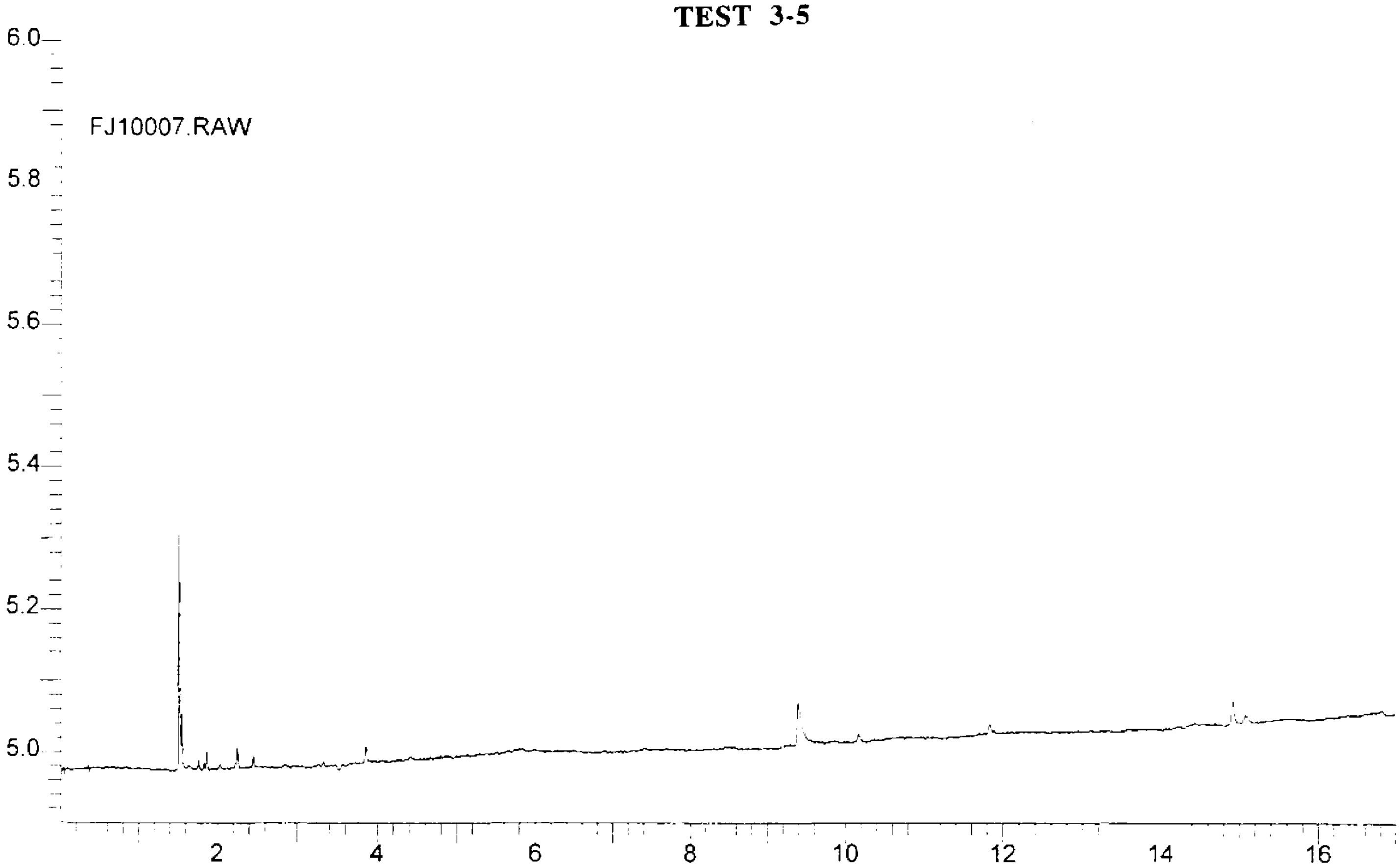
CONTROL CAR

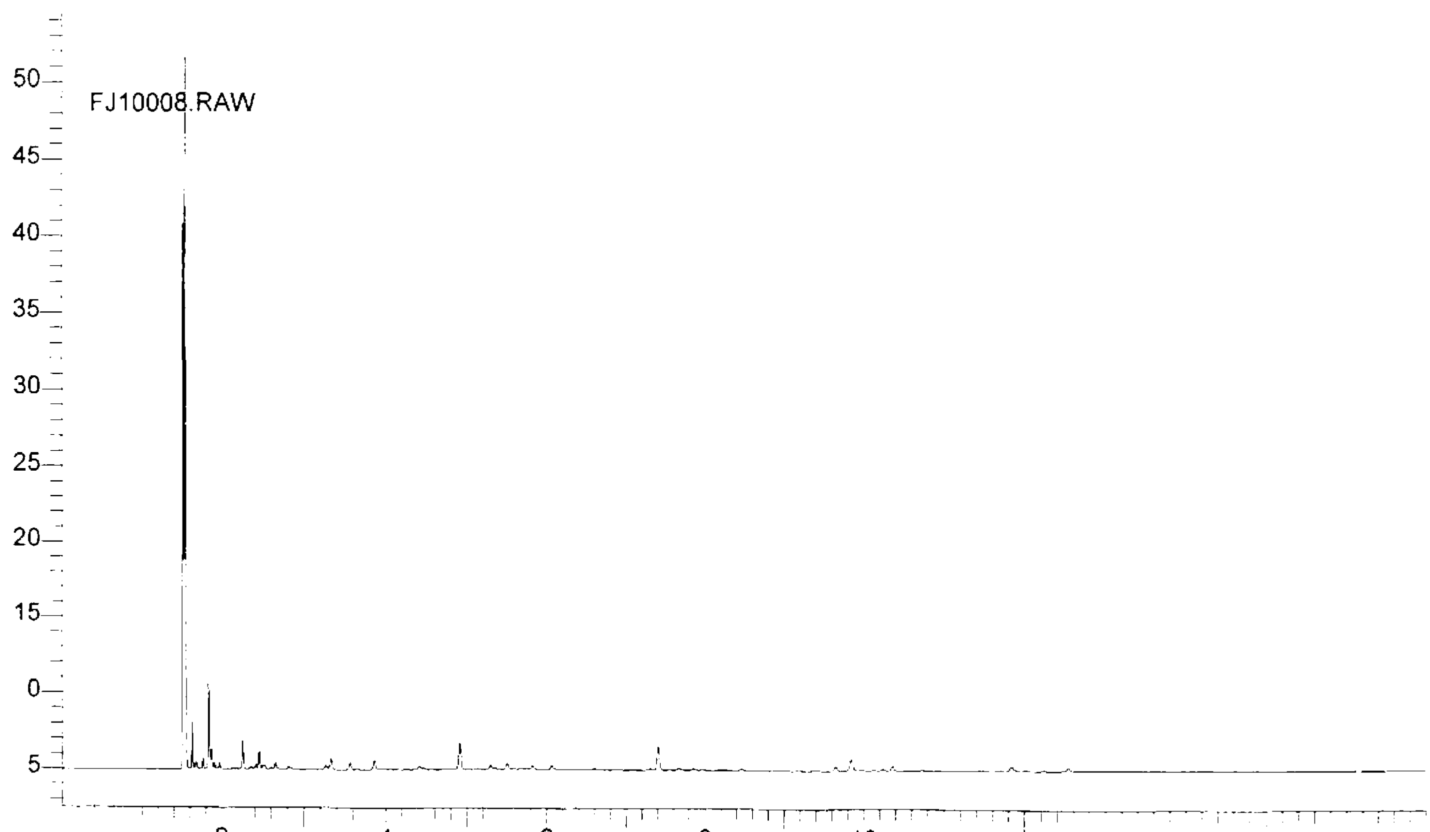




GAS CHROMATOGRAMS

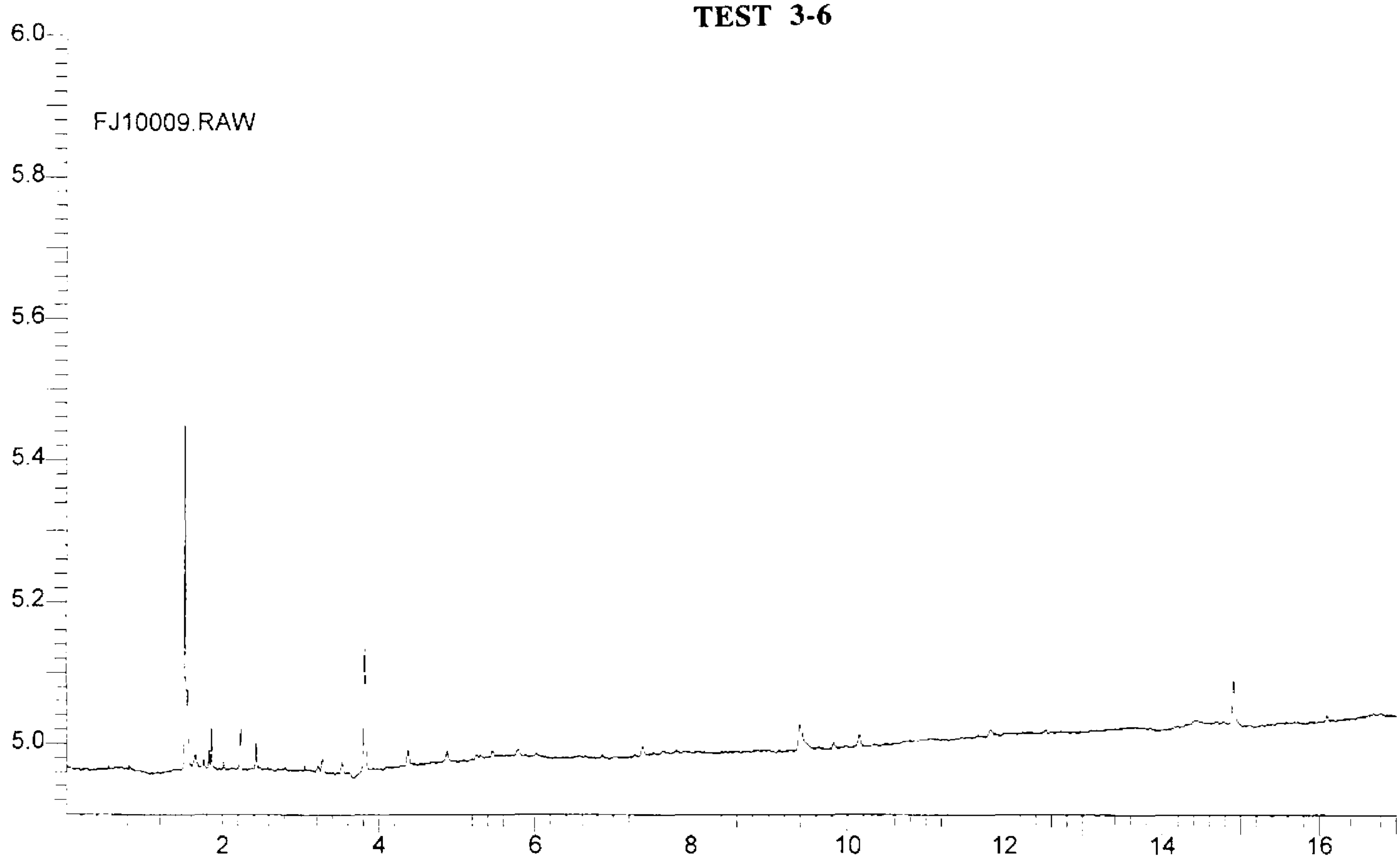
TEST 3-5

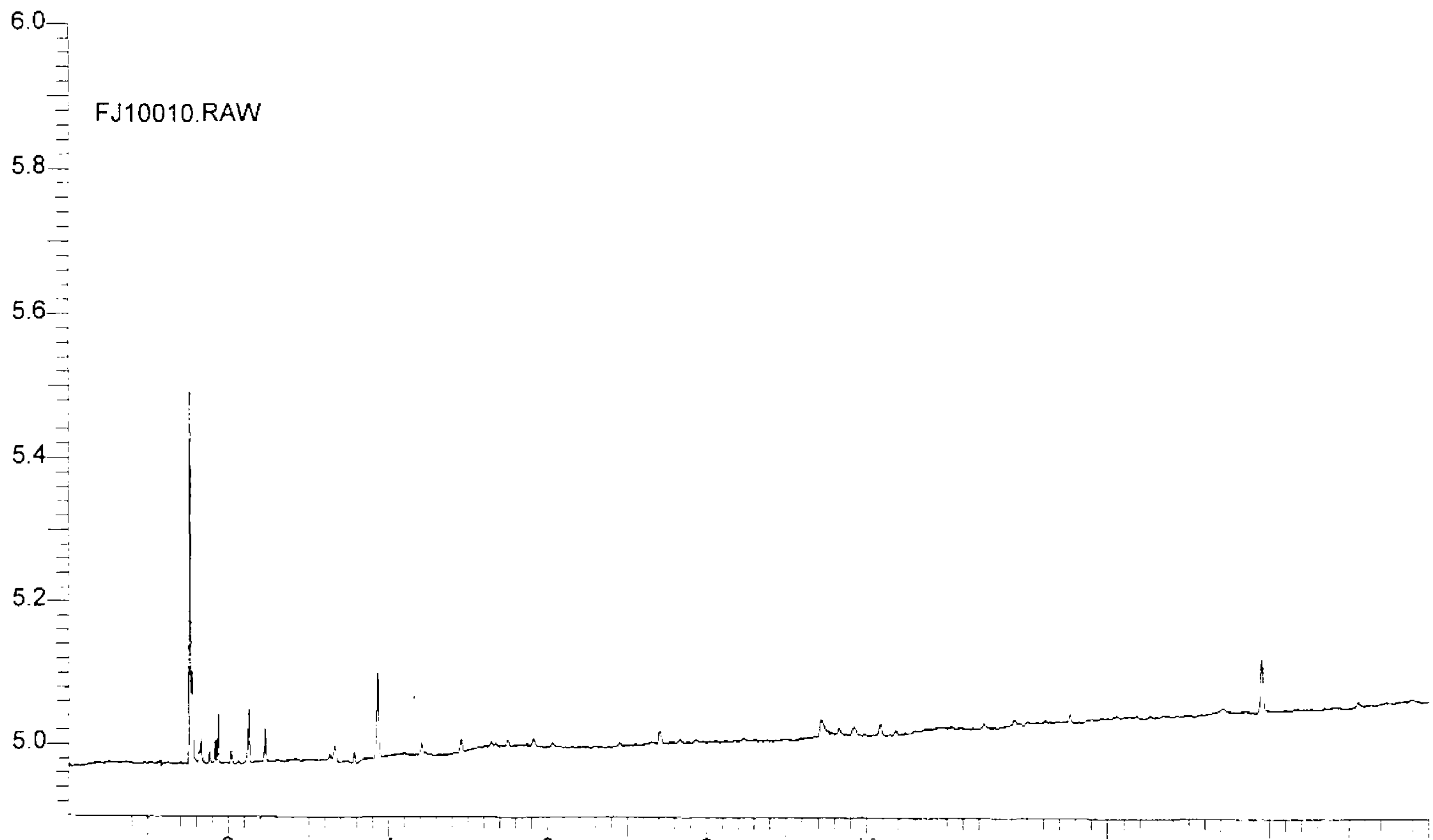




GAS CHROMATOGRAMS

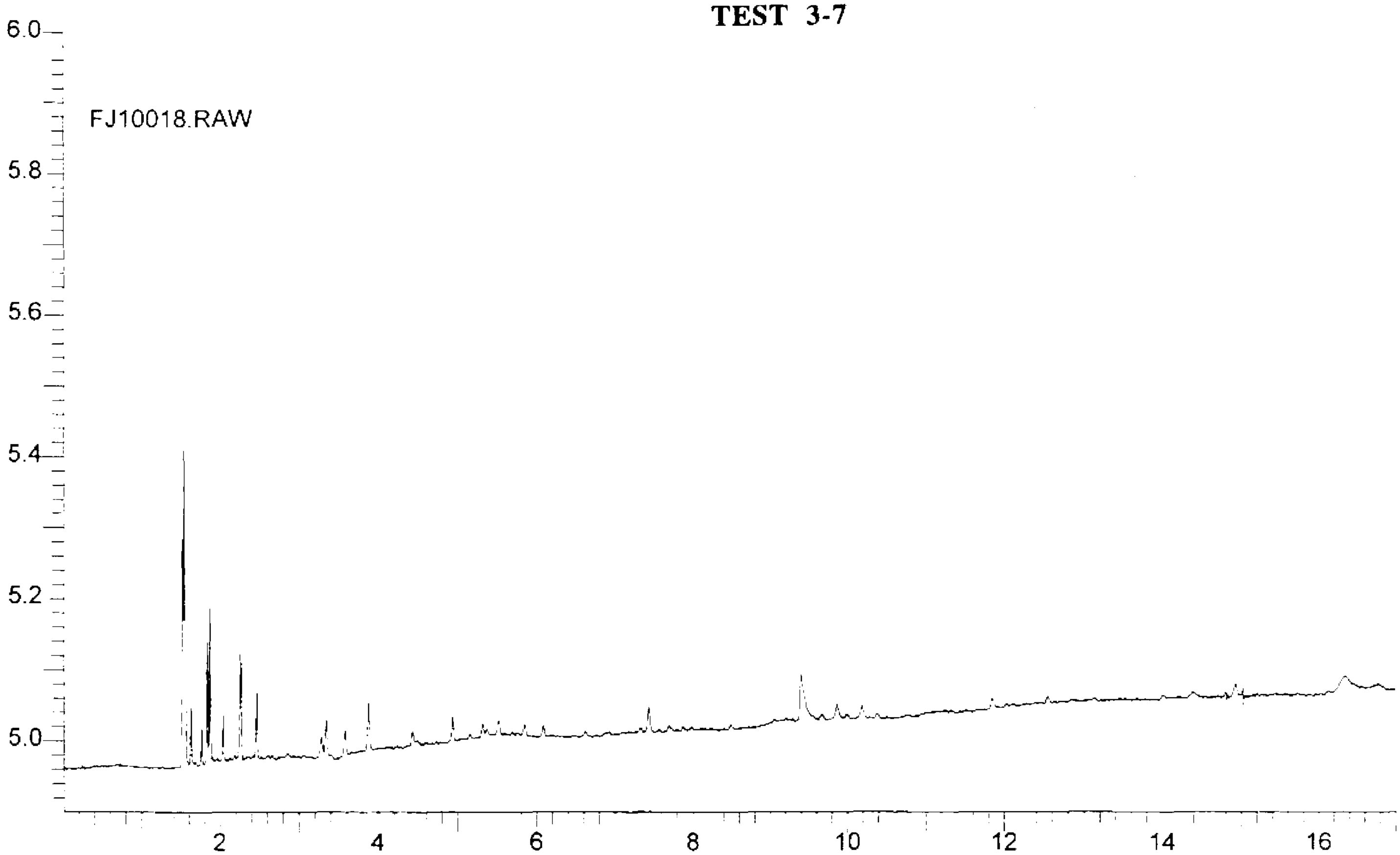
TEST 3-6

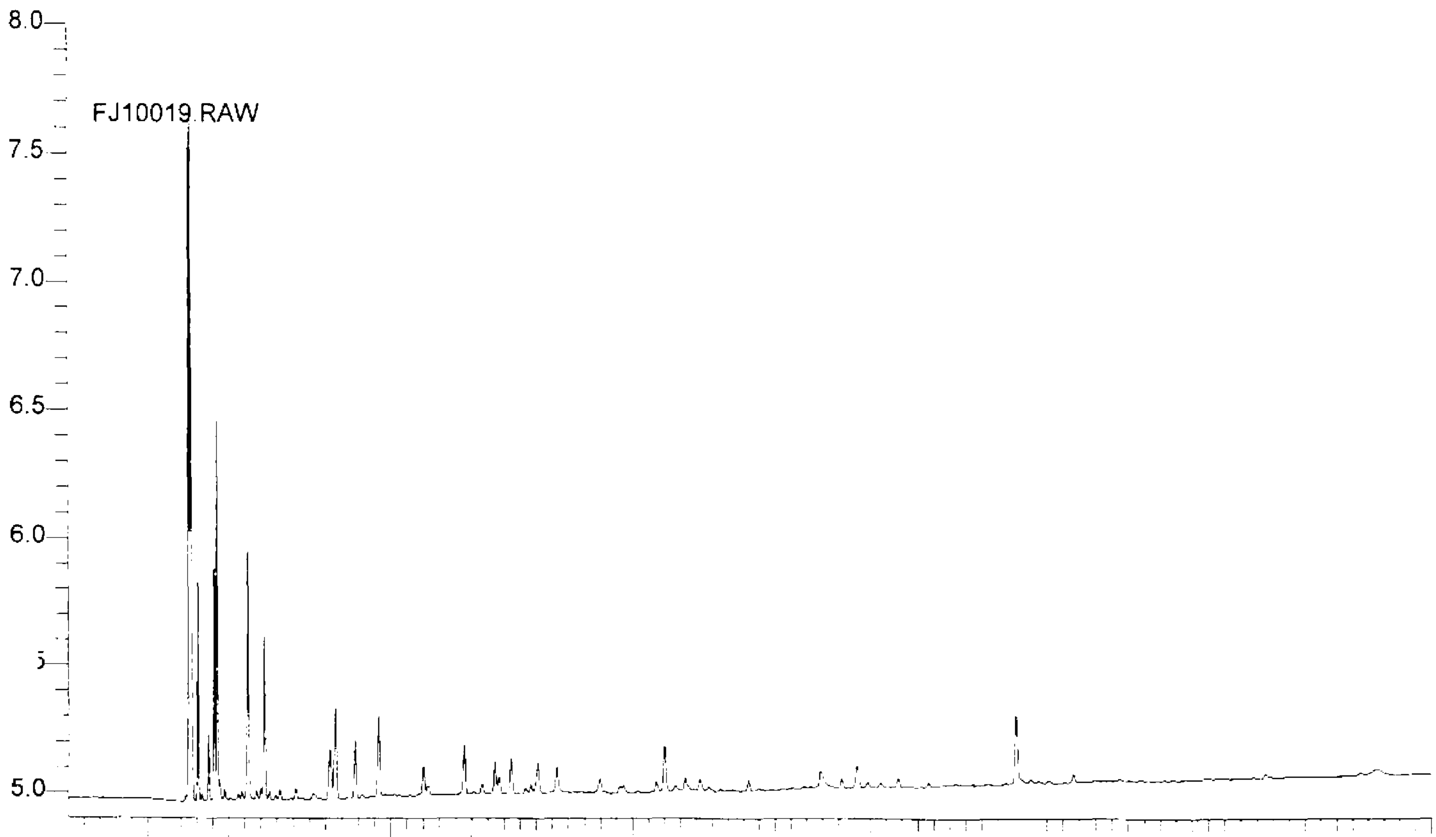




GAS CHROMATOGRAMS

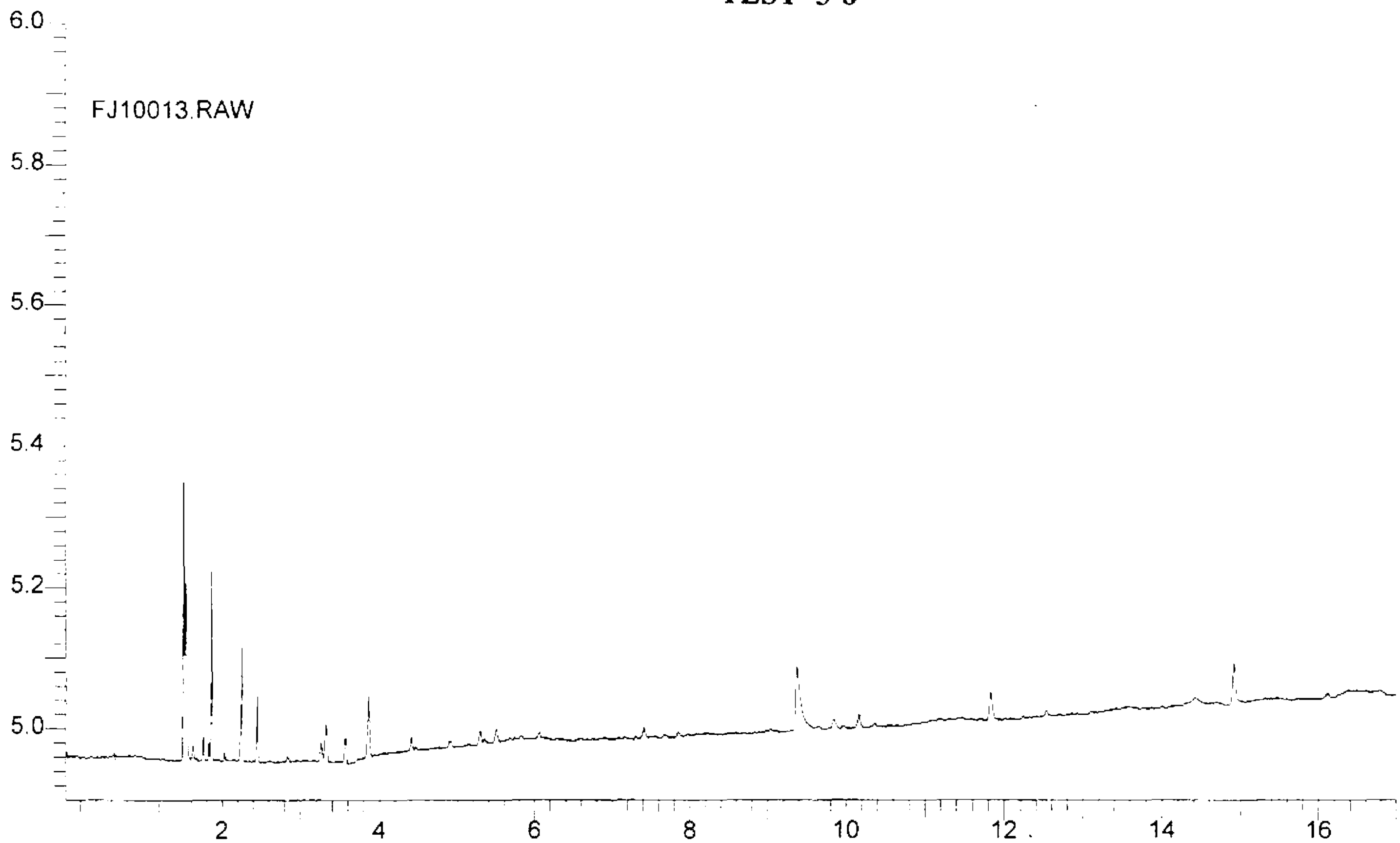
TEST 3-7

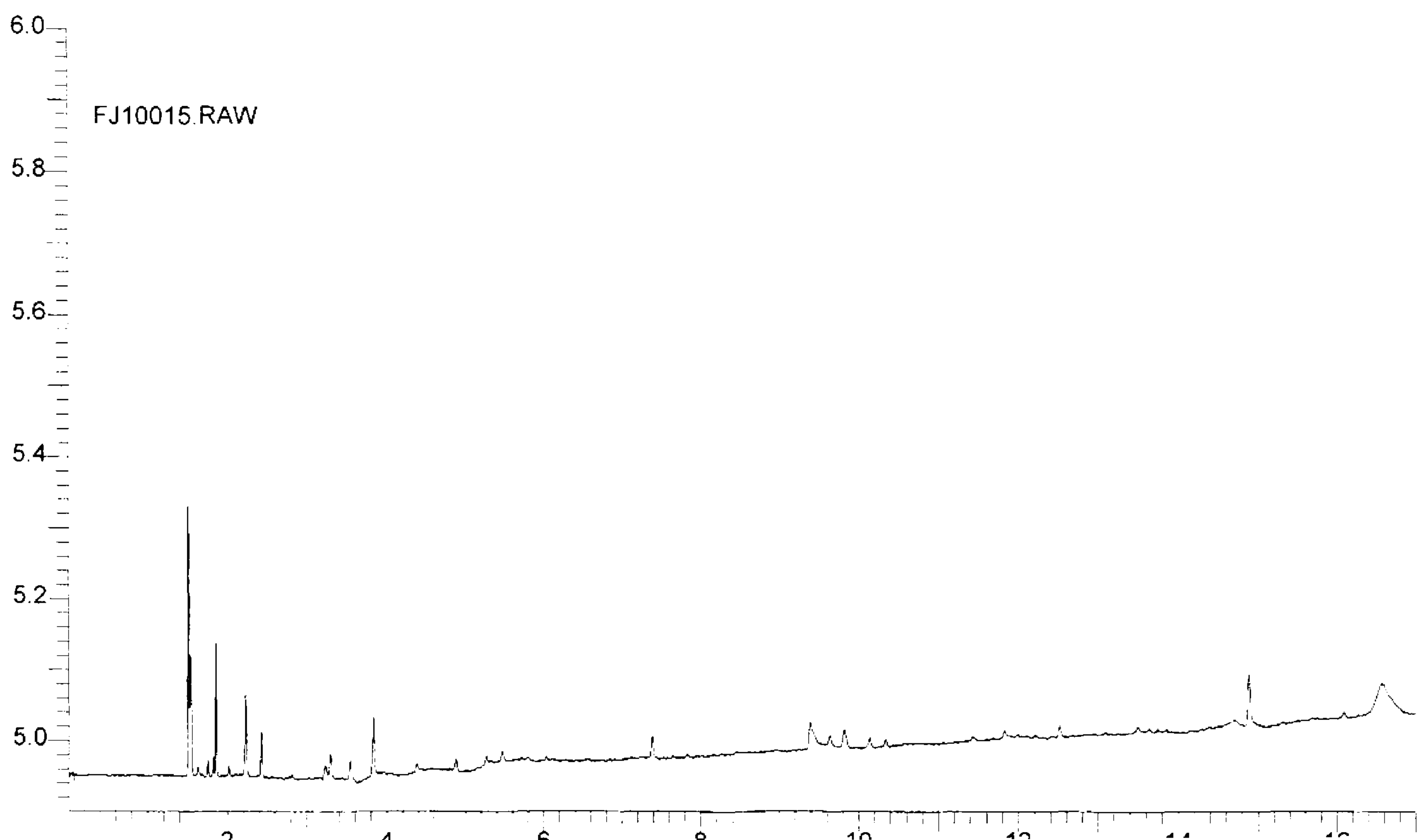




GAS CHROMATOGRAMS

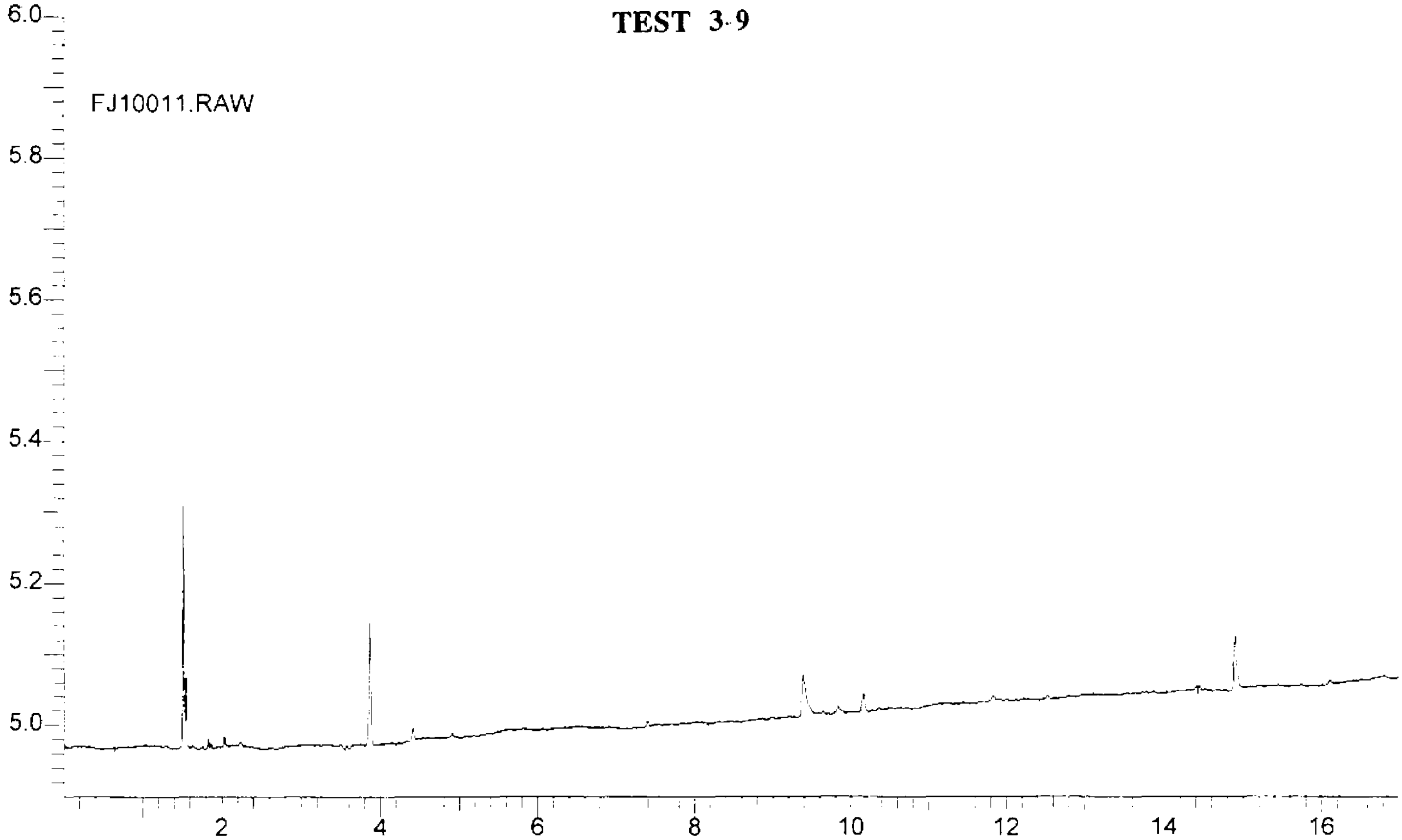
TEST 3-8

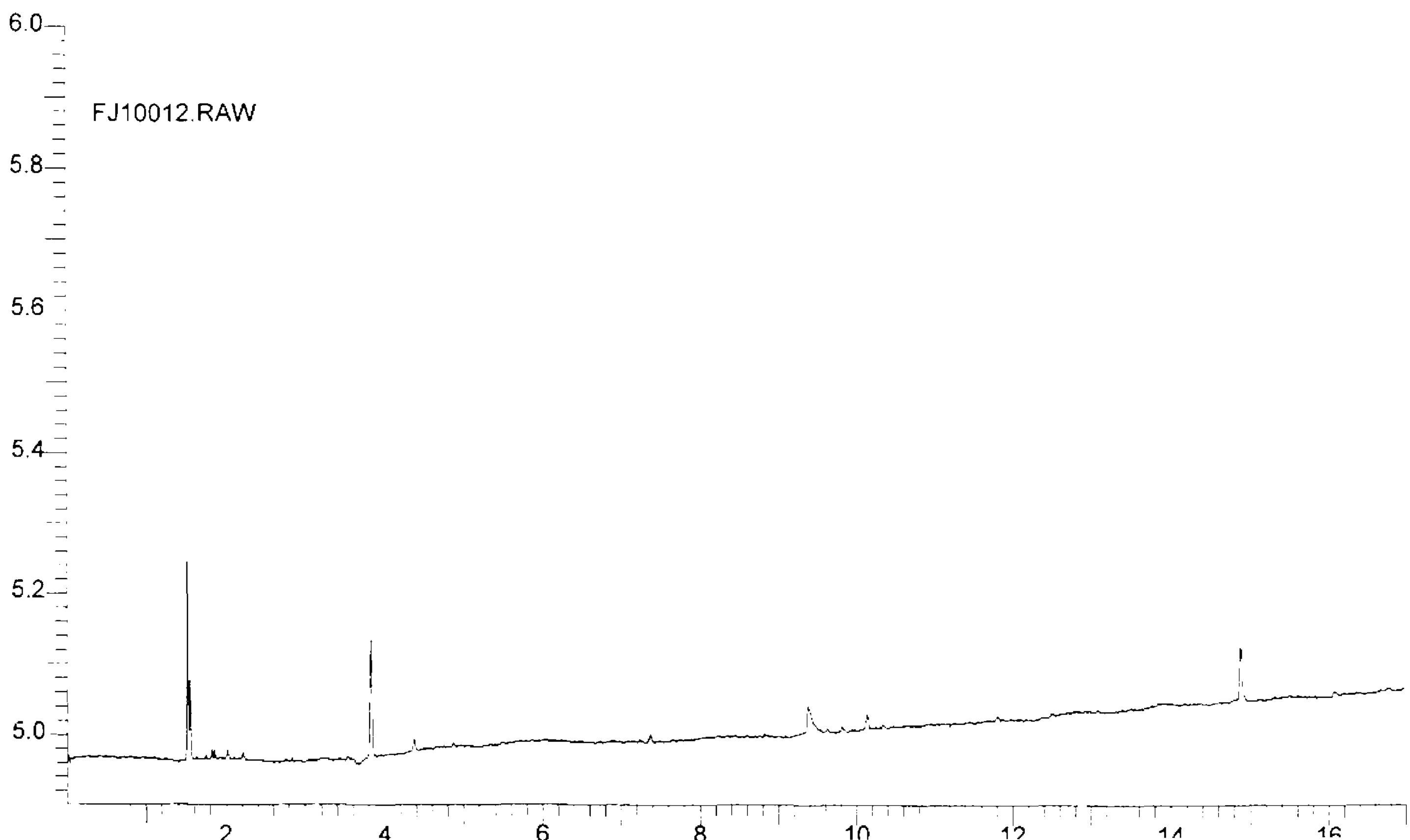




GAS CHROMATOGRAMS

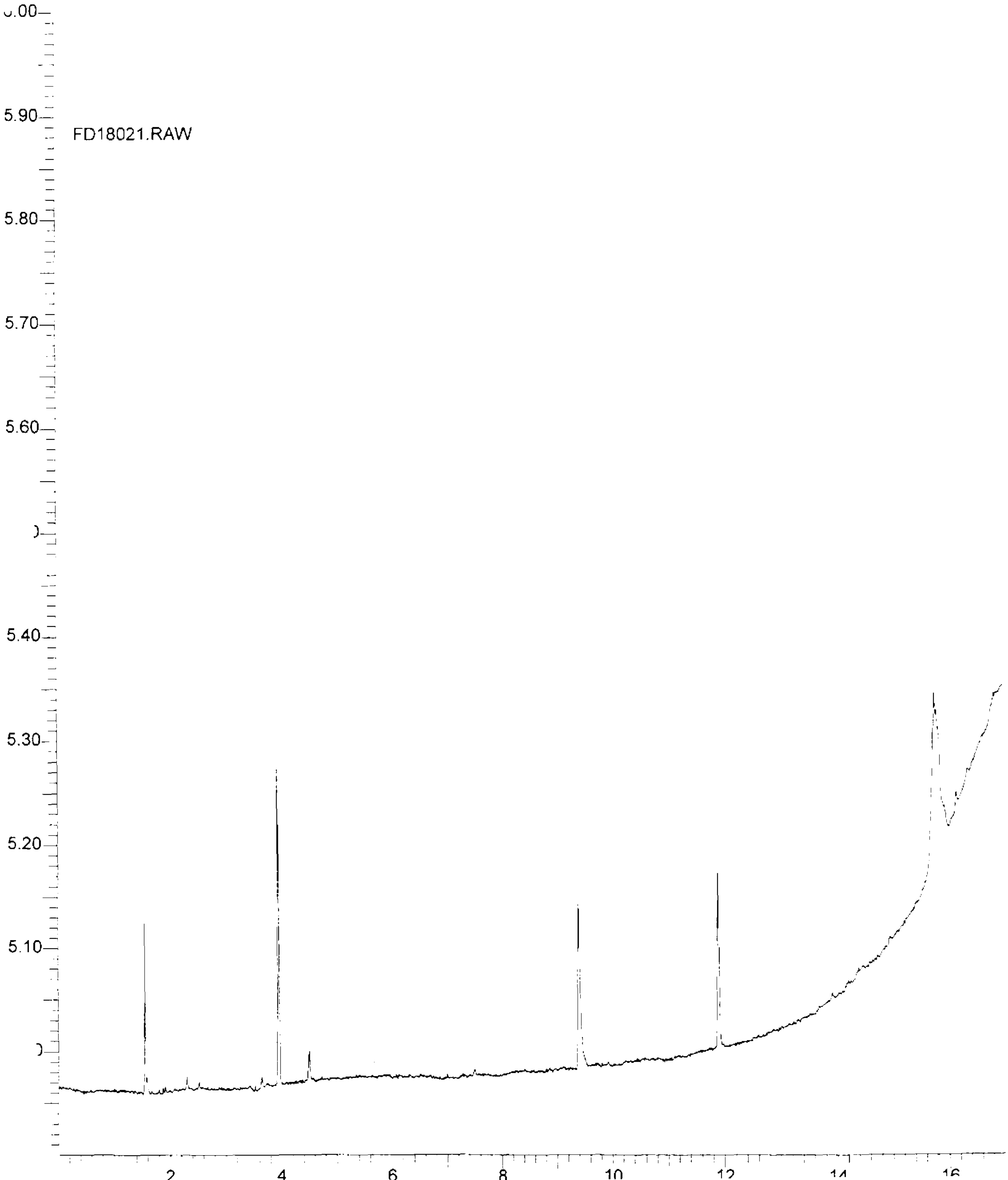
TEST 3-9





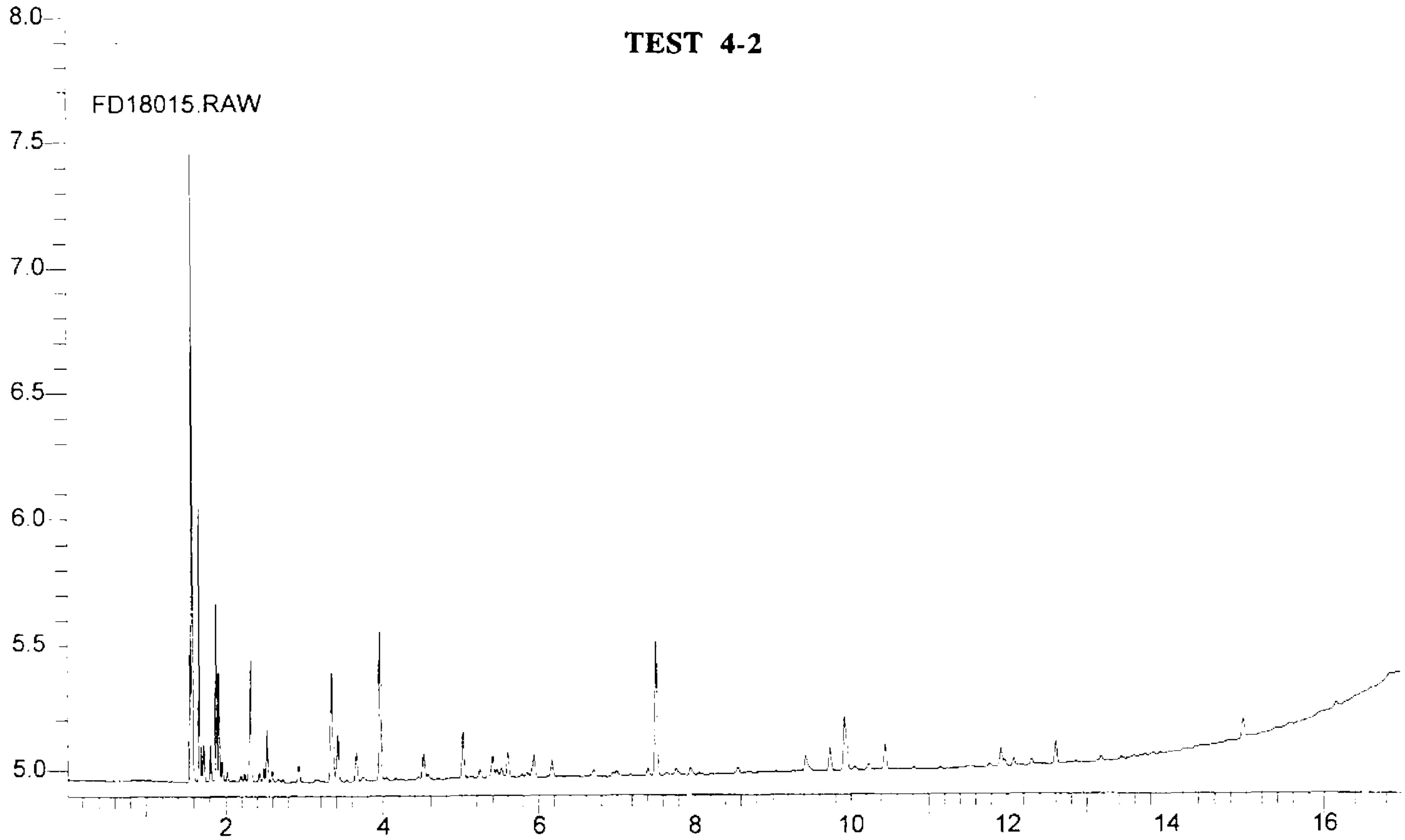
GAS CHROMATOGRAMS

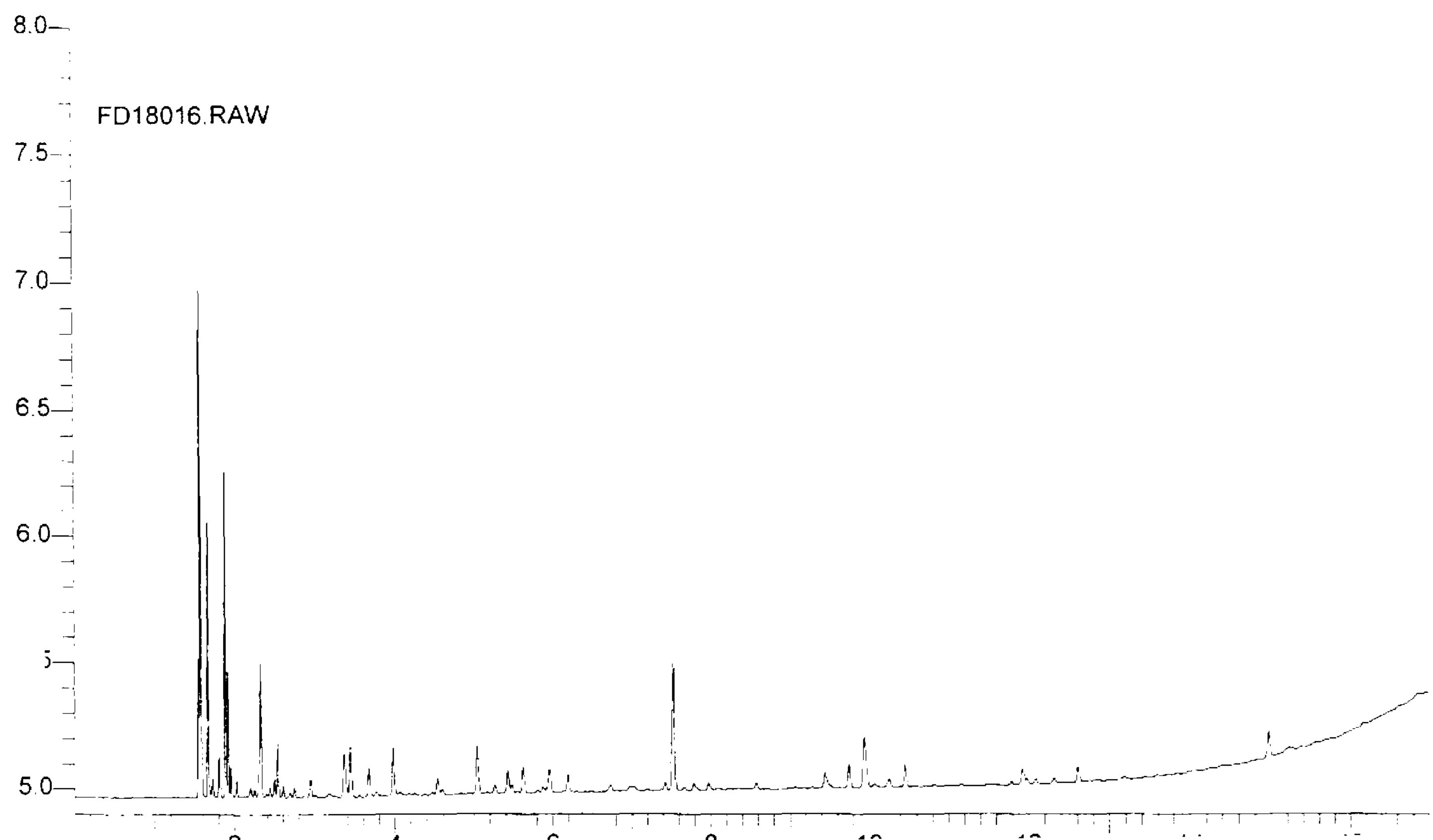
CONTROL CAR



GAS CHROMATOGRAMS

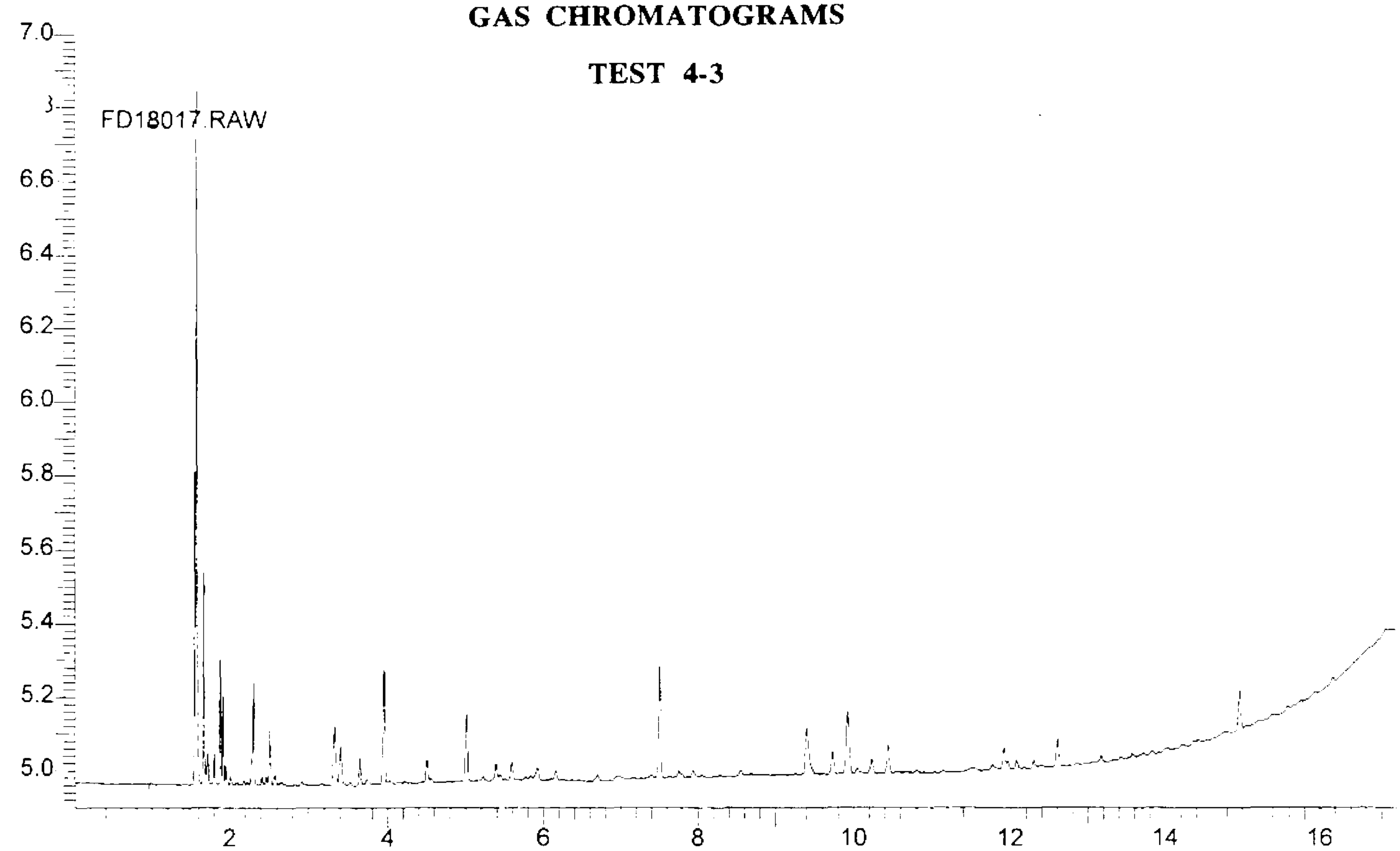
TEST 4-2

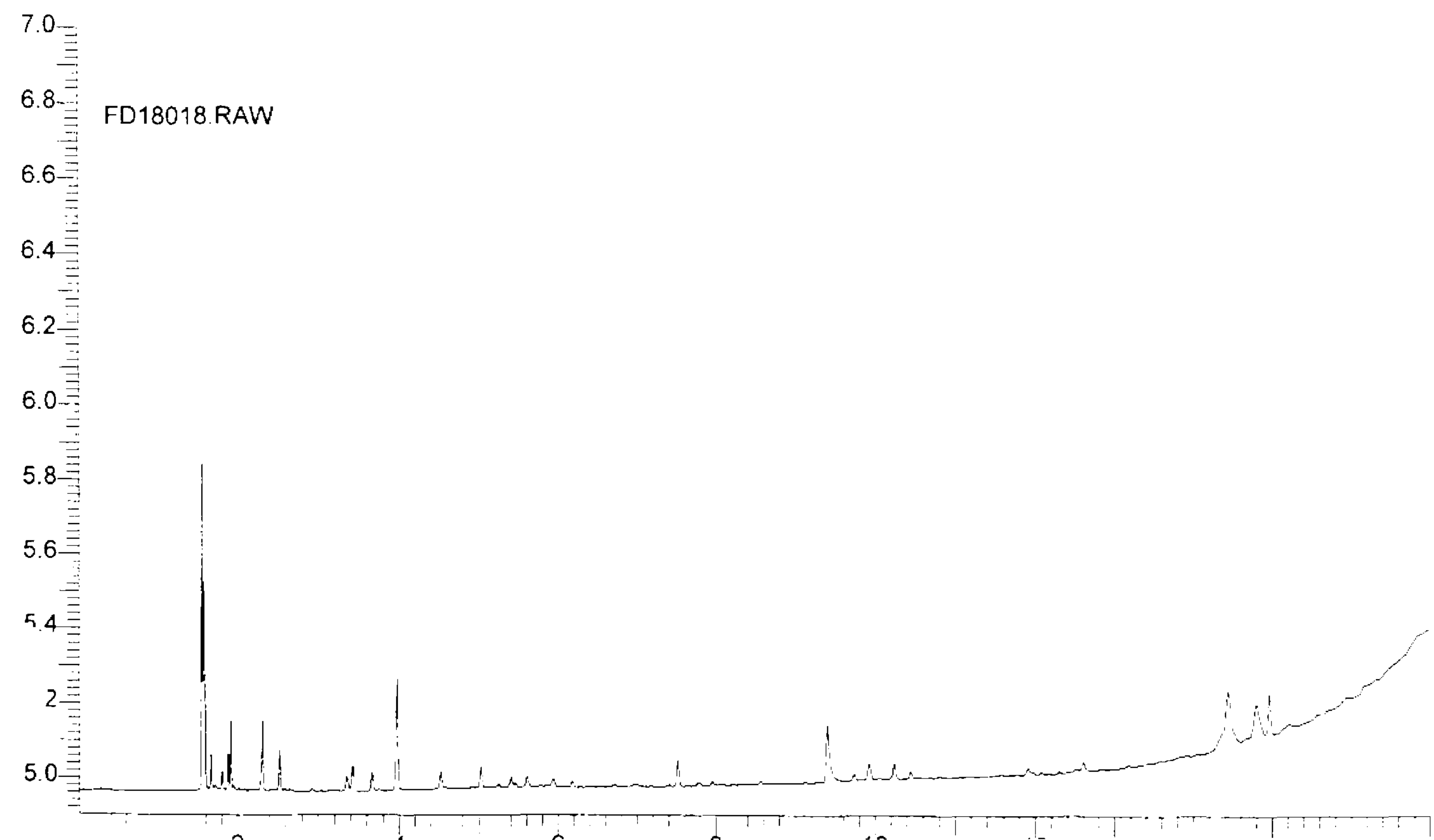




GAS CHROMATOGRAMS

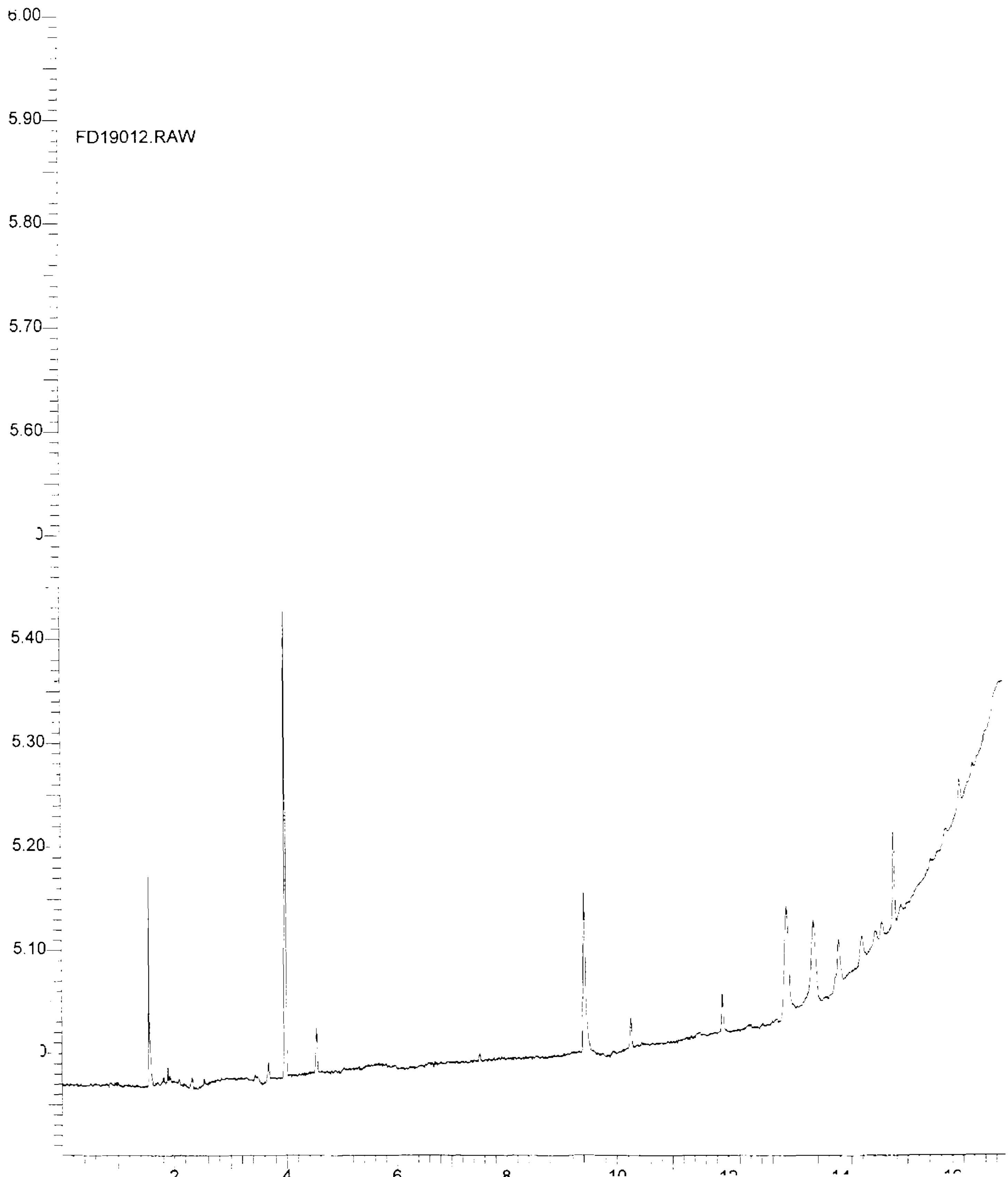
TEST 4-3





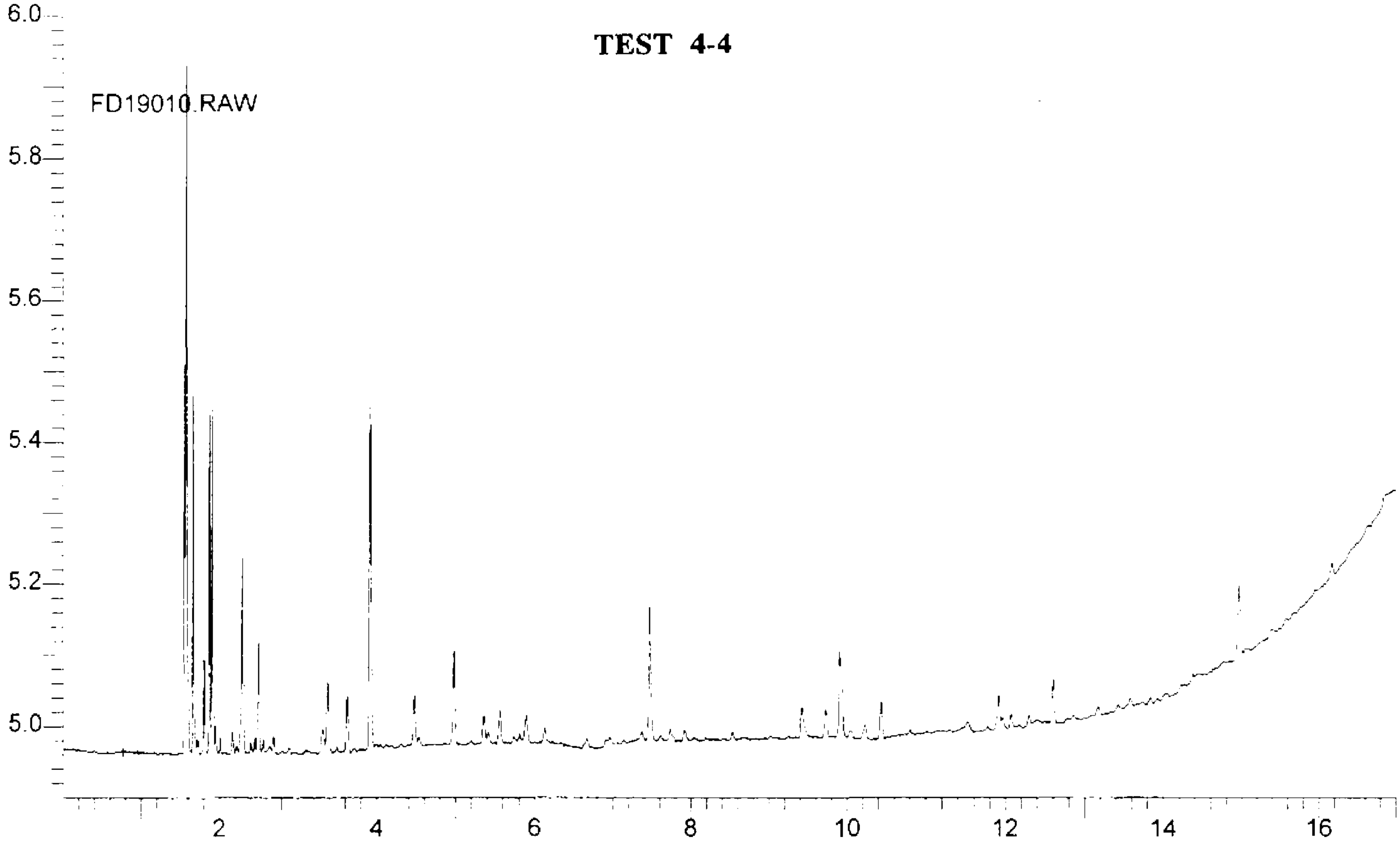
GAS CHROMATOGRAMS

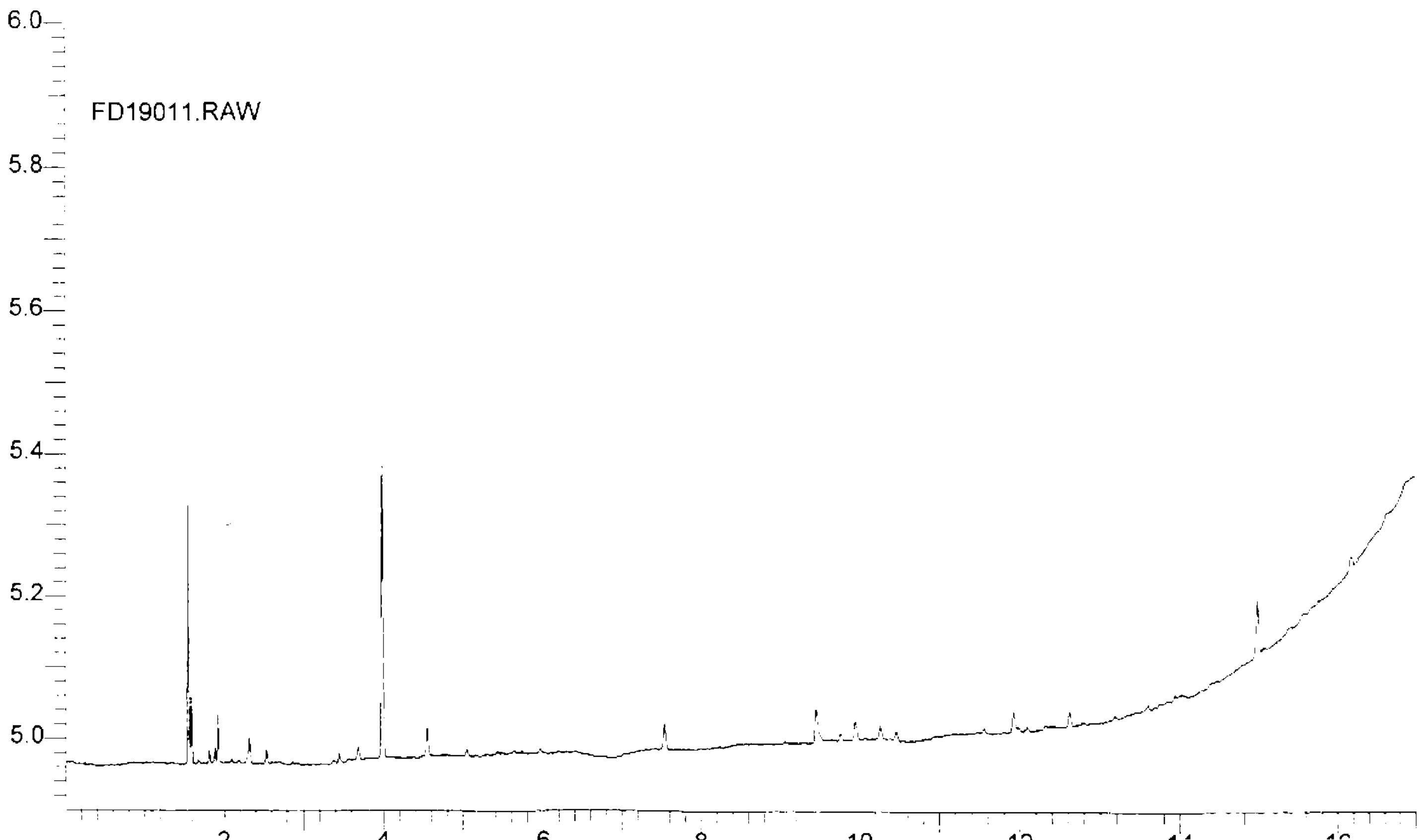
CONTROL CAR



GAS CHROMATOGRAMS

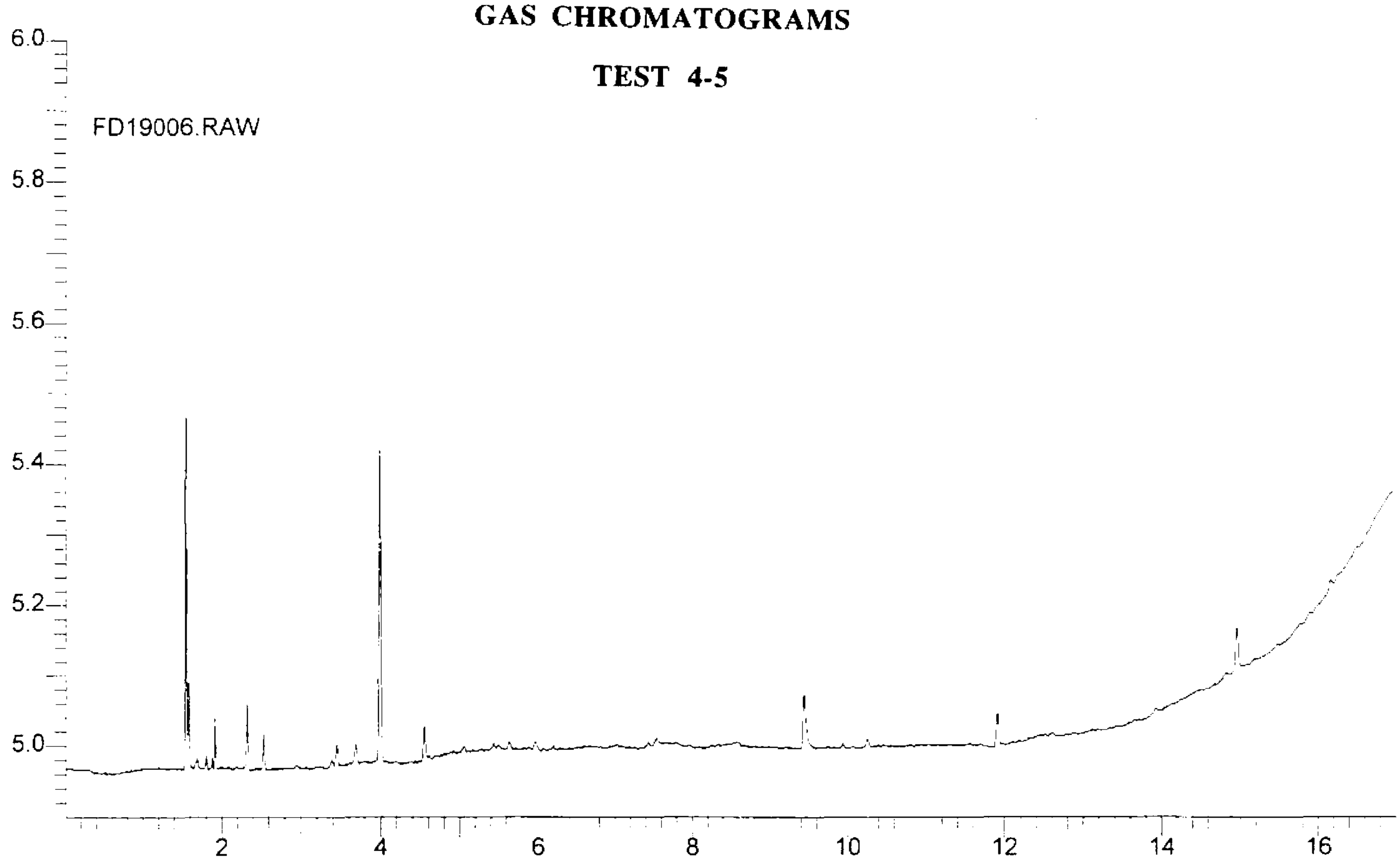
TEST 4-4

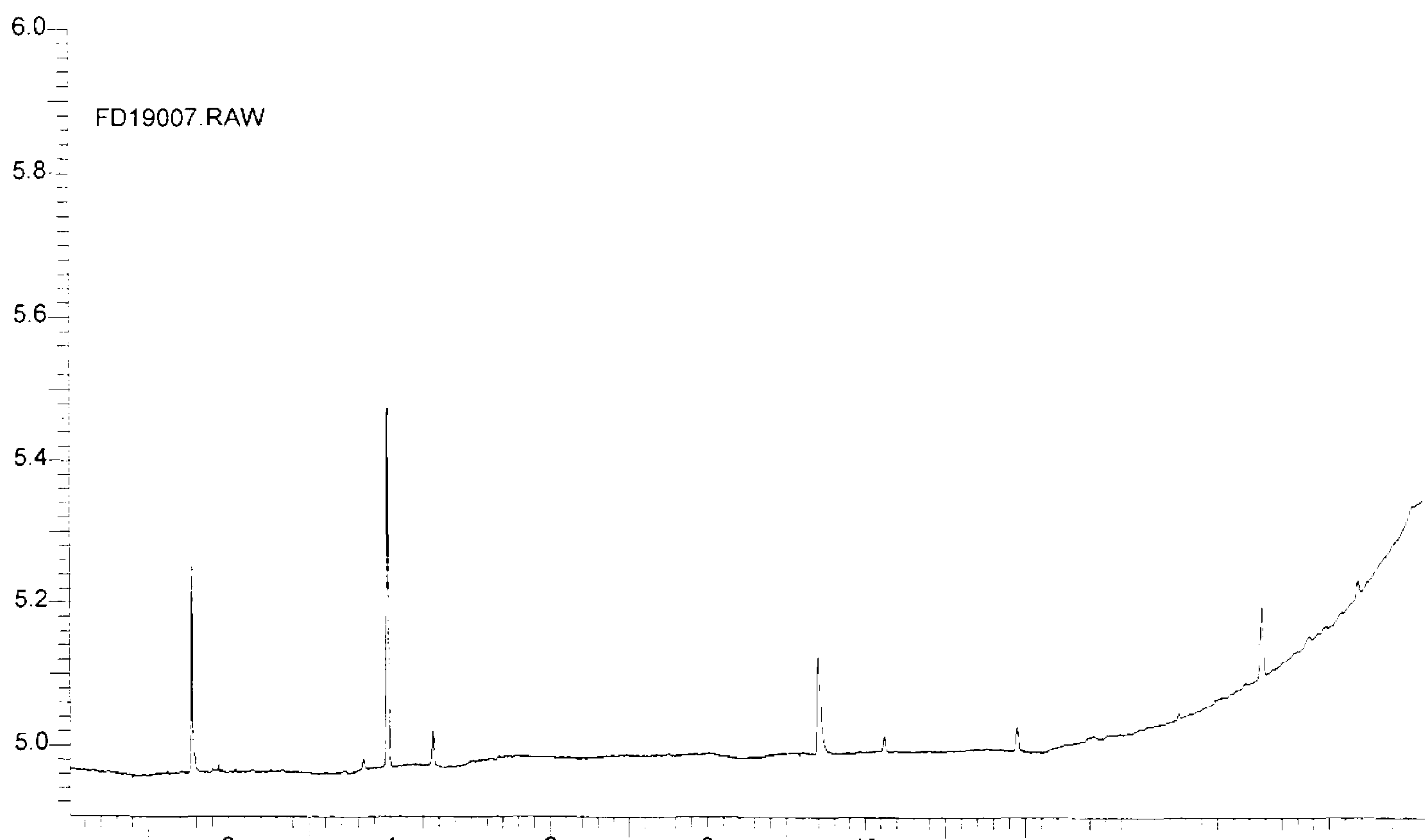




GAS CHROMATOGRAMS

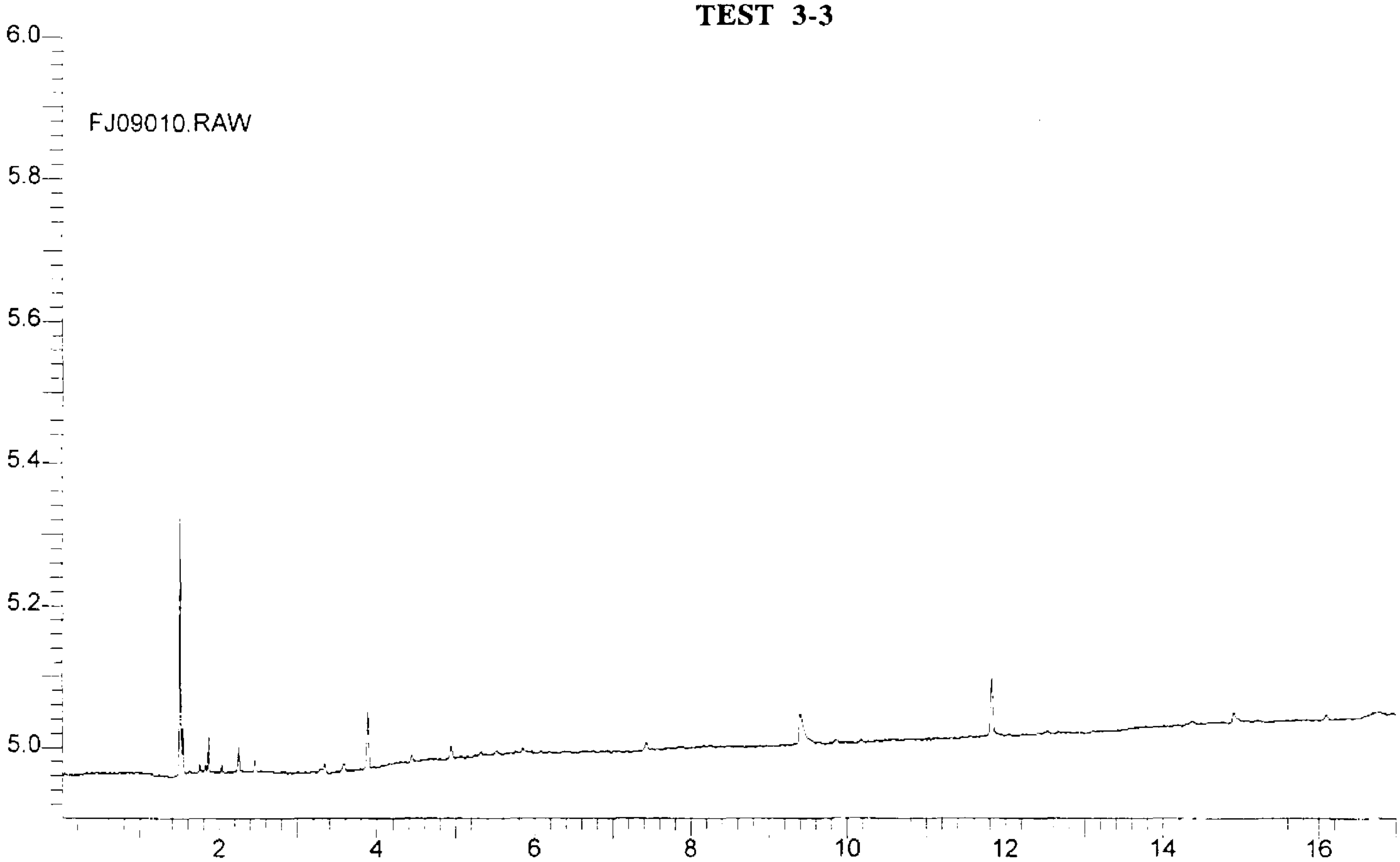
TEST 4-5

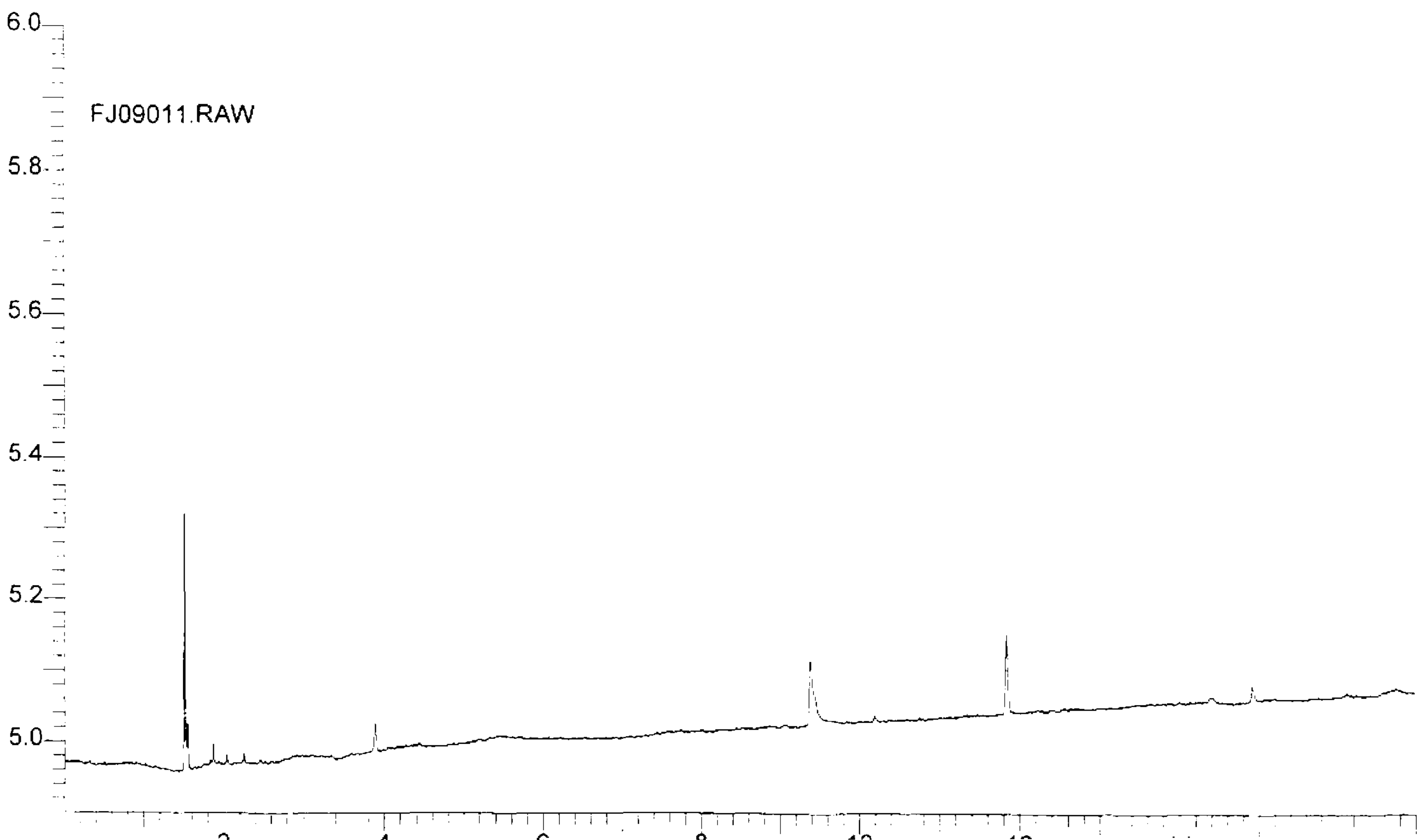




GAS CHROMATOGRAMS

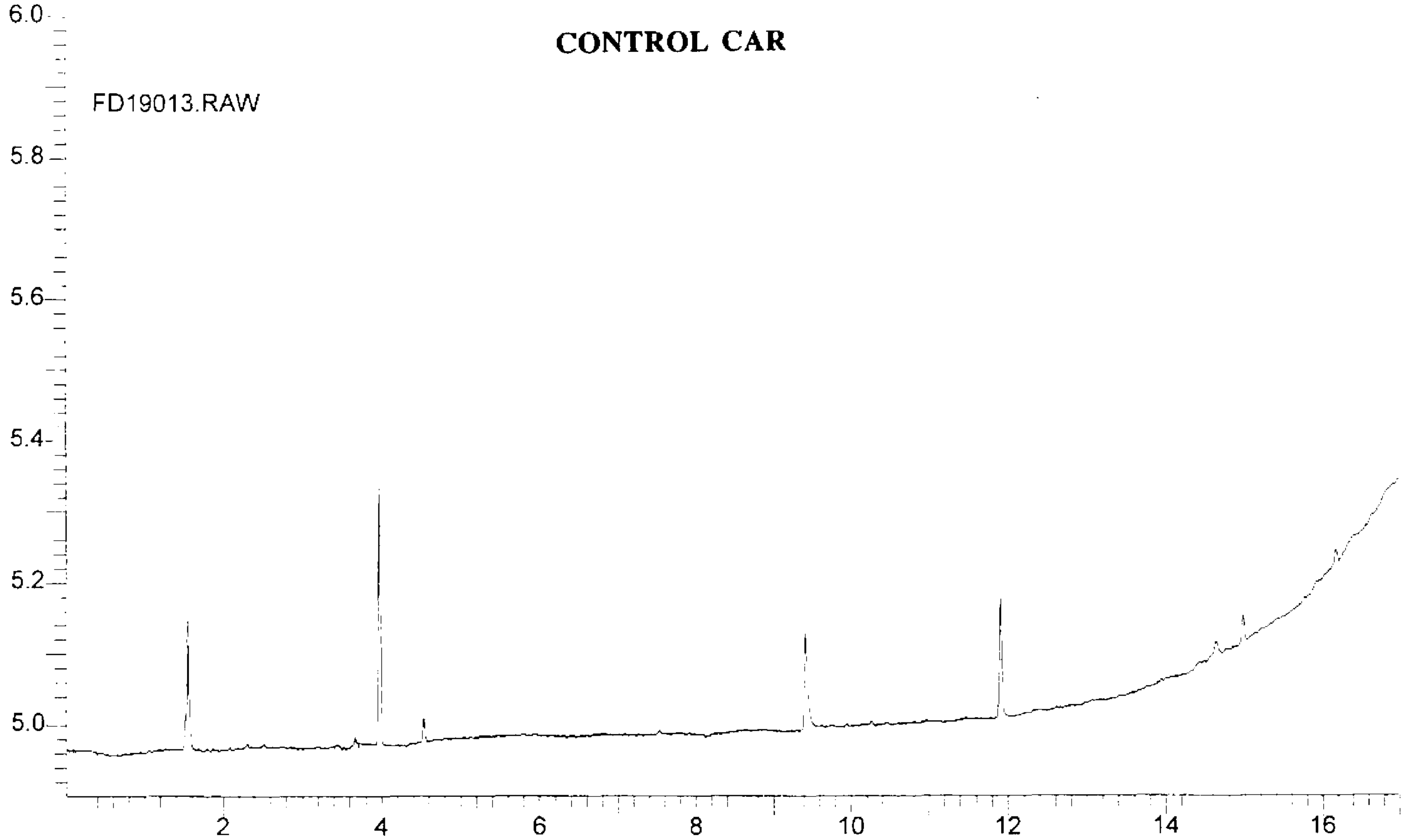
TEST 3-3

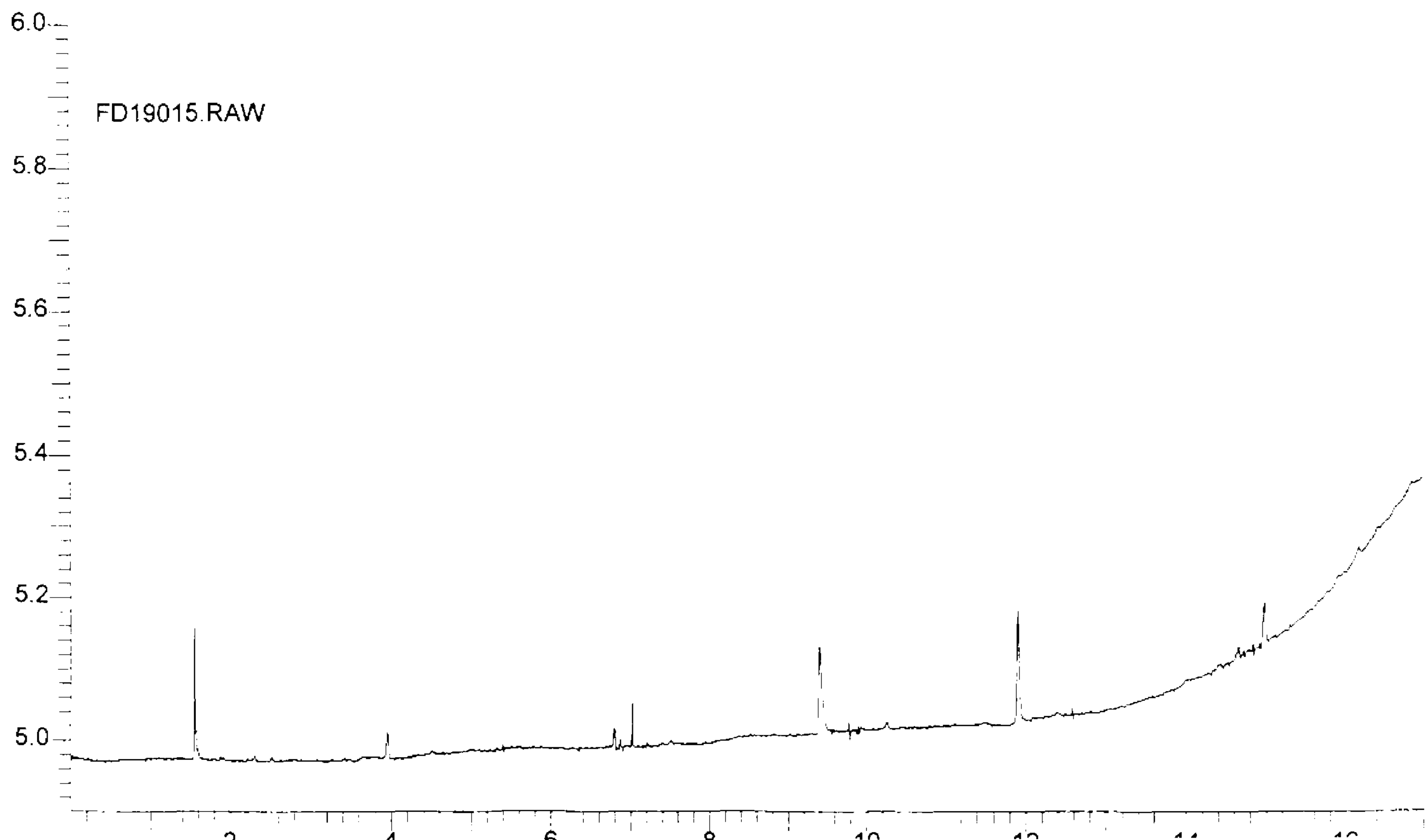




GAS CHROMATOGRAMS

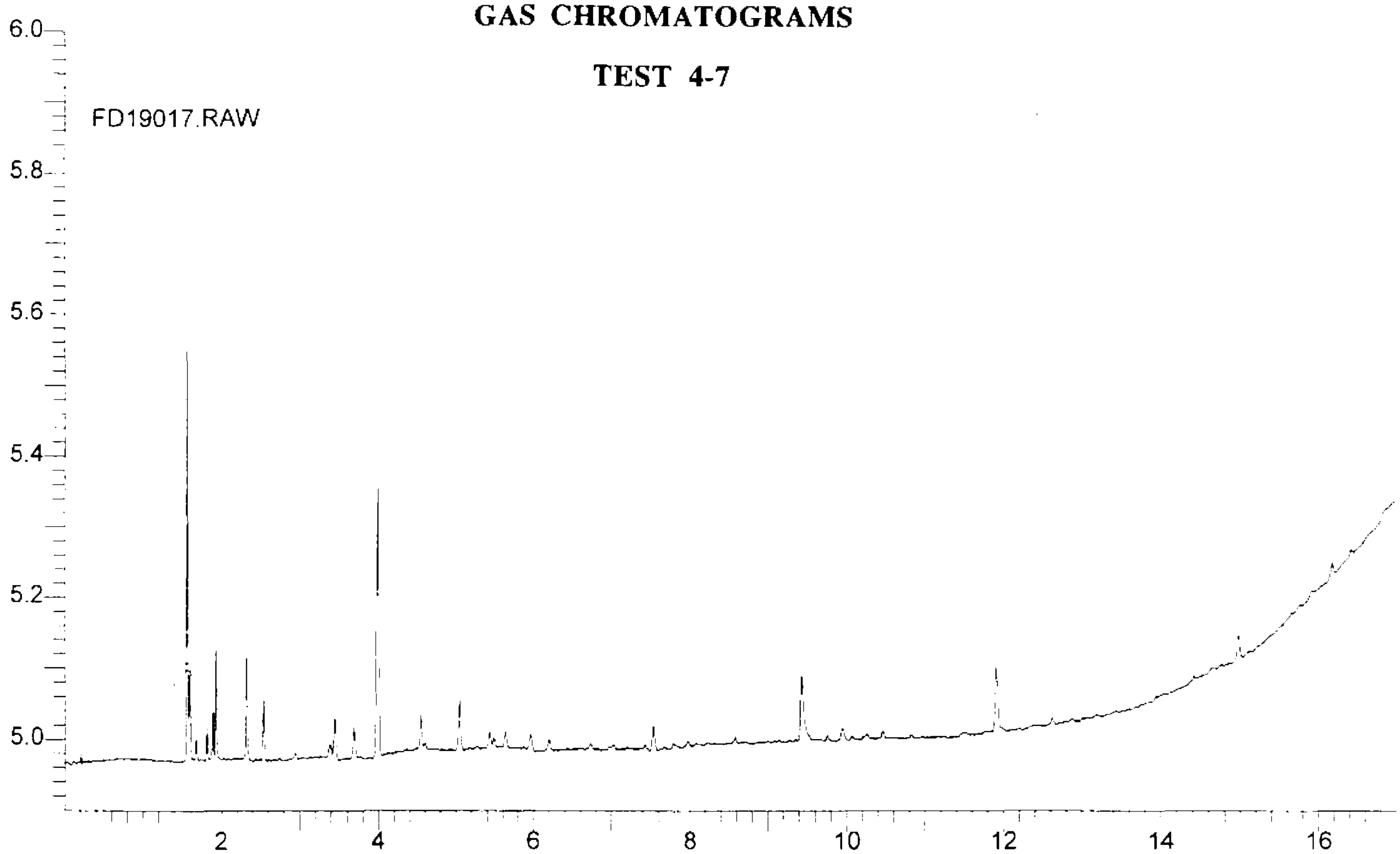
CONTROL CAR

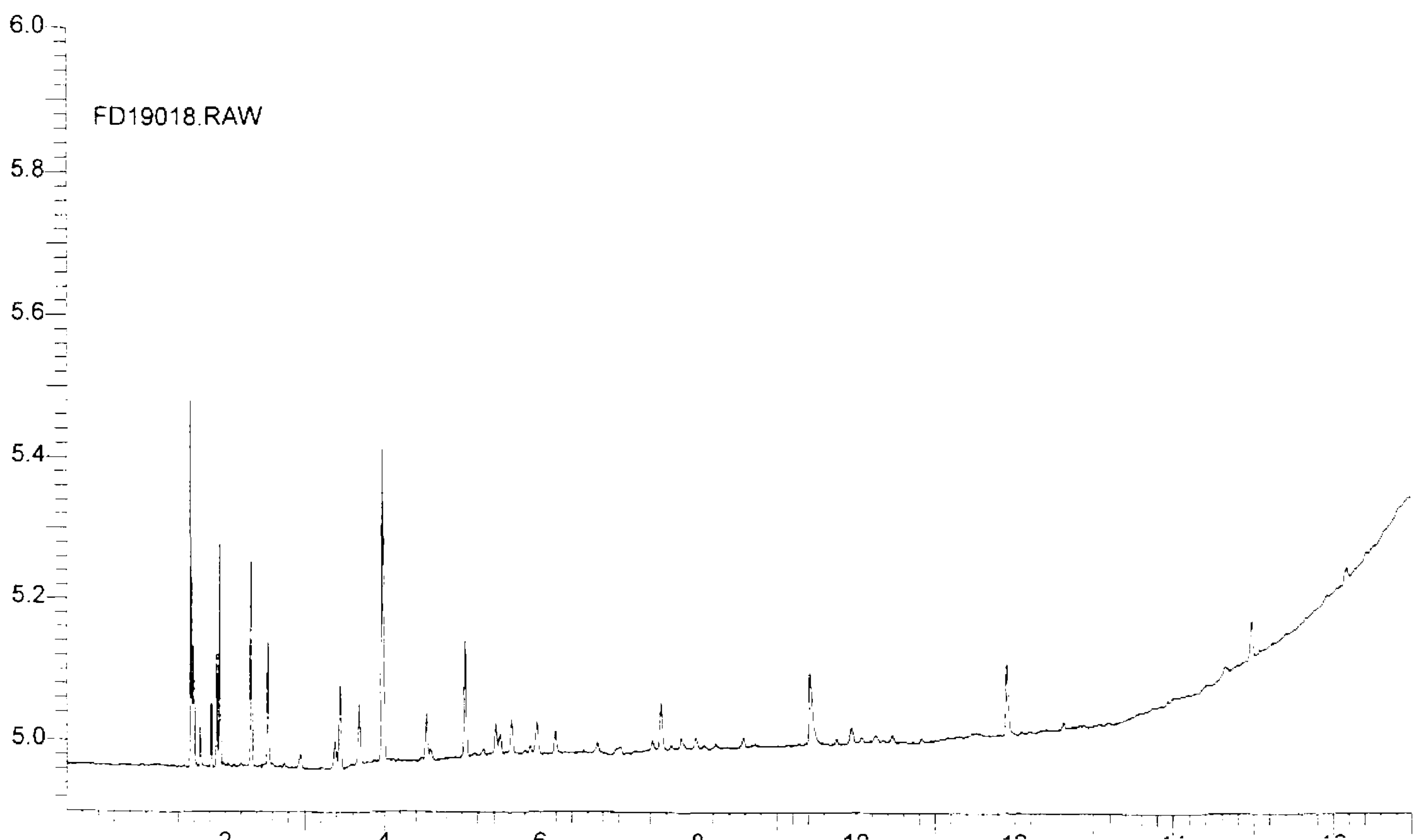




GAS CHROMATOGRAMS

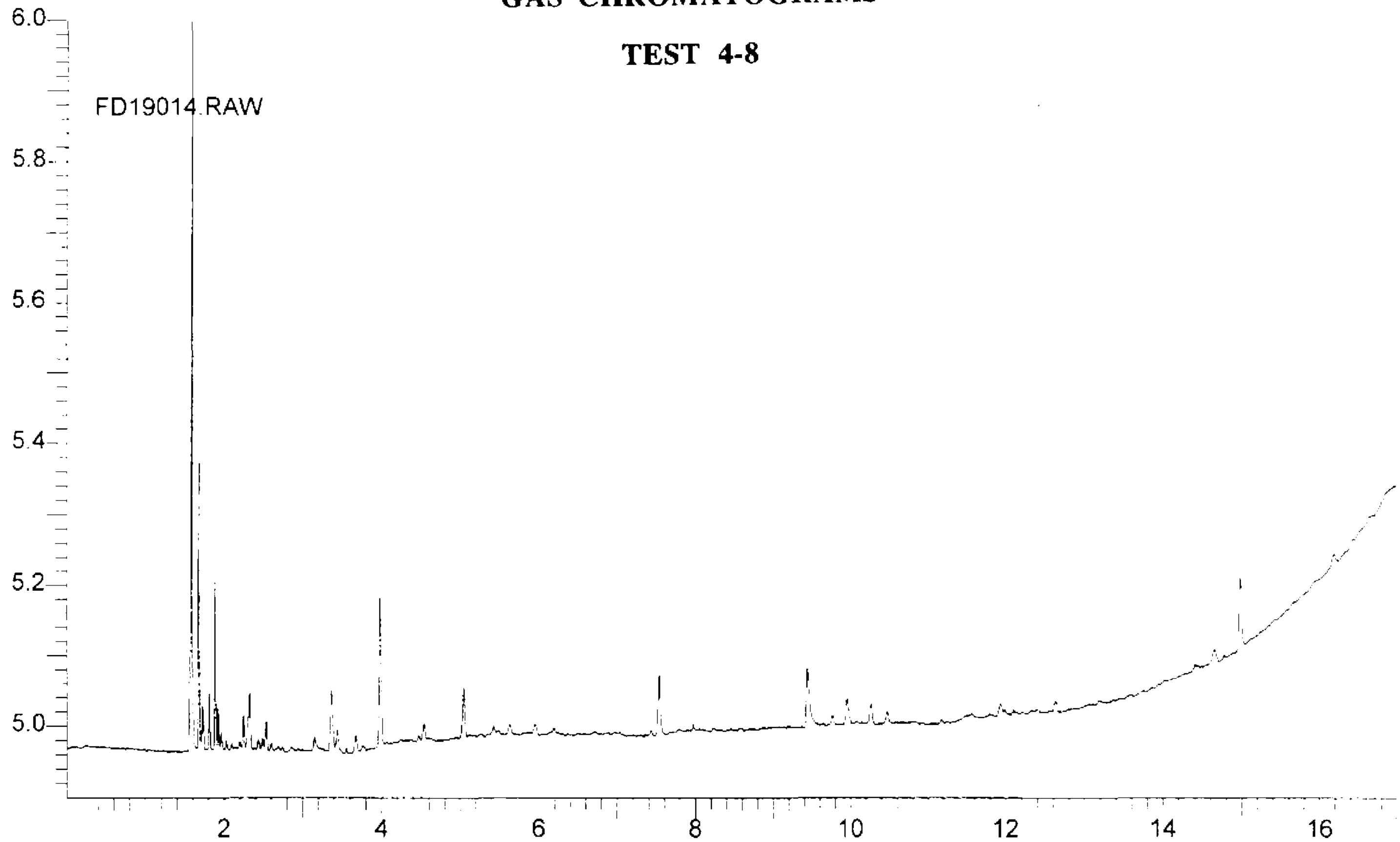
TEST 4-7

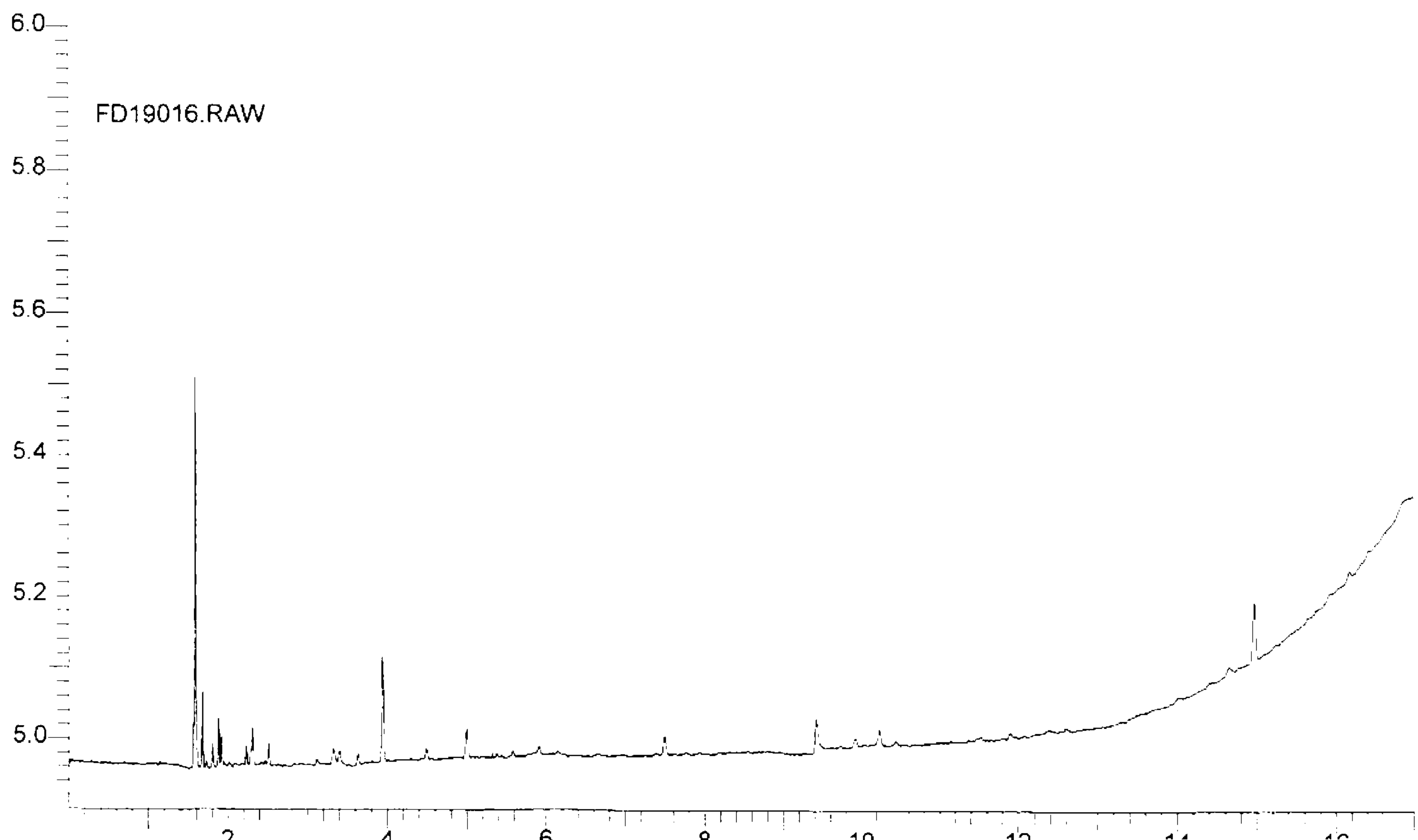




GAS CHROMATOGRAMS

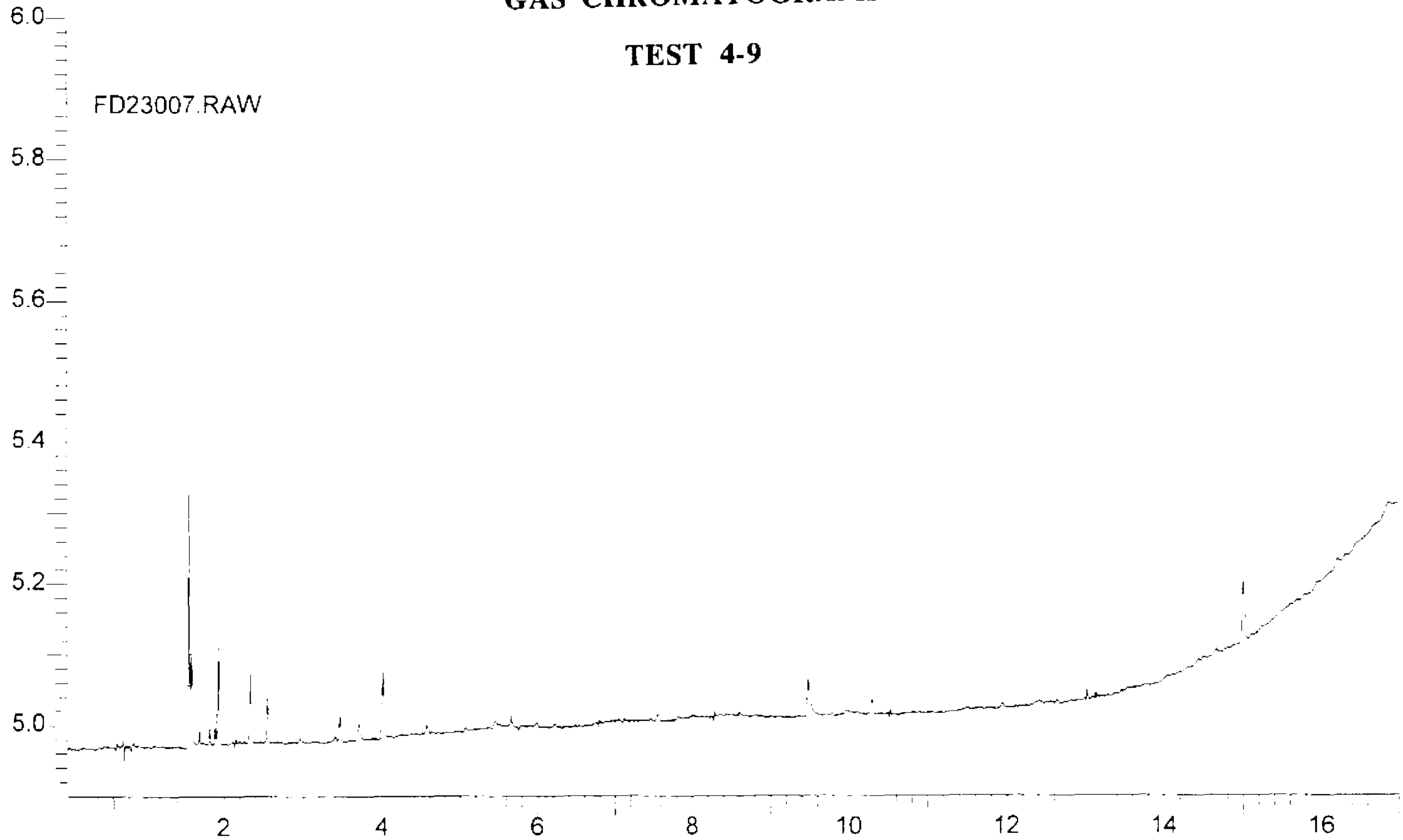
TEST 4-8

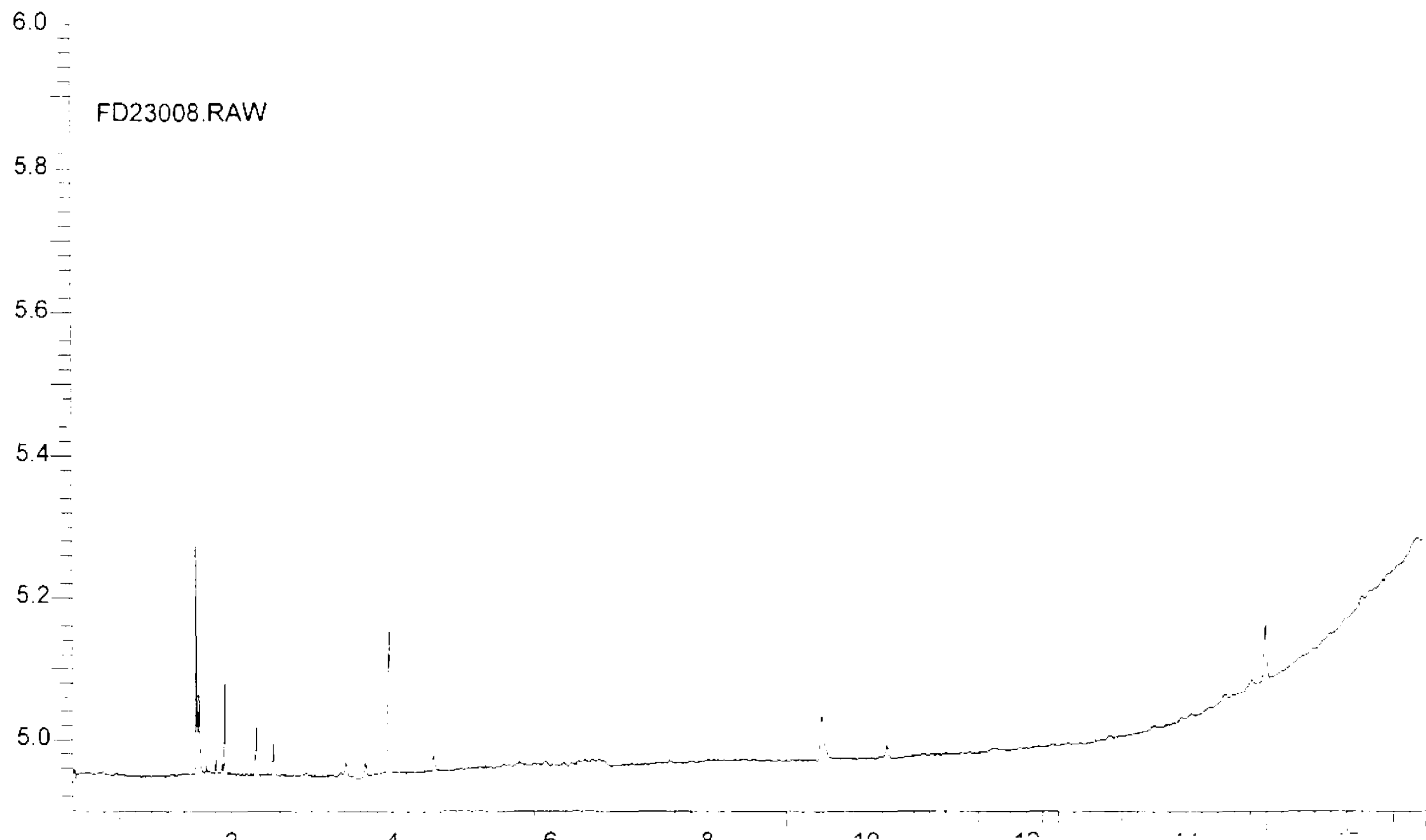




GAS CHROMATOGRAMS

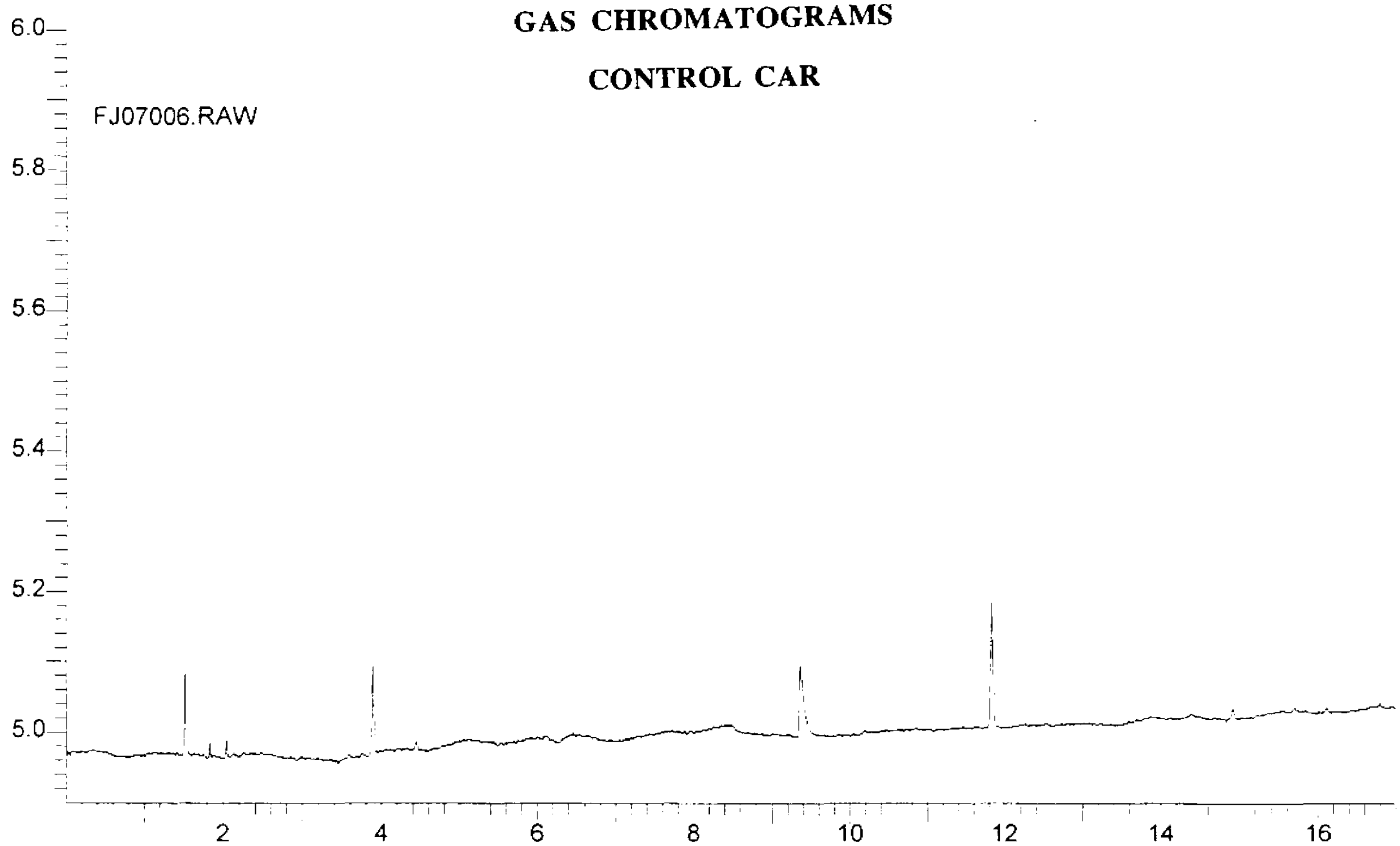
TEST 4-9

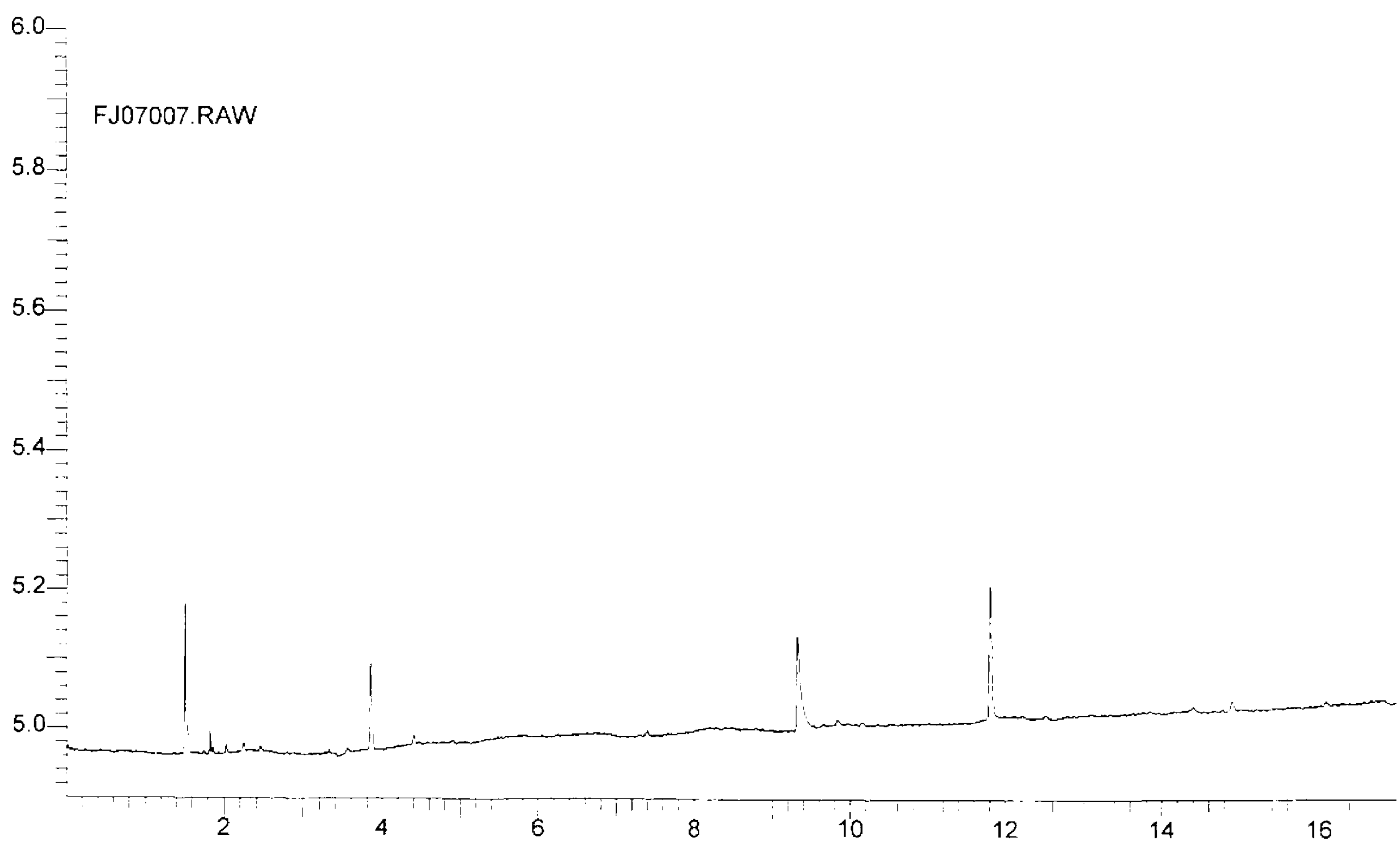




GAS CHROMATOGRAMS

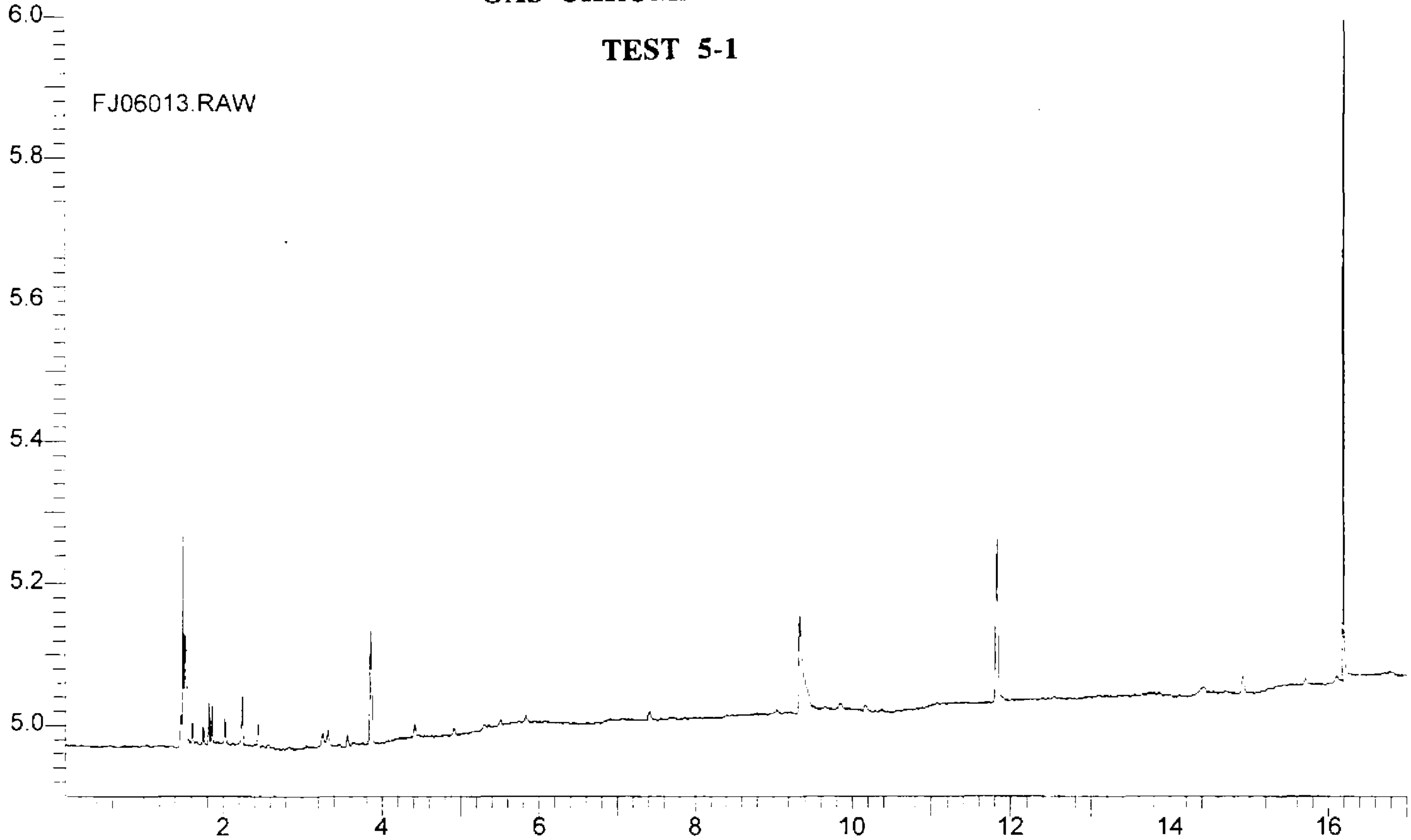
CONTROL CAR

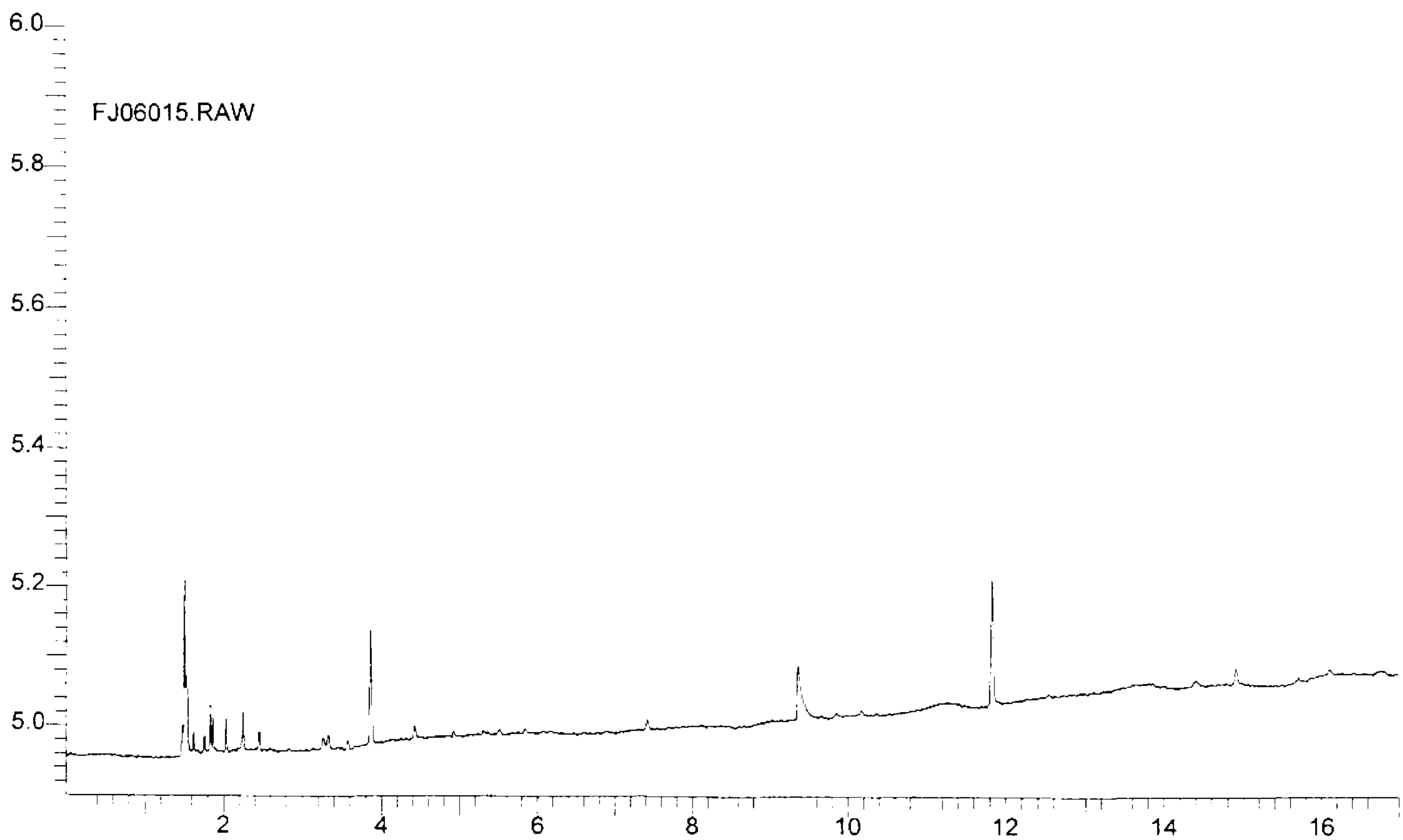




GAS CHROMATOGRAMS

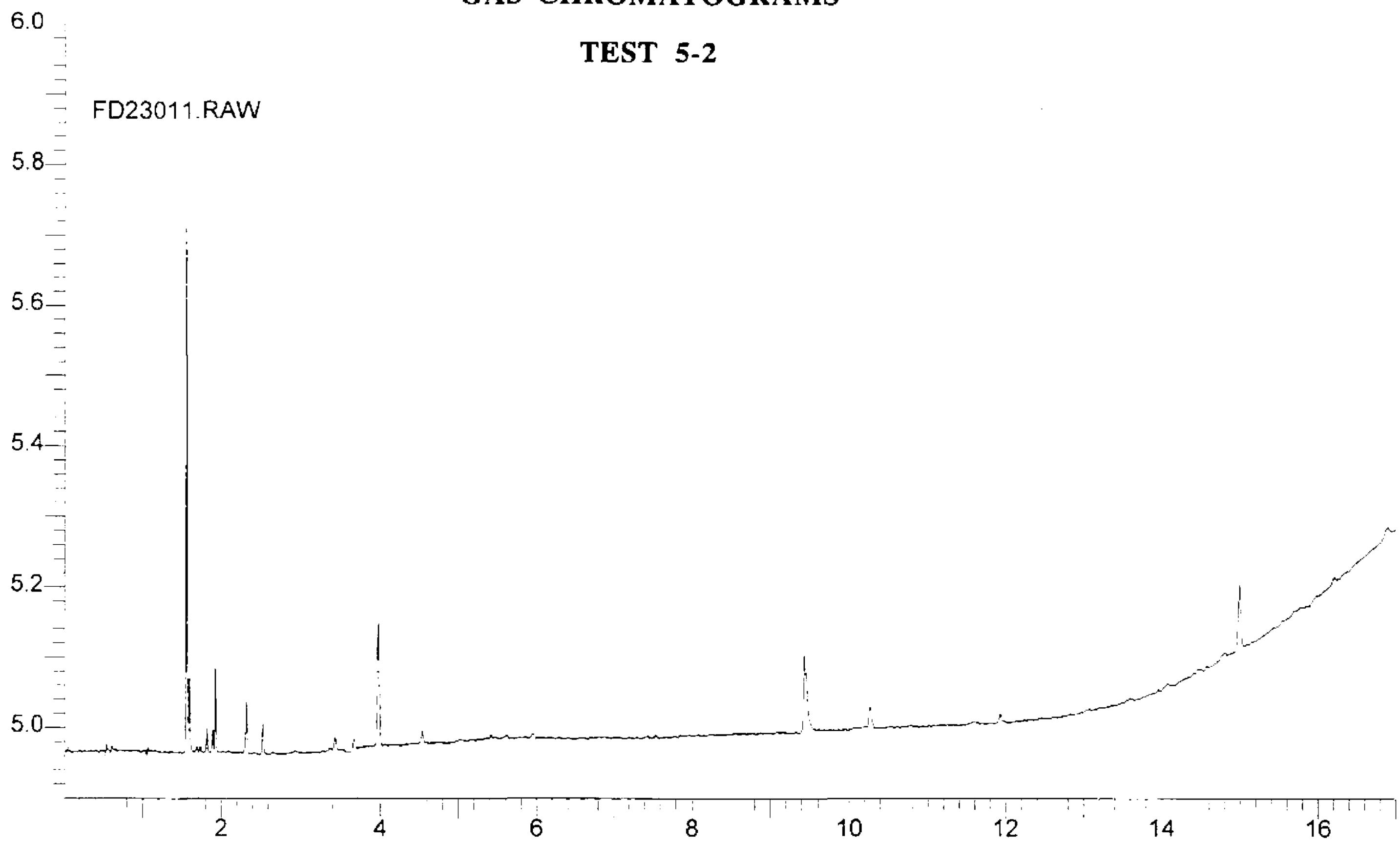
TEST 5-1

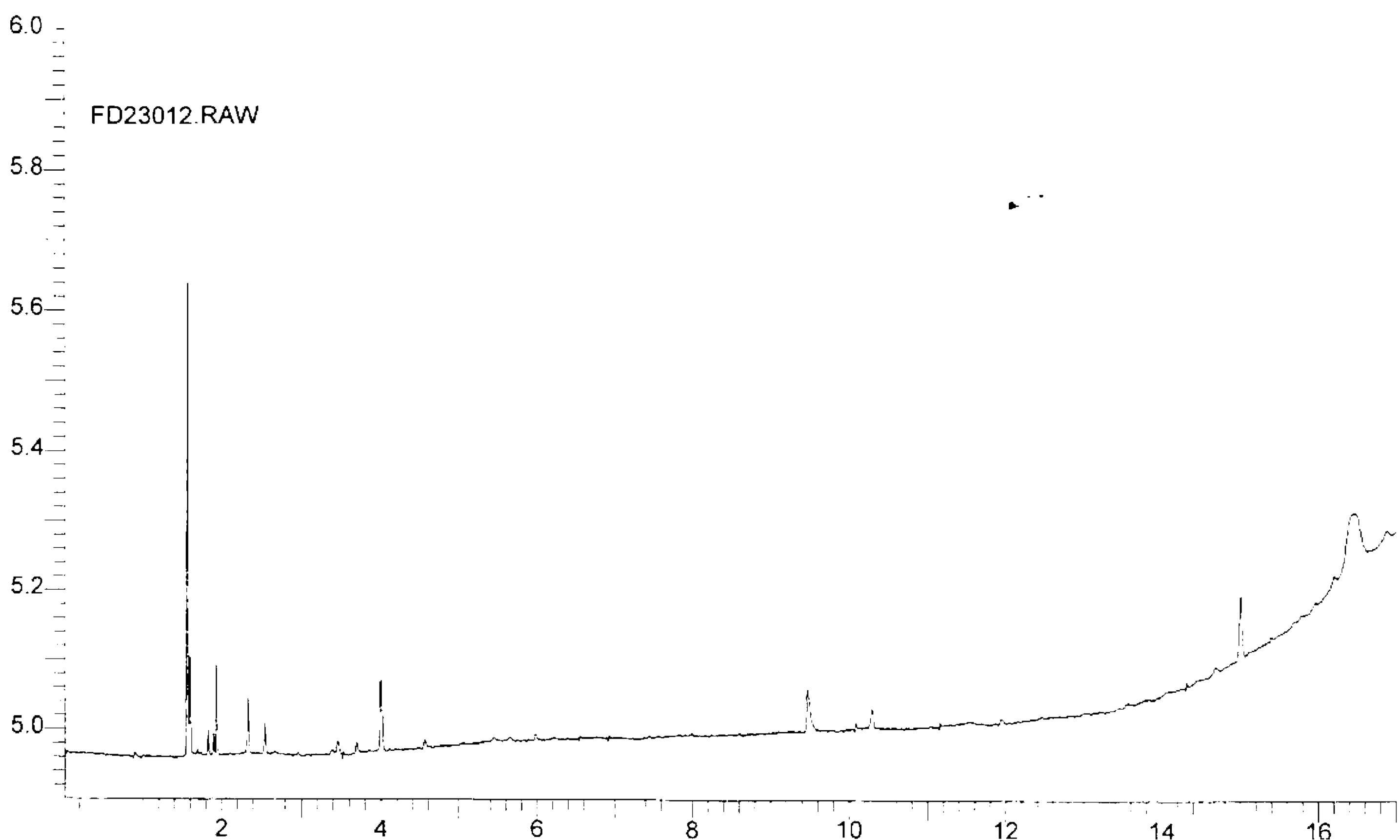




GAS CHROMATOGRAMS

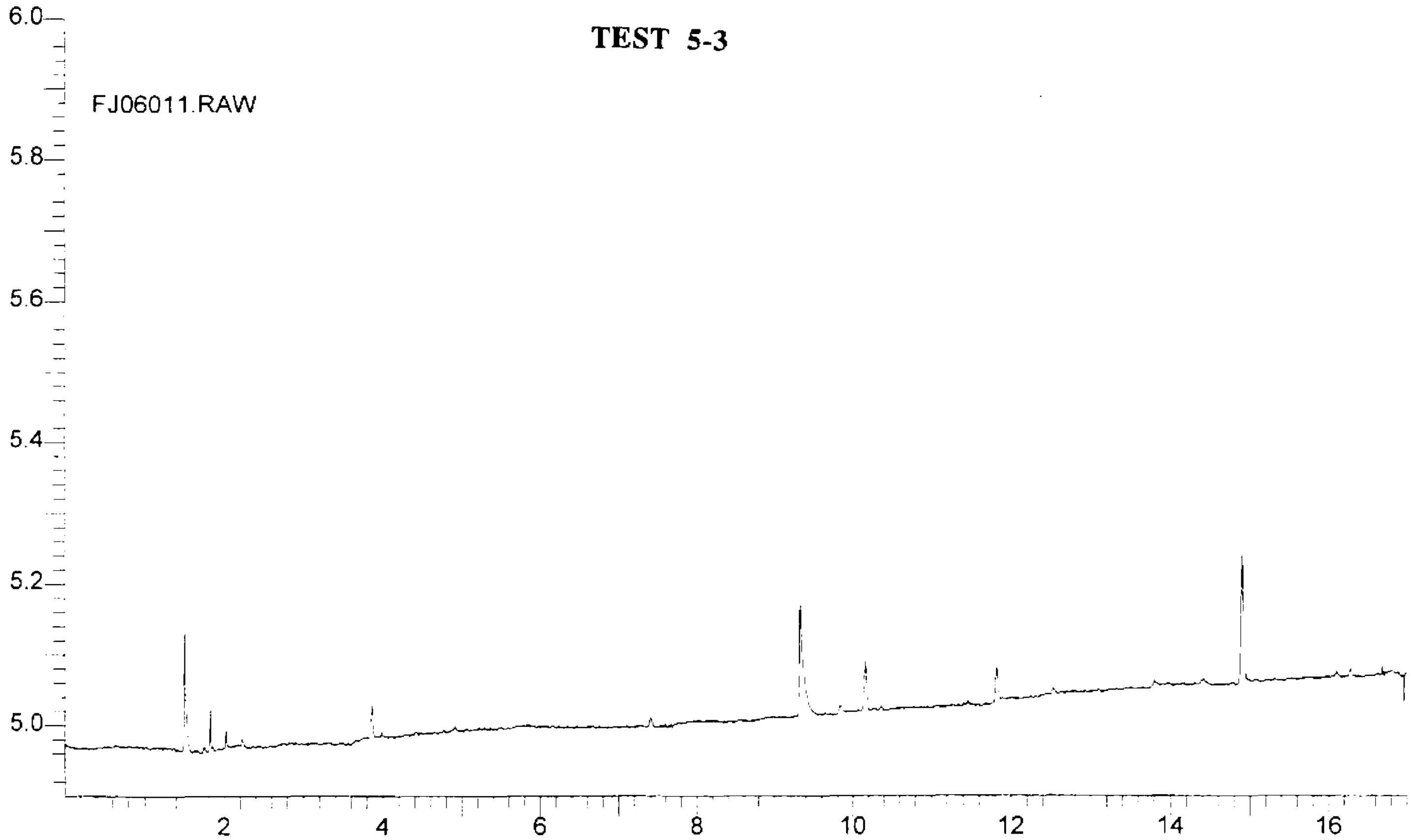
TEST 5-2

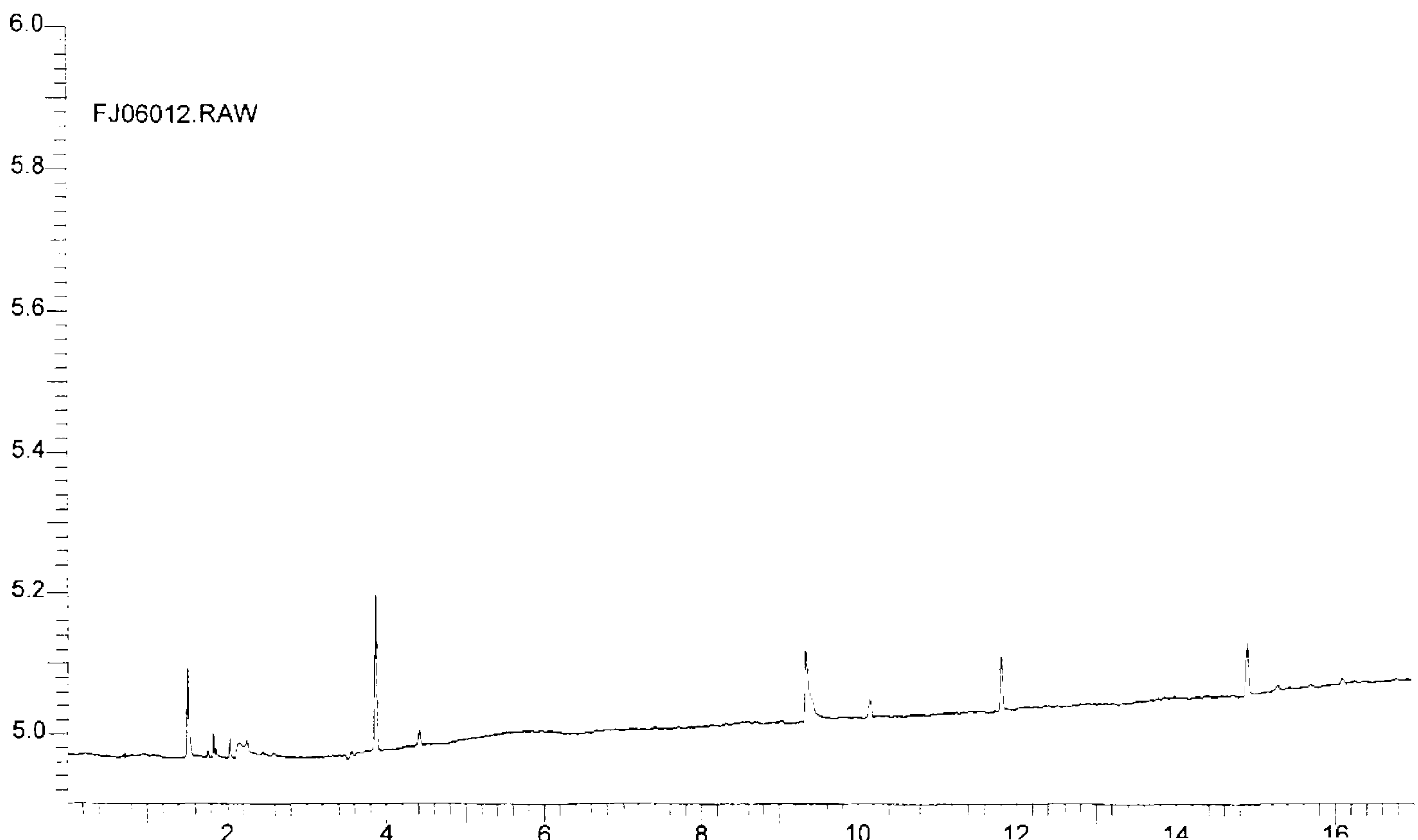




GAS CHROMATOGRAMS

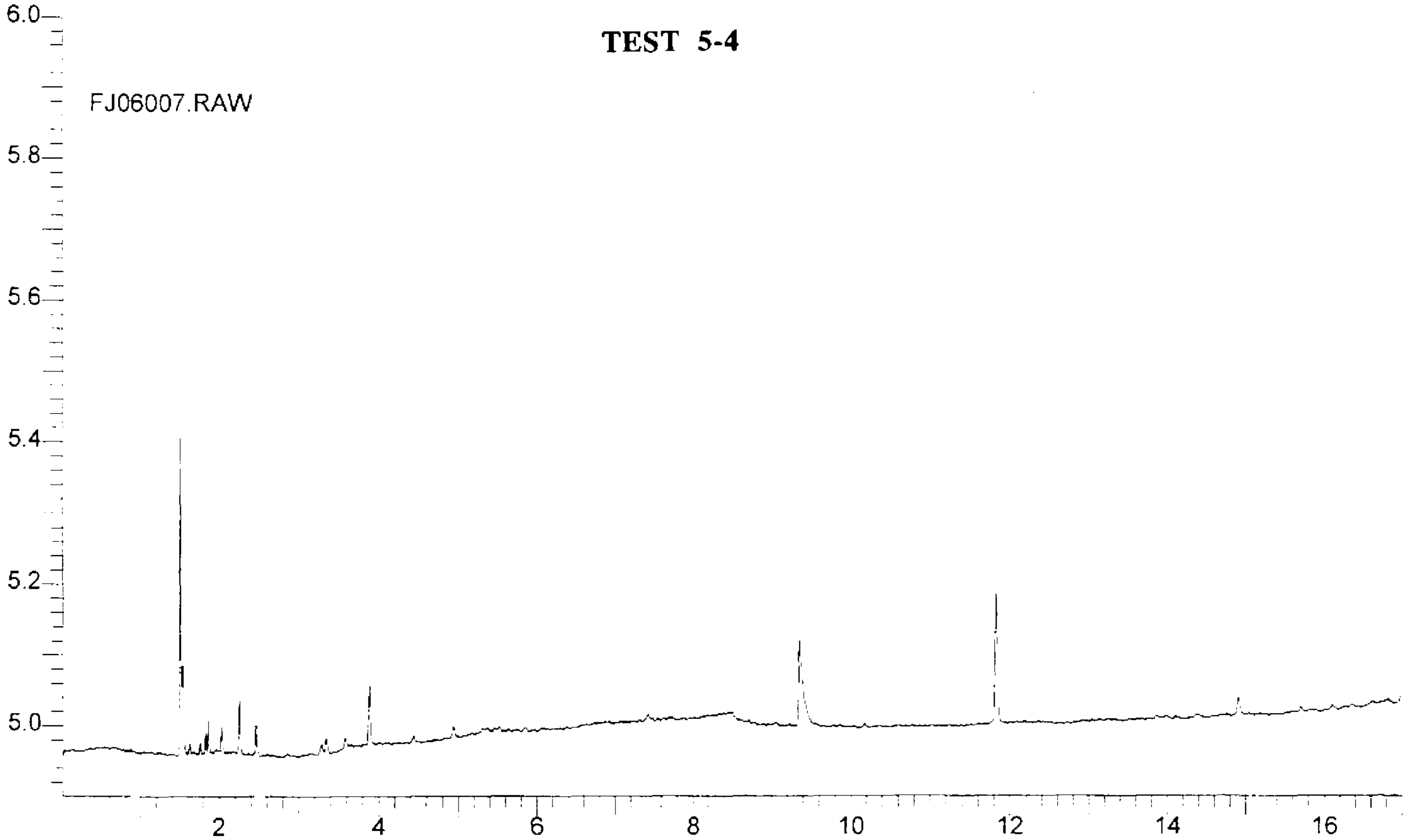
TEST 5-3

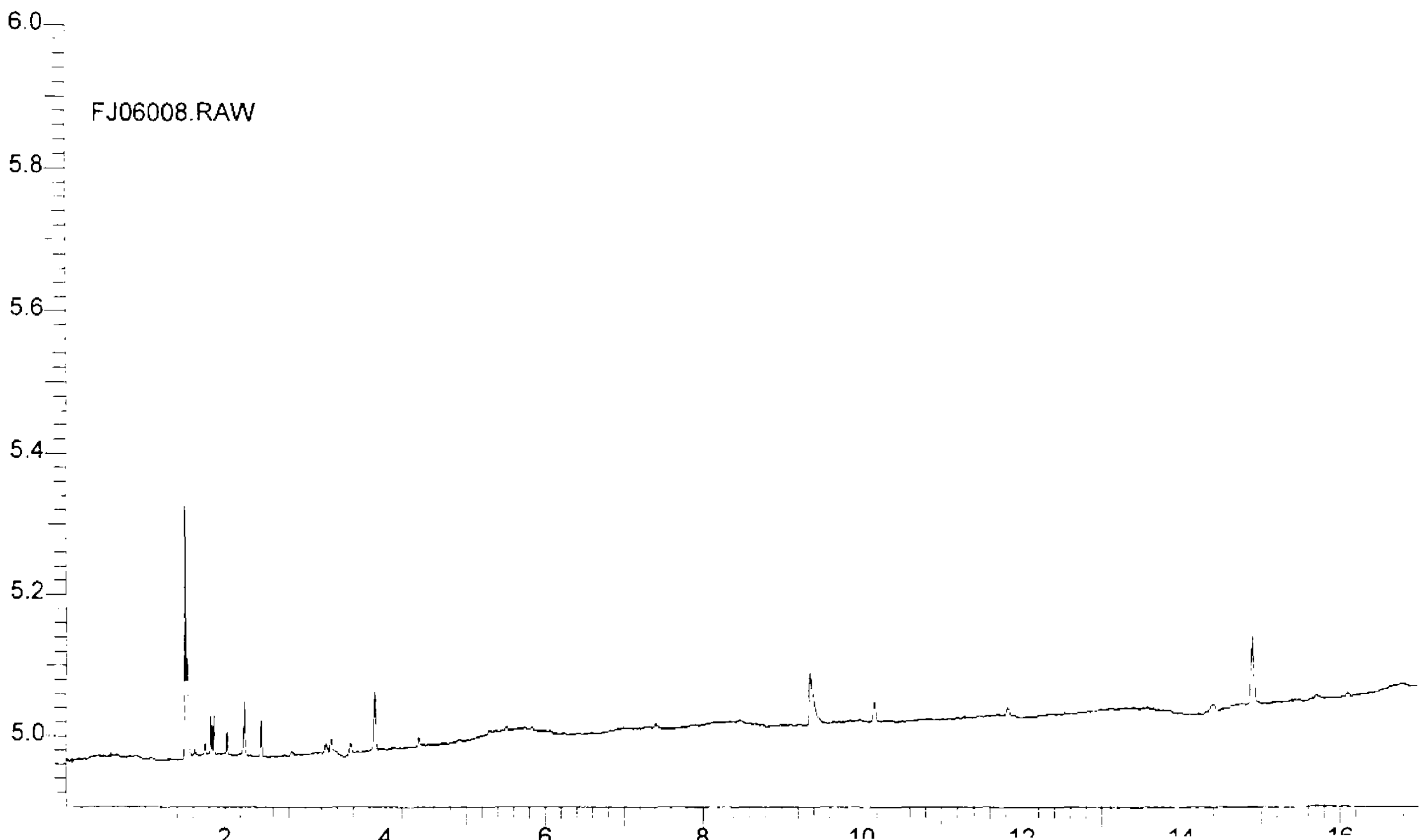




GAS CHROMATOGRAMS

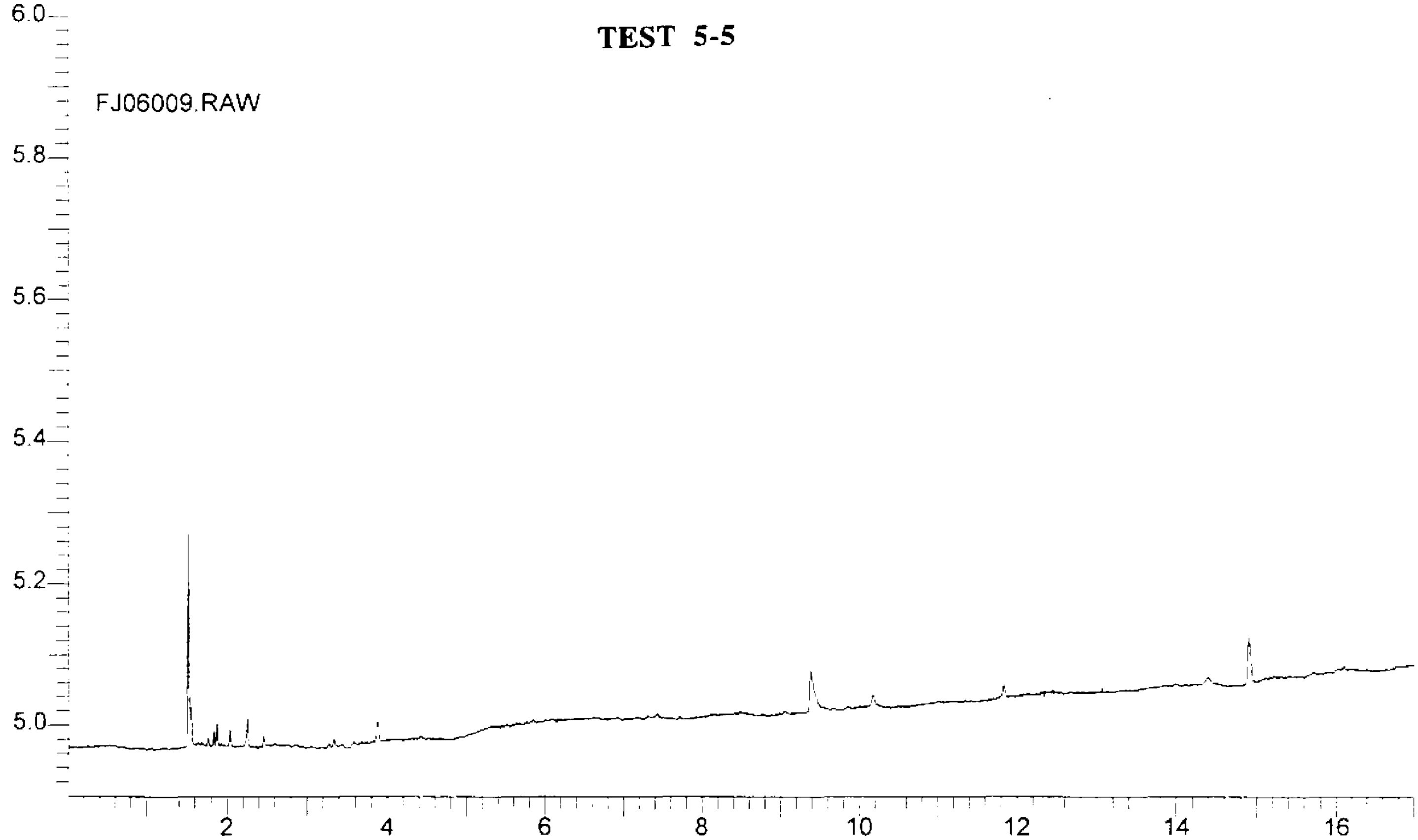
TEST 5-4

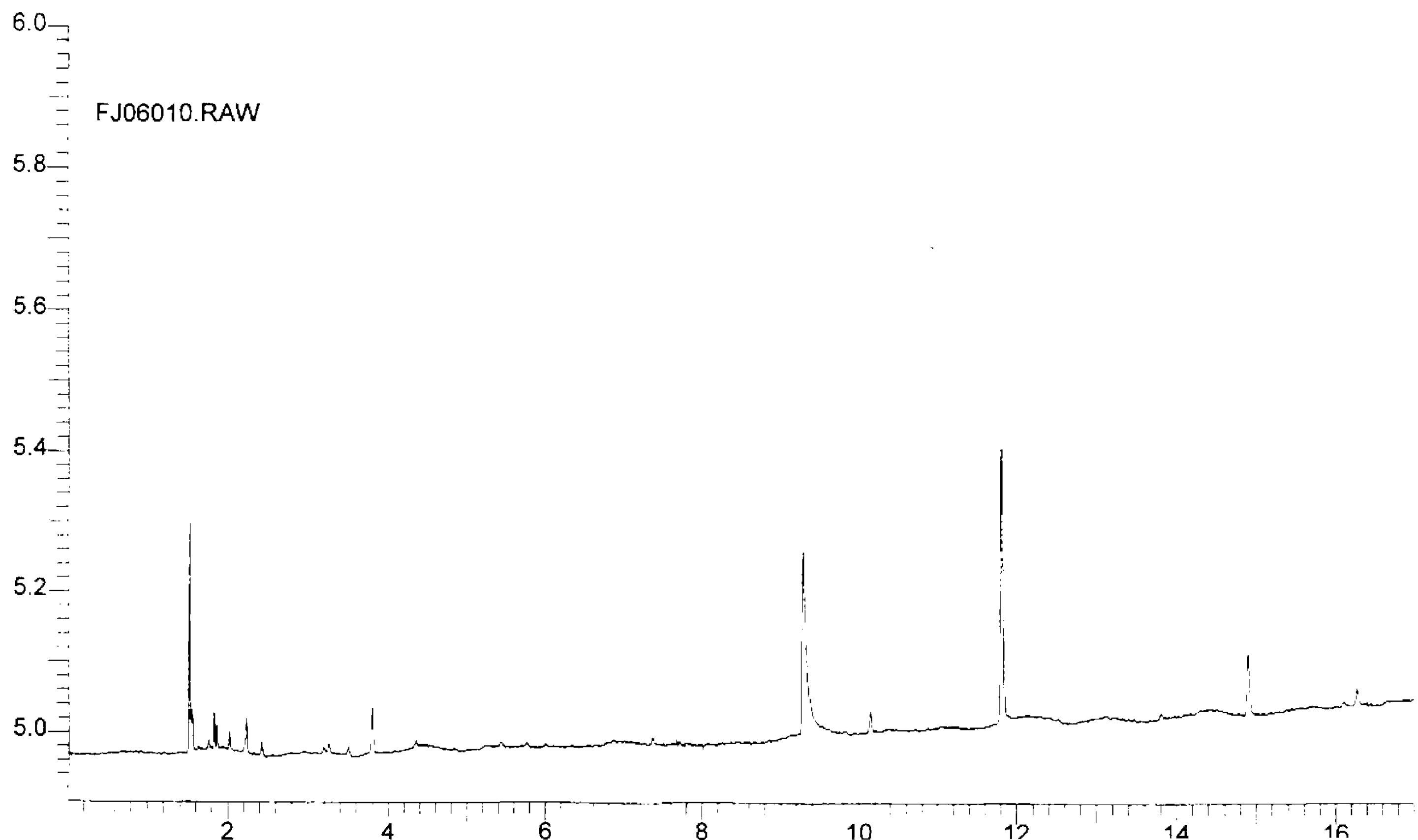




GAS CHROMATOGRAMS

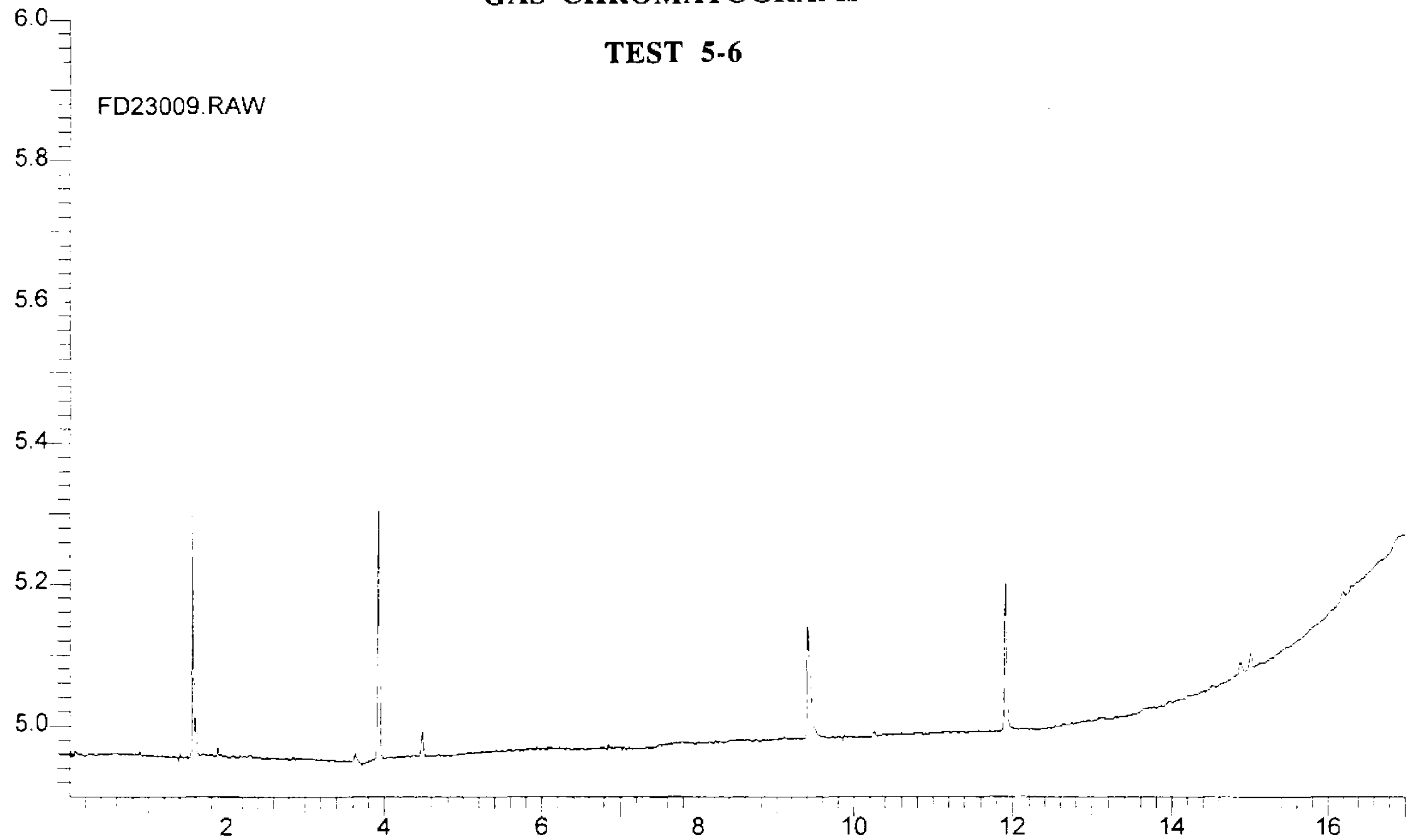
TEST 5-5

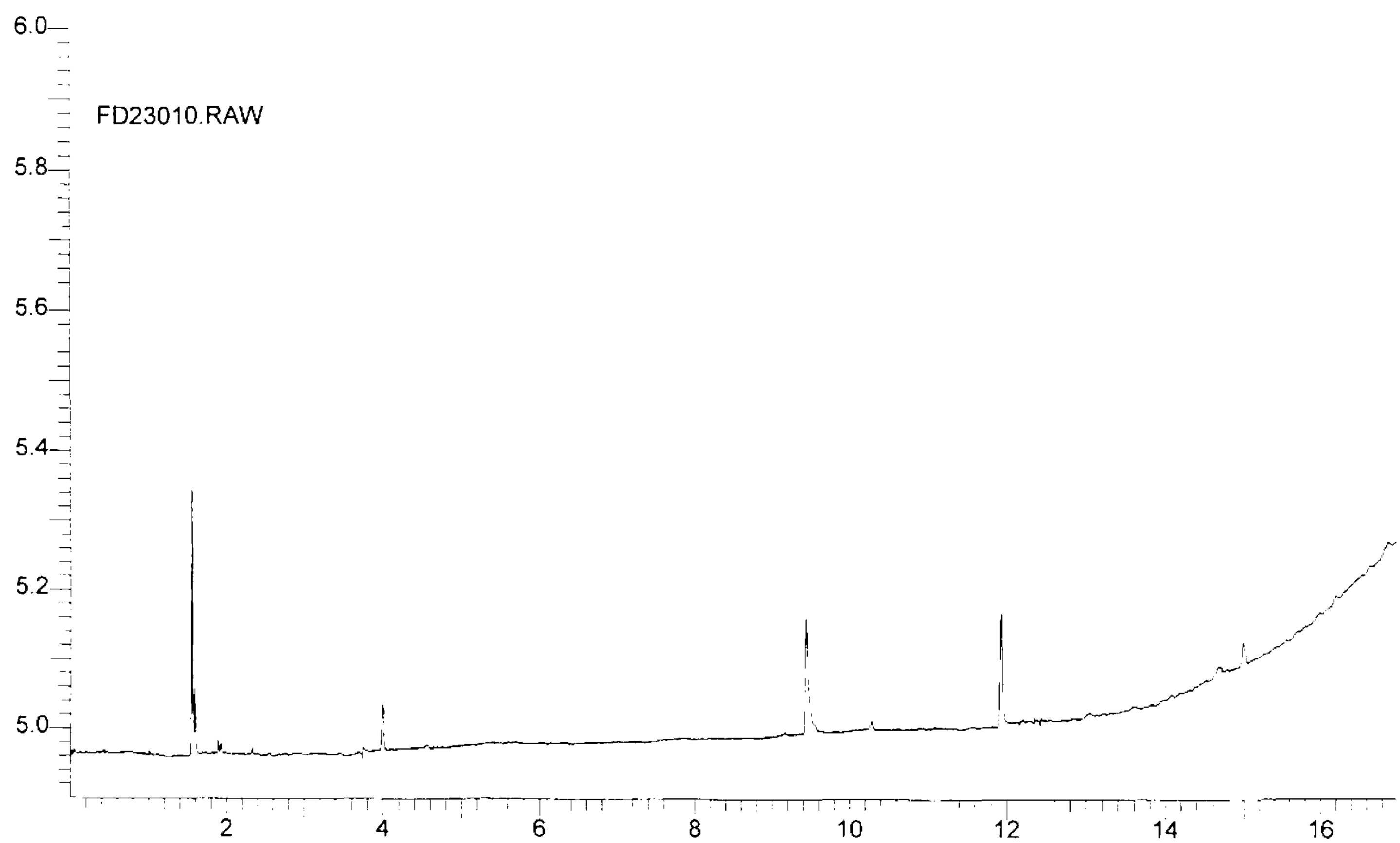




GAS CHROMATOGRAMS

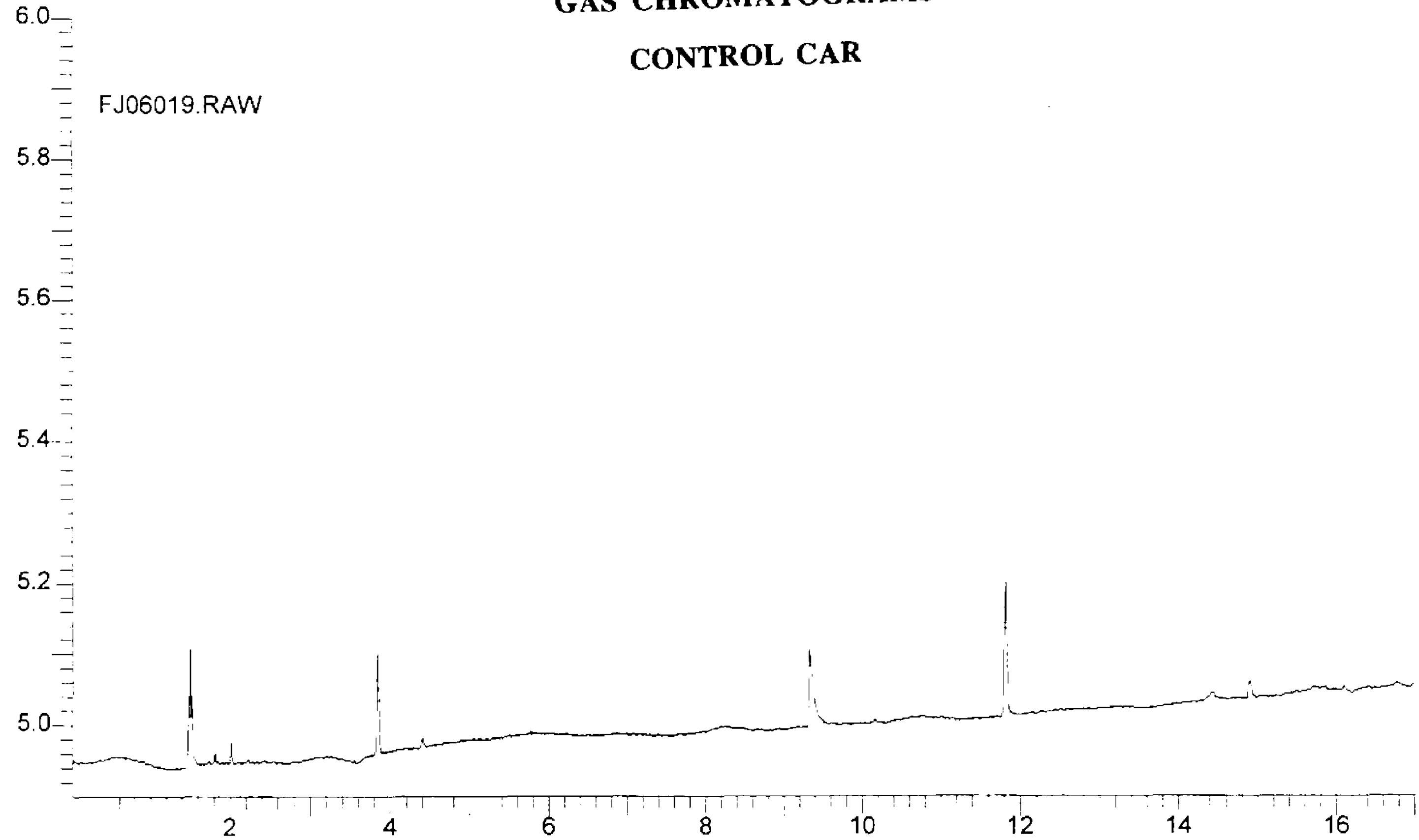
TEST 5-6

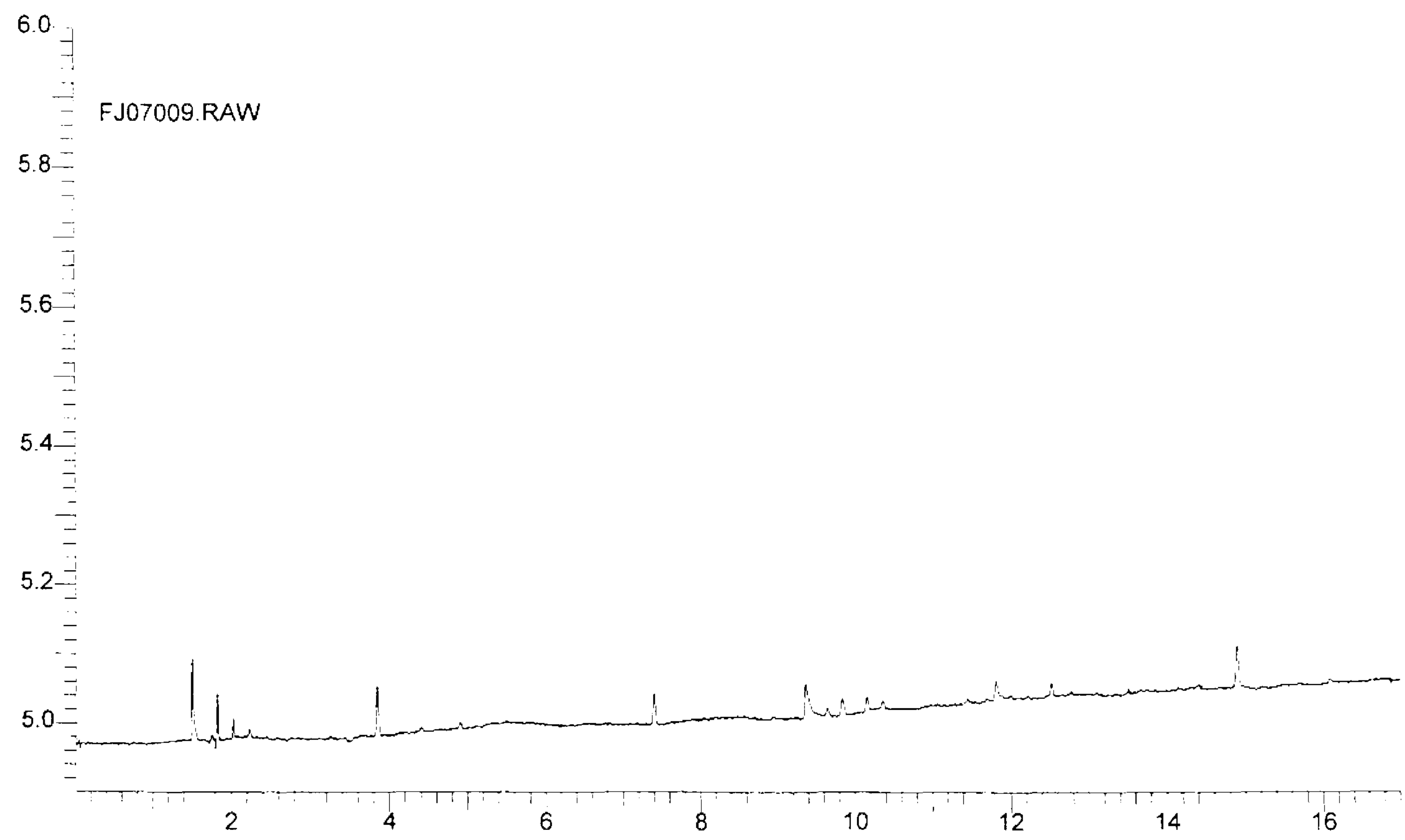




GAS CHROMATOGRAMS

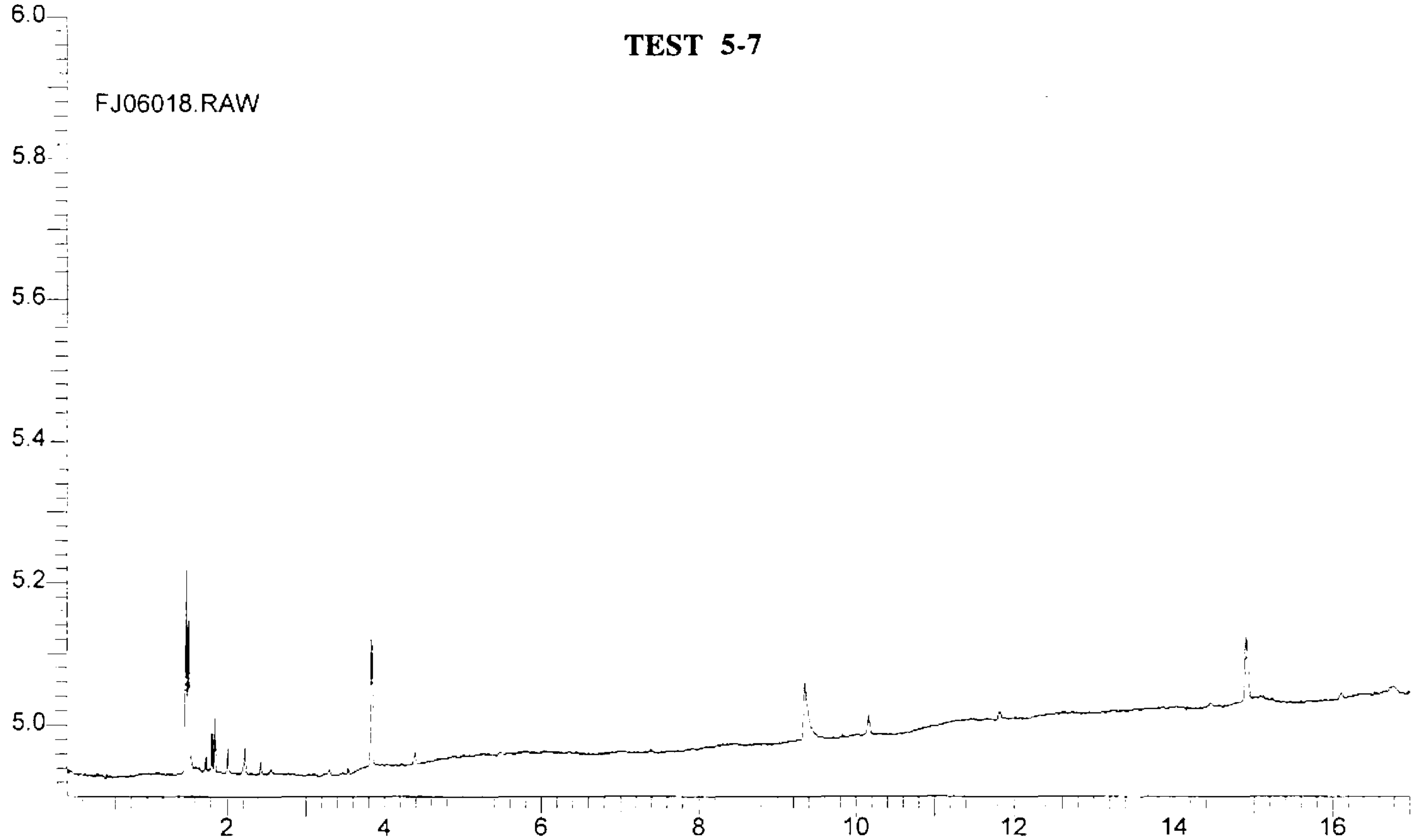
CONTROL CAR

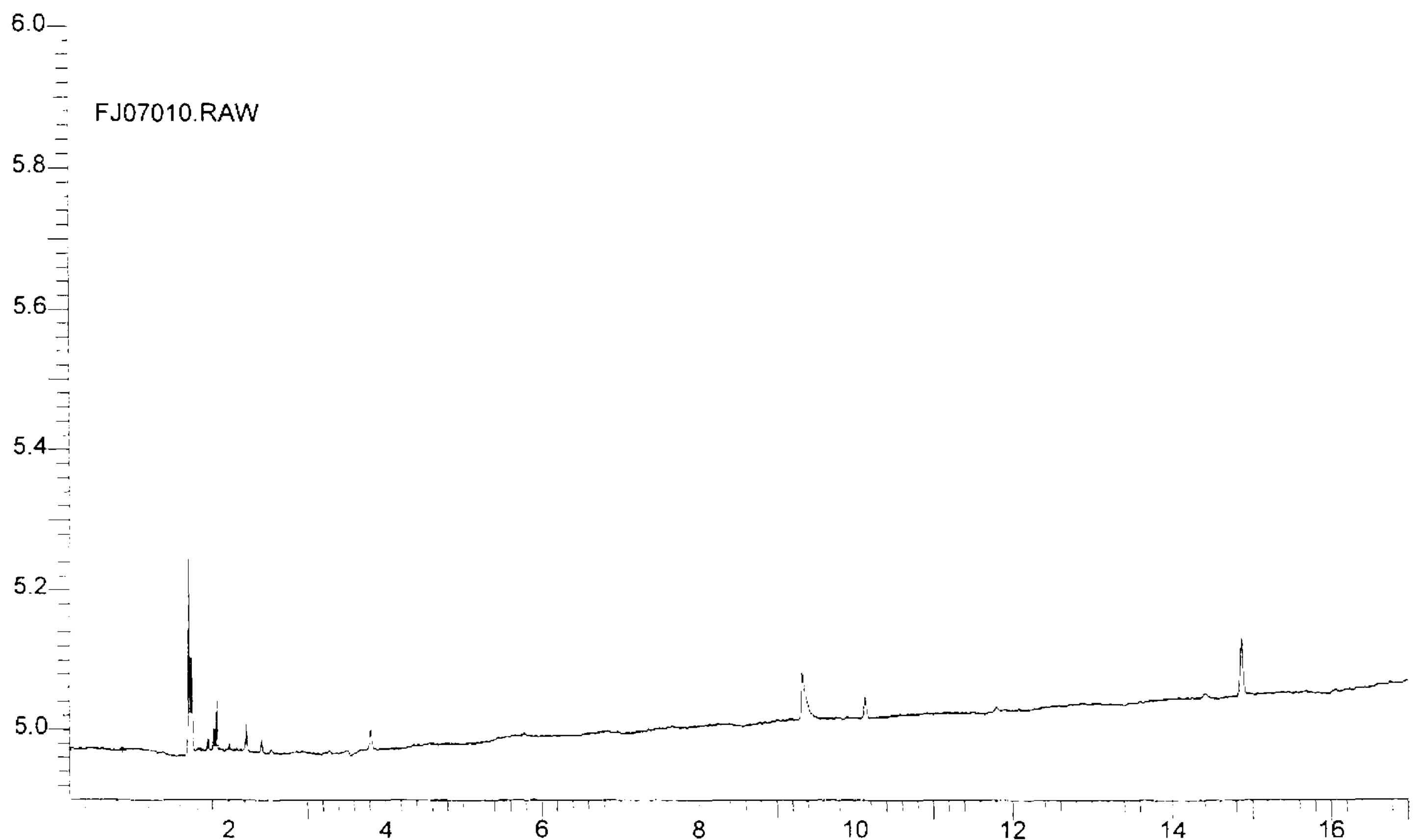




GAS CHROMATOGRAMS

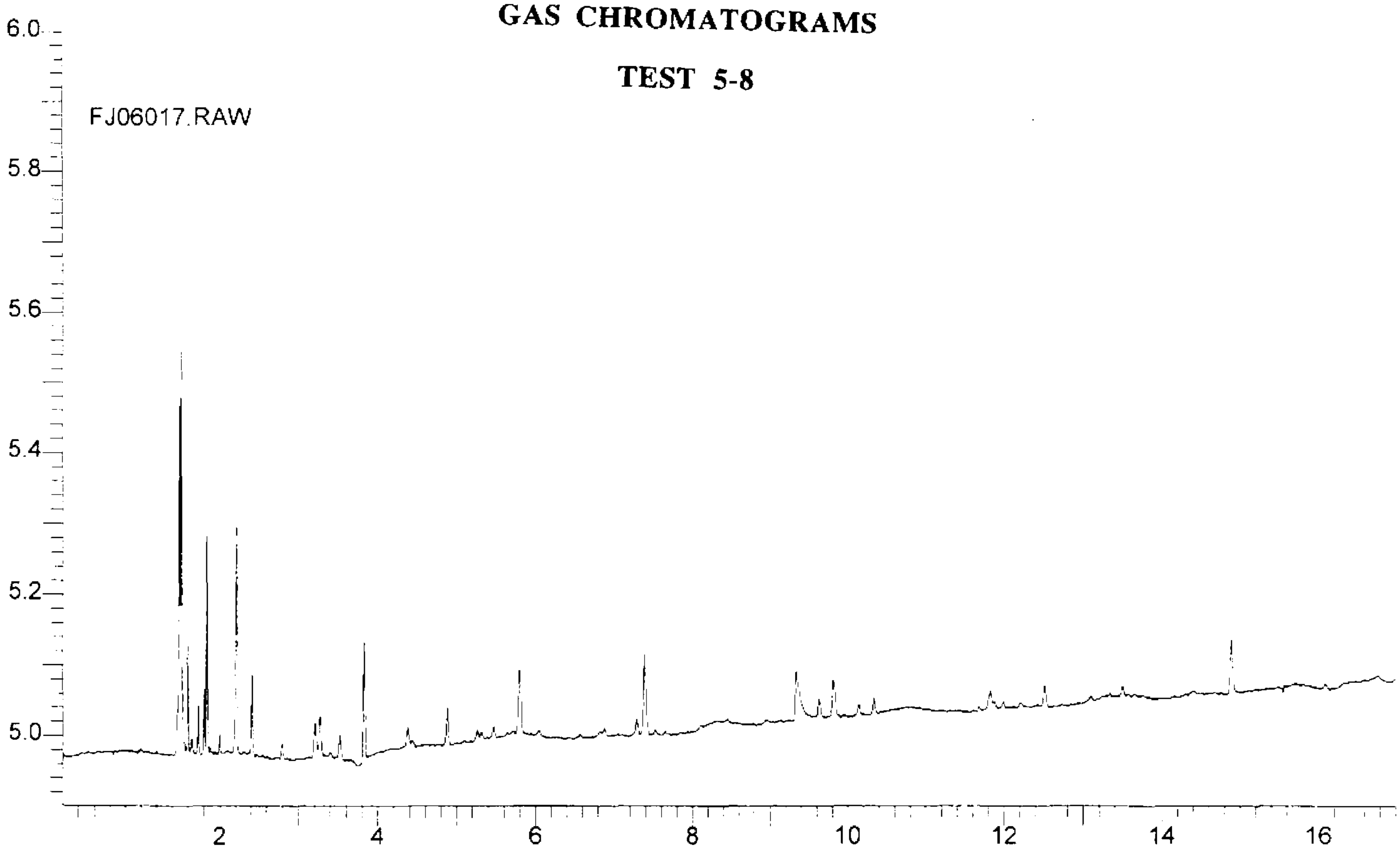
TEST 5-7

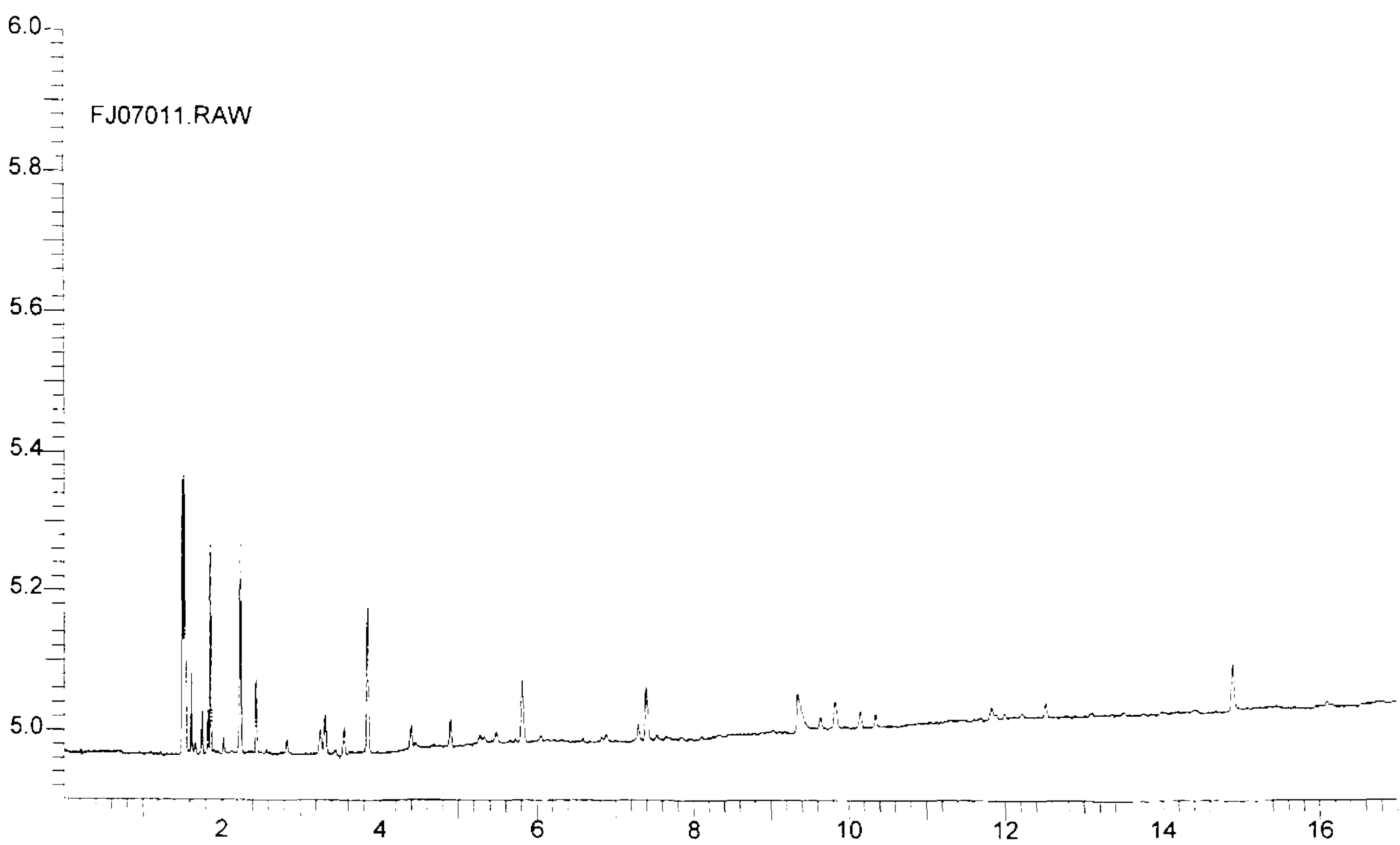




GAS CHROMATOGRAMS

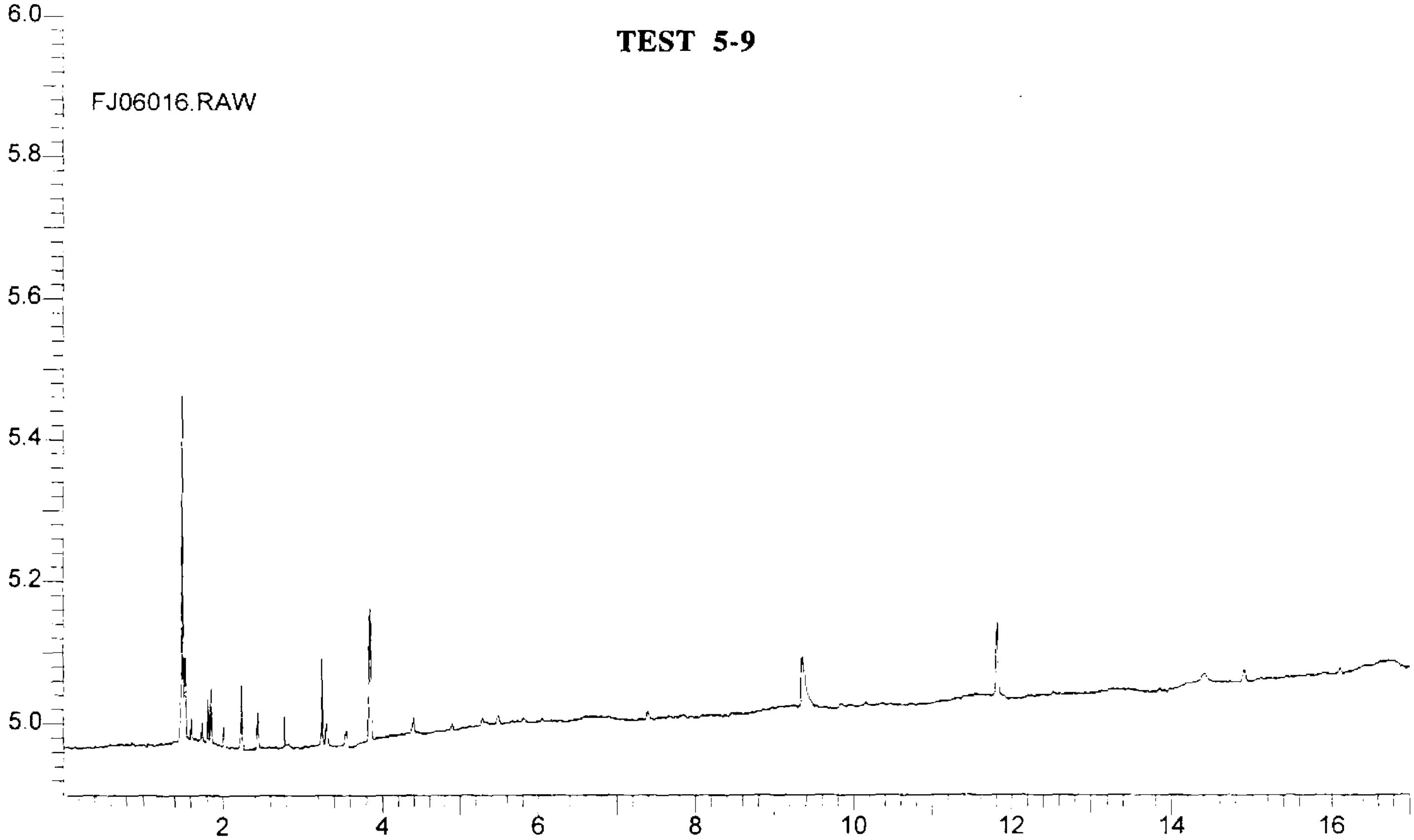
TEST 5-8

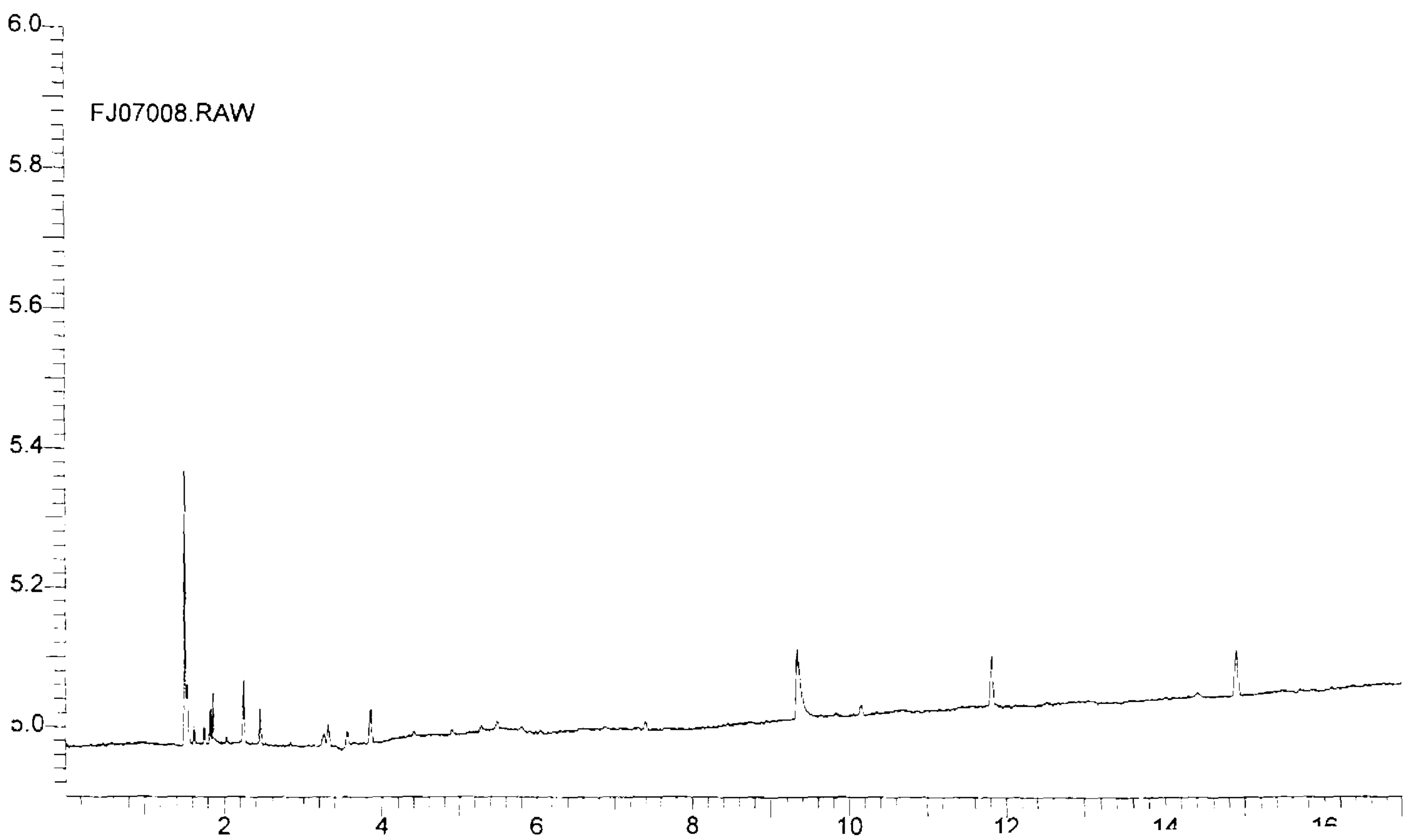




GAS CHROMATOGRAMS

TEST 5-9





3. Calculated Emissions Test Data

a. Data Roll-Up / Summary

(1) Control Car

DOT Test L... ontrol Car

	Time	Driver	Temp	RH	Press	25/25				IM240				Comments
						NOx	HC	CO	CO2	NOx	HC	CO	CO2	
11/19/96														
1						144	3	0.03	15	0.82	0.16	8.79	290.6	
2						161	4	0.04	14.8	0.82	0.14	6.85	293.3	
3										0.78	0.21	7.01	288.5	
4						151	2	0	15.2	0.79	0.22	7.16	290.8	
Avg						152	3	0.0233	15	0.8025	0.1825	7.4525	290.8	
Std-Dev						8.544	1	0.0208	0.2	0.0206	0.0386	0.9006	1.9647	
11/96/96						NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						143	3	0.01	15.1	0.93	0.15	6.65	288.1	
2						151	1	0.02	15.1	0.84	0.14	6.97	286.3	
3						169	8	0.01	15.2	0.85	0.18	7.32	290.7	
4										0.93	0.12	7.24	294.7	
AVG						154.33	4	0.0133	15.133	0.8875	0.1475	7.045	289.95	
STD Dev						13.317	3.6056	0.0058	0.0577	0.0492	0.025	0.3029	3.6455	
11/26/96	11:21	C	57.2	81	30.24	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						105	5	0.03	15	0.57	0.12	5.47	305.7	
2						26	0	0.05	14.9	0.62	0.12	5.89	307	
3						35	8	0.1	14.8	0.64	0.13	6.03	301.8	
4										0.67	0.16	6.61	307	
AVG						55.333	4.3333	0.06	14.9	0.625	0.1325	6	305.38	
STD Dev						43.247	4.0415	0.0361	0.1	0.042	0.0189	0.4712	2.4609	
11/26/96	13:50	C	54.5	86	30.23	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						80	5	0.06	14.9	0.85	0.2	8.41	302.5	
2						68	0	0.09	14.8	0.69	0.15	5.62	299.2	
3						51	7	0.07	15.1	0.69	0.16	5.71	299.2	
4										0.76	0.14	5.67	305.1	
AVG						66.333	4	0.0733	14.933	0.7475	0.1625	6.3525	301.5	
STD Dev						14.572	3.6056	0.0153	0.1528	0.0759	0.0263	1.3722	2.8601	
12/4/96	10:11	A	47.8	65	29.83									
1						39	0	0.07	14.9	0.67	0.37	11.14	309.5	
2						75	3	0.05	14.9	0.58	0.28	10.6	315.5	
3						41	1	0.03	14.9	0.61	0.22	9.95	319.6	
4										0.62	0.15	7.11	321.6	
Avg						51.667	1.3333	0.05	14.9	0.62	0.255	9.7	316.55	
Std-Dev						20.232	1.5275	0.02	0	0.0374	0.0933	1.7939	5.342	

DOT Test ontrol Car

	Time	Driver	Temp	RH	Press	25/25				IM240				Comments
						NOx	HC	CO	CO2	NOx	HC	CO	CO2	
12/9/96	9:29	A	46.85	45	29.56	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						159	1	0.02	15	0.81	0.14	7.28	308.4	
2						94	4	0.08	14.8	0.65	0.16	7.78	328.8	
3						64	5	0.03	14.5	0.65	0.18	7.24	321.8	
4										0.67	0.11	6.1	326.8	
AVG						105.67	3.3333	0.0433	14.767	0.695	0.1475	7.1	321.45	
STD Dev						48.563	2.0817	0.0321	0.2517	0.0772	0.0299	0.7105	9.1846	
12/9/96	19:37	A	40.1	54	30.53	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						93	3	0.01	15	0.8	0.15	3.28	318.9	
2						60	4	0.03	15.1	0.7	0.1	3.04	294.2	
3														
4														
AVG						76.5	3.5	0.02	15.05	0.75	0.125	3.16	306.55	
STD Dev						23.335	0.7071	0.0141	0.0707	0.0707	0.0354	0.1697	17.466	
12/10/96	9:49	B	42.8	45	30.63	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						11	16	0.01	15.1	0.79	0.1	6.86	331.4	RL 25/25 Run1 Systematic
2						48	3	0.02	14.7	0.8	0.14	8.55	334	Error. Not used in analysis.
3						134	4	0.05	14.9	0.73	0.11	8.14	342.3	
4										0.78	0.13	8.25	341.2	
AVG						91	3.5	0.035	14.8	0.775	0.12	7.95	337.23	
STD Dev						60.811	0.7071	0.0212	0.1414	0.0311	0.0183	0.747	5.3506	
12/10/96	18:01	A	43.7	30.59	50	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						82	7	0.18	14.9	0.71	0.13	4.7	308.7	
2						53	2	0.03	15.1	0.69	0.09	4.78	308.6	
3														
4														
AVG						67.5	4.5	0.105	15	0.7	0.11	4.74	308.65	
STD Dev						20.506	3.5355	0.1061	0.1414	0.0141	0.0283	0.0566	0.0707	
12/16/96	9:16	B	45	65	30.83	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						52	5	0.02	15	0.69	0.12	6.23	317.4	
2						39	3	0.03	14.9	0.63	0.08	5.7	323	
3						56	4	0.02	14.9	0.64	0.11	6.34	335.1	
4										0.67	0.11	6.04	333.5	
AVG						49	4	0.0233	14.933	0.6575	0.105	6.0775	327.25	
STD Dev						8.8882	1	0.0058	0.0577	0.0275	0.0173	0.2805	8.4808	

DOT Test … ontrol Car

	Time	Driver	Temp	RH	Press	25/25				IM240				Comments
						NOx	HC	CO	CO2	NOx	HC	CO	CO2	
12/4/96	17:35	A	48.2	58	30.68	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						139	6	0.13	14.7	0.81	0.19	7.38	323.1	
2														
3														
4														
AVG						139	6	0.13	14.7	0.81	0.19	7.38	323.1	
STD Dev														
12/5/96	9:28	C	43.7	48	30.8	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						140	6	0.1	15	0.57	0.13	8.46	315.2	
2						66	5	0.05	14.9	0.51	0.1	6.1	319.9	
3						85	4	0.04	15	0.65	0.12	8.59	315.7	
4										0.63	0.12	8.44	323	
AVG						97	5	0.0633	14.967	0.59	0.1175	7.8975	318.45	
STD Dev						38.432	1	0.0321	0.0577	0.0632	0.0126	1.2002	3.6937	
12/5/96	15:42	C	46.4	60	30.77	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						44	8	0.06	15	0.67	0.17	6.61	304.4	
2						99	7	0.11	14.9	0.6	0.15	6.9	300.9	
3						42	6	0.07	15.1	0.74	0.17	7.68	307.4	
4										0.68	0.13	7.37	303.7	
AVG						61.667	7	0.08	15	0.6725	0.155	7.14	304.1	
STD Dev						32.347	1	0.0265	0.1	0.0574	0.0191	0.4771	2.6696	
12/6/96	10:13	A	37.8	88	30.25	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						54	2	0.09	14.9	0.68	0.16	8.09	309.4	
2						36	2	0.11	14.9	0.63	0.1	6.34	327.4	
3						84	7	0.02	14.9	0.71	0.14	6.7	325.8	
4										0.79	0.18	9.31	335.2	
AVG						58	3.6667	0.0733	14.9	0.7025	0.145	7.61	324.45	
STD Dev						24.249	2.8868	0.0473	0	0.067	0.0342	1.3615	10.841	
12/6/96	14:38	C	41.5	78	30.36	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						61	8	0.03	14.9	0.62	0.14	5.97	313.2	
2						30	1	0.01	14.3	0.6	0.11	5.3	314.4	
3						176	4	0.15	14.7	0.68	0.13	5.68	319.8	
4										0.63	0.17	7.11	315.5	
AVG						89	4.3333	0.0633	14.633	0.6325	0.1375	6.015	315.73	
STD Dev						76.922	3.5119	0.0757	0.3055	0.034	0.025	0.7799	2.8745	

Device 3 IM2..

Test	NOx			HC			CO			CO2			Comments
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 7	Plate:	SGR105											
1	1.14	0.75		1.47	1.95		24.16	47.07		485.1	472		Car problem. DO not use in analysis
2	1.06	0.81		1.25	1.73		17.87	40.3		490.4	471.8		Leaking transmission.
3	1.07	0.83		1.54	1.78		27.57	41.27		473.6	472		
4	1.09	0.86		1.42	1.68		18.75	38.73		486.1	474.1		
	1.09	0.8125	0.2775	1.42	1.785	-0.365	22.0875	41.8425	-19.755	483.8	472.475	11.325	
Car 8	Plate:	TAG0927											
1	1.67	1.72		0.31	0.28		6.44	4.3		443.6	467.8		
2	1.61	1.63		0.28	0.25		5.57	3.92		444.2	471.4		
3	1.56	1.75		0.26	0.26		4.67	4.53		449.7	464.9		
4	1.62	1.82		0.24	0.26		3.75	4.07		456	473.5		
	1.615	1.73	-0.115	0.2725	0.2625	0.01	5.1075	4.205	0.9025	448.375	469.4	-21.025	
Car 9	Plate:	TAG0385											
1	1.46	0.92		0.08	0.06		4.07	1.33		474.7	448.2		
2	1.77	1.28		0.08	0.07		0.78	0.77		471.7	450.2		
3	1.79	1.04		0.08	0.08		0.68	1.49		466.1	458.7		
4	1.58	1.2		0.07	0.09		0.58	0.62		467.6	464.6		
	1.65	1.11	0.54	0.0775	0.075	0.0025	1.5275	1.0525	0.475	470.025	455.425	14.6	
Summary		dbar	0.04548		dbar	-0.0036		dbar	0.43524		dbar	4.55357	
		stddev	0.22789		stddev	0.03775		stddev	2.86135		stddev	12.9504	
		t	0.52797		t	-0.2503		t	0.40244		t	0.93029	

Device 1 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 1	Plate: Van												
1	817	780		19	20		0	0		10.9	10.8		
2	808	819		20	20		0	0		10.8	10.8		
3	811	834		18	21		0.01	0.12		11	10.9		
Avg	812	811	1	19	20.3333	-1.3333	0.00333	0.04	-0.0367	10.9	10.8333	0.06667	
Car 2	Plate: SGS165												
1	55	253		21	81		0.18	0.86		14.9	24.6		Problems with next run (W device)
2	75	174		25	60		0.19	0.73		14.9	14.3		Cloggged Line
3	73	90		33	32		0.2	0.22		15	14.8		
Avg	67.6667	132	-64.333	26.3333	46	-19.667	0.19	0.475	-0.285	14.9333	14.55	0.38333	
Car 3	Plate SGP208												
1	100	98		39	39		0.17	0.2		14.7	14.6		
2	128	98		37	36		0.43	0.17		14.6	14.7		
3	104	103		47	37		0.3	0.17		14	14.2		
Avg	110.667	99.6667	11	41	37.3333	3.66667	0.3	0.18	0.12	14.4333	14.5	-0.0667	
Car 4	Plate: S704												
1	132	98		33	27		0.24	0.19		15	15		
2	129	86		30	30		0.25	0.23		14.9	14.9		
3	104	53		30	20		0.22	0.16		14.9	15.1		
Avg	121.667	79	42.6667	31	25.6667	5.33333	0.23667	0.19333	0.04333	14.9333	15	-0.0667	
Car 5	Plate: Z338												
1	582	361		30	23		0	0.01		18.1	13.1		Run 1 - Systematic Error
2	489	369		28	20		0	0		13	13		Not used in analysis.
3	568	457		29	23		0	0		12.9	13.2		
Avg	528.5	395.667	132.833	28.5	22	6.5	0	0.00333	-0.0033	12.95	13.1	-0.15	
Car 6	Plate: S199												
1	158	168		10	14		0.07	0.11		14.9	14.9		
2	127	134		17	12		0.09	0.11		14.5	14.9		
3	151	153		17	11		0.12	0.08		14.8	14.9		
Avg	145.333	151.667	-6.3333	14.6667	12.3333	2.33333	0.09333	0.1	-0.0067	14.7333	14.9	-0.1667	

Device 5 IM.

Test	NOx			HC			CO			CO2			Comments
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 1	K-Car		Plate: SGM76E										
1	1.22	1.22		0.29	0.3		10.62	8.78		313.9	318.1		
2	1.18	1.32		0.43	0.44		15.82	15.45		310.9	316.9		
3	1.04	1.35		0.37	0.35		14.81	11.7		313.3	338.4		
4	1.2	1.37		0.36	0.44		13.22	18.2		314.4	314.8		
	1.16	1.315	-0.155	0.3625	0.3825	-0.02	13.6175	13.5325	0.085	313.125	322.05	-8.925	
Car2	K-Car	Plate: SCEV4											
1	1.39	1.37		0.1	0.09		6.54	3.98		334.3	333.9		
2	1.48	1.56		0.1	0.06		7.68	1.94		336.9	340		
3	1.58	1.56		0.15	0.06		8.96	1.76		342.7	339.4		
4	1.49	1.71		0.1	0.07		9.09	3.4		343.1	339.5		
	1.485	1.55	-0.065	0.1125	0.07	0.0425	8.0675	2.77	5.2975	339.25	338.2	1.05	
Car3	Dodge Pick-up		Plate: TD4501										
1	3.52	3.26		0.13	0.14		0.41	0.42		502.1	491.8		
2	3.51	2.99		0.13	0.14		0.58	0.6		499.2	488.8		
3	3.74	3.16		0.13	0.13		0.09	0.3		515.3	495.8		
4	3.83	2.89		0.12	0.14		0	0.67		494.3	513.1		
	3.65	3.075	0.575	0.1275	0.1375	-0.01	0.27	0.4975	-0.2275	502.725	497.375	5.35	
Car 4	Chevy Crusier		Plate: 835										
1	1.31	1.27		0.25	0.16		10.29	3.83		487.1	491.1		
2	1.2	1.32		0.25	0.17		9.39	3.61		483.6	496.8		Suspected equip problem
3	1.27	1.18		0.25	0.19		11.27	4.16		488.1	561.5		run 3 w not used in analysis
4	1.23	1.4		0.3	0.16		13.77	3.53		492.2	505.9		
	1.2525	1.33	-0.0775	0.2625	0.16333	0.09917	11.18	3.65667	7.52333	487.75	497.933	-10.183	
Car 5	K-Car		Plate: SGM95G										
1	1.17	1.19		0.11	0.1		4.3	3.52		322.4	323.2		
2	1.14	1.25		0.11	0.14		5.14	7.51		329.1	320.2		
3	1.19	1.24		0.13	0.11		6.35	3.89		330.3	323.3		
4	1.2	1.3		0.1	0.11		4.36	3.69		335.9	329.4		
	1.175	1.245	-0.07	0.1125	0.115	-0.0025	5.0375	4.6525	0.385	329.425	324.025	5.4	
Car 6	Chevy Crusier		Plate: SCEV6										
1	0.77	0.74		0.09	0.06		0.15	1.77		445.4	449.7		Insufficient warm up, run 1 w
2	0.8	0.76		0.07	0.06		0.02	0.08		457	462.4		not used in analysis.
3	0.67	0.75		0.07	0.08		0.09	0.1		465.2	453.2		
4	0.79	0.78		0.07	0.07		0.14	0		457.2	450.4		
	0.7575	0.76333	-0.0058	0.075	0.07	0.005	0.1	0.06	0.04	456.2	455.333	0.86667	

Device 4 IM240

Test	NOx			HC			CO			CO2			Comments
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 1	Cavalier Wagon	Plate: SGP735											
1	1.16	1.1		0.12	0.09		1.94	1.21		388.4	331.7		
2	1.32	1.17		0.09	0.09		2.12	0.95		397.4	337.9		
3	1.4	1.05		0.1	0.1		1.84	2.65		371.5	349.1		
4		1.18			0.08			0.93			345.9		
	1.29333	1.125	0.16833	0.10333	0.09	0.01333	1.96667	1.435	0.53167	385.767	341.15	44.6167	
Car2	Crusier	Plate: TAG0132											
1	3.71	2.06		1.1	0.85		16.79	6.5		432.5	457		
2	3.7	2.04		1.02	0.68		14.46	5.14		437.1	462.4		
3	3.65	2.11		1.2	0.74		18.24	5.72		447.8	467		
4	3.63			1.11			17.9			444.1			
	3.6725	2.07	1.6025	1.1075	0.75667	0.35083	16.8475	5.78667	11.0608	440.375	462.133	-21.758	
Car3	Dodge R	Plate: K9 Car											
1	5.13	4.73		0.96	0.44		33.88	6.09		553.6	581.9		
2	5.05	4.9		0.95	0.36		35.95	4.17		548.9	588.2		
3	5.21	4.6		0.96	0.38		35.84	4.62		547.1	591.6		
4	5.28	4.48		0.91	0.4		33.83	5.48		550.3	580.5		
	5.1675	4.6775	0.49	0.945	0.395	0.55	34.875	5.09	29.785	549.975	585.55	-35.575	
Car 4	Chevy Cruiser	Plate: TAG0744											
1	0.96	0.85		0.38	0.62		4.18	0.97		486.2	436.6		Bimodal Distribution
2	0.99	0.99		0.28	0.79		3.55	1.1		486.9	436.2		Apparent Cra problem
3	1.41	1		0.54	0.62		6.46	0.9		662.1	431.9		Not used in analysis.
4	1.61	0.92		0.54	0.54		9.59	1.03		670.4	432.6		
	0.975	0.94	0.035	0.33	0.6425	-0.3125	3.865	1	2.865	486.55	434.325	52.225	
Car 5	K-Car	Plate: SGP47P											
1	0.99	0.65		0.18	0.09		6.11	2.72		305.7	293.7		
2	1.12	0.72		0.23	0.07		8.52	1.82		312.4	295.3		Run 4 w tire went flat
3	1.21	0.65		0.25	0.07		9.57	1.96		330.6	294		Not used in analysis
4	1.24	0.64		0.22	0.09		7.68	4.45		339	308.6		
	1.14	0.67333	0.46667	0.22	0.07667	0.14333	7.97	2.16667	5.80333	321.925	294.333	27.5917	
Car 6	Plymouth	Plate: SGR583											
1	1.19			0.15			7.97			286.1			
2	1.02	0.59		0.12	0.08		4.81	4.08		285.9	272.4		
3	1.17	0.57		0.14	0.07		6.75	2.54		286.5	279.6		
4	1.01	0.62		0.09	0.07		5.09	3.49		289.6	293.9		
	1.0975	0.59333	0.50417	0.125	0.07333	0.05167	6.155	3.37	2.785	287.025	281.967	5.05833	

Device 4 IM.

Test	NOx W/O	NOx W	NOx D	HC W/O	HC W	HC D	CO W/O	CO W	CO D	CO2 W/O	CO2 W	CO2 D	Comments
Car 7	K-Car	Plate: SPZ647											
1	0.27	0.43		0.2	0.21		5.81	5.19		322.7	301.8		
2	0.37	0.46		0.2	0.19		6.09	4.31		321.2	300.7		
3	0.38	0.47		0.17	0.19		5.81	3.63		327.4	299.5		
4	0.38	0.46		0.2	0.15		4.97	4.74		334.3	300.8		
	0.35	0.455	-0.105	0.1925	0.185	0.0075	5.67	4.4675	1.2025	326.4	300.7	25.7	
Car 8	RAM Var	Plate: SGM68U											
1	5.45	5.52		0.5	0.21		8.71	0.08		653.3	608.9		
2	5.91	5.52		0.47	0.22		5.18	0.02		631.5	651.1		
3	5.87	5.72		0.55	0.25		5.18	0.23		618.7	613.9		
4	5.83	5.79		0.69	0.2		6.65	0.18		618.6	617.4		
	5.765	5.6375	0.1275	0.5525	0.22	0.3325	6.43	0.1275	6.3025	630.525	622.825	7.7	
Car 9	RAM Pick-UP		Plate: TO5666										
1	1.92	1.91		0.17	0.15		1.14	0.15		506.2	496.6		
2	1.98	2.07		0.19	0.14		1.8	0.01		500.4	496.1		
3	2.12	1.9		0.18	0.14		2.12	0.16		504.8	454.5		
4	2.35			0.23			1.12			508.5			
	2.0925	1.96	0.1325	0.1925	0.14333	0.04917	1.545	0.10667	1.43833	504.975	482.4	22.575	
Summary		dbar	0.42333		dbar	0.18729		dbar	7.36365		dbar	9.48854	
		stddev	0.52366		stddev	0.20049		stddev	9.71491		stddev	26.7947	
		t	2.28653		t	2.6422		t	2.14387		t	1.0016	

DOT Test [illegible] ontrol Car

	Time	Driver	Temp	RH	Press	25/25				IM240				Comments
						NOx	HC	CO	CO2	NOx	HC	CO	CO2	
12/16/96	20:00	A	47.3	86	30.77	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						102	1	0.09	14.8	0.88	0.11	6.28	352	
2						103	7	0.03	14.9	0.8	0.11	5.07	348.2	
3						34	3	0.02	14.8	0.84	0.11	5.92	341.8	
4														
AVG			-			79.667	3.6667	0.0467	14.833	0.84	0.11	5.7567	347.33	
STD Dev						39.552	3.0551	0.0379	0.0577	0.04	0	0.6213	5.1549	
12/17/96	13:29	C	51.8	99	30.59	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						79	2	0.01	14.8	0.78	0.18	7.48	308.8	
2						59	3	0.01	14.7	0.69	0.21	6.66	313.9	
3						101	0	0.02	14.9	0.73	0.17	8.23	317.9	
4										0.82	0.2	9.3	320.8	
AVG						79.667	1.6667	0.0133	14.8	0.755	0.19	7.9175	315.35	
STD Dev						21.008	1.5275	0.0058	0.1	0.0569	0.0183	1.1227	5.2029	
12/18/96	15:11	C	58.55	67	30.46	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						82	4	0.02	14.1	0.71	0.16	7.43	300.2	
2						95	5	0.02	14.8	0.64	0.18	8.06	298.2	
3						67	4	0.01	14.8	0.55	0.17	6.82	301.7	
4										0.72	0.17	7.55	304.7	
AVG						81.333	4.3333	0.0167	14.567	0.655	0.17	7.465	301.2	
STD Dev						14.012	0.5774	0.0058	0.4041	0.0785	0.0082	0.5094	2.7386	
12/18/96	19:53	A	53.6	71	30.45	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						99	8	0.01	14.7	1	0.18	5.65	299.9	
2						115	2	0.15	14.5	0.96	0.11	4.79	302.9	
3						136	3	0.01	15	1.03	0.11	4.76	299.8	
4										0.99	0.13	5.82	305.9	
AVG						116.67	4.3333	0.0567	14.733	0.995	0.1325	5.255	302.13	
STD Dev						18.556	3.2146	0.0808	0.2517	0.0289	0.033	0.5587	2.8987	
12/19/96	9:03	B	42.8	88	30.46	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						70	3	0.02	14.9	0.69	0.07	5.02	318.3	
2						52	0	0.02	14.8	0.65	0.1	5.06	319.6	
3						100	4	0.01	14.9	0.62	0.09	5.63	318.7	
4										0.66	0.1	6.21	317.7	
AVG						74	2.3333	0.0167	14.867	0.655	0.09	5.48	318.58	
STD Dev						24.249	2.0817	0.0058	0.0577	0.0289	0.0141	0.5608	0.7974	

DOT Test . ontroi Car

	Time	Driver	Temp	RH	Press	25/25				IM240				Comments
						NOx	HC	CO	CO2	NOx	HC	CO	CO2	
12/19/96	20:19	A	43.7	77	30.33	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						127	4	0.07	15	0.84	0.08	3.97	333.7	
2						94	5	0.03	15	0.83	0.09	4.53	335.4	
3						210	11	0.13	23	0.74	0.1	4.39	335.8	RL 25/25 Run 3 Systematic
4										0.77	0.09	6.41	335.3	Error. Not used in analysis.
AVG						110.5	4.5	0.05	15	0.795	0.09	4.825	335.05	
STD Dev						23.335	0.7071	0.0283	0	0.048	0.0082	1.0831	0.9256	
12/20/96	9:16	B	27.5	43	30.39	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						117	6	0.1	14.9	0.75	0.12	10.53	316.2	
2						229	3	0.06	15.1	0.65	0.08	7.44	334.7	
3						292	3	0.06	15	0.68	0.11	8.53	342.6	
4										0.7	0.1	7.16	339	
AVG						212.67	4	0.0733	15	0.695	0.1025	8.415	333.13	
STD Dev						88.636	1.7321	0.0231	0.1	0.042	0.0171	1.5288	11.736	
12/20/96	15:51	B	31.1	40	30.68	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						84	7	0.03	15.2	0.8	0.12	7.27	330.5	
2						60	3	0.02	15.3	0.61	0.11	8.15	339.7	
3						235	4	0.05	15.2	0.74	0.12	8.75	332.1	
4										0.81	0.13	11.31	371.1	
						126.33	4.6667	0.0333	15.233	0.74	0.12	8.87	343.35	
						94.87	2.0817	0.0153	0.0577	0.092	0.0082	1.7365	18.93	
1/8/97	10:14	B/A	31.1	36	30.67	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						107	1	0.01	15	0.72	0.12	8.75	315.5	
2						56	1	0.02	14.9	0.7	0.17	8.82	320.7	
3						50	0	0.02	14.3	0.7	0.1	7.64	317.9	
4										0.76	0.1	6.91	330	
AVG						71	0.6667	0.0167	14.733	0.72	0.1225	8.03	321.03	
STD Dev						31.321	0.5774	0.0058	0.3786	0.0283	0.033	0.9218	6.3495	
1/9/97	9:00	A	31.1	47	30.69	NOx	HC	CO	CO2	NOx	HC	CO	CO2	
1						174	2	0.02	14.8	0.72	0.13	10.63	316.8	
2						118	3	0.01	14.8	0.62	0.12	6.71	327.5	
3						320	19	0.11	31	0.72	0.15	10.29	328.7	RL 25/25 Run 3 Systematic
4										0.68	0.2	11.57	330.8	Error. Not used in analysis.
AVG						146	2.5	0.015	14.8	0.685	0.15	9.8	325.95	
STD Dev						104.29	9.5394	0.0551	9.3531	0.0473	0.0356	2.1299	6.2506	

3. Calculated Emissions Test Data

a. Data Roll-Up / Summary

b. Individual Statistical Data

3. Calculated Emissions Test Data

a. Data Roll-Up / Summary

(2) ASM 2525

Device 1 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 7	Plate:	DTT743											
1	422	610		1	8		0	0		14.7	14.9		
2	127	143		3	0		0	0		14.8	15		
3	423	144		1	2		0	0		15	15		
Avg	324	299	25	1.66667	3.33333	-1.6667	0	0	0	14.8333	14.9667	-0.1333	
Car 8	Plate:	GKD11C											
1	112	106		10	12		0.08	0.04		15	15		Run 2 - Systematic Error
2	18	114		10	12		0.04	0.05		25.4	14.9		Not used in analysis.
3	72	114		11	11		0.05	0.06		14.9	14.4		
Avg	92	111.333	-19.333	10.5	11.6667	-1.1667	0.065	0.05	0.015	14.95	14.7667	0.18333	
Car 9	Plate:	SGN376											
1	96	50		10	104		0.35	2.91		14.5	13		Car performance degrades sig
2	47	84		26	43		1.17	1.96		13.9	13.2		from test 1 to test 2
3	45	63		55	179		1.87	4.14		13.1	12		Not used in analysis.
Avg	62.6667	59	3.66667	30.3333	108.667	-78.333	1.13	3.00333	-1.8733	13.8333	12.7333	1.1	
Summary		Avg D	15.3125		Avg D	-0.75		Avg D	-0.0192		Avg D	0.00625	
		StdDev	57.1827		StdDev	8.2616		StdDev	0.11722		StdDev	0.19333	
		t	0.7574		t	-0.2568		t	-0.4625		t	0.09144	

Device 2 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 1	Plate:	SGS552											
1	227	119		52	64		0.27	0.28		14.7	15.1		
2	231	202		59	63		0.33	0.32		14.7	14.9		
3	214	197		50	68		0.33	0.35		14.7	14.9		
Avg	224	172.667	51.3333	53.6667	65	-11.333	0.31	0.31667	-0.0067	14.7	14.9667	-0.2667	
Car 2	Plate:	DTT743											
1	3108	3009		155	154		0.66	0.54		14.2	14.2		
2	3197	3036		160	149		0.68	0.52		14	14.1		
3	3144	3065		156	153		0.64	0.59		14.1	14.2		
Avg	3149.67	3036.67	113	157	152	5	0.66	0.55	0.11	14.1	14.1667	-0.0667	
Car 3	Plate	SGMU16U											
1	1089	1090		21	20		0.01	0.01		11.3	11.4		
2	1219	1141		24	21		0.01	0.01		11.4	11.4		
3	1135	1217		20	20		0.01	0.01		11.4	11.5		
Avg	1147.67	1149.33	-1.6667	21.6667	20.3333	1.33333	0.01	0.01	0	11.3667	11.4333	-0.0667	
Car 4	Plate:	SGN936											
1	283	198		20	20		0.01	0		14.3	14.1		Run 2 - System error
2	396	198		39	20		0.03	0		22.7	14.1		Not used in analysis.
3	228	200		23	21		0	0		14.2	14.1		
Avg	255.5	198.667	56.8333	21.5	20.3333	1.16667	0.005	0	0.005	14.25	14.1	0.15	
Car 5	Plate:	SGZ353											
1	375	714		22	35		0	0.01		12.4	22.5		Run -1 System error
2	449	386		32	25		0.01	0.01		12.8	12.6		Not used in analysis.
3	208	194		19	19		0.01	0		12.5	12.5		
Avg	344	290	54	24.3333	22	2.33333	0.00667	0.005	0.00167	12.5667	12.55	0.01667	
Car 6	Plate:	916											
1	1083	1072		40	44		0.14	0.25		15.1	15		
2	1296	1032		40	37		0.19	0.2		14.8	15.1		
3	1216	1000		42	39		0.27	0.16		14.8	15.1		
Avg	1198.33	1034.67	163.667	40.6667	40	0.66667	0.2	0.20333	-0.0033	14.9	15.0667	-0.1667	

Device 2 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 7	Plate:	P428											
1	387	598		9	33		0.02	0.42		15	14.6		Car not warm. Data #1 not used.
2	419	644		10	9		0.03	0		14.9	14.9		
3	550	582		8	13		0	0.02		14.9	15		
Avg	452	613	-161	9	11	-2	0.01667	0.01	0.00667	14.9333	14.95	-0.0167	
Car 8	Plate:	R484											
1	293	355		55	59		0.02	0.02		14.1	14.1		
2	298	296		57	55		0.01	0.02		13.8	13.9		
3	322	345		53	51		0.01	0.02		14.1	14.1		
Avg	304.333	332	-27.667	55	55	0	0.01333	0.02	-0.0067	14	14.0333	-0.0333	
Car 9	Plate:	SGR683											
1	270	296		32	27		0.03	0.02		14.2	14.2		
2	272	284		28	33		0.02	0.02		14.2	14.2		
3	229	266		34	32		0.02	0.02		14.2	14.2		
Avg	257	282	-25	31.3333	30.6667	0.66667	0.02333	0.02	0.00333	14.2	14.2	0	
Summary		Avg D	24.8333		Avg D	-0.2407		Avg D	0.01222		Avg D	-0.05	
		StdDev	93.6088		StdDev	4.56063		StdDev	0.03698		StdDev	0.11696	
		t	0.79587		t	-0.1584		t	0.99158		t	-1.2824	

Device 2 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 7	Plate:	P428											
1	387	598		9	33		0.02	0.42		15	14.6		Car not warm. Data #1 not used.
2	419	644		10	9		0.03	0		14.9	14.9		
3	550	582		8	13		0	0.02		14.9	15		
Avg	452	613	-161	9	11	-2	0.01667	0.01	0.00667	14.9333	14.95	-0.0167	
Car 8	Plate:	R484											
1	293	355		55	59		0.02	0.02		14.1	14.1		
2	298	296		57	55		0.01	0.02		13.8	13.9		
3	322	345		53	51		0.01	0.02		14.1	14.1		
Avg	304.333	332	-27.667	55	55	0	0.01333	0.02	-0.0067	14	14.0333	-0.0333	
Car 9	Plate:	SGR683											
1	270	296		32	27		0.03	0.02		14.2	14.2		
2	272	284		28	33		0.02	0.02		14.2	14.2		
3	229	266		34	32		0.02	0.02		14.2	14.2		
Avg	257	282	-25	31.3333	30.6667	0.66667	0.02333	0.02	0.00333	14.2	14.2	0	
Summary		Avg D	24.8333		Avg D	-0.2407		Avg D	0.01222		Avg D	-0.05	
		StdDev	93.6088		StdDev	4.56063		StdDev	0.03698		StdDev	0.11696	
		t	0.79587		t	-0.1584		t	0.99158		t	-1.2824	

Device 3 - 25/25 Test

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 1	Plate: Z331												
1	390	269		13	15		0.06	0.05		12.6	12.7		
2	189	322		16	21		0.03	0.05		12.2	12.8		
3	259	337		21	10		0.13	0.05		13.3	12.6		
Avg	279.333	309.333	-30	16.6667	15.3333	1.33333	0.07333	0.05	0.02333	12.7	12.7	-4E-15	
Car 2	Plate: SGM47H												
1	301	408		17	23		0.05	0.04		14.2	14.1		
2	379	440		22	25		0.02	0.04		14.2	14.3		
3	316	453		24	27		0.02	0.05		14.3	14.2		
Avg	332	433.667	-101.67	21	25	-4	0.03	0.04333	-0.0133	14.2333	14.2	0.03333	
Car 3	Plate: TAG0725												
1	12	339		11	2		0.03	0		14.8	14.9		Large difference between w/o w
2	10	347		3	5		0.03	0		14.7	15		for NOx
3	10	332		14	4		0.04	0		14.9	14.8		Not used in analysis.
Avg	10.6667	339.333	-328.67	9.33333	3.66667	5.66667	0.03333	0	0.03333	14.8	14.9	-0.1	
Car 4	Plate: SGP46B												
1	1154	1435		20	22		0.18	0.17		12.8	13		
2	1206	837		19	8		0.2	0.09		12.9	12.6		
3	827	825		2	8		0.1	0.12		12.7	12.7		
Avg	1062.33	1032.33	30	13.6667	12.6667	1	0.16	0.12667	0.03333	12.8	12.7667	0.03333	
Car 5	Plate: SGM92E												
1	157	153		3	212		0	6.05		13.7	10.7		Large difference between w/o w
2	129	135		6	243		0	6.48		13.7	10.5		for all species. degradation w/in test.
3	300	173		7	845		0	9.99		13.7	6.2		Not used in analysis.
Avg	195.333	153.667	41.6667	5.33333	433.333	-428	0	7.50667	-7.5067	13.7	9.13333	4.56667	
Car 6	Plate: SGN181												
1	1499	1719		21	8		0.22	0.12		14.7	14.9		
2	1623	1454		21	15		0.15	0.15		14.6	14.8		
3	1641	1519		19	15		0.28	0.15		14.5	14.8		
Avg	1587.67	1564	23.6667	20.3333	12.6667	7.66667	0.21667	0.14	0.07667	14.6	14.8333	-0.2333	

Device [illegible]/25 Test

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 7	Plate:	SGR105											
1	478	259		149	208		0.17	0.25		11.5	12.4		
2	487	313		143	196		0.15	0.2		11.5	12.1		
3	510	313		121	200		0.14	0.2		11.7	12.3		
Avg	491.667	295	196.667	137.667	201.333	-63.667	0.15333	0.21667	-0.0633	11.5667	12.2667	-0.7	
Car 8	Plate:	TAG0927											
1	837	964		27	29		0.04	0.02		14.9	14.9		
2	627	850		27	29		0.1	0.03		14.8	14.7		
3	723	709		26	26		0.06	0.14		14.9	14.7		
Avg	729	841	-112	26.6667	28	-1.3333	0.06667	0.06333	0.00333	14.8667	14.7667	0.1	
Car 9	Plate:	TAG0385											
1	831	344		3	1		0	0.03		14.6	14.3		
2	1235	799		0	7		0	0		14	14.7		
3	914	683		4	3		0	0		14.4	14.6		
Avg	993.333	608.667	384.667	2.33333	3.66667	-1.3333	0	0.01	-0.01	14.3333	14.5333	-0.2	
Summary		Avg D	55.9048		Avg D	-8.619		Avg D	0.00714		Avg D	-0.1381	
		StdDev	177.956		StdDev	24.5443		StdDev	0.04373		StdDev	0.27784	
		t	0.83116		t	-0.9291		t	0.43211		t	-1.315	

Device 4 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 1	Plate:	SGP735											
1	388	174		36	14		0.14	0.02		14.9	14.9		
2	209	92		15	14		0.06	0.02		14.9	14.9		
3	692	127		44	12		0.09	0.02		14.9	14.9		
Avg	429.667	131	298.667	31.6667	13.3333	18.3333	0.09667	0.02	0.07667	14.9	14.9	0	
Car 2	Plate:	TAG0132											
1	1847	1367		143	136		0.64	0.65		12.7	12.9		
2	2035	912		141	127		0.77	0.48		12.8	13.1		
3	1880	1154		145	133		0.64	0.59		12.6	13		
Avg	1920.67	1144.33	776.333	143	132	11	0.68333	0.57333	0.11	12.7	13	-0.3	
Car 3	Plate	K9 Car											
1	2771	2631		79	55		0.48	0.07		10.8	11.4		
2	2786	2565		82	53		0.62	0.08		10.9	11.6		
3	2879	2632		91	48		0.74	0.06		10.9	11.8		
Avg	2812	2609.33	202.667	84	52	32	0.61333	0.07	0.54333	10.8667	11.6	-0.7333	
Car 4	Plate:	TAG7044											
1	229	25		9	7		0.08	0.07		14.8	14.8		
2	127	71		13	0		0.28	0.06		14.8	15		
3	100	21		17	9		0.3	0.09		14.8	14.8		
Avg	152	39	113	13	5.33333	7.66667	0.22	0.07333	0.14667	14.8	14.8667	-0.0667	
Car 5	Plate:	SGP47P											
1	131	34		5	4		0.17	0		14.5	14.4		
2	116	76		12	9		0.14	0		14.6	14.6		
3	273	29		14	2		0.11	0.02		14.7	14.6		
Avg	173.333	46.3333	127	10.3333	5	5.33333	0.14	0.00667	0.13333	14.6	14.5333	0.06667	
Car 6	Plate:	SGR583											
1	214	144		9	6		0	0		14	13.8		
2	203	141		10	0		0	0		14	13.9		
3	194	158		8	0		0	0		14	14.2		
Avg	203.667	147.667	56	9	2	7	0	0	0	14	13.9667	0.03333	

Device 4 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 7	Plate:	SPZ647											
1	71	61		29	80		0.09	0.21		14.6	14.9		
2	18	51		38	88		0.26	0.28		14.5	14.9		
3	57	35		60	57		0.19	0.2		14.6	14.9		
Avg	48.6667	49	-0.3333	42.3333	75	-32.667	0.18	0.23	-0.05	14.5667	14.9	-0.3333	
Car 8	Plate:	SGM68U											
1	1403	1260		32	15		0.04	0.01		9	8.8		
2	1410	1414		32	9		0.04	0.01		9.1	8.9		
3	1378	1335		35	16		0.04	0.01		9.1	8.9		
Avg	1397	1336.33	60.6667	33	13.3333	19.6667	0.04	0.01	0.03	9.06667	8.86667	0.2	
Car 9	Plate:	TO5666											
1	293	261		12	0		0	0.01		10.5	10.3		
2	305	263		13	13		0.01	0		10.5	10.3		
3	314	296		14	0		0.01	0.01		10.5	10.3		
Avg	304	273.333	30.6667	13	4.33333	8.66667	0.00667	0.00667	0	10.5	10.3	0.2	
Summary		Avg D	184.963		Avg D	8.55556		Avg D	0.11		Avg D	-0.1037	
		StdDev	240.24		StdDev	17.6336		StdDev	0.1757		StdDev	0.30251	
		t	2.30973		t	1.45555		t	1.87815		t	-1.0284	

Device 5 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 1	Plate:	SGM76E											
1	329	340		14	12		0.02	0.02		13.6	13.9		
2	317	361		14	18		0.03	0.02		13.6	13.8		
3	311	317		15	22		0.02	0.02		13.5	13.8		
Avg	319	339.333	-20.333	14.3333	17.3333	-3	0.02333	0.02	0.00333	13.5667	13.8333	-0.2667	
Car 2	Plate:	SCEV4											
1	623	837		13	6		0	0		14.3	13.5		
2	608	574		2	2		0	0		14.3	13.9		
3	436	1003		2	7		0	0		14.3	13.8		
Avg	555.667	804.667	-249	5.66667	5	0.66667	0	0	0	14.3	13.7333	0.56667	
Car 3	Plate:	TD4501											
1	2056	2530		19	21		0	0		11.3	10.9		
2	1980	2321		29	20		0	0		11.3	11.1		
3	1866	2253		18	14		0	0		11.4	11.2		
Avg	1967.33	2368	-400.67	22	18.3333	3.66667	0	0	0	11.3333	11.0667	0.26667	
Car 4	Plate:	835											
1	222	375		12	18		0.09	0.08		14.6	14.9		
2	206	454		11	22		0.06	0.05		14.5	14.3		
3	224	359		10	15		0.07	0.04		14.9	14.4		
Avg	217.333	396	-178.67	11	18.3333	-7.3333	0.07333	0.05667	0.01667	14.6667	14.5333	0.13333	
Car 5	Plate:	SGM95G											
1	272	253		9	7		0	0		13.9	13.9		
2	215	312		9	12		0	0		14	13.5		
3	171	279		9	12		0	0		14	13.9		
Avg	219.333	281.333	-62	9	10.3333	-1.3333	0	0	0	13.9667	13.7667	0.2	
Car 6	Plate:	SCEV6											
1	95	496		2	18		0	0		14.8	15.2		
2	150	548		1	3		0	0		14.7	14.9		
3	244	554		1	4		0	0		14.8	15.1		
Avg	163	532.667	-369.67	1.33333	8.33333	-7	0	0	0	14.7667	15.0667	-0.3	

Device 5 RL 25/25

	NOx			HC			CO			CO2			
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	Comments
Car 7	Plate:	P35P											
1	2908	2678		16	15		0	0		10.2	10.2		
2	3504	2838		20	19		0	0		10.3	10.2		
3	3498	3169		22	13		0	0		10.4	10.5		
Avg	3303.33	2895	408.333	19.3333	15.6667	3.66667	0	0	0	10.3	10.3	0	
Car 8	Plate:	SGP15U											
1	2321	2055		45	42		0.04	0.02		11.4	10.91		Run 3 System error.
2	2090	2165		71	44		0.16	0.03		11.9	11.1		Not used in analysis.
3	4037	2183		102	47		0.19	0.05		22.6	11.4		
Avg	2205.5	2134.33	71.1667	58	44.3333	13.6667	0.1	0.03333	0.06667	11.65	11.1367	0.51333	
Car 9	Plate:	SGR500											
1	270	262		11	15		0.02	0.03		14	14.2		
2	268	337		19	19		0.03	0.02		14	14		
3	236	266		18	18		0.02	0.02		13.6	14.1		
Avg	258	288.333	-30.333	16	17.3333	-1.3333	0.02333	0.02333	0	13.8667	14.1	-0.2333	
Summary		Avg D	-92.352		Avg D	0.18519		Avg D	0.00963		Avg D	0.09778	
		StdDev	247.823		StdDev	6.4142		StdDev	0.02208		StdDev	0.32462	
		t	-1.118		t	0.08661		t	1.30862		t	0.90362	

3. Calculated Emissions Test Data

a. Data Roll-Up / Summary

(3) IM 240

DOT Emissi... est Program, IM240 Data

Device 1 IM240

Test	NOx			HC			CO			CO2			Comments
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 1	Van												
1	2.89	2.89		0.24	0.23		5.99	6.51		532.9	512.9		
2	2.95	2.76		0.26	0.24		6.08	5.93		540.3	520.9		
3	2.92	2.91		0.24	0.24		7.17	6.86		538	519.6		
4	2.92	2.73		0.24	0.27		6.5	9.75		535.2	531.9		
AVG	2.92	2.8225	0.0975	0.245	0.245	0	6.435	7.2625	-0.8275	536.6	521.325	15.275	
Car2	RedK Plate: SGS165												
1	0.71	0.74		0.41	0.34		11.96	13.25		302	309.8		
2	0.69	0.77		0.4	0.33		11.32	10.82		302.9	317		
3	0.64	0.81		0.42	0.37		11.22	8.14		307.6	314.7		
4	0.79	0.66		0.37	0.26		14.35	7.56		307.9	316.7		
AVG	0.7075	0.745	-0.0375	0.4	0.325	0.075	12.2125	9.9425	2.27	305.1	314.55	-9.45	
Car3	BlueK Plate: SGP208												
1	0.83	0.84		0.21	0.23		7.86	7.82		310	316.5		
2	0.8	0.74		0.22	0.29		6.8	7.12		311.1	315.8		
3	0.84	0.91		0.23	0.31		6.47	8.61		308.3	314.1		
4	0.67	0.78		0.25	0.25		6.26	6.16		311.4	320.2		
AVG	0.785	0.8175	-0.0325	0.2275	0.27	-0.0425	6.8475	7.4275	-0.58	310.2	316.65	-6.45	
Car 4	K-Car Plate: S704												
1	0.6	0.52		0.22	0.17		13.16	8.64		304.1	292.8		
2	0.54	0.49		0.27	0.22		13.21	9.1		308.8	292.7		
3	0.51	0.5		0.25	0.14		11.08	7.76		314.2	293.5		
4	0.51	0.57		0.25	0.19		11.88	9.1		312.1	297.1		
AVG	0.54	0.52	0.02	0.2475	0.18	0.0675	12.3325	8.65	3.6825	309.8	294.025	15.775	
Car 5	Brown Chevy Capı Plate: Z338												
1	1.54	1.62		0.17	0.13		6.73	1.51		470.2	450.8		Car not fully warmed, test 1 and 2 w/o not used in analysis.
2	1.55	1.69		0.17	0.13		6.19	1.62		479.6	457.7		
3	1.63	1.6		0.14	0.12		3.4	1.49		481.4	453.3		
4	1.71	1.61		0.14	0.14		1.98	4.14		489.7	456.9		
AVG	1.67	1.63	0.04	0.14	0.13	0.01	2.69	2.19	0.5	485.55	454.675	30.875	
Car 6	K-Car Plate: S199												
1	0.81	0.78		0.12	0.09		7.97	6.88		305.1	293.8		
2	0.85	0.76		0.12	0.14		8.42	10.06		304	293.1		
3	0.89	0.81		0.18	0.16		11.12	9.31		307.8	296.2		
4	0.78	0.9		0.12	0.17		9.03	7.79		307.2	305.9		
AVG	0.8325	0.8125	0.02	0.135	0.14	-0.005	9.135	8.51	0.625	306.025	297.25	8.775	

Device 1 [illegible]0

Test	NOx			HC			CO			CO2			Comments
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 7	Chevy Caprice Plate: DTT743												
1	1.1	1.12		0.22	0.19		4.31	2.84		463.5	427.2		
2	1.11	1.28		0.1	0.1		1.84	1.12		462.4	441.5		
3	1.05	1.32		0.11	0.2		1.56	4.07		443.7	438.9		
4	1.12	1.24		0.07	0.08		1.02	1.49		444.4	445.9		
AVG	1.095	1.24	-0.145	0.125	0.1425	-0.0175	2.1825	2.38	-0.1975	453.5	438.375	15.125	
Car 8	Buick Plate:GKD11C												
1	0.22	0.38		0.03	0.04		0.65	0.95		399.4	384.5		
2	0.24	0.34		0.04	0.04		4.35	1.2		385	388.8		
3	0.33	0.28		0.06	0.03		5.54	0.64		399.8	392.8		
4	0.22	0.3		0.07	0.04		5.58	2.73		439.5	405.9		
AVG	0.2525	0.325	-0.0725	0.05	0.0375	0.0125	4.03	1.38	2.65	405.925	393	12.925	
Car 9	K-Car Plate: N376												
1	0.59	0.36		0.41	0.66		23.47	38.43		319.1	259.8		Significant degradation in performance noted from test 1 to test 2. Car not used in analysis
2	0.56	0.49		0.35	0.71		22.71	32.44		313.3	280.9		
3	0.51	0.45		0.42	0.79		26.23	40.72		311.8	275.7		
4	0.44	0.56		0.46	0.66		26.18	34.01		314.3	287.8		
AVG	0.525	0.465	0.06	0.41	0.705	-0.295	24.6475	36.4	-11.753	314.625	276.05	38.575	
		dbar -1	-0.0138		dbar -1	0.0125		dbar -1	1.01531		dbar -1	10.3563	Car 9 not used in analysis
		stddev	0.07477		stddev	0.04022		stddev	1.65573		stddev	12.9899	
1.415		t	-0.5201		t	0.87899		t	1.73442		t	2.25498	

Device 2 IM240

Test	NOx			HC			CO			CO2			Comments
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 1	Red K-Car SGS552												
1	0.84	0.96		0.34	0.34		9.33	9.78		301.6	300.4		
2	0.82	1.04		0.28	0.31		7.36	11.12		305.6	309.7		
3	0.92	1.07		0.26	0.38		8.01	10.34		314.3	312.7		
4	0.92	0.92		0.26	0.3		8.8	8.47		313.6	312.2		
	0.875	0.9975	-0.1225	0.285	0.3325	-0.0475	8.375	9.9275	-1.5525	308.775	308.75	0.025	
Car2	Chevy Caprice DTT743												
1	4.63	4.88		1.29	1.13		17.72	11.84		438.1	443		
2	4.67	4.84		1.17	1.16		14.64	10.99		444.5	439.1		
3	4.5	4.78		1.23	1.18		18.02	11.06		444.6	442.7		
4	4.87	4.75		1.24	1.18		14.99	11.63		449.1	449.3		
	4.6675	4.8125	-0.145	1.2325	1.1625	0.07	16.3425	11.38	4.9625	444.075	443.525	0.55	
Car3	White Va Plate: SGM16U												
1	2.9	3.13		0.27	0.29		5.22	9.42		536.5	517		
2	2.98	2.95		0.28	0.33		6.15	8.99		530.5	519.9		
3	3.11	2.84		0.35	0.23		13.66	5.4		530.3	518.1		
4	2.91	2.77		0.27	0.27		7.21	9.09		536	531.4		
	2.975	2.9225	0.0525	0.2925	0.28	0.0125	8.06	8.225	-0.165	533.325	521.6	11.725	
Car 4	White K-(Plate: SGN936												
1	1.14	1.27		0.24	0.22		7.28	4.81		331.2	350.3		
2	1.24	1.16		0.27	0.17		6.94	3.84		334.5	325.7		
3	1.1	1.23		0.28	0.17		9.93	3.83		325.7	327.1		
4	1.19	1.19		0.3	0.2		8.48	5.28		333	329.6		
	1.1675	1.2125	-0.045	0.2725	0.19	0.0825	8.1575	4.44	3.7175	331.1	333.175	-2.075	
Car 5	Blue Chevy Capric Plate: SGZ353												
1	1.38	1.44		0.15	0.1		3.57	0.37		421.5	425.8		Run 2 w not used in analysis.
2	1.36	1.28		0.11	0.09		0.45	0.1		414.2	388.7		
3	1.37	1.42		0.11	0.1		0.7	0.39		426.6	434.1		
4	1.39	1.36		0.11	0.12		0.76	0.37		424.3	426.6		
	1.375	1.40667	-0.0317	0.12	0.10667	0.01333	1.37	0.37667	0.99333	421.65	428.833	-7.1833	
Car 6	White CHevy Capı Plate: 916												
1	2.47	1.68		0.36	0.31		3.48	1.17		445.4	441		
2	2.35	2.38		0.4	0.41		2.7	2.22		449.8	445.2		
3	2.35	2.41		0.42	0.39		2.52	1.76		451.9	446.8		
4	2.32	2.45		0.36	0.59		2.07	1.6		454.6	425.8		
	2.3725	2.23	0.1425	0.385	0.425	-0.04	2.6925	1.6875	1.005	450.425	439.7	10.725	

Device 2 IM240

Test	NOx			HC			CO			CO2			Comments
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 7	K-Car	Plate: P428											
1	1.31	1.44		0.25	0.35		8.35	9.29		329.1	321.9		
2	1.3	1.37		0.3	0.34		8.42	7.97		320.2	313.5		
3	1.25	1.43		0.42	0.32		9.52	8.34		328.8	316.4		
4	1.38	1.41		0.41	0.35		10.94	7.3		326	314.8		
	1.31	1.4125	-0.1025	0.345	0.34	0.005	9.3075	8.225	1.0825	326.025	316.65	9.375	
Car 8	K-Car	Plate:R484											
1		1.29			0.51			13.04			275.8		
2	1.34	1.3		0.49	0.4		10.31	9.15		300.9	301.1		
3	1.31	1.35		0.38	0.42		8.48	11.43		304.3	302.6		
4	1.28	1.44		0.36	0.41		7.98	11.81		298.8	301.1		
	1.31	1.345	-0.035	0.41	0.435	-0.025	8.92333	11.3575	-2.4342	301.333	295.15	6.18333	
Car 9	Plymouth	Plate: SGR683											
1	1.48	1.56		0.34	0.28		9.45	7.27		336.4	319.5		
2	1.51	1.51		0.4	0.42		11.41	10.08		337.5	325.4		
3	1.44	1.86		0.3	0.38		8.25	10.81		345.4	354.6		
4	1.44	1.57		0.29	0.41		8.73	11.09		353.6	332		
	1.4675	1.625	-0.1575	0.3325	0.3725	-0.04	9.46	9.8125	-0.3525	343.225	332.875	10.35	
Summary		dbar	-0.0494		dbar	0.00343		dbar	0.8063		dbar	4.40833	
		stddev	0.09794		stddev	0.04749		stddev	2.35188		stddev	6.77363	
		t	-1.5117		t	0.21643		t	1.02849		t	1.95242	

Device 3 IM

Test	NOx			HC			CO			CO2			Comments
	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 1	Plate:	Z331											
1	1.23	1.25		0.15	0.18		5.52	7.14		461.5	452.6		
2	1.39	1.26		0.17	0.18		6.89	6.82		473.9	444.3		
3	1.17	1.24		0.18	0.16		7.99	6.86		440.8	448.2		
4	1.14			0.19			6.36			457.7			
	1.2325	1.25	-0.0175	0.1725	0.17333	-0.0008	6.69	6.94	-0.25	458.475	448.367	10.1083	
Car2	Plate:	SGM47H											
1	0.86	0.94		0.15	0.15		8.81	6.17		301.3	304.4		
2	0.81	0.87		0.17	0.16		9.22	7.84		301.7	309		
3	0.82	0.87		0.15	0.15		8.59	7.33		307.5	301.6		
4	0.78	0.97		0.18	0.16		11.25	6.97		305.9	300.8		
	0.8175	0.9125	-0.095	0.1625	0.155	0.0075	9.4675	7.0775	2.39	304.1	303.95	0.15	
Car3	Plate:	TAG0725											
1	0.48	0.53		0.22	0.22		3.14	3.09		463.4	441.9		
2	0.48	0.5		0.2	0.22		2.54	6.08		466.3	448.2		
3	0.47	0.56		0.24	0.22		2.45	2.5		460.1	455.1		
4	0.54	0.65		0.23	0.23		3.45	6.37		467.6	457.8		
	0.4925	0.56	-0.0675	0.2225	0.2225	0	2.895	4.51	-1.615	464.35	450.75	13.6	
Car 4	Plate:	SGP46B											
1	3.99	4.4		0.47	0.43		17.86	13.82		625.4	632.3		
2	3.8	4.15		0.38	0.32		15.56	9.57		618.5	636		
3	4.64	4.35		0.37	0.31		16.61	9.85		659.8	641.4		
4	5.11			0.35			14.55			700.4			
	4.385	4.3	0.085	0.3925	0.35333	0.03917	16.145	11.08	5.065	651.025	636.567	14.4583	
Car 5	Plate:	SGM92E											
1	0.76	0.57		0.16	1.7		6.88	74.32		324.6	259.7		Significant degradation in perf.
2	0.84	0.48		0.12	2.51		5.92	107.2		330.4	236.4		w/o to with
3	0.76	0.1		0.1	3.48		5.55	153.1		330.2	204.9		Degradation of performance within
4	0.89	0.1		0.1	3.83		6.26	163.5		348.7	202.9		test. Do not use in analysis.
	0.8125	0.3125	0.5	0.12	2.88	-2.76	6.1525	124.53	-118.38	333.475	225.975	107.5	
Car 6	Plate:	SGN181											
1	3.68	2.65		0.46	0.3		15.46	15.53		373.9	316.8		w/o - test 1 different from rest
2	2.73	2.84		0.24	0.39		11.29	16.81		333.3	356.3		Car not warmed up. Not
3	2.73	2.69		0.2	0.22		9.39	12.23		334.7	327.1		used in analysis.
4	2.65	2.68		0.24	0.33		12.34	15.14		335	337.2		
	2.70333	2.715	-0.0117	0.22667	0.31	-0.0833	11.0067	14.9275	-3.9208	334.333	334.35	-0.0167	

Device 5 IM2..

	NOx			HC			CO			CO2			Comments
Test	W/O	W	D	W/O	W	D	W/O	W	D	W/O	W	D	
Car 7	Dodge Van	Plate: P35P											
1	5.53	4.63		0.12	0.12		1.9	1.91		467.6	456.7		
2	5.81	4.79		0.11	0.1		1.93	1.84		456.3	449.6		
3	5.78	4.87		0.11	0.11		1.83	1.82		472.4	459.8		
4	5.33	5.08		0.1	0.1		1.96	1.81		464.2	456.3		
	5.6125	4.8425	0.77	0.11	0.1075	0.0025	1.905	1.845	0.06	465.125	455.6	9.525	
Car 8	RAM Var Plate: SGM68U												
1	2.4	2.78		0.46	0.45		22.1	15.51		528.6	544.8		
2	2.61	2.79		0.51	0.47		25.89	16.79		514.2	550.5		
3	2.71	2.94		0.51	0.48		26.18	19.17		507.4	533.7		
4	2.67	2.89		0.46	0.43		23.1	17.09		513.8	508.7		
	2.5975	2.85	-0.2525	0.485	0.4575	0.0275	24.3175	17.14	7.1775	516	534.425	-18.425	
Car 9	RAM Pick-UP	Plate: TO5666											
1	1.13	1.18		0.17	0.19		8.45	11.13		364.3	322.5		Run1 w/o insufficient warm up
2	1.05	1.19		0.16	0.19		7.95	10.05		323	327.1		not used in analysis.
3	1.12	1.16		0.21	0.21		12.49	9.62		323.6	338.4		
4	1.4			0.24			11.99			333.9			
	1.19	1.17667	0.01333	0.20333	0.19667	0.00667	10.81	10.2667	0.54333	326.833	329.333	-2.5	
Summary		dbar	0.08139		dbar	0.01676		dbar	2.32046		dbar	-1.9824	
		stddev	0.34768		stddev	0.03614		stddev	3.3209		stddev	8.97273	
		t	0.70228		t	1.39107		t	2.09623		t	-0.6628	

3. Calculated Emissions Test Data

b. Individual Statistical Data

(1) Two way ANOVA for Control Car, Run x Day

Two way Analysis of Variance for Control Car

Factors:

Time of run (1st or last)

Day

Analysis of Variance for IM240_NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:M_A	0.0342071	1	0.0342071	4.68	0.0559
B:Day	0.0847568	10	0.00847568	1.16	0.4102
RESIDUAL	0.0731523	10	0.00731523		
TOTAL (CORRECTED)	0.192116	21			

Analysis of Variance for IM240_HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:M_A	0.000290909	1	0.000290909	0.74	0.4200
B:Day	0.00951761	10	0.000951761	2.41	0.0910
RESIDUAL	0.00395284	10	0.000395284		
TOTAL (CORRECTED)	0.0137614	21			

Analysis of Variance for IM240_CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:M_A	9.44576	1	9.44576	9.22	0.0125
B:Day	29.7631	10	2.97631	2.90	0.0538
RESIDUAL	10.2467	10	1.02467		
TOTAL (CORRECTED)	49.4556	21			

Analysis of Variance for IM240_CO2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:M_A	29.026	1	29.026	0.30	0.5991
B:Day	4733.82	10	473.382	4.96	0.0092
RESIDUAL	953.979	10	95.3979		
TOTAL (CORRECTED)	5716.83	21			

Analysis of Variance for RL_NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:M_A	210.986	1	210.986	0.27	0.6232
B:Day	25598.1	10	2559.81	3.22	0.0396
RESIDUAL	7960.07	10	796.007		
TOTAL (CORRECTED)	33769.2	21			

Analysis of Variance for RL_HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:M_A	2.78677	1	2.78677	8.03	0.0177
B:Day	12.7662	10	1.27662	3.68	0.0259
RESIDUAL	3.47108	10	0.347108		
TOTAL (CORRECTED)	19.0241	21			

Analysis of Variance for RL_CO - Typê III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:M_A	0.00104604	1	0.00104604	2.02	0.1859
B:Day	0.0073569	10	0.00073569	1.42	0.2951
RESIDUAL	0.00518407	10	0.000518407		
TOTAL (CORRECTED)	0.013587	21			

Analysis of Variance for RL_CO2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:M_A	0.0360045	1	0.0360045	2.92	0.1182
B:Day	0.3217	10	0.03217	2.61	0.0731
RESIDUAL	0.123245	10	0.0123245		
TOTAL (CORRECTED)	0.48095	21			

Summary ol Car Data with Student t Tests

RL25/25

Summary	NOx			HC			CO			CO2		
Date	AM	PM	D	AM	PM	D	AM	PM	D	AM	PM	D
11/19/96	152	154	-2	3	4	-1	0.0233	0.0133	0.01	15	15.1	-0.1
11/26/96	55.33	66.33	-11	4.33	4	0.33	0.06	0.0733	-0.0133	14.9	14.93	-0.03
12/4/96	51.67	139	-87.33	1.33	6	-4.67	0.05	0.13	-0.08	14.9	14.967	-0.067
12/5/96	97	61.67	35.33	5	7	-2	0.0633	0.08	-0.0167	14.97	15	-0.03
12/6/96	58	89	-31	3.67	4.33	-0.66	0.0733	0.0633	0.01	14.9	14.63	0.27
12/9/96	105.67	76.5	29.17	3.33	3.5	-0.17	0.0433	0.02	0.0233	14.77	15.05	-0.28
12/10/96	91	67.5	23.5	3.5	4.5	-1	0.035	0.105	-0.07	14.8	15	-0.2
12/16/96	49	79.7	-30.7	4	3.67	0.33	0.023	0.0467	-0.0237	14.93	14.83	0.1
12/18/96	81.33	116.67	-35.34	4.33	4.33	0	0.0167	0.0567	-0.04	14.57	14.73	-0.16
12/19/96	74	110.5	-36.5	2.33	4.5	-2.17	0.0167	0.05	-0.0333	14.87	15	-0.13
12/20/20	212.67	126.33	86.34	4	4.66	-0.66	0.0733	0.033	0.0403	15	15.23	-0.23
1/9/97	146	105.67	40.33	2.5	3.33	-0.83	0.015	0.0533	-0.0383	14.8	14.9	-0.1
		Avg	-1.6			-1.04167			-0.01931			-0.07975
		Std Dev	46.64948			1.391656			0.036164			0.149748
		t	-0.11375			-2.48252			-1.77076			-1.76631

IM240

Summary	NOx			HC			CO			CO2		
Date	AM	PM	D	AM	PM	D	AM	PM	D	AM	PM	D
11/19/96	0.8025	0.8875	-0.085	0.1825	0.1475	0.035	7.4525	7.045	0.4075	290.8	289.95	0.85
11/26/96	0.625	0.7475	-0.1225	0.1325	0.1625	-0.03	6	6.3525	-0.3525	305.375	301.5	3.875
12/4/96	0.62	0.81	-0.19	0.255	0.19	0.065	9.7	7.9	1.8	316.55	323.1	-6.55
12/5/96	0.59	0.6725	-0.0825	0.1175	0.155	-0.0375	7.8975	7.14	0.7575	318.45	304.1	14.35
12/6/96	0.7025	0.6325	0.07	0.145	0.1375	0.0075	7.61	6.015	1.595	324.45	315.725	8.725
12/9/96	0.695	0.75	-0.055	0.1475	0.125	0.0225	7.1	3.16	3.94	321.45	306.55	14.9
12/10/96	0.775	0.7	0.075	0.13	0.11	0.02	7.95	4.74	3.21	337.225	308.6	28.625
12/16/96	0.6575	0.84	-0.1825	0.105	0.11	-0.005	6.0775	5.757	0.3205	333.5	347.33	-13.83
12/18/96	0.655	0.995	-0.34	0.17	0.1325	0.0375	7.465	5.255	2.21	301.2	302.125	-0.925
12/19/96	0.655	0.795	-0.14	0.09	0.09	0	5.48	4.825	0.655	318.58	335.05	-16.47
12/20/20	0.695	0.74	-0.045	0.1025	0.12	-0.0175	8.415	8.87	-0.455	331.125	343.35	-12.225
1/9/97	0.685	0.645	0.04	0.15	0.1025	0.0475	9.8	7.6725	2.1275	325.95	328.3	-2.35
		Avg	-0.08813			0.012083			1.351292			1.58125
		Std Dev	0.119707			0.031566			1.372228			13.38399
		t	-2.44161			1.269597			3.266023			0.391842

3. Calculated Emissions Test Data

b. Individual Statistical Data

(3) Multi-factor regression of Control Car versus Environmental Factors

Model fitting results for: DOTERIC.co2a

dependent variable	coefficient	std. error	t-value	sig.level
CONSTANT	15.15255	0.157828	96.0067	0.0000
DOTERIC.rh	0.000079	0.001966	0.0402	0.9683
DOTERIC.temp	-0.006524	0.004183	-1.5597	0.1338

R-SQ. (ADJ.) = 0.0564	SE=	0.142308	MAE=	0.110101	DurbWat=	1.882
Previously: 0.0571		1.569622		1.081782		1.833

24 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

..rce	Sum of Squares	DF	Mean Square	F-Ratio	P-value
..odel	0.0683352	2	0.0341676	1.68715	.2092
Error	0.425285	21	0.0202517		
Total (Corr.)	0.493621	23			

R-squared = 0.138437
R-squared (Adj. for d.f.) = 0.0563831

Stnd. error of est. = 0.142308
Durbin-Watson statistic = 1.88154

Model fitting results for: DOTERIC.hca

pendent variable	coefficient	std. error	t-value	sig.level
CONSTANT	2.437952	1.53177	1.5916	0.1264
DOTERIC.rh	-0.020239	0.01908	-1.0608	0.3008
DOTERIC.temp	0.060292	0.040596	1.4852	0.1524

R-SQ. (ADJ.) = 0.0126 SE= 1.381146 MAE= 0.951903 DurbWat= 1.926
Previously: 0.0000 0.090429 0.064407 2.602
24 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

·ce	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	4.37610	2	2.18805	1.14704	.3367
Error	40.0589	21	1.90757		
Total (Corr.)	44.4350	23			

R-squared = 0.0984833
R-squared (Adj. for d.f.) = 0.0126245

Stnd. error of est. = 1.38115
Durbin-Watson statistic = 1.92[illegible]

Model fitting results for: DOTERIC.nob

Independent variable	coefficient	std. error	t-value	sig.level
CONSTANT	0.640129	0.100291	6.3827	0.0000
DOTERIC.rh	0.000152	0.001249	0.1220	0.9041
DOTERIC.temp	0.001489	0.002658	0.5602	0.5813

R-SQ. (ADJ.) = 0.0000 SE= 0.090429 MAE= 0.064407 DurbWat= 2.602
Previously: 0.2056 33.143565 23.243403 1.857
24 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

'rce	Sum of Squares	DF	Mean Square	F-Ratio	P-value
model	0.00470448	2	0.00235224	0.287650	.7529
Error	0.171727	21	0.00817745		
Total (Corr.)	0.176431	23			

R-squared = 0.0266647
R-squared (Adj. for d.f.) = 0

Stnd. error of est. = 0.0904293
Durbin-Watson statistic = 2.60204

Model fitting results for: DOTERIC.noa

pendent variable	coefficient	std. error	t-value	sig.level
CONSTANT	192.04475	36.758095	5.2246	0.0001
DOTERIC.rh	-0.46447	0.457854	-1.0145	0.3215
DOTERIC.temp	-1.605878	0.974178	-1.6484	0.114[illegible]

R-SQ. (ADJ.) = 0.2056 SE= 33.143565 MAE= 23.243403 DurbWat= 1.857
Previously: 0.0000 0.000000 0.000000 0.000
24 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

rce	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	8734.60	2	4367.30	3.97571	.0343
Error	23068.4	21	1098.50		
Total (Corr.)	31803.0	23			

R-squared = 0.274647 Stnd. error of est. = 33.1436
R-squared (Adj. for d.f.) = 0.205566 Durbin-Watson statistic = 1.85687

Model fitting results for: DOTERIC.co2b

Dependent variable	coefficient	std. error	t-value	sig.level
CONSTANT	443.239246	60.394851	7.3390	0.0000
DOTERIC.rh	0.864167	0.75227	1.1487	0.2636
DOTERIC.temp	-4.352376	1.600609	-2.7192	0.0129

R-SQ. (ADJ.) = 0.1946 SE= 54.456051 MAE= 31.416942 DurbWat= 2.124
Previously: 0.0564 0.142308 0.110101 1.882
24 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	22409.5	2	11204.7	3.77841	.039
Error	62274.7	21	2965.46		
Total (Corr.)	84684.2	23			

R-squared = 0.264624
R-squared (Adj. for d.f.) = 0.194588

Stnd. error of est. = 54.456
Durbin-Watson statistic = 2.123

Model fitting results for: DOTERIC.hcb

'ependent variable	coefficient	std. error	t-value	sig.level
CONSTANT	0.061787	0.039777	1.5533	0.1353
DOTERIC.rh	-0.000232	0.000495	-0.4680	0.6446
DOTERIC.temp	0.002059	0.001054	1.9533	0.0642

R-SQ. (ADJ.) = 0.0919 SE= 0.035865 MAE= 0.024804 DurbWat= 1.315
Previously: 0.0126 1.381146 0.951903 1.926
24 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

Source	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	0.00556802	2	0.00278401	2.16430	.1398
Error	0.0270130	21	0.00128633		
Total (Corr.)	0.0325810	23			

R-squared = 0.170898
R-squared (Adj. for d.f.) = 0.0919358

Stnd. error of est. = 0.0358655
Durbin-Watson statistic = 1.31511

Model fitting results for: DOTERIC.cob

[illegible]ependent variable	coefficient	std. error	t-value	sig.le[illegible]
[illegible]STANT	9.94964	1.7408	5.7156	0.0[illegible]
DOTERIC.rh	-0.018275	0.021683	-0.8428	0.4[illegible]
DOTERIC.temp	-0.042025	0.046135	-0.9109	0.3[illegible]

R-SQ. (ADJ.) =	0.0571	SE=	1.569622	MAE=	1.081782	DurbWat= 1.8[illegible]
Previously:	0.1946		54.456051		31.416942	2.12[illegible]

24 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

rce	Sum of Squares	DF	Mean Square	F-Ratio	P-value
Model	8.36135	2	4.18068	1.69690	.2074
Error	51.7380	21	2.46371		
Total (Corr.)	60.0994	23			

R-squared = 0.139125
R-squared (Adj. for d.f.) = 0.0571374

Stnd. error of est. = 1.56962
Durbin-Watson statistic = 1.83257

Model fitting results for: DOTERIC.coa

pendent variable	coefficient	std. error	t-value	sig.leve
CONSTANT	0.035165	0.034265	1.0262	0.31[illegible]
DOTERIC.rh	-0.000197	0.000427	-0.4616	0.64[illegible]
DOTERIC.temp	0.000641	0.000908	0.7055	0.48[illegible]

R-SQ. (ADJ.) = 0.0000 SE= 0.030896 MAE= 0.023131 DurbWat= 1.72[illegible]
Previously: 0.0919 0.035865 0.024804 1.31[illegible]
24 observations fitted, forecast(s) computed for 0 missing val. of dep. var.

Analysis of Variance for the Full Regression

...rce	Sum of Squares	DF	Mean Square	F-Ratio	P-va...
...del	0.000482961	2	0.000241480	0.252974	.77[illegible]
Error	0.0200459	21	0.000954566		
Total (Corr.)	0.0205288	23			

R-squared = 0.023526
R-squared (Adj. for d.f.) = 0

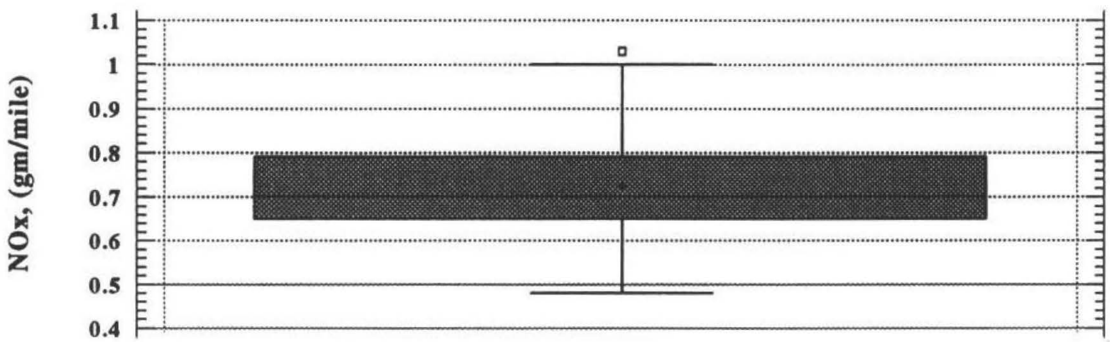
Stnd. error of est. = 0.030[illegible]
Durbin-Watson statistic = 1.72[illegible]

3. Calculated Emissions Test Data

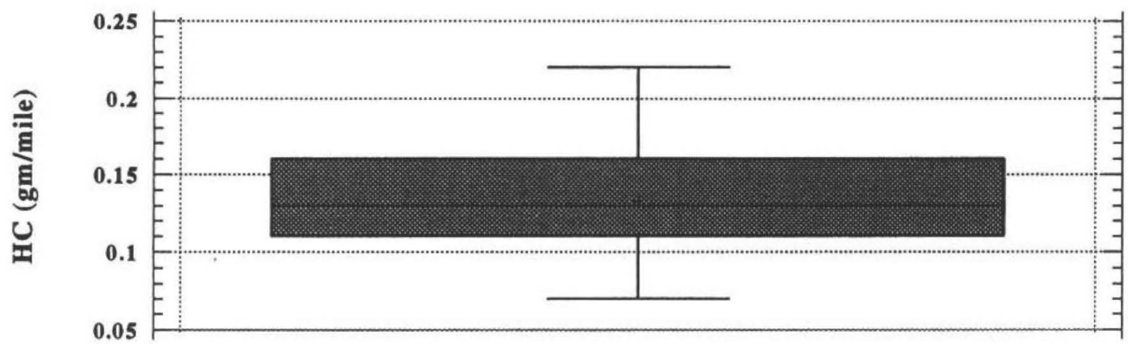
b. Individual Statistical Data

(4) Box and Whisker Plots, Range of Control Car Data

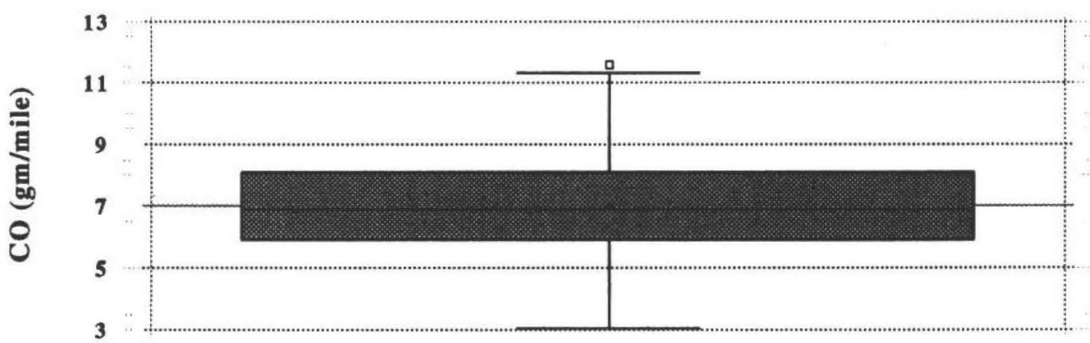
Box-and-Whisker Plot, IM240 Data for the Control Car



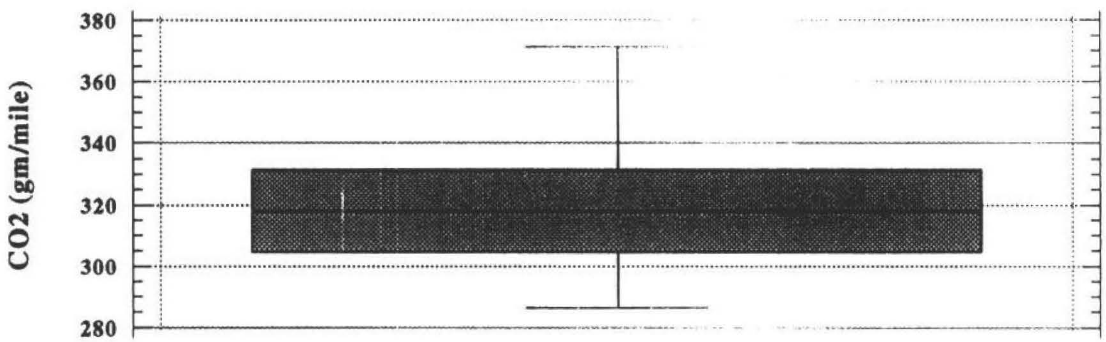
Box-and-Whisker Plot, IM240 Data for Control Car



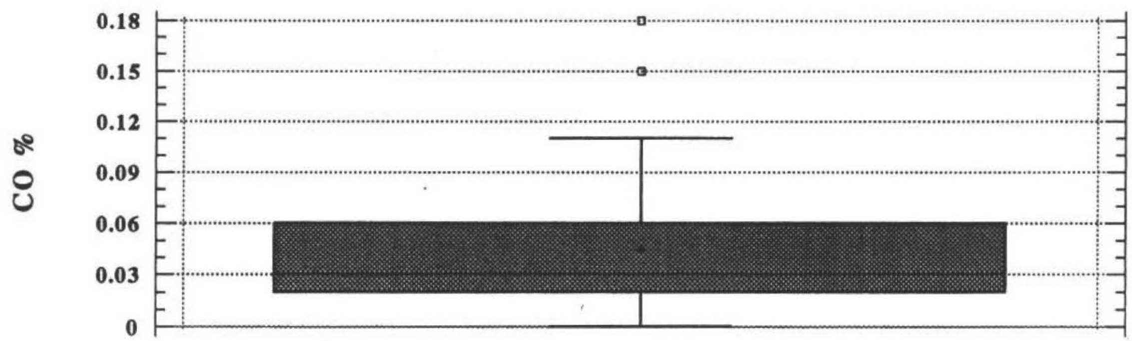
Box-and-Whisker Plot, IM240 Data for the Control Car



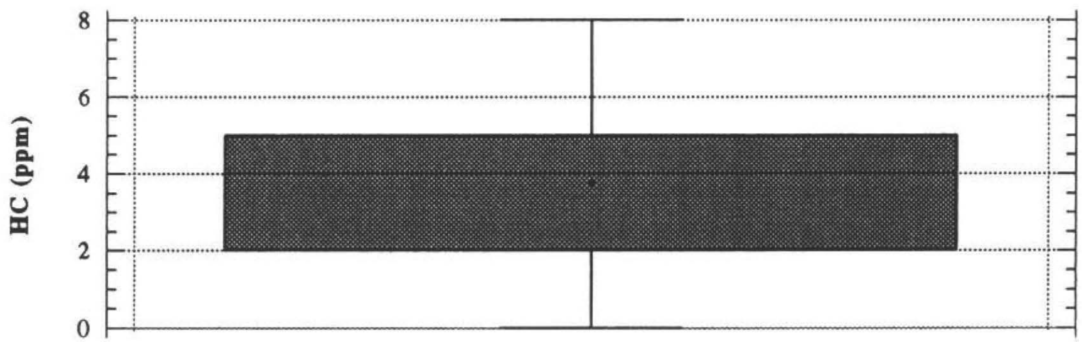
Box-and-Whisker Plot, IM240 Data for Control Car



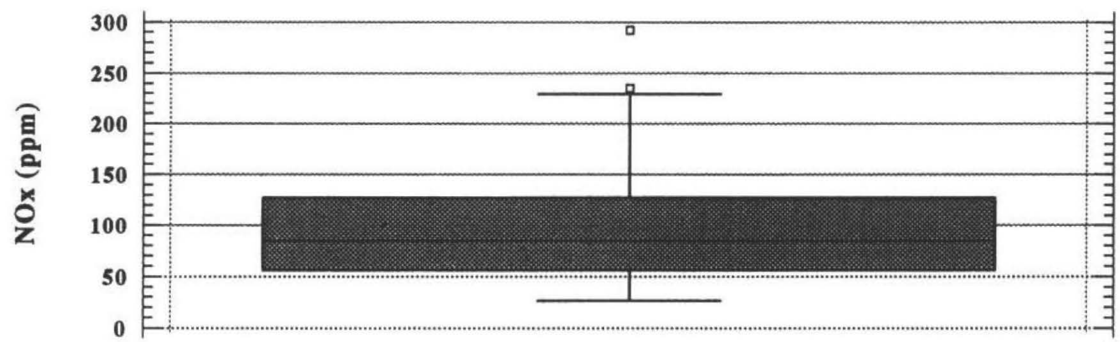
Box-and-Whisker Plot, RL 25/25 Data for Control Car



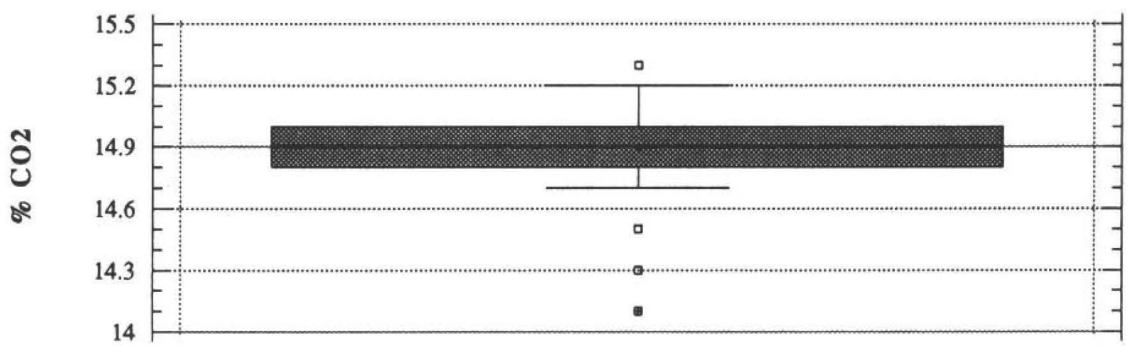
Box-and-Whisker Plot, RL 25/25 Data for the Control Car



Box-and-Whisker Plot, RL 25/25 Data for the Control Car



Box-and-Whisker Plot, RL 25/25 Data for the Control Car



3. Calculated Emissions Test Data

b. Individual Statistical Data

(5) Two way ANOVA, Device x Car

Two way Analysis of Variance for Device #1 Data from RL 25/25 Test.

Factors:

Device (without vs. with)

Car

Eight cars were used in this analysis.

Conclusions:

At the 80 % level (P= 0.20) no significant difference in any of the emissions measured was noted when a comparison of without vs. with the device is made.

For all emissions, a significant difference from car to car is noted ($P < 0.05$).

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	937.983	1	937.983	0.57	0.4813
B:Car	919610.0	7	131373.0	80.36	0.0000
RESIDUAL	11444.1	7	1634.87		
TOTAL (CORRECTED)	931992.0	15			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	2.247	1	2.247	0.07	0.8075
B:Car	2246.14	7	320.877	9.40	0.0042
RESIDUAL	238.964	7	34.1378		
TOTAL (CORRECTED)	2487.35	15			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.00146996	1	0.00146996	0.21	0.6625
B:Car	0.22221	7	0.031744 2	4.62	0.0306
RESIDUAL	0.0480955	7	0.00687078		
TOTAL (CORRECTED)	0.271775	15			

Analysis of Variance for CO_2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.058564	1	0.058564	0.62	0.4649
B:Car	28.7233	7	4.10333	43.46	0.0000
RESIDUAL	0.660892	7	0.0944131		
TOTAL (CORRECTED)	29.4428	15			

Two way Analysis of Variance for Device #2 Data from RL 25/25 Test

Factors:

Device (without vs. with)

Car

Nine cars were used in this analysis.

Conclusions:

At the 80 % level (P= 0.20) no significant difference in any of the emissions measured was noted when a comparison of without vs. with the device is made.

For all emissions, a significant difference from car to car is noted (P < 0.05).

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	2774.88	1	2774.88	0.63	0.4573
B:Car	1.39778E7	8	1.74722E6	398.80	0.0000
RESIDUAL	35049.3	8	4381.17		
TOTAL (CORRECTED)	1.40156E7	17			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.25992	1	0.25992	0.02	0.8799
B:Car	30719.3	8	3839.91	369.23	0.0000
RESIDUAL	83.1975	8	10.3997		
TOTAL (CORRECTED)	30802.7	17			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.000671856	1	0.000671856	0.98	0.3609
B:Car	0.697199	8	0.0871499	127.46	0.0000
RESIDUAL	0.00547011	8	0.000683764		
TOTAL (CORRECTED)	0.703341	17			

Analysis of Variance for CO_2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.011265	1	0.011265	1.64	0.2357
B:Car	22.8233	8	2.85291	416.29	0.0000
RESIDUAL	0.0548249	8	0.00685312		
TOTAL (CORRECTED)	22.8893	17			

Two way Analysis of Variance for Device #3 Data from RL 25/25 Test.

Factors:

Device (without vs. with)

Car

Seven Cars were used in this analysis.

Conclusions:

At the 80 % level (P= 0.20) no significant difference in any of the emissions measured was noted when a comparison of without vs. with the device is made.

For all emissions, a significant difference from car to car is noted (P < 0.05).

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	10938.3	1	10938.3	0.69	0.4462
B:Car	2.48753E6	6	414588.0	26.18	0.0005
RESIDUAL	95002.8	6	15833.8		
TOTAL (CORRECTED)	2.59347E6	13			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	259.979	1	259.979	0.86	0.3982
B:Car	40835.7	6	6805.96	22.60	0.0007
RESIDUAL	1806.84	6	301.139		
TOTAL (CORRECTED)	42902.6	13			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.000178571	1	0.000178571	0.19	0.6853
B:Car	0.0617752	6	0.0102959	10.76	0.0054
RESIDUAL	0.00574277	6	0.000957128		
OTAL (CORRECTED)	0.0676965	13			

Analysis of Variance for CO2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	.0667921	1	0.0667921	1.73	0.2362
B:Car	16.1685	6	2.69475	69.89	0.0000
RESIDUAL	0.231351	6	0.0385586		
TOTAL (CORRECTED)	16.4667	13			

Two way Analysis of Variance for Device # 4, Data from ASM2525

Factors:

Device (without vs. with)

Car

Nine cars were used in this analysis

Conclusions:

At the 80 % level (p=0.20) a significant difference in NO_x, HC and CO emissions was noted when a comparison of without vs. with is made. A reduction in all emissions occurred with the device.

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	153961.0	1	153961.0	5.34	- 0.0497
B:Car	1.38552E7	8	1.7319E6	60.01	0.0000
RESIDUAL	230865.0	8	28858.1		
TOTAL (CORRECTED)	1.424E7	17			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	326.657	1	326.657	2.10	0.1855
B:Car	30692.0	8	3836.5	24.65	0.0001
RESIDUAL	1245.14	8	155.642		
TOTAL (CORRECTED)	32263.8	17			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.05445	1	0.05445	3.53	0.0972
B:Car	0.678893	8	0.0848617	5.50	0.0133
RESIDUAL	0.123474	8	0.0154342		
TOTAL (CORRECTED)	0.856817	17			

Analysis of Variance for CO2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.00293889	1	0.00293889	0.04	0.8513
B:Car	81.285	8	10.1606	133.21	0.0000
RESIDUAL	0.610199	8	0.0762749		
TOTAL (CORRECTED)	81.8981	17			

Two way Analysis of Variance for Device #5 Data from RL 25/25 Test.

Factors:

Device (without vs. with)

Car

Nine Cars were used in this analysis.

Conclusions:

At the 80 % level (P= 0.20) no significant difference in any of the emissions measured was noted when a comparison of without vs. with the device is made.

For all emissions, a significant difference from car to car is noted (P < 0.05).

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	38383.0	1	38383.0	1.25	0.2960
B:Car	1.92879E7	8	2.41098E6	78.52	0.0000
RESIDUAL	245651.0	8	30706.4		
TOTAL (CORRECTED)	1.95719E7	17			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.1008	1	0.1008	0.00	0.9470
B:Car	3051.45	8	381.432	18.27	0.0002
RESIDUAL	166.986	8	20.8733		
TOTAL (CORRECTED)	3218.54	17			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.000419534	1	0.000419534	1.71	0.2279
B:Car	0.0123989	8	0.00154987	6.30	0.0087
RESIDUAL	0.00196819	8	0.000246024		
TOTAL (CORRECTED)	0.0147866	17			

Analysis of Variance for CO_2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.0431201	1	0.0431201	0.82	0.4012
B:Car	44.9636	8	5.62045	106.78	0.0000
RESIDUAL	0.421087	8	0.0526359		
TOTAL (CORRECTED)	45.4278	17			

Two way Analysis of Variance for Device #1, Data from IM240 Test.

Factors:

Device (without vs. with)

Car

Conclusions:

At the 80 % level (P=0.20) a significant difference in CO and CO_2 emissions were noted when a comparison of without vs. with the device is made.

A significant difference from car to car is noted ($P < 0.05$).

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.000763141	1	0.000763141	0.27	0.6227
B:Car	9.46617	7	1.35231	484.15	0.0000
RESIDUAL	0.019552	7	0.00279314		
TOTAL (CORRECTED)	9.48649	15			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.000625	1	0.000625	0.77	0.4176
B:Car	0.134263	7	0.0191804	23.71	0.0002
RESIDUAL	0.0056625	7	0.000808929		
TOTAL (CORRECTED)	0.14055	15			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	4.1209	1	4.1209	3.01	0.1264
B:Car	182.948	7	26.1355	19.08	0.0005
RESIDUAL	9.58839	7	1.36977		
TOTAL (CORRECTED)	196.658	15			

Analysis of Variance for CO_2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	429.111	1	429.111	5.09	0.0588
B:Car	113019.0	7	16145.6	191.33	0.0000
RESIDUAL	590.706	7	84.3866		
TOTAL (CORRECTED)	114039.0	15			

Two way Analysis of Variance for Device #3 Data fromIM240 Test.

Factors:

Device (without vs. with)

Car

Seven Cars were used in this analysis.

Conclusions:

At the 80 % level (P= 0.20) no significant difference in any of the emissions measured was noted when a comparison of without vs. with the device is made.

For all emissions, a significant difference from car to car is noted (P < 0.05).

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.00725953	1	0.00725953	0.28	0.6213
B:Car	20.5789	6	3.42981	132.11	0.0000
RESIDUAL	0.155769	6	0.0259615		
TOTAL (CORRECTED)	20.7419	13			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.0000442864	1	0.0000442864	0.06	0.8140
B:Car	0.109225	6	0.0182042	25.55	0.0005
RESIDUAL	0.00427505	6	0.000712508		
TOTAL (CORRECTED)	0.113544	13			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.664246	1	0.664246	0.16	0.7051
B:Car	258.354	6	43.059	10.52	0.0057
RESIDUAL	24.5497	6	4.09162		
TOTAL (CORRECTED)	283.568	13			

Analysis of Variance for CO_2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	72.5543	1	72.5543	0.87	0.3977
B:Car	144750.0	6	24125.0	287.69	0.0000
RESIDUAL	503.145	6	83.8575		
TOTAL (CORRECTED)	145325.0	13			

Two way Analysis of Variance for Device #4 Data from IM240 Test.

Factors:

Device (without vs. with)

Car

Eight Cars were used in this analysis.

Conclusions:

At the 80 % level (P= 0.20) a significant difference in NO_x, HC, CO and CO_2 emissions was noted when a comparison of without vs. with the device is made. Emissions are signficantly less for the with device measurements.

For all emissions, a significant difference from car to car is noted ($P < 0.05$).

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.716732	1	0.716732	5.23	0.0561
B:car	55.3319	7	7.90456	57.65	0.0000
RESIDUAL	0.959866	7	0.137124		
TOTAL (CORRECTED)	57.0085	15			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.140318	1	0.140318	6.98	0.0333
B:Car	1.33589	7	0.190841	9.50	0.0041
RESIDUAL	0.140686	7	0.0200981		
TOTAL (CORRECTED)	1.61689	15			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	216.895	1	216.895	4.60	0.0692
B:Car	555.404	7	79.3435	1.68	0.2547
RESIDUAL	330.326	7	47.1894		
TOTAL (CORRECTED)	1102.63	15			

Analysis of Variance for CO_2 - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	360.164	1	360.164	1.00	0.3499
B:Car	232120.0	7	33160.0	92.37	0.0000
RESIDUAL	2512.91	7	358.987		
TOTAL (CORRECTED)	234993.0	15			

Two way Analysis of Variance for Device #5 Data from IM240 Test.

Factors:

Device (without vs. with)

Car

Nine Cars were used in this analysis.

Conclusions:

At the 80 % level (P= 0.20) a significant difference in CO emissions was noted when a comparison of without vs. with the device is made. Emissions are signficantly less for the with device measurements.

For all emissions, a significant difference from car to car is noted ($P < 0.05$).

Analysis of Variance for NOx - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.0298087	1	0.0298087	0.49	0.5097
B:Car	33.8236	8	4.22795	69.95	0.0000
RESIDUAL	0.483515	8	0.0604394		
TOTAL (CORRECTED)	34.337	17			

Analysis of Variance for HC - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	0.00126337	1	0.00126337	1.93	0.2019
B:Car	0.303673	8	0.0379592	58.08	0.0000
RESIDUAL	0.00522873	8	0.000653591		
TOTAL (CORRECTED)	0.310165	17			

Analysis of Variance for CO - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	24.2303	1	24.2303	4.39	0.0693
B:Car	738.179	8	92.2724	16.73	0.0003
RESIDUAL	44.1135	8	5.51419		
TOTAL (CORRECTED)	806.523	17			

Analysis of Variance for CO2 - Type III Sums of Squares

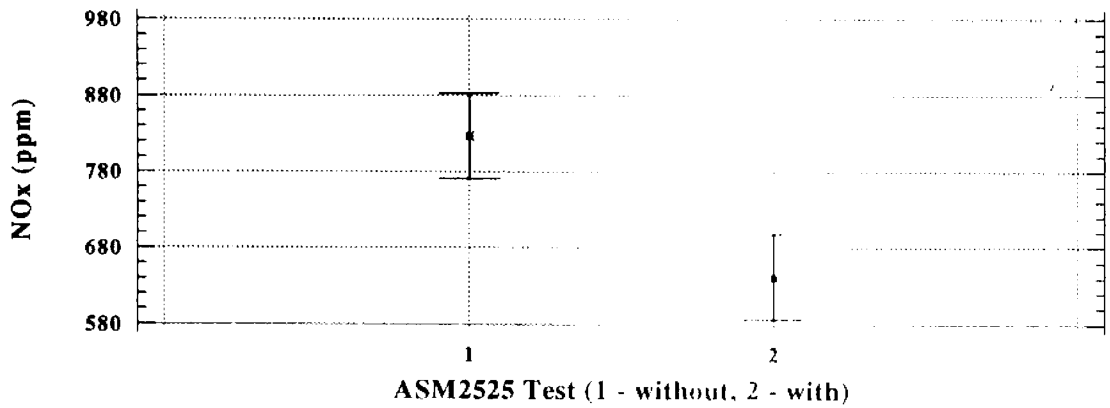
Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Device	17.6775	1	17.6775	0.44	0.5330
B:Car	119603.0	8	14950.3	371.38	0.0000
RESIDUAL	322.046	8	40.2558		
TOTAL (CORRECTED)	119942.0	17			

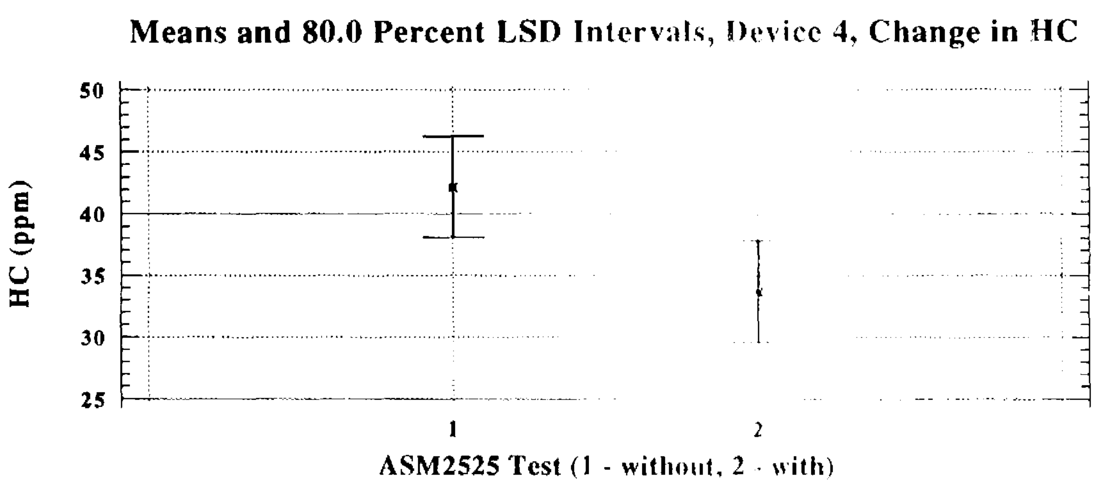
3. Calculated Emissions Test Data

b. Individual Statistical Data

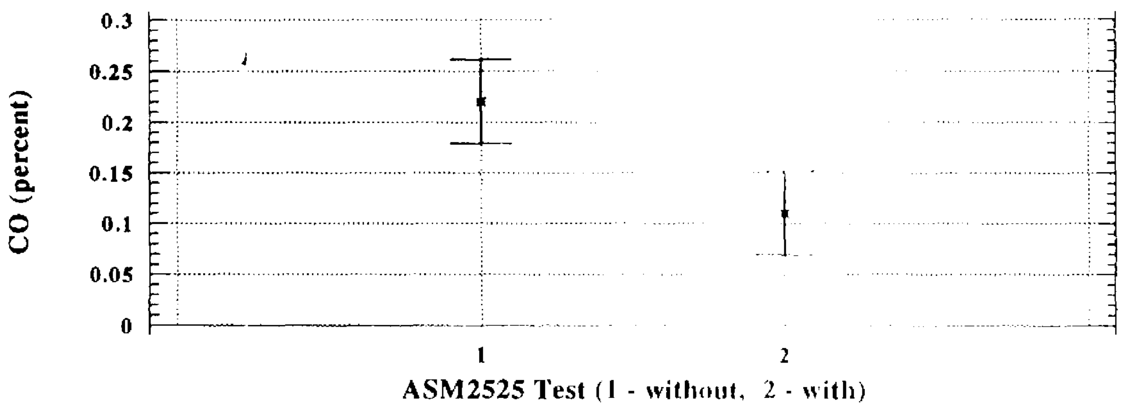
(6) Least Significant Different Tests for Devices

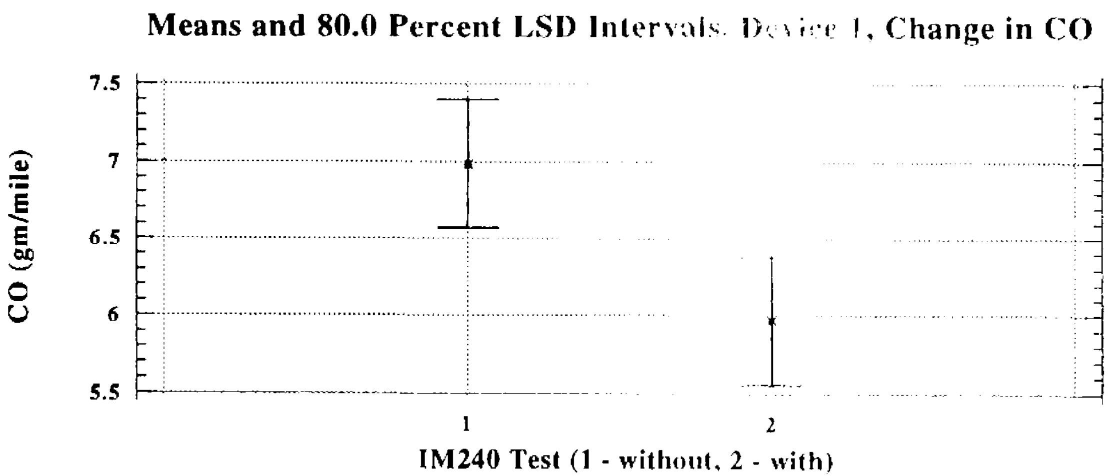
Means and 80.0 Percent LSD Intervals, Device 4, Change in NOx



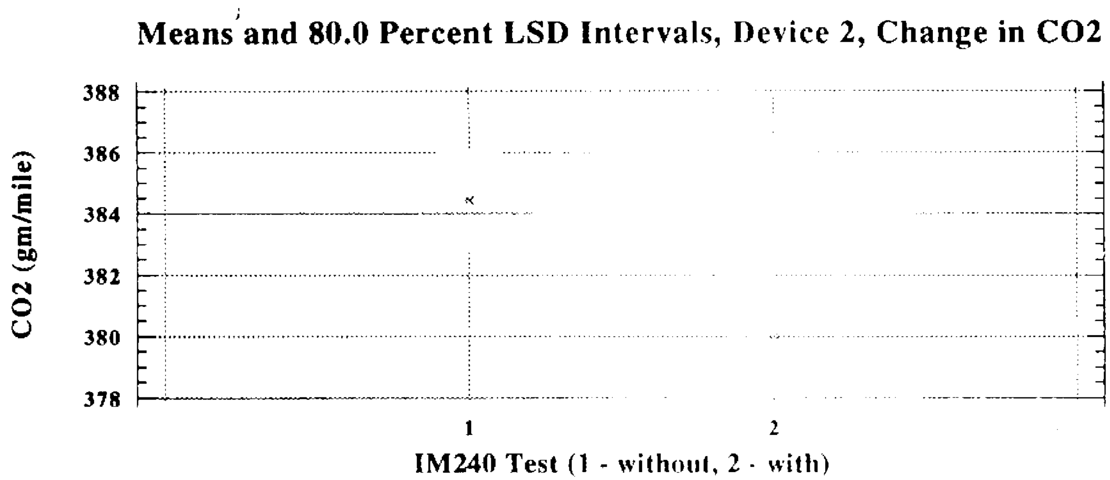

Means and 80.0 Percent LSD Intervals, Device 4, Change in HC
HC (ppm)
50
45
40
35
30
25
1
2
ASM2525 Test (1 - without, 2 - with)

Means and 80.0 Percent LSD Intervals, Device 4, Change in CO

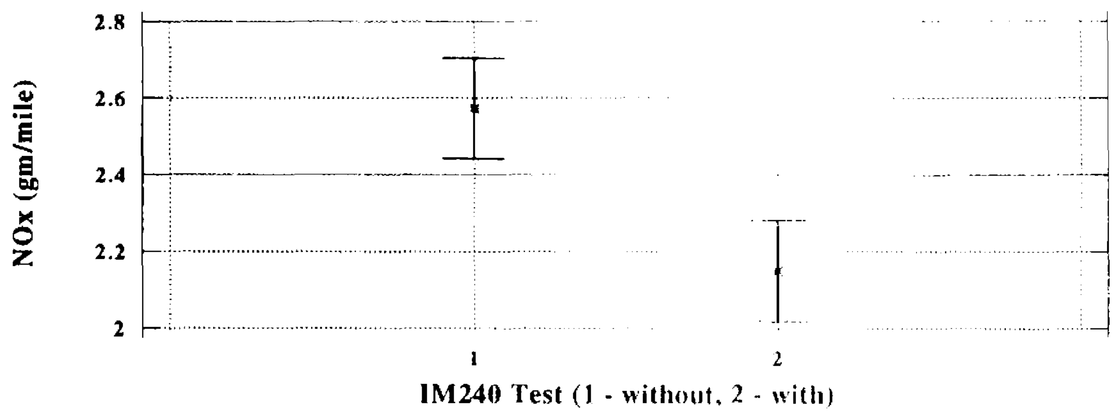


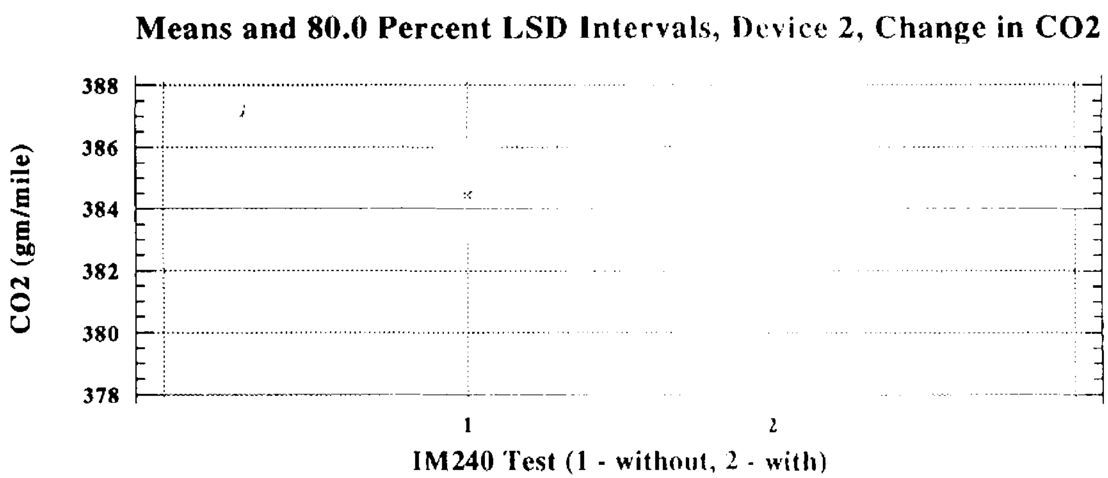


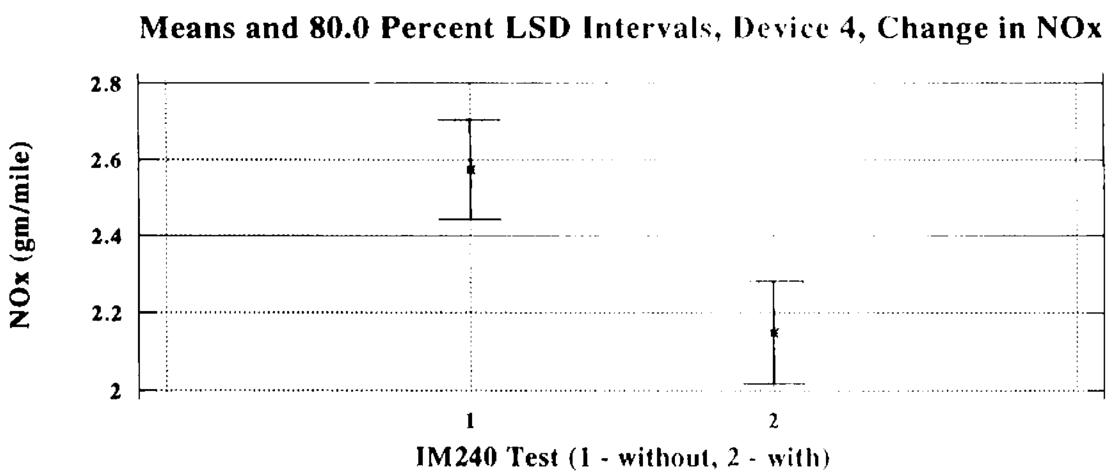
Means and 80.0 Percent LSD Intervals, Device 1, Change in CO
CO (gm/mile)
7.5
7
6.5
6
5.5
1
2
IM240 Test (1 - without, 2 - with)

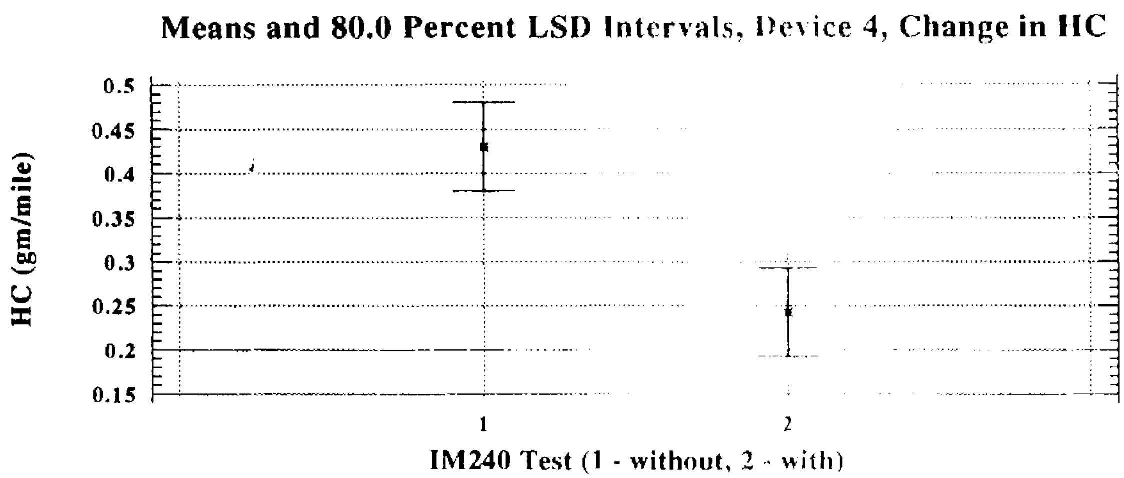

Means and 80.0 Percent LSD Intervals, Device 2, Change in CO2
CO2 (gm/mile)
388
386
384
382
380
378
1
2
IM240 Test (1 - without, 2 - with)

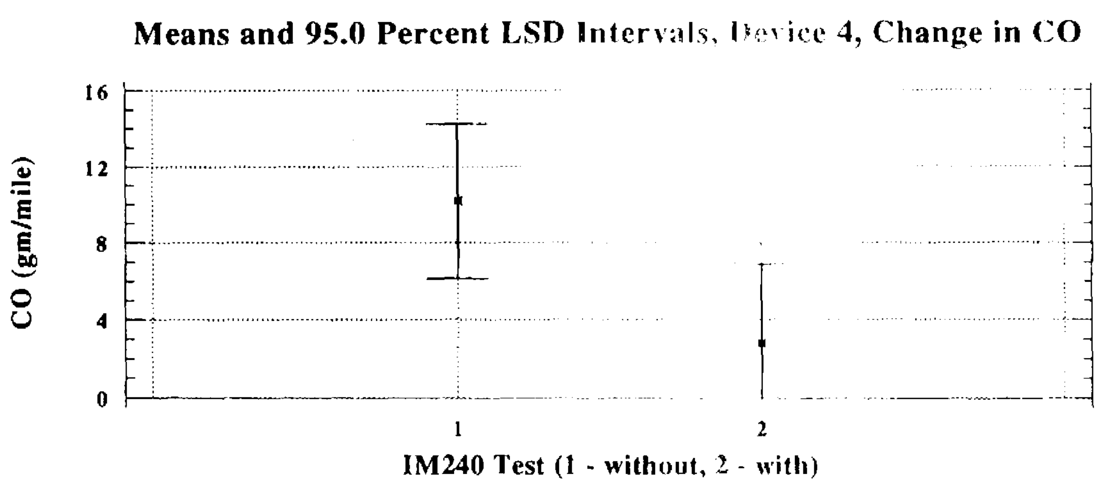
Means and 80.0 Percent LSD Intervals, Device 4, Change in NOx

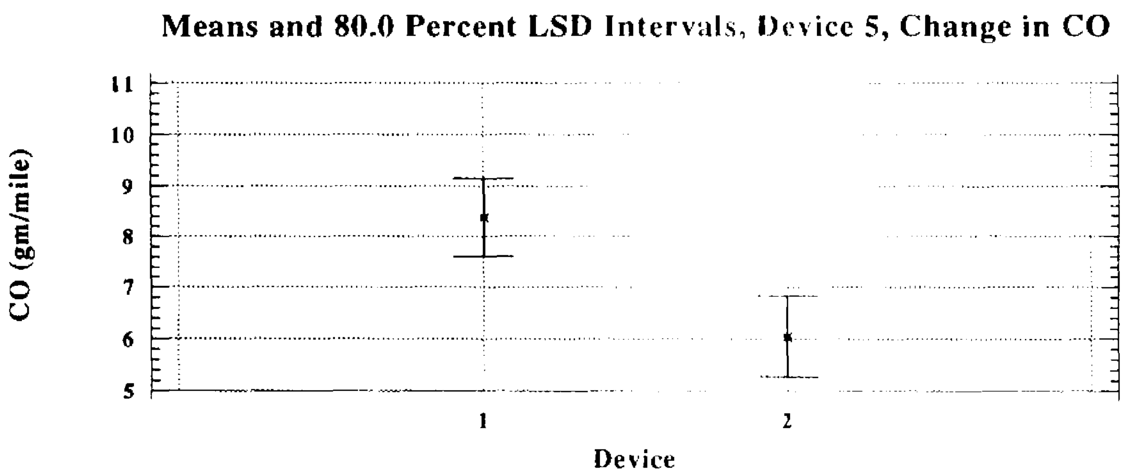



Means and 80.0 Percent LSD Intervals, Device 2, Change in CO2
388
386
384
382
380
378
CO2 (gm/mile)
1
2
IM240 Test (1 - without, 2 - with)


Means and 80.0 Percent LSD Intervals, Device 4, Change in NOx
2.8
2.6
2.4
2.2
2
NOx (gm/mile)
1
2
IM240 Test (1 - without, 2 - with)


Means and 80.0 Percent LSD Intervals, Device 4, Change in HC
HC (gm/mile)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
1
2
IM240 Test (1 - without, 2 - with)


Means and 95.0 Percent LSD Intervals, Device 4, Change in CO
CO (gm/mile)
16
12
8
4
0
1
2
IM240 Test (1 - without, 2 - with)



Means and 80.0 Percent LSD Intervals, Device 5, Change in CO
CO (gm/mile)
11
10
9
8
7
6
5
1
2
Device

4. Emissions Gas Analysis Data

a. Data Roll-Up / Summary

b. Individual Statistical Data

HYDROCARBON ANALYSIS

Hydrocarbon Carbon Data									n= 8		
Device 1	Car 1	Car 2	Car 3	Car 4	Car 5	Car 6	Car 7	Car 8	Average	Std Dev	t
C3's	3.87E+00	5.30E+01	5.58E+00	1.05E+00	7.21E+00	1.30E+01	9.42E-01	1.02E+00	10.711	1.76E+01	1.72
C4's	-5.29E-05	1.38E-02	2.30E-03	5.26E-03	-1.11E-03	-1.14E-02	0.00E+00	-5.84E-06	0.001	7.01E-03	0.44
C5's	-9.36E-04	1.79E-03	4.90E-04	4.54E-03	0.00E+00	-7.02E-03	0.00E+00	0.00E+00	0.000	3.25E-03	-0.12
C6's	5.17E-03	4.05E-03	7.01E-03	2.17E-03	-1.35E-02	-1.44E-02	5.16E-03	9.39E-03	0.001	9.23E-03	0.20
Benzene	0.00E+00	7.06E-03	9.63E-03	-6.09E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.002	3.97E-03	1.43
C7's	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000	0.00E+00	#DIV/0!
Toluene	0.00E+00	1.24E-02	6.77E-03	8.18E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.002	4.63E-03	1.53
C8's	9.05E-04	-7.15E-03	1.85E-03	-6.01E-03	-1.18E-03	-2.20E-02	-1.51E-03	-2.83E-03	-0.005	7.64E-03	-1.76
Xylene's	0.00E+00	1.60E-02	0.00E+00	0.00E+00	0.00E+00	1.90E-02	0.00E+00	0.00E+00	0.004	8.15E-03	1.52
C9's	4.85E-03	-7.81E-04	1.70E-03	-3.33E-03	3.11E-04	1.18E-02	-1.62E-03	5.45E-03	0.002	4.89E-03	1.33
Trimethylbenze	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000	0.00E+00	#DIV/0!
C10's	0.00E+00	0.00E+00	1.78E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000	6.30E-04	1.00
C11's/C12's	1.47E-03	2.30E-03	-3.34E-03	3.45E-03	-8.29E-05	-3.60E-03	6.67E-04	5.64E-03	0.001	3.17E-03	0.73
g C/10^6g sample	9.40E+01	1.28E+03	1.36E+02	2.54E+01	1.72E+02	3.11E+02	2.28E+01	2.62E+01	257.871	4.23E+02	1.73
CO	0.00E+00	4.08E+04	-2.40E+03	6.00E+03	-9.60E+03	0.00E+00	0.00E+00	3.60E+03	4800.000	1.52E+04	0.89
CO2	-9.60E+03	6.89E+05	3.00E+04	-1.20E+04	-7.07E+05	-5.32E+05	4.20E+04	-1.44E+04	-64200.000	4.19E+05	-0.43
Total g C/10^6g Before/After	-9.51E+03	7.31E+05	2.77E+04	-5.97E+03	-7.16E+05	-5.31E+05	4.20E+04	-1.08E+04	-59142.129	4.32E+05	-0.39
% Change	1.01E+00	5.53E-01	9.83E-01	1.00E+00	1.71E+00	1.56E+00	9.75E-01	1.01E+00	1.100	3.66E-01	-0.77

Hydrocarb[illegible]arbon Data

Device 2	Car 1	Car 2	Car 3	Car 4	Car 5	Car 6	Car 7	Car 8	Car 9	n=9 Avg	StdDev	t
C3's	-1.55E+00	6.48E+00	2.35E+01	-1.17E+01	7.16E-01	1.00E+01	4.67E+00	1.67E+01	-2.26E+00	5.18E+00	1.06E+01	1.47
C4's	-5.46E-04	6.82E-04	1.36E-03	-8.85E-03	1.84E-03	4.02E-03	3.13E-04	1.22E-03	-5.89E-03	-6.50E-04	4.07E-03	-0.48
C5's	7.41E-04	4.91E-03	6.86E-03	-5.93E-03	1.02E-03	3.93E-03	3.89E-02	2.70E-03	-1.28E-02	4.47E-03	1.43E-02	0.94
C6's	3.52E-02	2.68E-02	2.80E-02	1.14E-02	-4.09E-03	1.72E-02	-3.40E-02	9.43E-03	2.27E-02	1.25E-02	2.10E-02	1.79
Benzene	0.00E+00	0.00E+00	8.13E-04	-4.58E-03	0.00E+00	5.84E-03	4.00E-03	0.00E+00	-4.04E-03	2.26E-04	3.31E-03	0.21
C7's	0.00E+00	0.00E+00	-9.25E-05	-2.16E-03	0.00E+00	-2.19E-03	0.00E+00	-5.97E-03	0.00E+00	-1.16E-03	2.03E-03	-1.71
Toluene	0.00E+00	0.00E+00	3.77E-03	-3.72E-03	0.00E+00	6.54E-03	2.15E-03	-1.10E-04	0.00E+00	9.59E-04	2.90E-03	0.99
C8's	3.75E-03	-7.25E-04	2.20E-03	2.84E-03	4.63E-03	-4.61E-03	-2.02E-03	-2.61E-04	-2.19E-03	4.01E-04	3.12E-03	0.39
Xylene's	0.00E+00	0.00E+00	6.06E-03	-5.70E-03	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00	5.95E-04	3.37E-03	0.53
C9's	-4.68E-02	5.38E-03	2.36E-03	3.96E-03	-5.28E-03	-2.46E-03	-8.45E-03	-1.22E-03	-3.11E-03	-6.18E-03	1.59E-02	-1.17
Trimethylbenze	0.00E+00	0.00E+00	1.06E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-04	3.54E-04	1.00
C10's	4.19E-02	0.00E+00	-8.56E-04	-2.86E-03	0.00E+00	0.00E+00	0.00E+00	3.97E-02	0.00E+00	8.66E-03	1.83E-02	1.42
C11's/C12's	3.72E-02	1.21E-01	9.21E-03	5.21E-03	-5.77E-02	4.36E-02	4.42E-03	-1.06E-03	6.43E-03	1.87E-02	4.79E-02	1.17
g C/10^6g sample	-2.91E+01	1.75E+02	5.70E+02	-2.81E+02	8.95E+00	2.49E+02	1.12E+02	4.06E+02	-5.37E+01	1.29E+02	2.57E+02	1.50
CO	0.00E+00	0.00E+00	1.08E+04	-3.60E+03	0.00E+00	7.20E+03	3.60E+03	-1.20E+03	-1.68E+04	0.00E+00	7.73E+03	0.00
CO2	7.08E+04	9.12E+04	8.16E+04	4.68E+04	-2.27E+05	-1.85E+05	1.08E+04	-1.27E+05	-7.20E+03	-2.72E+04	1.21E+05	-0.67
Total g C/10^6g Before/After	7.08E+04	9.14E+04	9.30E+04	4.29E+04	-2.27E+05	-1.77E+05	1.45E+04	-1.28E+05	-2.41E+04	-2.71E+04	1.21E+05	-0.67
	0.94	0.94	0.94	0.97	1.21	1.12	0.99	1.09	1.02	1.02	9.44E-02	-0.78

HYDROCARBON ANALYSIS

Hycarbon/C... on Data

Device 3	Car 1	Car 2	Car 3	Car 4	Car 5	Car 6	Avg	StdDev	t
C3's	2.63E+01	3.28E+00	5.61E-01	7.82E-01	-2.60E+02	6.78E+00	-3.70E+01	1.10E+02	-0.83
C4's	1.01E-02	-5.28E-03	0.00E+00	-2.59E-03	-2.12E-01	8.10E-03	-3.35E-02	8.74E-02	-0.94
C5's	1.25E-02	-7.62E-03	0.00E+00	-3.68E-03	-1.41E-01	1.17E-02	-2.13E-02	5.91E-02	-0.88
C6's	4.52E-03	-5.11E-03	4.63E-04	6.97E-03	-1.03E-01	2.25E-03	-1.57E-02	4.31E-02	-0.89
Benzene	1.14E-02	0.00E+00	0.00E+00	0.00E+00	-5.12E-02	0.00E+00	-6.64E-03	2.23E-02	-0.73
C7's	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.05E-02	0.00E+00	-8.42E-03	2.06E-02	-1.00
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.04E-02	-9.29E-03	-8.29E-03	1.62E-02	-1.25
C8's	1.27E-03	-1.70E-02	1.77E-03	6.79E-03	-7.34E-03	1.65E-02	3.20E-04	1.15E-02	0.07
Xylene's	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.36E-02	0.00E+00	-8.93E-03	2.19E-02	-1.00
C9's	0.00E+00	-1.38E-02	0.00E+00	0.00E+00	-4.15E-02	6.03E-03	-8.21E-03	1.76E-02	-1.14
Trimethylbenze	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	#DIV/0!
C10's	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	#DIV/0!
C11's/C12's	-1.07E-04	4.94E-03	8.16E-05	-2.20E-03	0.00E+00	-1.89E-03	1.36E-04	2.56E-03	0.13
g C/10^{6}g sample	6.33E+02	7.51E+01	1.37E+01	1.93E+01	-6.28E+03	1.65E+02	-8.96E+02	2.65E+03	-0.83
CO	1.08E+04	-2.40E+03	0.00E+00	2.40E+03	-1.92E+04	4.80E+03	-6.00E+02	1.02E+04	-0.14
CO2	3.00E+04	-6.36E+04	8.52E+04	1.21E+05	-1.92E+04	3.12E+04	3.08E+04	6.71E+04	1.12
Total g C/10^{6}g Before/After	4.14E+04	-6.59E+04	8.52E+04	1.24E+05	-4.47E+04	3.62E+04	2.93E+04	7.32E+04	0.98
% Change	9.71E-01	1.04E+00	9.46E-01	9.23E-01	1.03E+00	9.77E-01	9.82E-01	4.72E-02	0.93

HYDROCARBON ANALYSIS

Hydrocarbc arbon Data

Device 4	Car 1	Car 2	Car 3	Car 4	Car 5	Car 6	Car 7	Car 8	Car 9	n=9 Avg	StdDev	t
C3's	-2.69E+01	9.78E+01	5.76E+00	1.29E+02	1.02E+01	2.10E+01	-6.85E+00	8.69E-01	6.70E+01	3.31E+01	5.27E+01	1.89
C4's	2.69E-02	1.59E-02	7.37E-03	4.23E-02	0.00E+00	5.97E-03	-1.48E-02	1.54E-03	1.37E-02	1.10E-02	1.65E-02	2.00
C5's	-1.23E-02	1.30E-02	6.54E-03	1.50E-02	0.00E+00	2.11E-03	-1.15E-02	2.49E-03	5.10E-03	2.27E-03	9.43E-03	0.72
C6's	-2.32E-02	1.52E-02	2.30E-02	1.34E-02	3.05E-02	-3.03E-03	-1.21E-02	-7.58E-03	3.49E-03	4.42E-03	1.75E-02	0.76
Benzene	9.91E-04	-2.11E-02	0.00E+00	1.70E-02	0.00E+00	0.00E+00	-1.10E-02	0.00E+00	3.90E-03	-1.14E-03	1.04E-02	-0.33
C7's	-2.16E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.02E-03	0.00E+00	0.00E+00	-4.64E-04	9.22E-04	-1.51
Toluene	-9.13E-04	3.06E-02	0.00E+00	2.10E-02	8.18E-03	0.00E+00	-4.61E-03	0.00E+00	6.90E-03	6.79E-03	1.17E-02	1.74
C8's	1.05E-03	-2.74E-03	-1.79E-03	-5.53E-05	-2.54E-03	-5.09E-03	-1.42E-03	-2.19E-03	6.61E-03	-9.06E-04	3.30E-03	-0.82
Xylene's	-4.27E-03	3.93E-02	0.00E+00	3.39E-02	7.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.54E-03	1.63E-02	1.57
C9's	-3.63E-04	8.76E-03	-2.40E-03	4.69E-03	-8.21E-04	7.24E-04	-6.35E-04	0.00E+00	0.00E+00	1.11E-03	3.45E-03	0.96
Trimethylbenzer	-4.47E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.97E-04	1.49E-03	-1.00
C10's	0.00E+00	-2.63E-02	-3.71E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-7.05E-03	1.43E-02	-1.48
C11's/C12's	-3.27E-04	-1.36E-02	-3.40E-03	1.85E-03	3.72E-03	-4.28E-03	3.85E-04	6.01E-05	1.26E-03	-1.59E-03	5.12E-03	-0.93
g C/10^6g sample	-6.47E+02	2.35E+03	1.35E+02	3.11E+03	2.49E+02	5.03E+02	-1.68E+02	2.03E+01	1.61E+03	7.96E+02	1.27E+03	1.88
CO	-1.56E+04	7.92E+04	2.40E+03	3.00E+04	0.00E+00	1.68E+04	1.32E+04	0.00E+00	2.40E+03	1.43E+04	2.75E+04	1.56
CO2	5.04E+04	-1.36E+05	-9.60E+03	-4.80E+03	-6.48E+04	1.68E+04	8.76E+04	-2.28E+04	2.40E+04	-6.53E+03	6.51E+04	-0.30
Total g C/10^6g Before/After	3.42E+04	-5.41E+04	-7.06E+03	2.83E+04	-6.46E+04	3.41E+04	1.01E+05	-2.28E+04	2.80E+04	8.53E+03	5.13E+04	0.50
% Change	9.78E-01	1.04E+00	1.00E+00	9.81E-01	1.05E+00	9.77E-01	9.35E-01	1.02E+00	0.970	9.95E-01	3.64E-02	0.34

HYDROCARBON ANALYSIS

Hydrocarbo[illegible]arbon Data — n=9

Device 5	Car 1	Car 2	Car 3	Car 4	Car 5	Car 6	Car 7	Car 8	Car 9	Avg	StdDev	t
C3's	1.57E+00	7.19E-01	-7.73E+00	-4.61E-01	1.77E+00	9.82E+00	-6.10E+00	-1.34E+01	-3.35E+01	-5.25E+00	1.25E+01	-1.26
C4's	3.86E-03	-7.48E-04	0.00E+00	-4.12E-03	-8.28E-03	4.74E-03	4.77E-03	5.49E-03	2.13E-02	3.00E-03	8.28E-03	1.09
C5's	0.00E+00	-1.15E-05	0.00E+00	0.00E+00	-1.88E-04	0.00E+00	1.13E-02	0.00E+00	1.00E-02	2.35E-03	4.73E-03	1.49
C6's	-1.94E-02	3.84E-03	1.77E-02	-7.93E-03	1.13E-03	-1.62E-03	1.66E-02	2.04E-02	5.33E-03	4.01E-03	1.30E-02	0.93
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.79E-03	4.21E-04	1.26E-03	1.00
C7's	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	#DIV/0!
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.68E-03	7.42E-04	2.23E-03	1.00
C8's	2.15E-02	7.07E-03	1.28E-03	-5.05E-02	8.57E-03	1.76E-02	1.54E-04	8.66E-03	-4.56E-04	1.53E-03	2.09E-02	0.22
Xylene's	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.81E-03	4.23E-04	1.27E-03	1.00
C9's	-4.04E-03	0.00E+00	3.47E-03	-5.26E-02	2.49E-02	5.71E-03	6.90E-03	0.00E+00	7.64E-03	-8.91E-04	2.11E-02	-0.13
Trimethylbenze	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	#DIV/0!
C10's	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	#DIV/0!
C11's/C12's	1.58E-02	-2.36E-02	-2.62E-03	-2.86E-03	-1.49E-02	2.59E+00	-8.15E-03	4.24E-03	4.14E-03	2.85E-01	8.66E-01	0.99
g C/10^6g sample	4.02E+01	1.49E+01	-1.84E+02	-2.28E+01	4.36E+01	5.96E+02	-1.45E+02	-3.18E+02	-7.99E+02	-8.59E+01	3.69E+02	-0.70
CO	0.00E+00	0.00E+00	0.00E+00	1.20E+03	1.20E+04	2.40E+03	2.40E+03	0.00E+00	7.20E+03	2.80E+03	4.16E+03	2.02
CO_2	1.24E+05	8.76E+04	1.20E+04	-1.32E+04	1.02E+05	-1.68E+04	2.29E+05	1.80E+05	-1.20E+04	7.69E+04	9.07E+04	2.55
Total g C/10^6g Before/After	1.24E+05	8.76E+04	1.18E+04	-1.20E+04	1.14E+05	-1.38E+04	2.31E+05	1.80E+05	-5.60E+03	7.96E+04	9.03E+04	2.65
% Change	9.19E-01	9.27E-01	9.93E-01	1.01E+00	9.28E-01	1.01E+00	8.22E-01	7.94E-01	1.006	9.34E-01	8.07E-02	2.00

VITALIZER

12/4/96

VIN	HC's (ppm) 31996 Before	HC's (ppm) 31996 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	1.60E+01		13.1		0.08	
C4's	0.00E+00					
C5's	0.00E+00					
C6's	1.40E-02					
Benzene	0.00E+00					
C7's	0.00E+00					
Toluene	0.00E+00					
C8's	9.52E-03					
Xylene's	0.00E+00					
C9's	1.10E-02					
Trimethylbenzene	0.00E+00					
C10's	0.00E+00					
C11's/C12's	4.19E-03					
g C/10^6 g sample	389	0	1566000	0	9600	0
Total g C/10^6 g	1575989	0				

VIN	HC's (ppm) 12948 Before	HC's (ppm) 12948 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	2.88E+01	2.49E+01	9.9	10.0	0.00	0.00
C4's	1.09E-02	1.09E-02				
C5's	6.33E-03	7.27E-03				
C6's	1.93E-02	1.41E-02				
Benzene	0.00E+00	0.00E+00				
C7's	0.00E+00	0.00E+00				
Toluene	0.00E+00	0.00E+00				
C8's	9.95E-03	9.04E-03				
Xylene's	0.00E+00	0.00E+00				
C9's	1.33E-02	8.46E-03				
Trimethylbenzene	0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00				
C11's/C12's	3.30E-03	1.83E-03				
g C/10^6 g sample	695	601	1190400	1200000	0	0
Total g C/10^6 g	1191095	1200601				

VIN	HC's (ppm) 29823 Before	HC's (ppm) 29823 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	9.28E+01	3.98E+01	13.2	7.4	0.45	0.11
C4's	2.56E-02	1.18E-02				
C5's	9.34E-03	7.55E-03				
C6's	2.48E-02	2.07E-02				
Benzene	1.41E-02	7.00E-03				
C7's	0.00E+00	0.00E+00				
Toluene	2.10E-02	8.56E-03				
C8's	9.98E-03	1.71E-02				
Xylene's	1.60E-02	0.00E+00				
C9's	1.28E-02	1.36E-02				
Trimethylbenzene	0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00				
C11's/C12's	8.29E-03	5.99E-03				
g C/10^6 g sample	2239	963	1580400	891600	54000	13200
Total g C/10^6 g	1638639	905783				

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VIN	HC's (ppm) 68742 Before	HC's (ppm) 68742 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	2.56E+01	2.00E+01	13.3	13.1	0.12	0.14
C4's	1.71E-02	1.48E-02				
C5's	9.96E-03	9.47E-03				
C6's	4.28E-02	3.58E-02				
Benzene	9.63E-03	0.00E+00				
C7's	0.00E+00	0.00E+00				
Toluene	6.77E-03	0.00E+00				
C8's	1.21E-02	1.03E-02				
Xylene's	0.00E+00	0.00E+00				
C9's	1.16E-02	9.85E-03				
Trimethylbenzene	0.00E+00	0.00E+00				
C10's	1.78E-03	0.00E+00				
C11's/C12's	3.89E-03	7.23E-03				
g C/10^6 g sample	623	487	1596000	1566000	14400	16800
Total g C/10^6 g	1611023	1583287				

VIN	HC's (ppm) 31996 Before	HC's (ppm) 31996 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	1.28E+01	6.84E+00	14.1	14.3	0.07	0.01
C4's	0.00E+00	0.00E+00				
C5's	0.00E+00	0.00E+00				
C6's	1.12E-02	2.26E-02				
Benzene	0.00E+00	0.00E+00				
C7's	0.00E+00	0.00E+00				
Toluene	0.00E+00	0.00E+00				
C8's	1.73E-02	2.07E-02				
Xylene's	0.00E+00	0.00E+00				
C9's	1.40E-02	1.81E-02				
Trimethylbenzene	0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00				
C11's/C12's	9.64E-03	1.70E-03				
g C/10^6 g sample	314	170	1693200	1716000	8400	1200
Total g C/10^6 g	1701914	1717370				

VIN	HC's (ppm) 32760 Before	HC's (ppm) 32760 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	3.15E+01	3.04E+01	11.2	11.3	0.17	0.12
C4's	9.16E-03	3.90E-03				
C5's	6.93E-03	2.39E-03				
C6's	1.14E-02	9.20E-03				
Benzene	5.15E-03	5.76E-03				
C7's	0.00E+00	0.00E+00				
Toluene	5.98E-03	5.16E-03				
C8's	9.32E-03	1.53E-02				
Xylene's	0.00E+00	0.00E+00				
C9's	1.08E-02	1.41E-02				
Trimethylbenzene	0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00				
C11's/C12's	4.80E-03	1.35E-03				
g C/10^6 g sample	760	735	1338000	1350000	20400	14400
Total g C/10^6 g	1359160	1365135				

VIN	HC's (ppm) 28983 Before	HC's (ppm) 28983 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	1.66E+01	9.35E+00	8.4	14.3	0.01	0.09
C4's	3.29E-03	4.40E-03				
C5's	0.00E+00	0.00E+00				
C6's	1.44E-02	2.79E-02				
Benzene	0.00E+00	0.00E+00				
C7's	0.00E+00	0.00E+00				
Toluene	0.00E+00	0.00E+00				
C8's	1.65E-02	1.77E-02				
Xylene's	0.00E+00	0.00E+00				
C9's	1.53E-02	1.50E-02				
Trimethylbenzene	0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00				
C11's/C12's	6.77E-03	6.85E-03				
g C/10^6 g sample	403	231	1008000	1714800	1200	10800
Total g C/10^6 g	1009603	1725831				

VIN	HC's (ppm) 08399 Before	HC's (ppm) 08399 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	3.62E+01	2.32E+01	7.9	12.4	0.00	0.00
C4's	1.14E-02	2.28E-02				
C5's	9.28E-03	1.63E-02				
C6's	1.52E-02	2.95E-02				
Benzene	0.00E+00	0.00E+00				
C7's	0.00E+00	0.00E+00				
Toluene	0.00E+00	0.00E+00				
C8's	0.00E+00	2.20E-02				
Xylene's	2.46E-02	5.59E-03				
C9's	1.18E-02	0.00E+00				
Trimethylbenzene	0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00				
C11's/C12's	7.38E-03	1.10E-02				
g C/10^6 g sample	877	566	950400	1482000	0	0
Total g C/10^6 g	951277	1482566				

VIN	HC's (ppm) 27311 Before	HC's (ppm) 27311 After	CO_2 (%) Before	CO_2 (%) After	CO (%) Before	CO (%) After
C1's-C3's	8.67E+00	7.73E+00	14.1	13.8	0.00	0.00
C4's	0.00E+00	0.00E+00				
C5's	0.00E+00	0.00E+00				
C6's	2.60E-02	2.08E-02				
Benzene	0.00E+00	0.00E+00				
C7's	0.00E+00	0.00E+00				
Toluene	0.00E+00	0.00E+00				
C8's	1.43E-02	1.58E-02				
Xylene's	0.00E+00	0.00E+00				
C9's	9.82E-03	1.14E-02				
Trimethylbenzene	0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00				
C11's/C12's	2.44E-03	1.77E-03				
g C/10^6 g sample	213	190	1692000	1650000	0	0
Total g C/10^6 g	1692213	1650190				

CARBON ANALYSIS

12/6/96

VIN	HC's (ppm) 31986		CO_2 (%)		CO (%)		HC's (ppm) 86770		CO_2 (%)		CO (%)		HC's (ppm) 86665		CO_2 (%)		CO (%)	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
C1's-C3's	4.52E+00	6.81E+00	13.8	14.2	0.00	0.03	7.53E+01	2.00E+02	13.0	11.7	1.78	3.47	9.04E+00	8.02E+00	14.1	14.3	0.06	0.03
C4's	0.00E+00	0.00E+00					2.89E-02	9.98E-02					4.51E-03	4.51E-03				
C5's	0.00E+00	0.00E+00					2.08E-02	6.02E-02					0.00E+00	0.00E+00				
C6's	1.08E-02	9.88E-03					3.52E-02	3.33E-02					1.51E-02	5.75E-03				
Benzene	0.00E+00	0.00E+00					9.28E-02	1.98E-01					0.00E+00	0.00E+00				
C7's	0.00E+00	0.00E+00					4.36E-03	3.00E-02					0.00E+00	0.00E+00				
Toluene	0.00E+00	0.00E+00					2.26E-02	1.03E-01					0.00E+00	0.00E+00				
C8's	1.85E-02	1.87E-02					1.92E-02	2.33E-02					1.57E-02	1.86E-02				
Xylene's	0.00E+00	0.00E+00					1.78E-02	1.03E-01					0.00E+00	0.00E+00				
C9's	1.26E-02	1.18E-02					1.37E-02	2.53E-02					1.59E-02	1.04E-02				
Trimethylbenzene	0.00E+00	0.00E+00					0.00E+00	5.73E-03					0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00					0.00E+00	0.00E+00					0.00E+00	0.00E+00				
C11's/C12's	7.71E-03	1.97E-03					6.04E-03	0.00E+00					5.64E-03	0.00E+00				
g C/10 g sample	114	167	1659600	1707600	0	3600	1827	4858	1562400	1408800	213600	416400	222	196	1695600	1710000	7200	3600
Total g C/10 g	1659714	1711367					1777827	1830058					1703022	1713798				

FUEL CAT
12/9/96

VIN	HC's (ppm) 31986		CO_2 (%)		CO (%)		HC's (ppm) 86582		CO_2 (%)		CO (%)		HC's (ppm) 10406		CO_2 (%)		CO (%)	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
C1's-C3's	7.76E+00		8.2		0.03		3.52E+01	3.67E+01	10.2	9.6	0.00	0.00	4.98E+01	4.33E+01	12.7	12.0	0.00	0.00
C4's	0.00E+00						7.99E-03	8.53E-03					6.16E-03	5.48E-03				
C5's	0.00E+00						7.07E-03	6.33E-03					6.63E-03	1.72E-03				
C6's	3.14E-02						4.34E-02	8.18E-03					5.29E-02	2.61E-02				
Benzene	0.00E+00						0.00E+00	0.00E+00					0.00E+00	0.00E+00				
C7's	0.00E+00						0.00E+00	0.00E+00					0.00E+00	0.00E+00				
Toluene	0.00E+00						0.00E+00	0.00E+00					0.00E+00	0.00E+00				
C8's	9.05E-03						1.41E-02	1.03E-02					1.33E-02	1.40E-02				
Xylene's	0.00E+00						0.00E+00	0.00E+00					0.00E+00	0.00E+00				
C9's	4.82E-03						0.00E+00	4.68E-02					1.24E-02	7.04E-03				
Trimethylbenzene	0.00E+00						0.00E+00	0.00E+00					0.00E+00	0.00E+00				
C10's	8.22E-03						4.86E-02	6.65E-03					0.00E+00	0.00E+00				
C11's/C12's	8.93E-02						4.83E-02	1.11E-02					1.85E-01	6.33E-02				
g C/10 g sample	203	0	985200	0	3600	0	862	891	1218000	1147200	0	0	1227	1052	1526400	1435200	0	0
Total g C/10 g	989003	0					1218862	1148091					1527627	1436252				

VIN	HC's (ppm) 64002		CO_2 (%)		CO (%)		HC's (ppm) 37188		CO_2 (%)		CO (%)		HC's (ppm) 49016		CO_2 (%)		CO (%)	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
C1's-C3's	2.77E+02	2.53E+02	12.9	12.2	0.56	0.47	6.42E+01	7.59E+01	13.0	12.6	0.27	0.30	4.36E+01	4.29E+01	9.1	11.0	0.00	0.00
C4's	5.79E-02	5.65E-02					2.09E-02	2.98E-02					1.64E-02	1.45E-02				
C5's	5.99E-02	5.30E-02					1.66E-02	2.25E-02					6.44E-03	5.43E-03				
C6's	8.21E-02	5.41E-02					4.03E-02	2.89E-02					3.75E-03	7.84E-03				
Benzene	2.65E-02	2.57E-02					5.24E-03	9.82E-03					0.00E+00	0.00E+00				
C7's	1.00E-02	1.01E-02					0.00E+00	2.16E-03					0.00E+00	0.00E+00				
Toluene	6.09E-02	5.71E-02					6.19E-03	9.91E-03					0.00E+00	0.00E+00				
C8's	1.01E-02	7.94E-03					1.35E-02	1.06E-02					1.64E-02	1.18E-02				
Xylene's	6.84E-02	6.24E-02					0.00E+00	5.70E-03					0.00E+00	0.00E+00				
C9's	1.61E-02	1.38E-02					1.36E-02	9.61E-03					0.00E+00	5.28E-03				
Trimethylbenzene	6.00E-03	4.94E-03					0.00E+00	0.00E+00					0.00E+00	0.00E+00				
C10's	3.04E-03	3.89E-03					0.00E+00	2.86E-03					0.00E+00	0.00E+00				
C11's/C12's	1.84E-02	9.19E-03					8.07E-02	7.55E-02					7.41E-03	6.51E-02				
g C/10 g sample	6675	6106	1544400	1462800	67200	56400	1561	1842	1556400	1509600	32400	36000	1050	1041	1096800	1323600	0	0
Total g C/10 g	1618278	1525306					1590361	1547442					1097850	1324641				

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VIN	HC's (ppm) 26038 Before	After	CO_2 (%) Before	After	CO (%) Before	After	HC's (ppm) 31998 Before	After	CO_2 (%) Before	After	CO (%) Before	After	HC's (ppm) 98643 Before	After	CO_2 (%) Before	After	CO (%) Before	After
C1's-C3's	6.74E+01	5.73E+01	12.3	13.9	0.18	0.12	1.78E+01		13.5		0.13		6.83E+01	6.36E+01	12.0	11.9	0.04	0.01
C4's	1.97E-02	1.57E-02					0.00E+00						2.54E-02	2.51E-02				
C5's	1.99E-02	1.60E-02					0.00E+00						6.03E-02	2.14E-02				
C6's	3.13E-02	1.41E-02					6.08E-03						1.15E-02	4.55E-02				
Benzene	5.84E-03	0.00E+00					0.00E+00						4.00E-03	0.00E+00				
C7's	0.00E+00	2.19E-03					0.00E+00						0.00E+00	0.00E+00				
Toluene	6.54E-03	0.00E+00					0.00E+00						8.07E-03	5.93E-03				
C8's	9.09E-03	1.37E-02					1.35E-02						1.01E-02	1.21E-02				
Xylene's	5.00E-03	0.00E+00					0.00E+00						0.00E+00	0.00E+00				
C9's	0.00E+00	2.46E-03					9.37E-03						0.00E+00	8.45E-03				
Trimethylbenzene	0.00E+00	0.00E+00					0.00E+00						0.00E+00	0.00E+00				
C10's	0.00E+00	0.00E+00					0.00E+00						0.00E+00	0.00E+00				
C11 thru C12's	5.02E-02	6.58E-03					1.66E-03						1.28E-02	8.41E-03				
g C/10^6 g sample	1630	1381	1478400	1663200	21600	14400	430	0	1623600	0	15600	0	1648	1536	1436400	1425600	4800	1200
Total g C/10^6 g	1501630	1678981					1639630	0					1442848	1428336				

12/10/96

VIN	HC's (ppm) 26275 Before	After	CO_2 (%) Before	After	CO (%) Before	After	HC's (ppm) 68774 Before	After	CO_2 (%) Before	After	CO (%) Before	After
C1's-C3's	4.03E+01	2.36E+01	11.4	12.4	0.00	0.01	2.65E+01	2.87E+01	13.0	13.1	0.00	0.14
C4's	1.30E-02	1.18E-02					0.00E+00	5.89E-03				
C5's	9.91E-03	7.21E-03					0.00E+00	1.28E-02				
C6's	4.23E-02	3.28E-02					2.27E-02	0.00E+00				
Benzene	0.00E+00	0.00E+00					0.00E+00	4.04E-03				
C7's	0.00E+00	5.97E-03					0.00E+00	0.00E+00				
Toluene	5.37E-03	5.48E-03					0.00E+00	0.00E+00				
C8's	1.01E-02	1.04E-02					8.80E-03	1.10E-02				
Xylene's	0.00E+00	0.00E+00					0.00E+00	0.00E+00				
C9's	7.03E-03	8.25E-03					2.49E-03	5.61E-03				
Trimethylbenzene	0.00E+00	0.00E+00					0.00E+00	0.00E+00				
C10's	3.97E-02	0.00E+00					0.00E+00	0.00E+00				
C11 thru C12's	6.16E-03	7.22E-03					1.30E-02	6.58E-03				
g C/10^6 g sample	980	574	1364400	1491600	0	1200	640	693	1558800	1566000	0	16800
Total g C/10^6 g	1365380	1493374					1559440	1583493				

COMPLIANCE AND RESEARCH
12/16/96

VIN	HC's (ppm) 31998 Before	After	CO_2 (%) Before	After	CO (%) Before	After	HC's (ppm) 53059 Before	After	CO_2 (%) Before	After	CO (%) Before	After	HC's (ppm) 32083 Before	After	CO_2 (%) Before	After	CO (%) Before	After
C1's-C3's	8.57E+00		14.4		0.01		2.04E+02	2.31E+02	12.3	11.9	0.52	0.65	1.88E+02	8.97E+01	10.2	11.3	0.70	0.04
C4's	0.00E+00						9.57E-02	6.88E-02					3.43E-02	1.84E-02				
C5's	0.00E+00						5.06E-02	6.29E-02					2.75E-02	1.45E-02				
C6's	1.77E-02						3.54E-02	5.86E-02					2.96E-02	1.45E-02				
Benzene	0.00E+00						2.56E-02	2.46E-02					2.34E-02	4.45E-02				
C7's	0.00E+00						8.94E-03	1.11E-02					0.00E+00	0.00E+00				
Toluene	0.00E+00						7.03E-02	7.12E-02					4.09E-02	1.03E-02				
C8's	1.35E-02						8.63E-03	7.58E-03					1.50E-02	1.78E-02				
Xylene's	0.00E+00						6.05E-02	6.47E-02					4.76E-02	8.29E-03				
C9's	1.11E-02						9.65E-03	1.00E-02					8.76E-03	0.00E+00				
Trimethylbenzene	0.00E+00						0.00E+00	4.47E-03					0.00E+00	0.00E+00				
C10's	0.00E+00						0.00E+00	0.00E+00					0.00E+00	2.63E-02				
C11 thru C12's	5.62E-03						7.56E-03	7.89E-03					7.98E-03	2.15E-02				
g C/10^6 g sample	210	0	1725600	0	1200	0	4933	5581	1473600	1423200	62400	78000	4519	2169	1224000	1359600	84000	4800
Total g C/10^6 g	1727010	0					1540933	1506781					1312519	1366569				

CARBON ANALYSIS