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Technical Report

Exhaust Emissions from In-Use High-Mileage Passenger Cars 1979 Model Year California Vehicles

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I. Abstract

This report contains an analysis of the results of Federal Test Procedure (FTP) emissions testing of 98 1979 model year California vehicles that had accumulated between 40,000 and 50,000 miles. The vehicles were procured from the general public and represented the largest selling models and engines marketed by the major domestic manufacturers during the 1979 model year. All vehicles were screened for proper use and maintenance. Also, prior to initial emissions testing, minor control system disablements and engine parameter maladjustments were corrected. Although some differences exist, the screening criteria and program protocols were such that the test results are comparable to present Recall surveillance testing. Following initial testing, the vehicles that failed to meet the 1979 California standards (HC = 0.41 g/mi, CO = 9.0 g/mi, NOx = 1.5 g/mi) received restorative maintenance and were retested.

Test results indicate that the vehicles tested were generally not in compliance with the HC standard. CO and NOx performance was better than HC performance with fewer vehicles failing and average levels generally at or near the standard. The overall average emission levels for the initial test were 0.73 g/mi for total hydrocarbon (THC), 0.60 g/mi for nonmethane hydrocarbon (NMHC), 8.5 g/mi for CO, and 1.6 g/mi for NOx. None of the manufacturers had average HC (THC or NMHC) levels below the 0.41 g/mi standard. The restorative maintenance was successful in reducing NOx and CO but was less successful in reducing HC. The overall average after-maintenance levels for CO and NOx were below the applicable standards while the average after-maintenance HC level remained above the standard.

II. Introduction

The Office of Mobile Sources (OMS) has been examining various alternative motor vehicle emission compliance programs. As part of this evaluation the possibility of assessing compliance based on the performance of properly used and maintained light-duty vehicles near the end of their statutory useful-life (50,000 miles) has been discussed. To do this type of compliance assessment, vehicles could, for example, be tested between 40,000 and 50,000 miles. To evaluate the impact of the concept of testing vehicles between 40,000 and 50,000 miles we need to evaluate the effects of this type of program proposal on the stringency of the emission compliance program, the causes and potential remedies of noncompliance, and the cost and associated difficulties in conducting such a high mileage compliance program. This report analyzes emission data generated by a sample of properly used and maintained 1979 model year California vehicles, and discusses how these data relate to compliance program stringency and noncompliance remedies. The analysis of test program costs and implementation are contained in a separate report entitled "A Summary of the Procurement Activities of In-Use High Mileage Passenger Cars (the AESI Small Sample Study)," EPA Report No. EPA-AA-CPSB-83-07.

The stringency of a compliance program is related to the requirements placed on the manufacturers as a result of the structure of the compliance program itself. The current emission compliance program requires vehicles to be capable of compliance with the emission standards for their statutory useful life (5 years or 50,000 miles for light-duty vehicles). Although very little testing currently is done between 40,000 and 50,000 miles, properly maintained and used vehicles within this mileage range should be meeting the emission standards under the current rules. Thus, current requirements lead us to assume that the stringency of the compliance program should be unaffected by changes in compliance testing mileages. The data generated under this testing program will allow us to begin to evaluate this assumption by measuring the capability of current vehicles to comply with emission standards between 40,000 to 50,000-miles.

Having quantified the ability of in-use vehicles to meet emission standards, we must also examine options to remedy noncompliance when it occurs. The noncompliance remedy issue deals with the ability of the compliance program to effectively identify emission noncompliance and cause that noncompliance to be corrected. To evaluate a manufacturer's ability to remedy noncompliance, we need to examine the responsiveness of those vehicles that fail to meet the standards to restorative maintenance and the type of restorative maintenance necessary to remedy the emission noncompliance. The types of vehicle failures that are encountered in-use between 40,000 and 50,000 miles and the maintenance necessary to correct these failures must be considered when evaluating the effectiveness of a compliance program. For example, certain types of vehicle problems can be efficiently repaired in the field while others are more effectively corrected by design changes. The compliance program structure should be such that it can effectively handle the types of problems encountered most often.

Two EPA programs currently collect emission data on in-use vehicles; the present in-use compliance (Recall) program and the Emission Factors program. The current Recall program has authority to determine compliance through 50,000 miles. However, vehicles are typically tested for compliance at a lower average mileage. Few individual vehicles close to 50,000 miles have been tested in the Recall program. The Emission Factors program has tested many vehicles in the 40,000 to 50,000-mile range. However, Emission Factors vehicles are not screened for proper use and maintenance and are, therefore, generally ineligible for use in a compliance determination. (The Clean Air Act relieves the manufacturers of the responsibility of assuring the emission compliance of vehicles that are <u>not</u> properly used and maintained.) Thus, insufficient data were available to evaluate a high mileage in-use compliance program.

Because the available data on properly used and maintained in-use vehicles in the 40,000-50,000 mile range were too limited to adequately address the necessary issues, a testing program was initiated to gather additional data. This report presents the data from the first phase of this data-gathering process. Testing of subsequent model year Federal vehicles is underway. In a future report, all pertinent high mileage information will be considered to provide a consolidated analysis.

This initial data-gathering effort was conducted under contract at the AESi facility in the Los Angeles area of California. The vehicles tested in this first testing phase were 1979 model year gasoline-fueled light-duty vehicles certified for sale in California. 1979 model year California vehicles were selected for testing for this program because they were equipped with the most current emission control technology for vehicles that were old enough to have accumulated the necessary 40,000 to 50,000 miles at the time the testing took place. The actual average test vehicle mileage for this test program was 43,806 miles. The vehicles were procured from the general public in Los Angeles and Orange counties in California.

All of the vehicles were screened for proper use and maintenance and inspected by AESi mechanics. Vehicles that had not received proper maintenance and those with major control system disablements were rejected from the program. Minor disablements and maladjustment were corrected prior to the initial test. These protocols were followed so that our test fleet would represent properly used and maintained vehicles including proper engine parameter adjustments.

The vehicle screening and inspection criteria were similar to the criteria used in the Recall surveillance program. The initial tests performed in this test program are generally comparable to the Agency's Recall program surveillance tests. While in some cases the specific protocols are different, these differences are not expected to significantly influence measured average emission performance. Thus, these data represent a reasonable measure of manufacturer compliance at high mileage for these classes of vehicles.

Each vehicle accepted into the program was tested using the Federal Test Procedure as outlined in 40 CFR Part 86 Subpart B. Vehicles that did not meet the 1979 California emission standards of 0.41 g/mi HC, 9.0 g/mi CO, and 1.5 g/mi NOx were repaired and retested. The goal of the repair process was to correct the causes of the emission failures and restore the vehicles to manufacturer design specification, hopefully so that they could meet the standards. In many instances, representatives of the various manufacturers aided in the diagnosis and repair process.

The vehicle sample procured and tested for the program is shown in Appendix 1. The sample consisted of vehicles representing the largest selling model types and engine displacements for each of the three major domestic manufacturers; GM, Ford, and Chrysler. Some Mitsubishi vehicles were also included because they represented a significant portion of Chrysler's product offering.

Individual vehicle test results are shown in Appendix 2. A brief summary of the test vehicle procurement, inspection, and maintenance procedures is contained in Appendix 3. As discussed earlier, a detailed discussion of the vehicle procurement for this program is contained in a separate report.

III. Test Results

A. The 1979 California HC Standard

Before beginning the discussion of this program's test results, a brief discussion of the 1979 California HC standard is warranted. The 1979 California HC standard applies to nonmethane HC. To be in compliance with the 1979 California 0.41 g/mi HC standard a vehicle's total HC level multiplied by the appropriate Methane Content Correction Factor (MCCF) must be below the 0.41 g/mi level. For the 1979 model year, the California Air Resources Board allowed the use of a general MCCF of 0.89. In addition, manufacturers were allowed to use alternative MCCF's if they could demonstrate that the alternative MCCF's better represented the performance of their vehicles. Therefore, from the standpoint of compliance with the 1979 California HC standard of 0.41 g/mi, the relevant HC level is the factored or nonmethane HC level. The Federal program, however, uses total HC as the value to compare against the Federal standard. Therefore, the total HC level is the level relevant to the Federal Program.

For this report parallel calculations were made for total HC (THC) and mon-methane HC (NMHC). Pass/Fail rates were also determined based on both THC and NMHC levels. For making pass/fail determinations the THC and NMHC levels were compared to the 0.41 g/mi standard.

While much of the discussion in the report will focus on the THC levels the reader should keep in mind that the manufacturers designed, certified, and built their 1979 model year California vehicles to comply with the 0.41 g/mi HC standard by using emission levels factored by the appropriate MCCF. The MCCF's applied to the test data for each engine family tested are shown in Table 4.

B. Initial Test Data--Overview

The discussion of the test data that follows, and the related tables and figures, concentrate mainly on various average emission levels. The nature of the averaging process tends, at times, to obscure some of the detail of the underlying data. To give the reader some feel for the profile and range of the underlying data, Figures 1 through 4 have been prepared. For these figures, the initial test results were sorted by emission level in ascending order for each pollutant. These sorted emission levels were then plotted. Each point on the plot represents the emission level of one of the 98 initial tests. The vehicle with the lowest test level is on the left with levels increasing to the right in ascending order. Also plotted in these figures are the applicable emission standards. By examining these figures we find that most of the vehicles have emission levels that are grouped near the standard (the left and center portions of the curves). There is also a second smaller group of vehicles that has higher and more variable emission levels (portion of the curve near the right end where the slope begins to increase). Finally on the far right of the figures we find a very small group of vehicles with very high emission levels.

These figures also allow the reader to graphically evaluate the total emissions generated by the test fleet. The areas shown under the curves representing the emission levels represent the total amount of each pollutant emitted by the test fleet. The areas under the standard lines represent the total amount of each pollutant allowed by the standards. The areas that lie above the emission level curves and below the standard lines on the left end of each figure represent the amount by which the passing vehicles were able to better the standards. On the right end of each figure where the emission level curves are above the standard lines (test vehicles failed to meet the standards) the areas between the lines represent the amount of each pollutant that is in excess of that allowed by the standards. The differences between the two areas under the emission level curves and the standard lines represent the total amounts of pollutant emitted by the test fleet that are above or below the amounts allowed by the standards. These values have been calculated and are shown in Table 1, below.

Table 1
Total Emission*
Initial Tests

	Number of Vehicles	Total Amount Measured	Total** Amount Allowed by Standard	Excess Amount	Excess as Percent of Amount Allowed
THC	98	72	40	32	80
NMHC	98	59	40	19	48
CO	98	832	882	-50	-6
NOx	98	160	147	13	9

* The emission values shown are grams of pollutant emitted for each mile traveled by the entire fleet (grams per fleet mile).

** Total amount allowed = standard x number of vehicles.

Figure 1
THC Performance in Ascending Order
Initial Test Data

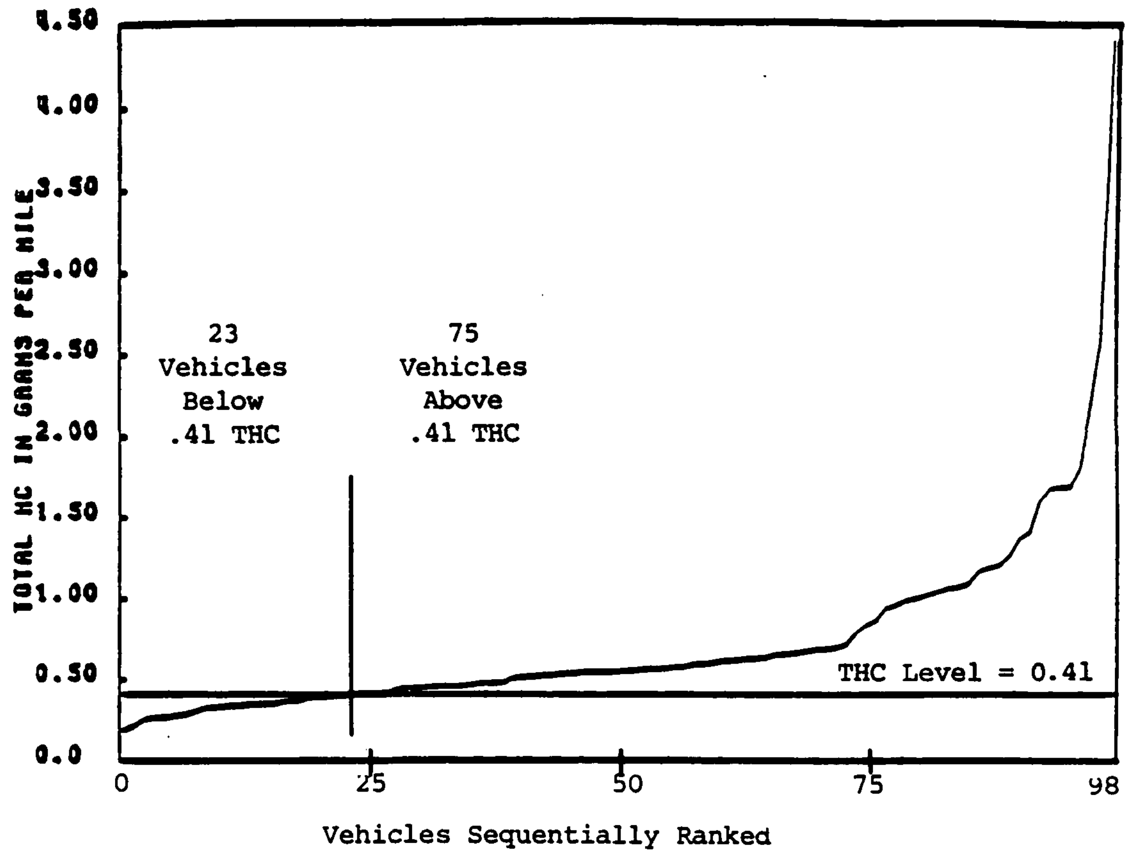


Figure 2
NMHC Performance in Ascending Order
Initial Test Data

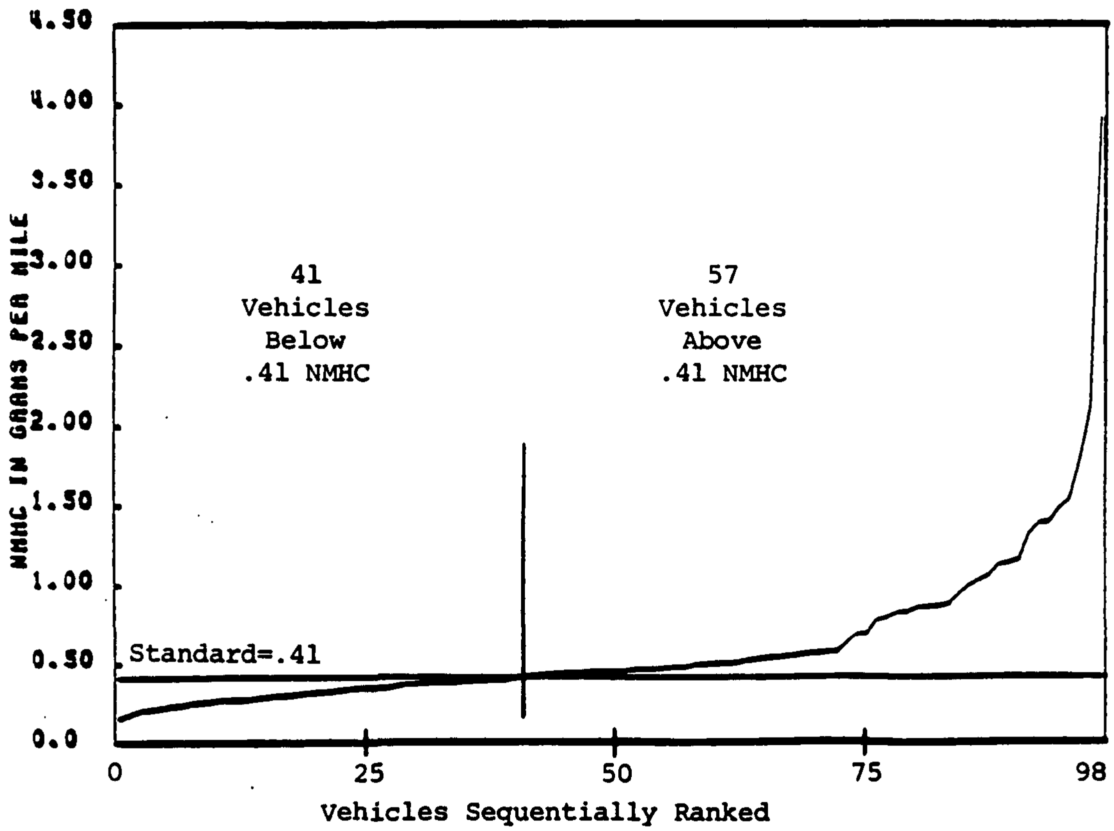


Figure 3
CO Performance in Ascending Order
Initial Test Data

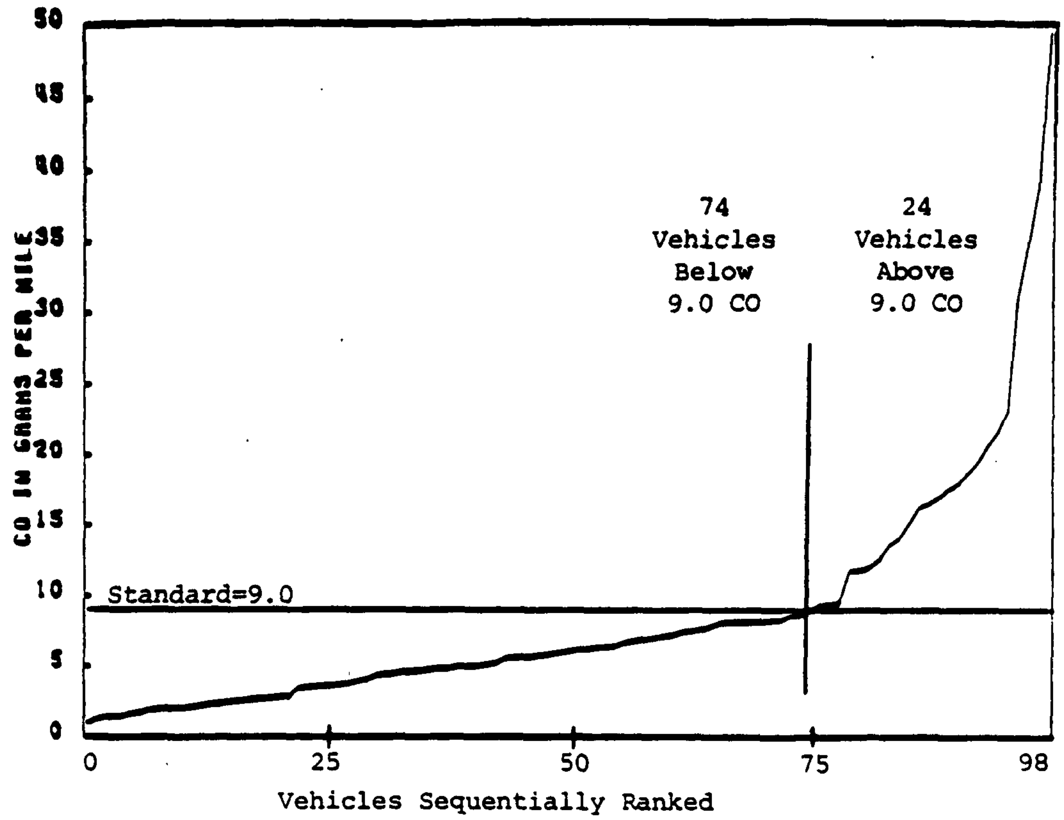
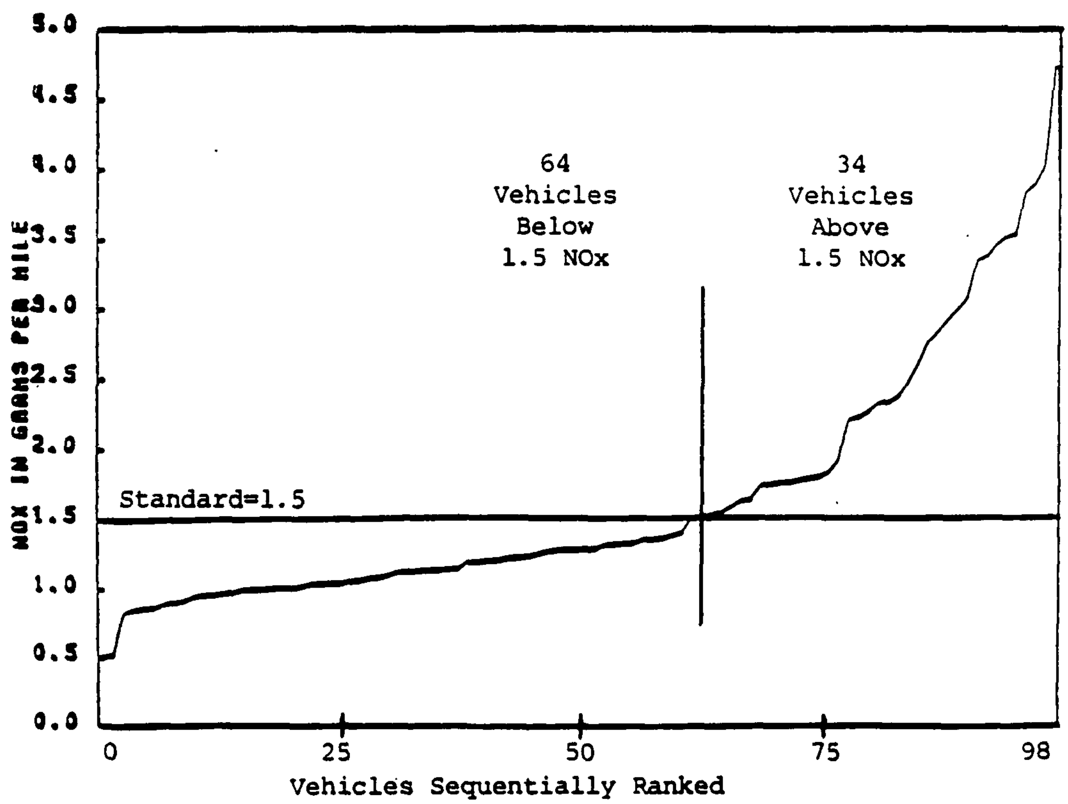


Figure 4
NOx Performance in Ascending Order
Initial Test Data



The total amount of pollutant exceeds the allowable amount for all pollutants except CO. THC and NMHC have the highest percentage exceedances of 80 percent and 48 percent respectively. The NOx exceedance is lower at 9 percent.

C. Initial Test Data--Detail

Table 2 and Figures 5 through 8 contain the average emission levels for each manufacturer for the initial emission tests. Again, these levels are representative of manufacturers' compliance levels for the particular vehicles tested. None of the manufacturers had initial average THC or NMHC levels below the 0.41 g/mi standard. Only Ford had an initial average CO level below the 9.0 g/mi standard. General Motors and Chrysler had initial average NOx levels at or below the 1.5 g/mi standard. THC and NMHC were the most consistently failed pollutants with the highest initial overall percent of standard average emission level (0.733 g/mi or 179 percent of the standard for THC and 0.600 g/mi or 146 percent of the standard for NMHC). The overall initial average CO emission level was below the standard (8.49 g/mi or 94 percent of the standard) and the overall initial average NOx level was slightly above the standard (1.63 g/mi or 109 percent of the standard).

Table 3 shows the pass/fail rates for each manufacturer for the initial test. In Table 3 the number of vehicles that met the standards for all three pollutants is shown in the "total pass" column. Separate pass rates were prepared based on THC and NMHC. The percentage figures shown are the percentages of each manufacturers' total. The numbers shown in the "total failed" columns for each pollutant are the number of vehicles failing to meet the California standard for that pollutant. Because some vehicles failed to meet the standards for more than one pollutant the total of the failed columns will exceed the total number of vehicles tested. Again separate failure rates were prepared for THC and NMHC. For the 98 vehicles tested in this program, 13 percent (13 vehicles) met the California standards for all 3 pollutants based on THC. Twenty-four percent (24 vehicles) met all 3 standards based on NMHC. Figure 9 shows the pass/fail breakdown for all pollutants and combinations of pollutants.

The average emission levels and failure rates for each engine family tested are shown in Table 4. When examining this data the reader must keep in mind that the number of vehicles tested per engine family varied considerably (only one vehicle was tested in some families). The pass/fail rates are shown as percentages and are particularly susceptible to misinterpretation if the engine family sample size is not taken into consideration.

Based on THC, General Motors' engine family 940E2LU (231-CID V-6) had the best pass/fail performance with a 50 percent pass rate (Ford engine family 1.6G1X128 also had a 50 percent pass rate but only two vehicles were tested in that

Table 2
Average Emission Levels
Initial Test

Manufacturer	Number of Vehicles	Total HC Average	Non-Methane* HC Average	CO Average	NOx Average
GM	54	.729	.593	9.34	1.52
Ford	33	.569	.446	4.31	1.81
Chrysler	7	.740	.629	13.33	1.38
Mitsubishi	4	2.140	1.905	23.10	1.96
All	98	.733	.600	8.49	1.63

1979 California Standards:

HC = .41 (Non-Methane)*
CO = 9.0
NOx = 1.5

Average Vehicle Mileage:

43,806 miles

*Non-Methane HC = Total HC x Methane Content Correction Factor.

Figure 5
Average THC Levels
Initial Test Data

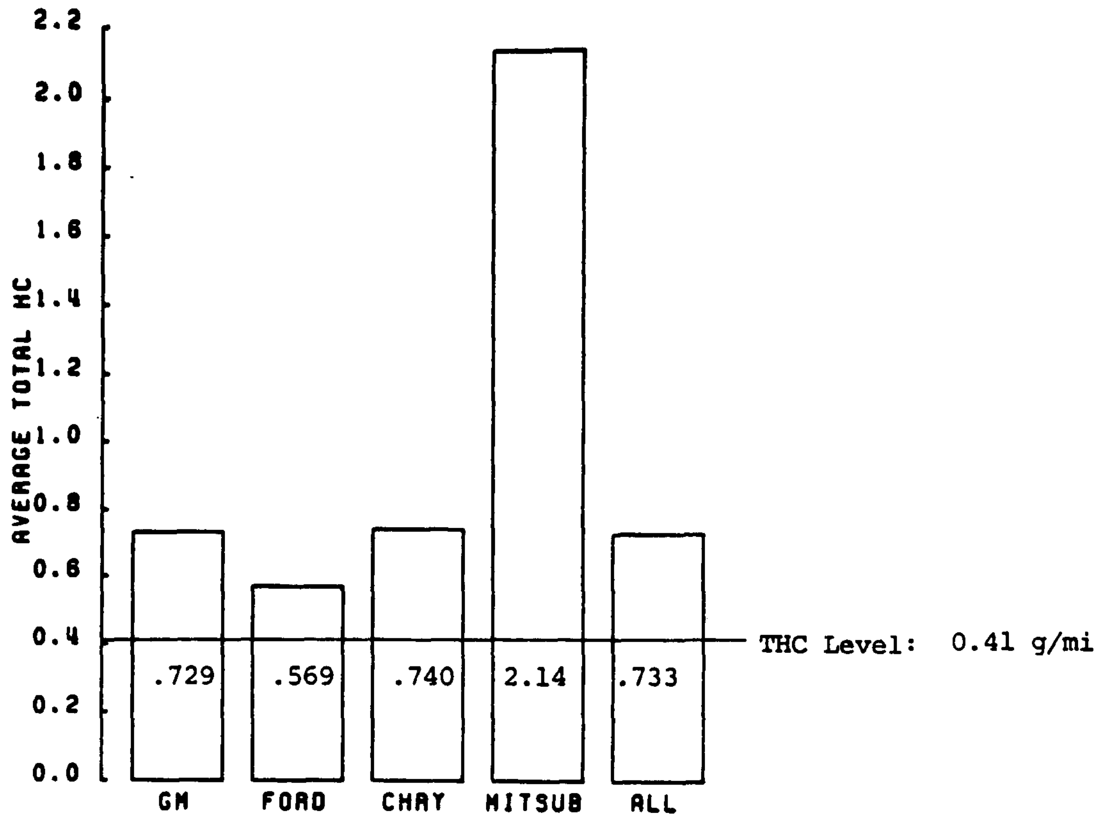


Figure 6
Average NMHC Levels
Initial Test Data

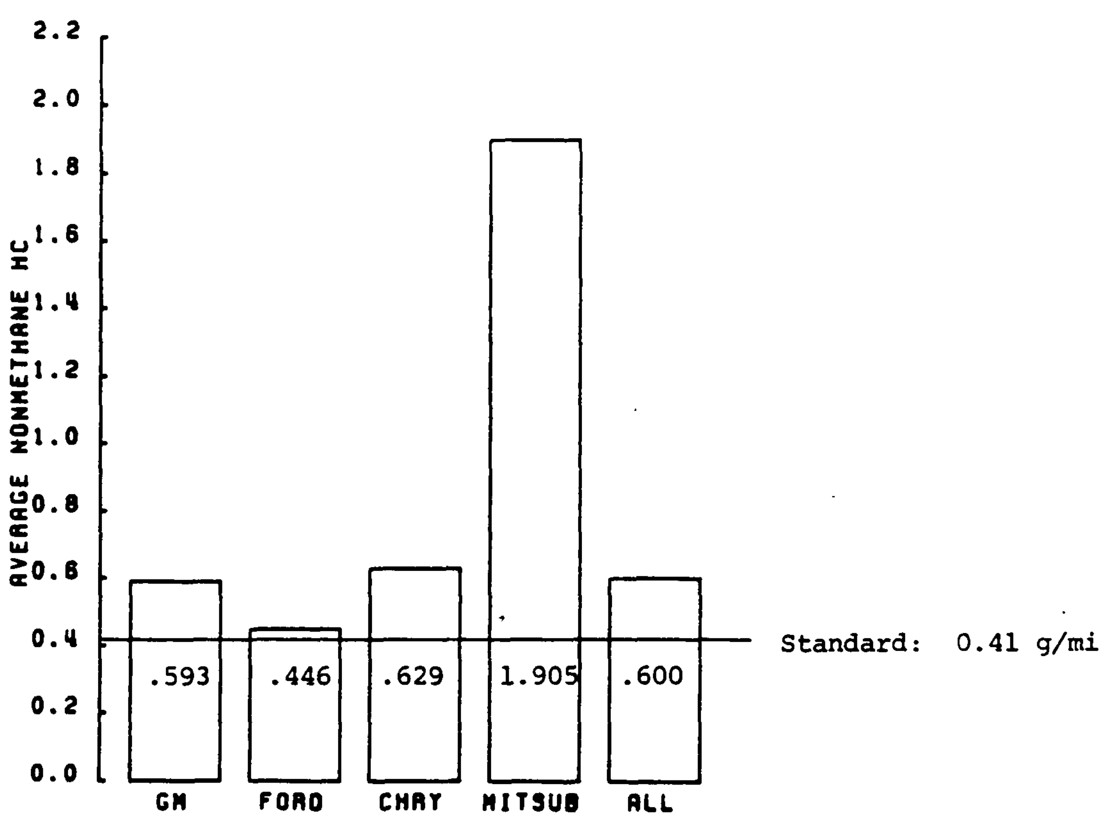


Figure 7
Average CO Levels
Initial Test Data

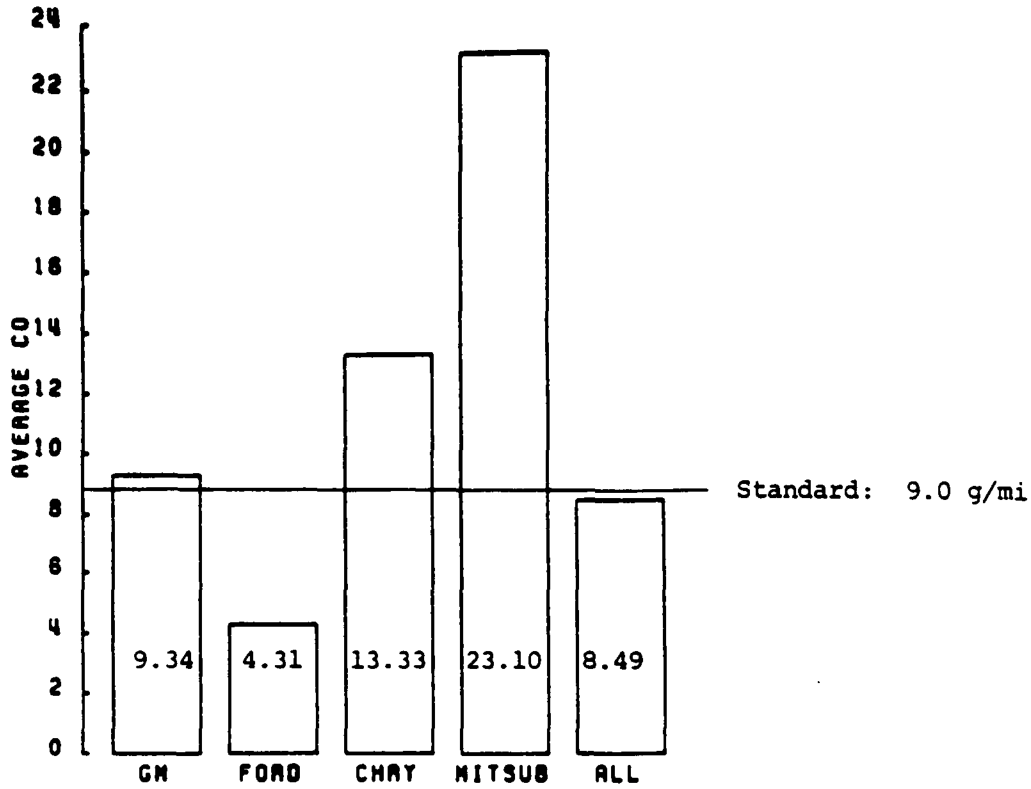


Figure 8
Average NOx Levels
Initial Test Data

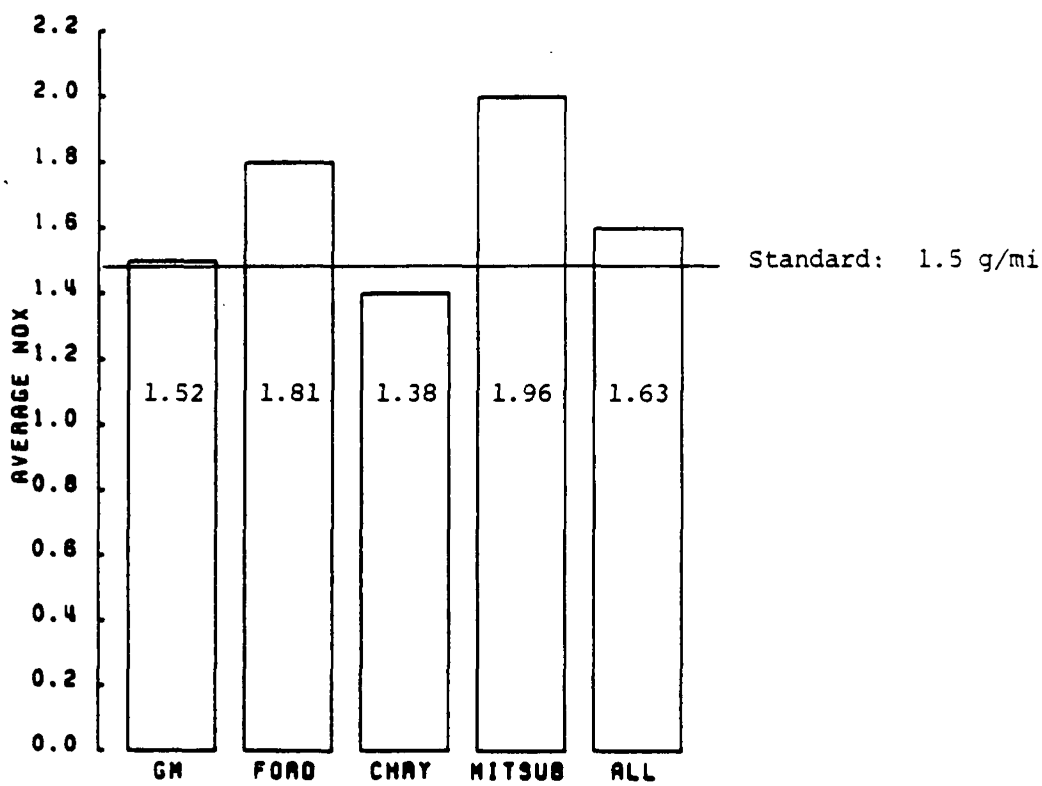


Table 3
Pass/Fail Rates
Initial Test

MFR	Number of Vehicles	Total Pass	Percent Pass	Total Failed HC	Percent Failed HC	Total Failed CO	Percent Failed CO	Total Failed NOx	Percent Failed NOx
GM	54	9(THC*) 19(NMHC**)	17(THC) 35(NMHC)	43(THC) 30(NMHC)	80(THC) 56(NMHC)	15	28	14	26
Ford	33	4(THC) 5(NMHC)	12(THC) 15(NMHC)	21(THC) 17(NMHC)	64(THC) 52(NMHC)	2	6	16	48
Chrysler	7	0(THC) 0(NMHC)	0(THC) 0(NMHC)	7(THC) 6(NMHC)	100(THC) 86(NMHC)	3	43	2	29
Mitsubishi	4	0(THC) 0(NMHC)	0(THC) 0(NMHC)	4(THC) 4(NMHC)	100(THC) 100(NMHC)	4	100	2	50
All	98	13(THC) 24(NMHC)	13(THC) 24(NMHC)	75(THC) 57(NMHC)	77(THC) 58(NMHC)	24	24	34	35

*Based on Total Hydrocarbon (THC) compared to .41 g/mi.

**Based on Non-Methane Hydrocarbons (NMHC) compared to .41 g/mi.
NMHC = THC x Methane Content Correction Factor.

Figure 9
Combined Pass/Fail Rates
Initial Test Data

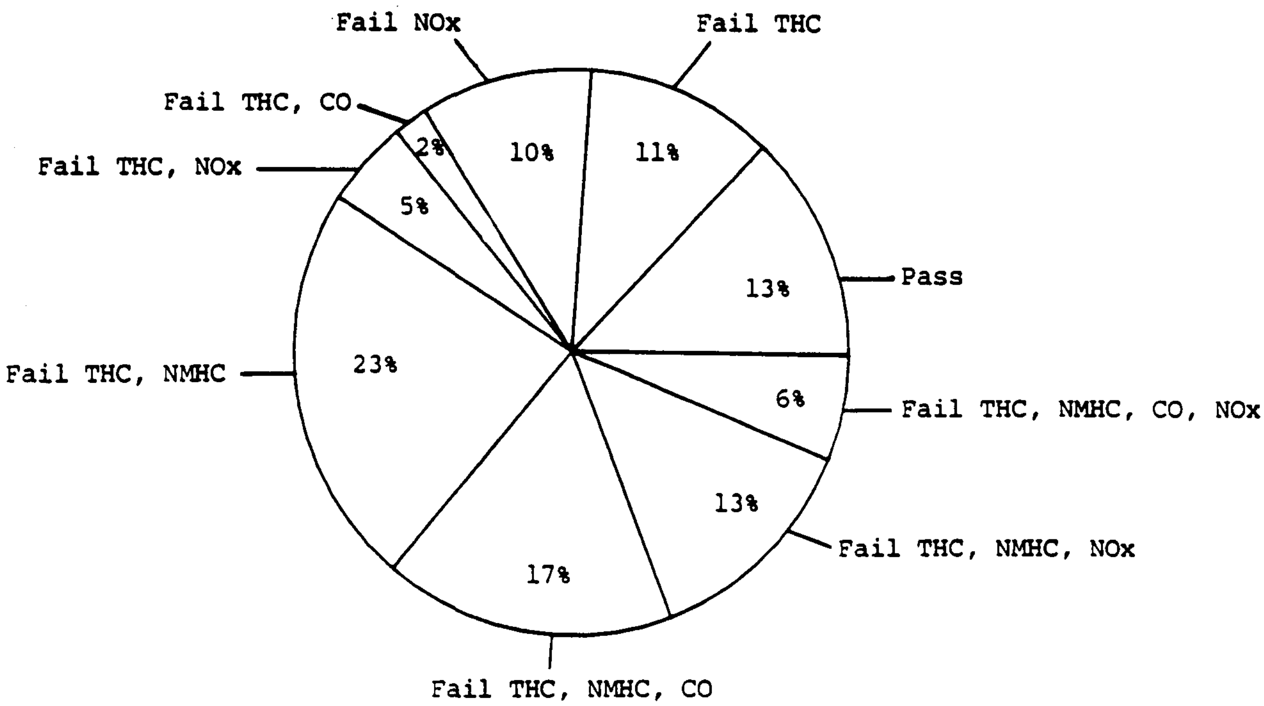


Table 4
Engine Family and Manufacturer
Average Emission Levels and Failure Rates
Initial Tests

Manufacturer	Engine Family	Number of Vehicles	MCCF	Average THC	Average NMHC	Average CO	Average NOx	Percent Pass Based on THC	Percent Pass Based on NMHC	Percent Failed THC	Percent Failed NMHC	Percent Failed CO	Percent Failed NOx
GM	910W2KQU	6	.81	1.560	1.260	14.80	1.73	0	0	100	100	50	33
GM	920X2CEU	1	.81	.460	.373	6.23	1.00	0	100	100	0	0	0
GM	930H2AU	8	.81	.539	.436	7.60	1.12	13	25	88	75	13	13
GM	940E2CYU	2	.89	.785	.699	7.36	2.84	0	0	100	100	0	100
GM	940E2LU	12	.81	.639	.518	9.91	1.90	50	50	42	33	25	33
GM	940E4DVT	1	.81	1.710	1.385	18.13	1.79	0	0	100	100	100	100
GM	940E4DVY	1	.81	.550	.446	8.65	2.22	0	0	100	100	0	100
GM	910L4RU	12	.81	.697	.564	8.63	1.10	8	33	92	67	33	8
GM	910Y2V	11	.81	.490	.397	7.68	1.47	9	55	82	18	27	18
GM	All	54	N/A	.729	.593	9.34	1.52	17	35	80	56	28	26

1979 California Standards:
HC = .41
CO = 9.0
NOx = 1.5

Average Vehicle Mileage:

43,806 miles

THC = Total HC
Failing THC means THC exceeded 0.41 g/mi.

NMHC = Non-Methane HC = THC x MCCF
Failing NMHC means NMHC exceeded 0.41 g/mi.

Table 4
Engine Family and Manufacturer
Average Emission Levels and Failure Rates
Initial Tests

Manufacturer	Engine Family	Number of Vehicles	MCCF	Average THC	Average NMHC	Average CO	Average NOx	Percent Pass Based on THC	Percent Pass Based on NMHC	Percent Failed THC	Percent Failed NMHC	Percent Failed CO	Percent Failed NOx
Ford	5.0AV1X150	7	.79	.841	.665	3.01	1.42	0	0	100	100	0	29
Ford	1.6G1X128	2	.83	.250	.208	1.45	1.91	50	50	0	0	0	50
Ford	2.3A1X150	12	.79	.429	.339	3.73	2.22	25	25	25	17	8	67
Ford	2.3B1TR80 XR80	4	.73	.480	.350	4.17	2.10	0	25	75	0	0	75
Ford	2.8BV1X150	2	.79	.855	.675	13.33	1.36	0	0	100	100	50	0
Ford	3.3B1X150	4	.79	.622	.492	6.27	1.32	0	0	100	100	0	25
Ford	4.1AX1X150	2	.79	.555	.438	2.58	1.52	0	0	100	100	0	50
Ford	All	33	N/A	.569	.446	4.31	1.81	12	15	64	52	6	48
Chrysler	9CD/318/360-4-GP	3	.85	.957	.813	20.46	.86	0	0	100	100	67	0
Chrysler	9CF-105-2-BP	4	.85	.578	.491	7.99	1.78	0	0	100	75	25	50
Chrysler	All	7	N/A	.740	.629	13.33	1.38	0	0	100	86	43	29
Mitsubishi	4G3M-C	2	.89	1.230	1.090	20.49	1.12	0	0	100	100	100	0
Mitsubishi	4G3P-C	2	.89	3.060	2.719	25.71	2.80	0	0	100	100	100	100
Mitsubishi	All	4	N/A	2.140	1.905	23.10	1.96	0	0	100	100	100	50
All	All	98	N/A	.733	.600	8.49	1.63	13	24	77	58	24	35

family). Based on NMHC General Motors engine family 910Y2V (305-CID V-8) did the best with a 55 percent pass rate (GM engine family 920X2CEU had a NMHC pass rate of 100 percent but only one vehicle was tested in that family). No engine family had THC based average emission levels for all three pollutants below the standard and only GM engine families 910Y2V and 920X2CEU (one vehicle tested) had NMHC based average emission levels for all three pollutants below the standard.

As noted above, the average HC (both THC and NMHC) levels and failure rates are higher than the corresponding measures for the other pollutants. The THC and NMHC failure rates for the individual families tend to indicate that HC failures are occurring across all manufacturers and all families. For example, only three (15 percent) of the 20 individual families tested had THC failure rates below 50 percent and only six families (30 percent) had NMHC failure rates below 50 percent for the initial tests.

D. Restorative Maintenance

Following the initial tests, those vehicles that failed to meet the 1979 California emission standards received extensive maintenance aimed at correcting the cause of failure. These vehicles were then retested. Table 5 and Figures 10 through 13 compare the average initial test results with the average after maintenance test results for all of the vehicles that received restorative maintenance and were retested. (Ten General Motors vehicles failed THC but passed NMHC on the initial test. These vehicles did not receive maintenance and were not retested because they met the 1979 California NMHC standard. The data from these 10 vehicles are not included in Table 5 or Figures 9 through 12. Also, one failing Ford vehicle was withdrawn from the program by the owner before it had been repaired and retested.) For the total population of retested vehicles average emission level reductions occurred for all pollutants for all manufacturers except Ford (THC, NMHC, and CO) and Mitsubishi (NOx). The overall average emission levels for all of the retested vehicles were reduced 0.07 g/mi (8 percent) for THC, 0.06 g/mi (9 percent) for NMHC, 1.43 g/mi (15 percent) for CO, and 0.44 g/mi (24 percent) for NOx. The overall average retest emission levels for all of the retested vehicles for CO and NOx were below the applicable standards following the maintenance. However, the average THC and NMHC retest levels failed to meet the 0.41 g/mi standard.

Tables 6 through 9 show the changes in emission levels resulting from the restorative maintenance for each pollutant separately. Only those vehicles that failed to meet each individual pollutant's standard on the initial test are included in the table for that pollutant. Presenting the data separately for each pollutant, rather than grouped together as in Table 5, removes the impact of the vehicles that received maintenance aimed at correcting a different pollutant's emission failure

Table 5
Average Emission Levels
Initial Tests vs After Maintenance tests
for All Retested Vehicles

Manufacturer	Number of Retested Vehicles	Total HC Initial Average	Total HC After Maintenance	Percent Change Total HC	Non-Methane* HC Initial Average	Non-Methane* HC After Maintenance	Percent Change Non-Methane HC	CO Initial Average	CO After Maintenance	Percent Change CO	NOx Initial Average	Nox After Maintenance	Percent Change NOx
GM	35	.905	.732	19	.737	.595	19	11.56	8.52	26	1.77	1.30	27
Ford	28	.605	.660	- 9	.475	.517	- 9	4.59	5.45	-19	1.90	1.27	33
Chrysler	7	.740	.649	12	.629	.551	12	13.33	11.28	15	1.38	1.19	14
Mitsubishi	4	2.140	2.123	1	1.905	1.889	1	23.10	20.74	10	1.96	2.89	-47
All	74	.843	.772	8	.691	.631	9	9.71	8.28	15	1.80	1.36	24

1979 California Standards:
HC = .41 (Non-methane)*
CO = 9.0
NOx = 1.5

Average Vehicle Mileage:

43,806 miles

*Non-methane HC = Total HC x Methane Content Correction Factor.

Figure 10
Average THC Levels
Before vs After Maintenance
All Retested Vehicles

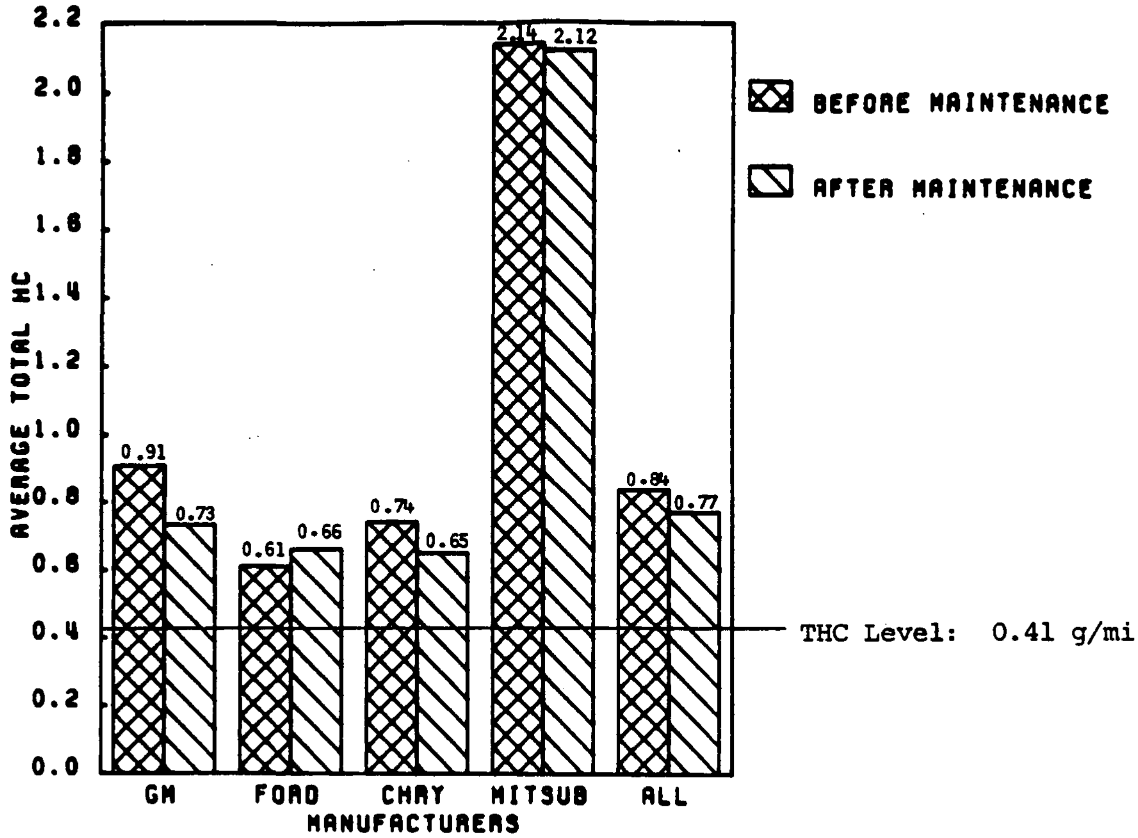


Figure 11
Average NMHC Levels
Before vs After Maintenance
All Retested Vehicles

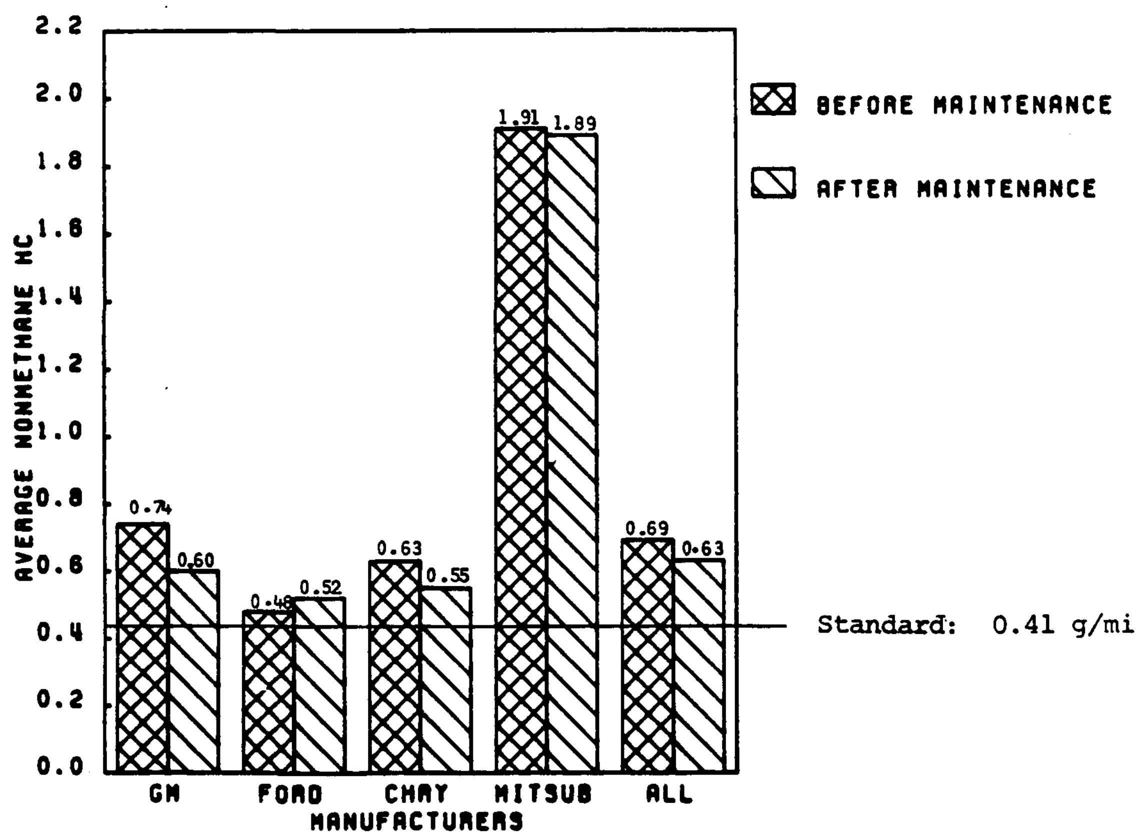


Figure 12
Average CO Levels
Before vs After Maintenance
All Retested Vehicles

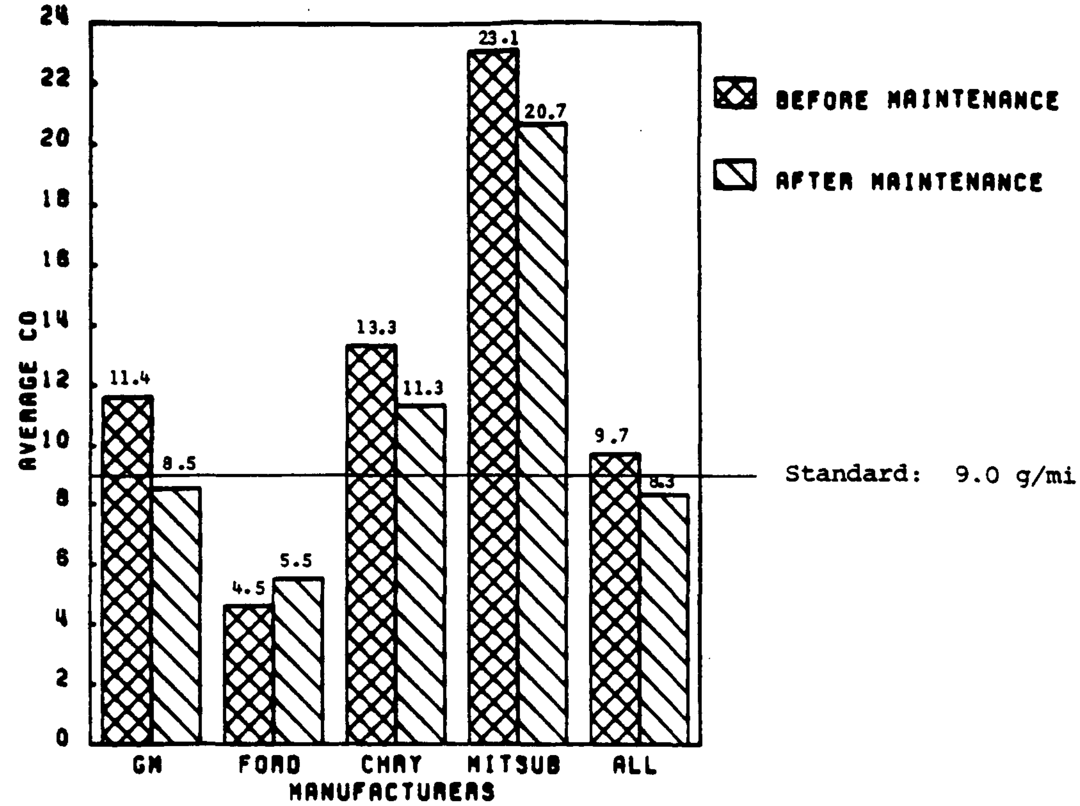
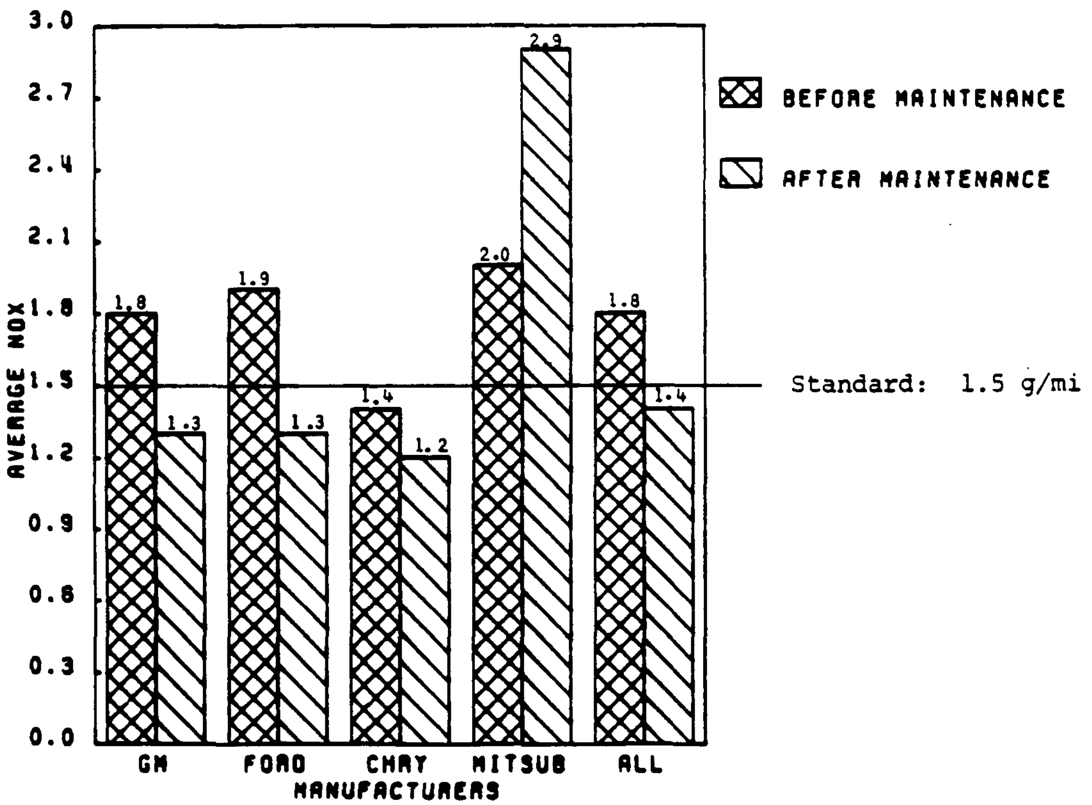


Figure 13
Average NOx Levels
Before vs After Maintenance
All Retested Vehicles



from the analysis of the maintenance aimed at correcting the particular pollutant of interest. The pollutant specific analysis gives a better measure of our ability to identify and correct specific causes of failure. When considered separately the reductions in average emission levels due to the maintenance were 0.09 g/mi (9 percent) for THC, 0.09 g/mi (12 percent) for NMHC, 5.6 g/mi (29 percent) for CO, and 1.13 g/mi (44 percent) for NOx. Also, when considered separately the average retest emission levels for all pollutants except NOx, remained above the applicable standard following the maintenance.

Table 6
Average Total HC Levels
Initial Tests vs After
Maintenance Tests for Retested Vehicles
That Failed Total HC on the Initial Test

Manufacturer	Number of Retested Vehicles	Total HC Initial Average	Total HC After Maintenance	Percent Reduction
GM	33	.942	.757	20
Ford	20	.720	.783	-9
Chrysler	7	.740	.649	12
Mitsubishi	4	2.140	2.123	1
All	64	.925	.839	9

Table 7
Average Non-Methane HC Levels
Initial Tests vs After
Maintenance tests for Retested Vehicles
That Failed Non-Methane HC on the Initial Test

Manufacturer	Number of Retested Vehicles	Non-Methane HC--Initial Average	Non-Methane HC--After Maintenance	Percent Reduction
GM	30	.807	.638	21
Ford	17	.598	.619	-4
Chrysler	6	.670	.574	14
Mitsubishi	4	1.905	1.889	1
All	57	.807	.714	12

Table 8
Average CO Levels
Initial Tests vs After
Maintenance tests for Retested Vehicles
That Failed CO on the Initial Test

Manufacturer	Number of Retested Vehicles	CO Initial Average	CO After Maintenance	Percent Reduction
GM	15	18.18	10.98	40
Ford	2	16.44	15.99	3
Chrysler	3	22.26	16.99	24
Mitsubishi	4	23.10	20.74	10
All	24	19.36	13.78	29

Table 9
Average NOx Levels
Initial Tests vs After
Maintenance tests for Retested Vehicles
That Failed NOx on the Initial Test

Manufacturer	Number of Retested Vehicles	NOx Initial Average	NOx After Maintenance	Percent Reduction
GM	14	2.76	1.42	49
Ford	16	2.46	1.30	47
Chrysler	2	2.20	1.66	25
Mitsubishi	2	2.80	2.78	1
All	34	2.59	1.46	44

The pass/fail rates for all of the retested vehicles are shown in Table 10 and Figures 14 through 17. (The figures also show total vehicles tested and initial failure rates.) The NOx failure rate for all manufacturers' vehicles except Mitsubishi was significantly reduced by the maintenance. The overall NOx failure rate was reduced 59 percent. General Motors' vehicles also showed a significant decrease in their CO failure rate following the maintenance. The overall CO failure rate was reduced 25 percent mainly as a result of the GM failure rate decrease. The maintenance was not effective in reducing the THC failure rate for any of the manufacturers tested. However,

Table 10
Pass/Fail Rates for Retested Vehicles*
Initial versus After Maintenance Tests
Numbers shown are number of vehicles

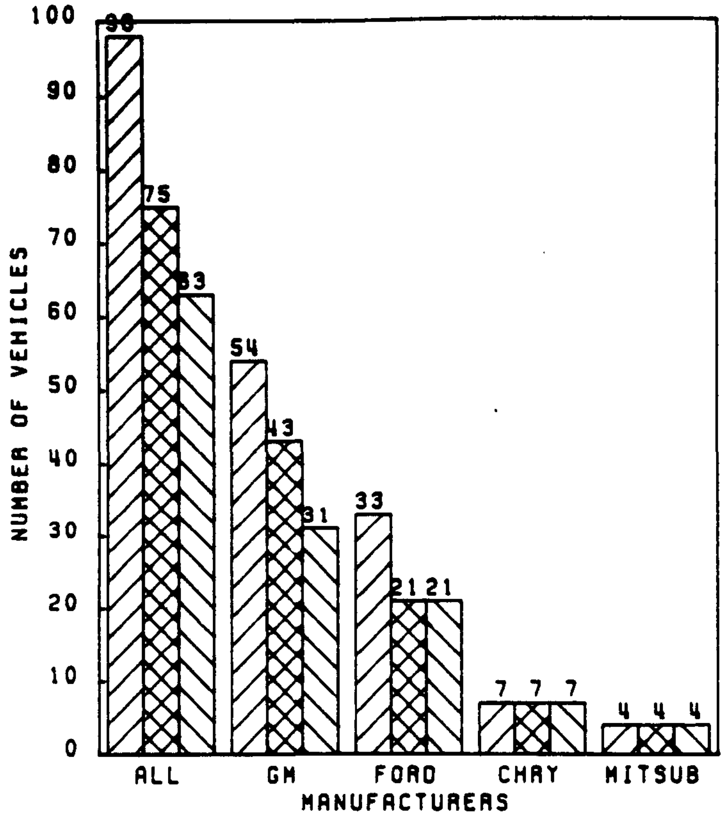
Manufacturer	Number of Vehicles Retested	Pass Initial	Pass After Maintenance	Failed HC Initial	Failed HC After Maintenance	Failed CO Initial	Failed CO After Maintenance	Failed NOx Initial	Failed NOx After Maintenance
GM	35	0(THC**) 0(NMHC***)	4(THC) 12(NMHC)	33 (THC) 30(NMHC)	31 (THC) 23(NMHC)	15	8	14	5
Ford	28	0(THC) 0(NMHC)	6(THC) 7(NMHC)	20(THC) 17(NMHC)	21(THC) 18(NMHC)	2	4	16	5
Chrysler	7	0(THC) 0(NMHC)	0(THC) 0(NMHC)	7(THC) 6(NMHC)	7(THC) 7(NMHC)	3	2	2	1
Mitsubishi	4	0(THC) 0(NMHC)	0(THC) 0(NMHC)	4(THC) 4(NMHC)	4(THC) 4(NMHC)	4	4	2	3
All	74	0(THC) 0(NMHC)	10(THC) 19(NMHC)	64 (THC) 57(NMHC)	63 (THC) 52(NMHC)	24	18	34	14

*The 10 GM vehicles that failed THC only and were not retested are not included in this table.

**Based on Total hydrocarbons (THC) compared to .41 g/mi

***Based on non-methane hydrocarbons (NMHC) compared to .41 g/mi
NMHC = THC x Methane Content Correction Factors.

Figure 14
THC Pass/Fail Rates



NOTE: The failed after maintenance levels shown do not contain the ten GM vehicles that failed THC but were not retested.

Figure 15
NMHC Pass/Fail Rates

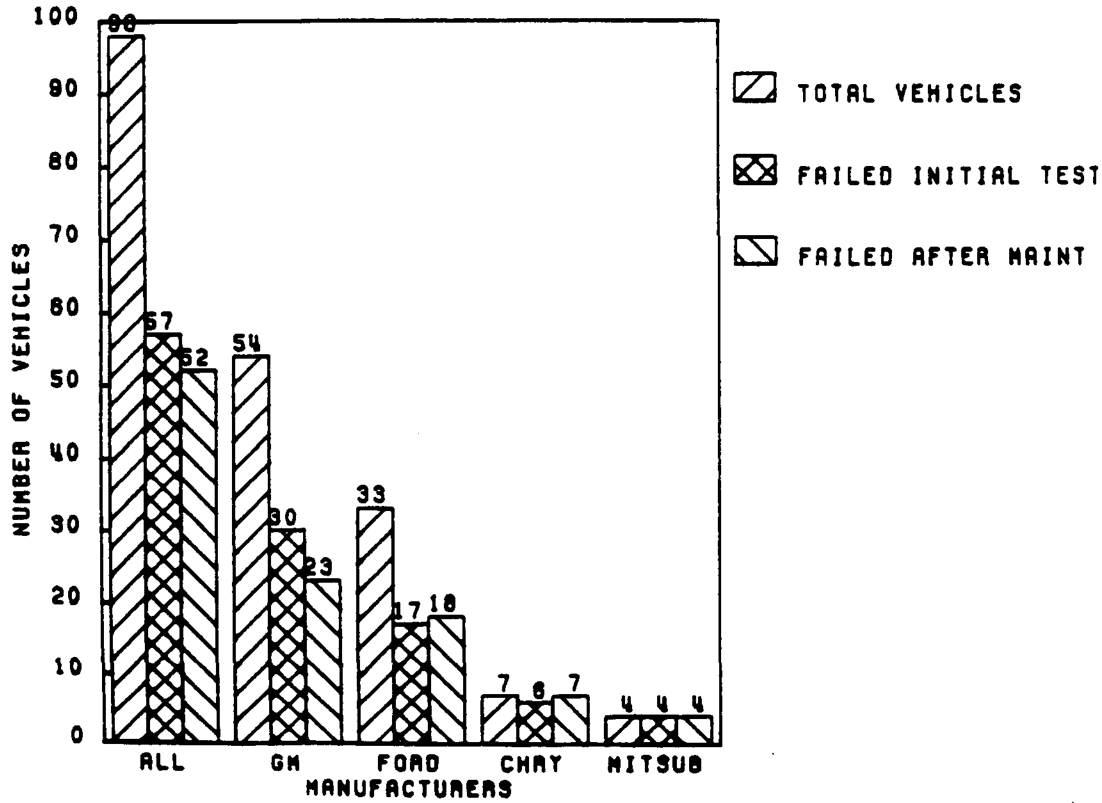


Figure 16
CO Pass/Fail Rates

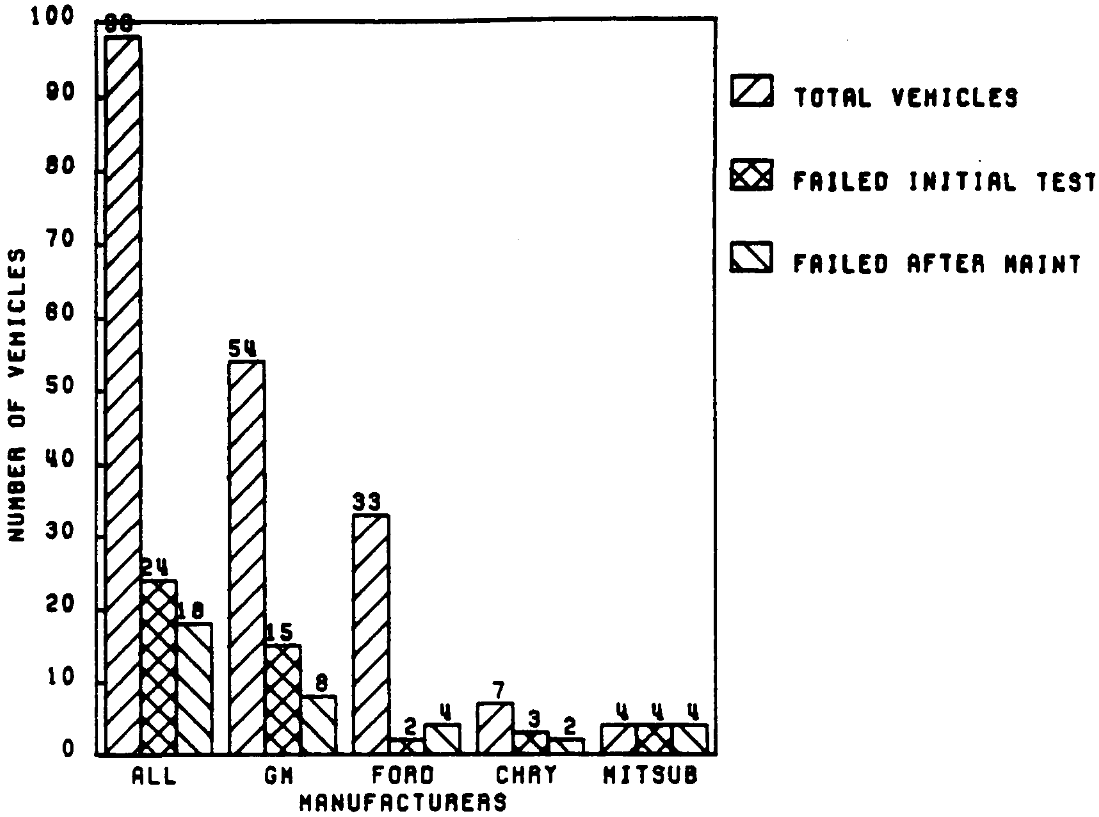
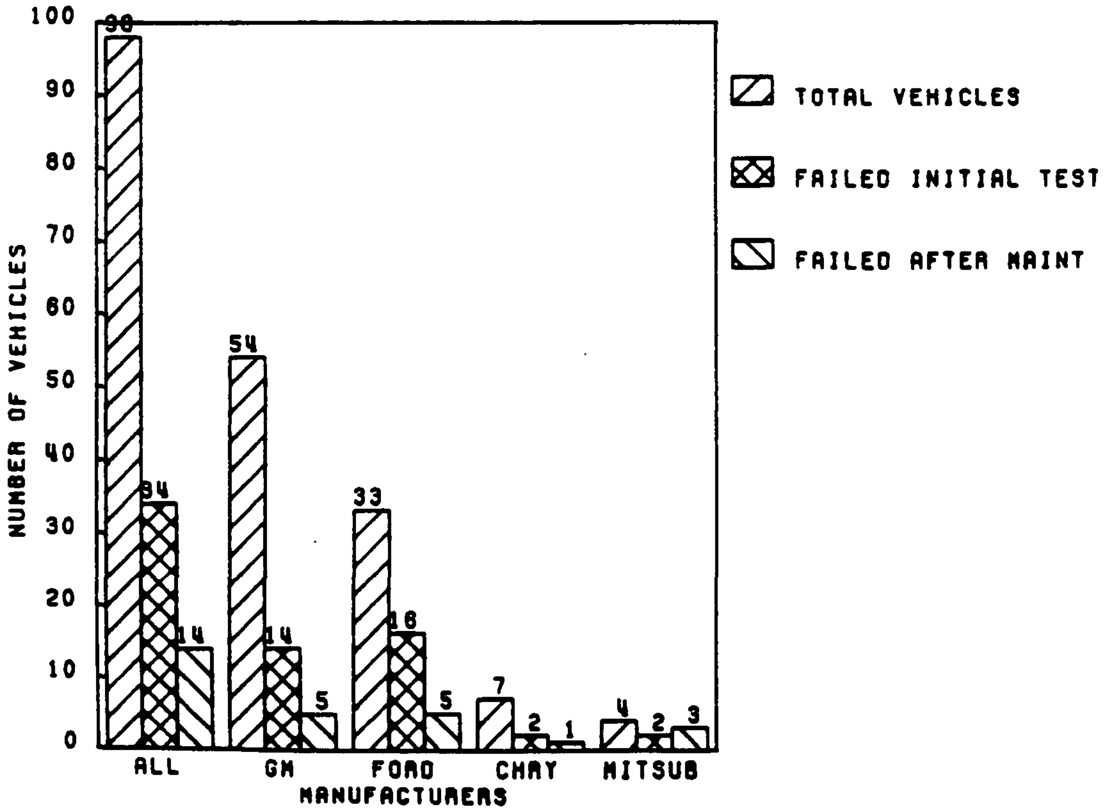


Figure 17
NOx Pass/Fail Rates



the General Motors NMHC failure rate was reduced by 23 percent (seven vehicles) and as a result of this GM rate reduction the overall NMHC failure rate was reduced 9 percent. (The NMHC failure rates for Ford and Chrysler increased by one.)

IV. Failure Analysis

Incoming vehicles received a complete inspection upon arrival at the laboratory. Table 11 contains a summary listing of the problems diagnosed during the incoming inspections for the vehicles accepted into the program. Following this inspection the vehicles received an initial maintenance that was limited to the correction of maladjustments and minor system disablements (see Appendix 2 for a more detailed description of the inspection and maintenance procedures and individual vehicle maintenance). Following the incoming inspection and maintenance the vehicles received their initial test. If the vehicles failed to meet the 1979 California standards (0.41 g/mi NMHC, 9.0 g/mi CO, and 1.5 g/mi NOx) on the initial test they received an additional maintenance sequence. During this second repair sequence all of the remaining problems diagnosed during the incoming inspection were corrected as well as any subsequently diagnosed problems. All repairs were intended to restore the vehicle to manufacturer design specification. Non-specification adjustments (e.g., setting choke lean of manufacturer specification) were not performed.

Prior to the initial test, parameters such as idle mixture, idle speed, choke setting, ignition timing, etc., were only reset if they were outside of the manufacturers' specified tolerances (or the EPA assigned tolerance if no tolerance existed for a manufacturer). Vehicles that were received with their idle limiter caps intact were adjusted only within the range of the limiter cap prior to the initial test. Vehicles that came into the program with their idle mixture limiter caps missing or obviously tampered were assumed to be incorrectly adjusted and were reset to the manufacturers' specifications prior to the initial test. These procedures were adopted so the test vehicles would be properly adjusted for the initial test and would approximate future vehicles with non-adjustable parameters.

During the second restorative maintenance process all diagnosed malfunctions were repaired and all parameters were reset to the exact manufacturers' specified settings. Prior to the second test the limiter caps were removed and the idle mixture readjusted to the manufacturers' specifications when necessary.

In Table 11 the items that were generally corrected prior to the initial test are marked with an asterisk (*). To the extent that these initial adjustments and repairs were successful in correcting potential emission performance

Table 11
Diagnosed Vehicle Problems
All Vehicles

Problem Diagnosed	Number of Occurrences (Percent of each Manufacturer's Vehicles)				
	GM	Ford	Chrysler	Mitsubishi	ALL
Carburetor Fuel System					
*Limiter Caps Missing	6 (11)	25 (76)	6 (86)	4 (100)	41 (42)
Caps Intact Mixture Incorrect	23 (43)	1 (3)	2 (29)	0 (0)	26 (27)
*Incorrect Curb Idle Speed	24 (44)	8 (24)	5 (71)	4 (100)	41 (42)
*Incorrect Fast Idle Speed	20 (37)	0 (0)	0 (0)	0 (0)	20 (20)
*Incorrect Choke Adjustment	5 (9)	2 (6)	0 (0)	0 (0)	7 (7)
*Incorrect Choke Pull-off Adjustment	11 (20)	1 (3)	0 (0)	0 (0)	12 (12)
Defective Choke Pull-off	6 (11)	2 (6)	0 (0)	0 (0)	8 (8)
Incorrect Float Adjustment	4 (7)	0 (0)	0 (0)	0 (0)	4 (4)
Incorrect Carburetor Venturi Bypass Vacuum Adjustment	0 (0)	5 (15)	0 (0)	0 (0)	5 (5)

*--Items generally corrected prior to the initial test.

Table 11 (Continued)
Diagnosed Vehicle Problems
All Vehicles

Problem Diagnosed	Number of Occurrences (Percent of each Manufacturer's Vehicles)				
	GM	Ford	Chrysler	Mitsubishi	ALL
Ignition System					
*Incorrect Timing	19 (35)	11 (33)	1 (14)	2 (50)	33 (34)
*Incorrect Spark plugs	14 (26)	1 (3)	1 (14)	0 (0)	16 (16)
*Fouled Spark Plugs	3 (6)	0 (0)	2 (29)	2 (50)	7 (7)
Defective Vacuum Advance	0 (0)	4 (12)	0 (0)	2 (50)	6 (6)
EGR System					
*Plugged Vacuum Lines	3 (6)	1 (3)	0 (0)	0 (0)	4 (4)
Defective EGR Valve	8 (15)	4 (12)	0 (0)	2 (50)	14 (14)
Incorrect EGR Valve	2 (4)	0 (0)	0 (0)	0 (0)	2 (2)
Defective Backpressure Transducer	0 (0)	2 (6)	0 (0)	0 (0)	2 (2)
Plugged EGR Passage	0 (0)	7 (21)	3 (43)	1 (25)	11 (11)

*--Items generally corrected prior to the initial test.

Table 11 (Concluded)
Diagnosed Vehicle Problems
All Vehicles

Problem Diagnosed	Number of Occurrences (Percent of each Manufacturer's Vehicles)				
	GM	Ford	Chrysler	Mitsubishi	ALL
Other Systems					
Defective O_2 Sensor	1 (2)	1 (3)	0 (0)	0 (0)	2 (2)
Air Injection Defects	1 (2)	2 (6)	0 (0)	0 (0)	3 (3)
Evap Defects	5 (9)	1 (3)	0 (0)	0 (0)	6 (6)
PCV Defects	6 (11)	3 (9)	0 (0)	0 (0)	9 (9)
Fresh Air Inlet System Defects	4 (7)	10 (30)	1 (14)	0 (0)	15 (15)

problems, these vehicle problems did not contribute directly to an increase in initial test emission levels or failure rates. However, indirect increases in emissions due to, for example, build up of deposits in the combustion chamber, accelerated deterioration, damage to the catalyst, etc., as a result of the malfunction/maladjustment could not be determined. It is possible that these types of indirect increases could have contributed to both initial and after maintenance emission levels.

As previously discussed Tables 5 through 10, and the related Figures 13 through 16, compare the manufacturers' before retest performance with their after retest performance. The CO reductions were generally the result of carburetor, choke system, and idle mixture adjustments or repairs. (The idle mixture adjustments performed after the initial test required the removal of the idle mixture limiter caps prior to the adjustment.) The NOx reductions were generally the result of EGR system repairs. Typical repairs were EGR valve replacement and EGR passage cleaning. The average NOx levels and failure rates were reduced more than any other pollutant. Average THC and NMHC levels and failure rates were reduced less than the other pollutants. In the majority of cases the maintenance performed did not reduce the THC and NMHC levels sufficiently to meet the standard. The largest THC or NMHC failure rate reduction was for GM NMHC where 7 out of 30 failing vehicles (23 percent) met the standard based on NMHC following maintenance.

As pointed out above, THC and NMHC were the most often failed pollutants and the least correctable. The cause of these THC and NMHC failures was not discovered during the program. The potential exists for some type of catalyst deactivation to be causing the problem (e.g., poisoning, deterioration, carbon build-up masking adequate catalyst performance, etc). At present, however, we have no evidence to support this hypothesis. We have initiated a test program at the Environmental Protection Agency's Motor Vehicle Emission Laboratory in Ann Arbor, Michigan aimed at isolating the performance of the catalyst from the performance of the rest of the vehicle on some high mileage (40,000 - 50,000 miles) 1980 and 1981 model year vehicles. This followup program should allow us to determine if excess catalyst deactivation is a major contributing factor to HC failure.

The vehicles in some engine families experienced higher than expected levels of malfunction for certain emission related systems. GM engine family 940E2LU had an EGR valve diaphragm failure rate of 33 percent. Four of the 12 vehicles tested for this engine family had leaking EGR valve diaphragms. Another GM family, 940E2CYU, had a 100 percent EGR valve failure rate but only two vehicles were tested for this family. Both of these families are Buick 3.8 liter V-6 engine families. It is possible that these two engine families have similar enough system designs to be treated as a single group for the purpose of evaluating these EGR failures but further investigation beyond the scope of this analysis would be necessary to confirm this.

Ford engine family 2.3A1X150 also experienced EGR system problems. Of the 12 vehicles tested for this engine family 4 (33 percent) had plugged EGR spacer plate passageways, 2 (17 percent) had broken EGR exhaust backpressure transducers, and 2 (17 percent) had defective EGR valves (one of the vehicles with a defective EGR valve also had a plugged EGR spacer plate passageway). Another Ford engine family (2.3B1TR80XR80) also had plugged EGR spacer plate passageways. Two of the four vehicles tested in this family (50 percent) suffered from the plugging problem (one of these vehicles also had a defective EGR valve). Both of these Ford families are 2.3 liter 4 cylinder engine families and, as with the GM engine families discussed earlier, these designs may also be similar enough to be grouped together.

All of the vehicles that experienced EGR system problems in the Ford and GM engine families discussed above failed to meet the 1.5 g/mi NOx standard on the initial test. The initial test average NOx levels for all four of these engine families also failed to meet the 1.5 g/mi NOx standard. Following restorative maintenance all but two of the 15 vehicles were able to meet the NOx standard and all four of the engine families had after-maintenance average NOx levels at or below the standard.

V. Data Variability

The variability of the data is important because of its affect on the level of confidence with which we are able to estimate in-use emission performance. The greater the variability of the data, the wider our confidence interval for any given sample size. Since actual variability is fixed, we are only able to decrease the width of the confidence interval by increasing the sample size. Table 12 shows the standard deviation (the square root of the variance) of the data for each pollutant for each manufacturer, and for all manufacturers combined for the initial tests.

Table 12 also compares the lower 95 percent confidence bound with the emission standard for each pollutant. Where this lower bound exceeds the standard we are 95 percent confident that the population average or mean emission level for that pollutant for that manufacturer exceeds the standard. The width of the interval between the average and the lower bound for each manufacturer is different because of differences in each manufacturer's sample size and standard deviation.

Table 12
Lower Bounds
95 Percent Confidence Level
One Sided Interval
Initial Tests

MFR	Sample Size	Pollutant	t	Standard Deviation	95% Lower Bound	Average Emission Level	95% Interval As Percent of Standard
GM	54	THC	1.674	.517	.611	.729	29
GM	54	NMHC	1.674	.420	.497	.593	23
GM	54	CO	1.674	7.96	7.53	9.34	20
GM	54	NOx	1.674	.86	1.32	1.52	13
Ford	33	THC	1.694	.250	.495	.569	18
Ford	33	NMHC	1.694	.198	.388	.446	14
Ford	33	CO	1.694	3.82	3.18	4.31	13
Ford	33	NOx	1.694	.91	1.54	1.81	18
Chry	7	THC	1.943	.263	.547	.740	47
Chry	7	NMHC	1.943	.223	.465	.629	40
Chry	7	CO	1.943	9.85	6.10	13.33	80
Chry	7	NOx	1.943	.73	.84	1.38	36
Mit	4	THC	2.353	1.524	.347	2.140	437
Mit	4	NMHC	2.353	1.357	.308	1.905	390
Mit	4	CO	2.353	11.39	9.70	23.10	149
Mit	4	NOx	2.353	1.07	.70	1.96	84
All	98	THC	1.661	.578	.636	.733	24
All	98	NMHC	1.661	.498	.516	.600	20
All	98	CO	1.661	8.14	7.12	8.49	15
All	98	NOx	1.661	.88	1.48	1.63	10

Lower Bound = Average - $t \frac{s}{\sqrt{n}}$

1979 California Standards: HC = 0.41 (Non-methane)
CO = 9.0
NOx = 1.5

THC = Total HC
NMHC = Non-methane HC = THC x MCCF

At the 95 percent level the GM, Chrysler, and fleet-wide lower bounds for THC and NMHC exceed the 0.41 g/mi standard. The Ford lower bound for THC exceeds the 0.41 g/mi standard while the Ford NMHC lower bound was below the 0.41 g/mi standard. Mitsubishi's lower bound for CO exceeds the 9.0 g/mi standard. Ford's lower bound exceeds the NOx standard.

Also shown in Table 12 is the one-sided 95 percent interval as a percent of the applicable standard. This value is the amount, as a percentage, by which each manufacturer's test vehicle sample average must exceed the standard for each pollutant before we can be 95 percent confident that the standard has been exceeded by that manufacturer's vehicles. As discussed above these values are based on each manufacturer's data variability as measured by the standard deviation and the manufacturer's sample size. The size of the interval increases as the standard deviation increases and the interval decreases as the sample size increases. If, for example, we compare the Ford THC interval (18 percent) with the Mitsubishi THC interval (437 percent) we can see how sample size and standard deviation affect the interval. Ford had the best average THC performance of the manufacturers tested and Mitsubishi had the worst. However, due to Ford's small standard deviation and larger sample size we can predict THC noncompliance for Ford but we are unable to do so for Mitsubishi. We are unable to predict noncompliance (at the 95 percent level) for Mitsubishi due to its large interval. This large interval is the result of Mitsubishi's large standard deviation and small sample size.

For the manufacturers in this test program for which a relatively large sample was tested (GM and Ford) the percent of sample intervals range from a high of 29 percent (GM THC) to a low of 13 percent (GM NOx and Ford CO). The relatively small sample sizes for Mitsubishi and Chrysler make it difficult to predict emission performance based the test data.

We can also quantify the confidence level for our estimated standard deviation in a manner similar to what we have done for the emission levels above. The confidence interval for standard deviation is also a function of sample size. For our fleet sample size of 98 vehicles the 95 percent confidence interval for the standard deviation estimate is plus or minus 14 percent. This means that the standard deviation that we have calculated for the test fleet from our sample will be within plus or minus 14 percent of the true standard deviation of the population 95 percent of the time.

VI. Discussion

Before developing conclusions based on the testing conducted under this program, a general discussion of the data and its limitations is in order. First of all, the vehicle sample was relatively small. As indicated earlier in this report, this data gathering effort is only the first and smallest phase of the overall project. Because the test sample is small and the actual in-use vehicle population is large and diverse, differences may exist between the characteristics of the sample and those of the actual population. Also, the vehicles tested were all certified for sale in California. As discussed earlier, 1979 model year California vehicles were selected because they represented the most current emission control technology for vehicles with sufficient mileage at the time testing took place. Because only California vehicles were tested in this program care must be exercised in using these data to predict emission performance of vehicles in other vehicle populations. A further limitation of the vehicle sample is its technological mix. The sample vehicles consisted primarily of oxidation catalyst-equipped vehicles. The data generated by these oxidation catalyst vehicles may not give a good indication of how future vehicles equipped with three-way closed loop systems will perform.

While some limitations do exist in the data due to sample construction constraints, the following trends in the data are apparent:

A. Based on the data generated in this program it appears that vehicles in the 40,000 to 50,000-mile range are on average <u>not</u> meeting the .41 g/mi HC standard. For the vehicles in this program the overall and individual manufacturer average THC and NMHC emission levels were above the 0.41 g/mi standard. Also, the failure rates were high (greater than 50 percent) for all manufacturers tested.

B. Typical restorative maintenance procedures (fuel metering and ignition system repairs) were unable to significantly reduce the HC failure rate. Neither the AESi mechanics nor the manufacturers' representatives (when present) were successful in diagnosing and repairing the HC failures. After repairs the overall and individual manufacturer average THC and NMHC levels remained above the 0.41 g/mi standard for the retested vehicles.

C. The overall average CO emission level was below the 9.0 g/mi standard. Individually, Chrysler and Mitsubishi had problems with CO. However, CO levels appeared to respond favorably to restorative maintenance. CO emission levels and failure rates were both reduced following maintenance. CO failures were typically the result of carburetor and choke system problems which were relatively easy to diagnose and repair.

D. The overall average NOx emission level was slightly (9 percent) above the 1.5 g/mi standard. Individually Ford and Mitsubishi had difficulty with NOx. The NOx levels and failure rates responded very well to restorative maintenance. The NOx level and failure rate were both reduced by the maintenance. NOx failures were typically the result of EGR system problems. These were easily diagnosable and repairable due in part to their similarity to NOx problems discovered at low mileage in previous in-use compliance programs.

These data trends tend to indicate that HC compliance may be a significant problem. As discussed in the Introduction section of this report, we assumed at the outset that because manufacturers are currently responsible for emission compliance through 50,000 miles we would not encounter a significant amount of noncompliance in our test program. The CO and NOx emission performance of the test vehicles is the type of performance that was anticipated; average levels at or very near the standard and some engine families and/or manufacturers performing better than others. However, the HC standard was exceeded on average by all manufacturers. In addition, the vast majority of engine families also had average HC levels above the standard. This indicates that the HC problem is a general rather than a design, engine family, or manufacturer specific problem. If this limited sample HC noncompliance is indicative of the total current vehicle population, the causes of this noncompliance must be found before implementation of any compliance program that tests in-use vehicles in the 40,000 to 50,000-mile range. Assuming that this problem can be remedied by design change, such a new compliance program could be viewed as more stringent than the current compliance program although the stringency of the standards as provided by the Clean Air Act is not changed.

The current compliance program has the flexibility to test vehicles in the 40,000 to 50,000-mile range and if the HC noncompliance trend persists as further data are collected, some type of current compliance program response may be required. At the present time, however, the cause of the HC problem has not been determined, and may not be manifested in the newer 3-way catalyst technology. As discussed earlier, we have initiated a test program aimed at isolating engine performance from catalyst performance to determine to what extent each of these subsystems contribute to the problem. Until such time as the extent and cause of the HC problem are accurately defined, the correct remedial compliance response will be difficult to formulate.

In addition to measuring emission levels of vehicles between 40,000 to 50,000 miles in this test program, we also wanted to quantify the variability of emission data from vehicles in this mileage range. From the information gathered on the variability of the data we will be able to assess our ability to accurately determine average emission levels. As indicated earlier, the percent of standard 95 percent lower confidence bound for the larger samples (GM and Ford) were in the 10 percent to 30 percent range. For the small samples taken in this program these seem acceptable.

VII. Conclusions

This study was undertaken to develop information pertaining to the emission performance of properly used and maintained vehicles in the 40,000 to 50,000-mile range and to use this information to evaluate the feasibility of incorporating this type of testing into an emission compliance program. This report has presented the data and discussed the relationship of the data to the issues of program stringency and possible noncompliance remedies. Based on the data generated during this program we have developed the following conclusions:

A. Although the current compliance program requires emission compliance through 50,000 miles, the data from the vehicles tested in this program indicate that there may be a general in-use HC noncompliance problem. All manufacturers tested had average THC and NMHC levels above the .41 g/mi standard and HC failure rates in excess of 50 percent. The true extent and cause of the HC noncompliance problem was not determined during this test program. Therefore, we were unable to determine what type remedial action is appropriate for correcting the apparent HC noncompliance problem. Further testing and failure analysis is necessary.

B. CO and NOx performance was such that, for these pollutants, program changes incorporating testing in the 40,000 to 50,000-mile range do not appear to present nonconformance problems or require the development of alternative remedial mechanisms. The average CO and NOx levels were at or near the standards and traditional restorative maintenance procedures appeared to be effective. We must point out, however, that our evaluation of CO and NOx performance was conducted on vehicles designed to meet the 1979 California standards of 9.0 g/mi CO and 1.5 g/mi NOx and that the resulting conclusions may not be applicable to current Federal vehicles designed to meet the 3.4 g/mi CO and 1.0 g/mi NOx Federal standards.

C. For the data collected in this test program the data variability was such that average emission levels could be determined within acceptable confidence ranges when samples of sufficient size were taken.

These conclusions are restricted by the data limitations as outlined in the Discussion section above. It is important to consider that the data sample was small (98 vehicles) and from a restricted population (California vehicles). Given the limitations of the data, the projection of the trends observed in this test program to other vehicle populations may not be totally appropriate. However, the trends observed, particularly the trend for HC noncompliance, tend to indicate the need for further evaluation of vehicles near the end of their statutory useful life (50,000 miles). As indicated earlier in this report, additional data on 1980 and 1981 model year Federal vehicles is presently being collected. As the investigation continues and additional data become available our ability to quantify both emission levels and emission variability will improve.

APPENDICES

APPENDIX 1

Test Vehicle Sample

Manufacturer	Engine Family	Description CID - # Cyl	Number Of Vehicles
GM	910L4RU	305 - V8	12
GM	910Y2V	305 - V8	11
GM	910W2KQU	98 - L4	6
GM	920X2CEU	151 - L4	1
GM	930H2AU	260 - V8	8
GM	940E2CYU	231 - V6	2
GM	940E2LU	231 - V6	12
GM	940E4DVT	231 - V6	1
GM	940E4DVY	231 - V6	1
Ford	1.6G1X128	98 - L4	2
Ford	2.3A1X150	140 - L4	12
Ford	2.3B1TR80xR80	140 - L4	4
Ford	2.8BV1x150	171 - V6	2
Ford	3.3B1x150	200 - L6	4
Ford	4.1A1x150	250 - L6	2
Ford	5.0AV1x150	302 - V8	7
Chrysler	9CD-318/360-4-GP	318 - V8	3
Chrysler	9CF-105-2-BP	105 - L4	4
Mitsubishi	4G3M-C	98 - L4	2
Mitsubishi	4G3P-C	98 - L4	2
Total			98

Appendix 2
Individual Vehicle Test Results

1979 MODEL YEAR CALIFORNIA VEHICLE TEST RESULTS

MFG	ENG.	VEH	TEST	INER	HP	MILE	HC	CO	NOX	MPG
GM	910L4RU	415	SPEC	3500	12.0	49262	.54	5.77	1.32	15.77
GM	910L4RU	415	RM	3500	12.0	49283	.48	9.03	1.03	15.38
GM	910L4RU	419	SPEC	3500	12.4	41204	.36	4.46	.86	15.68
GM	910L4RU	421	SPEC	3500	12.2	45876	.48	7.55	1.03	15.77
GM	910L4RU	422	SPEC	3500	12.0	42627	.52	14.10	1.18	15.06
GM	910L4RU	422	RM	3500	12.0	42668	.52	6.88	1.13	15.26
GM	910L4RU	426	SPEC	3500	12.4	40161	.46	5.98	1.00	15.19
GM	910L4RU	435	SPEC	3500	12.4	40018	.66	6.08	1.12	16.34
GM	910L4RU	435	RM	3500	12.4	40039	.66	6.49	1.20	16.09
GM	910L4RU	442	SPEC	4000	12.5	42016	1.01	4.88	1.74	14.85
GM	910L4RU	442	RM	4000	12.5	42036	.72	3.66	1.52	14.87
GM	910L4RU	456	SPEC	4000	12.8	41641	.51	2.89	1.12	13.57
GM	910L4RU	458	SPEC	3500	12.0	44998	1.38	18.87	.89	14.62
GM	910L4RU	458	RM	3500	12.0	45040	.37	5.50	1.05	15.96
GM	910L4RU	503	SPEC	3500	11.3	42333	.53	4.69	1.07	15.54
GM	910L4RU	503	RM	3500	11.3	42353	.61	6.30	1.29	16.13
GM	910L4RU	536	SPEC	4000	12.8	40102	.69	11.85	.99	14.00
GM	910L4RU	536	RM	4000	12.8	40124	.47	6.26	1.00	14.30
GM	910L4RU	537	SPEC	3500	11.3	46920	1.22	16.42	.83	14.45
GM	910L4RU	537	RM	3500	11.3	46939	.65	4.26	1.34	16.53
GM	910W2KQU	427	SPEC	2500	9.2	42374	1.62	19.63	3.90	24.28
GM	910W2KQU	427	RM	2500	9.2	42394	1.35	10.92	1.79	24.22
GM	910W2KQU	432	SPEC	2250	9.2	42045	1.42	8.13	1.26	23.40
GM	910W2KQU	432	RM	2250	9.2	42086	1.31	6.36	1.54	23.73
GM	910W2KQU	443	SPEC	2500	9.2	49115	2.20	35.02	1.09	21.83
GM	910W2KQU	443	RM	2500	9.2	49136	2.19	26.33	1.23	22.05
GM	910W2KQU	447	SPEC	2500	9.2	49391	1.70	11.82	1.22	25.66
GM	910W2KQU	447	RM	2500	9.2	49453	1.85	11.00	1.42	24.35
GM	910W2KQU	513	SPEC	2500	9.2	44581	.57	6.95	1.13	23.57
GM	910W2KQU	513	RM	2500	9.2	44603	.52	5.88	1.23	23.33
GM	910W2KQU	515	SPEC	2250	9.2	47765	1.82	7.26	1.77	23.89
GM	910W2KQU	515	RM	2250	9.2	47787	2.41	16.12	1.61	22.91
GM	910Y2V	433	SPEC	4000	13.3	42331	.42	2.41	.99	13.42
GM	910Y2V	434	SPEC	4000	10.2	41209	.46	4.88	1.03	12.88
GM	910Y2V	437	SPEC	4000	9.7	42242	.45	8.59	2.93	15.17
GM	910Y2V	437	RM	4000	9.7	42264	.43	7.60	1.53	14.40
GM	910Y2V	444	SPEC	4000	9.7	45074	.47	7.71	1.28	14.36
GM	910Y2V	445	SPEC	4000	11.6	40933	.35	6.73	3.52	15.56
GM	910Y2V	445	RM	4000	11.6	40950	.35	7.43	1.10	14.21
GM	910Y2V	448	SPEC	4000	13.3	46215	.48	4.60	.96	13.59
GM	910Y2V	514	SPEC	4000	10.2	40965	.55	9.55	1.18	14.41
GM	910Y2V	514	RM	4000	10.2	40987	.44	8.41	1.24	14.00
GM	910Y2V	518	SPEC	4000	10.2	45151	.42	8.98	1.13	13.35
GM	910Y2V	527	SPEC	4000	10.2	47752	.97	16.68	.94	14.05
GM	910Y2V	527	RM	4000	10.2	47775	.69	10.04	1.23	13.94
GM	910Y2V	533	SPEC	4000	11.6	49199	.40	4.81	1.12	14.14
GM	910Y2V	534	SPEC	4000	10.2	46768	.42	9.49	1.11	13.73
GM	910Y2V	534	RM	4000	10.2	46789	.56	13.79	1.09	14.07
GM	920X2CEU	428	SPEC	3000	10.4	41034	.46	6.23	1.00	19.63
GM	930H2AU	436	SPEC	3500	12.2	41711	.57	6.28	1.24	16.99
GM	930H2AU	436	RM	3500	12.2	41737	.45	3.74	1.15	17.08
GM	930H2AU	439	SPEC	3500	12.2	40818	.55	7.88	1.63	16.95
GM	930H2AU	439	RM	3500	12.2	40843	.56	7.54	1.40	16.96
GM	930H2AU	440	SPEC	3500	12.2	46826	.62	8.13	1.21	16.17

1979 MODEL YEAR CALIFORNIA VEHICLE TEST RESULTS

MFG	ENG.	VEH	TEST	INER	HP	MILE	HC	CO	NOX	MPG
GM	930H2AU	440	RM	3500	12.2	46847	.47	6.41	1.24	16.55
GM	930H2AU	450	SPEC	3500	12.2	45096	.45	8.27	1.00	16.23
GM	930H2AU	455	SPEC	3500	12.2	40837	.61	9.41	.97	16.14
GM	930H2AU	455	RM	3500	12.2	40859	.53	8.94	1.00	15.77
GM	930H2AU	502	SPEC	3500	12.2	44844	.54	8.15	.95	15.48
GM	930H2AU	502	RM	3500	12.2	44866	.52	6.19	1.34	17.11
GM	930H2AU	526	SPEC	3500	12.2	40579	.39	5.65	.95	15.42
GM	930H2AU	538	SPEC	3500	12.2	40659	.58	7.06	1.05	16.73
GM	930H2AU	538	RM	3500	12.2	40682	.58	5.70	1.20	16.82
GM	940E2CYU	420	SPEC	3500	12.2	42766	.52	7.22	2.60	19.51
GM	940E2CYU	420	RM	3500	12.2	42787	.44	7.12	1.28	19.36
GM	940E2CYU	516	SPEC	3500	12.2	40424	1.05	7.50	3.08	17.30
GM	940E2CYU	516	RM	3500	12.2	40444	.54	6.61	1.67	17.66
GM	940E2LU	423	SPEC	3500	12.0	42651	.84	17.08	1.32	17.35
GM	940E2LU	423	RM	3500	12.0	42672	.33	3.47	1.11	17.67
GM	940E2LU	424	SPEC	3500	11.3	42633	2.61	49.45	3.38	16.43
GM	940E2LU	424	RM	3500	11.3	42653	1.19	32.13	1.00	17.33
GM	940E2LU	424	ADD1	3500	11.3	42718	.65	12.24	1.25	17.48
GM	940E2LU	425	SPEC	3500	12.5	43981	.95	15.18	4.03	17.01
GM	940E2LU	425	RM	3500	12.5	44001	.71	10.81	1.35	16.69
GM	940E2LU	429	SPEC	3500	12.2	41386	.37	6.40	.91	16.76
GM	940E2LU	430	SPEC	3500	12.2	43771	.19	2.59	1.35	17.52
GM	940E2LU	431	SPEC	3500	12.5	46624	.46	5.67	2.47	17.91
GM	940E2LU	431	RM	3500	12.5	46646	.46	6.14	.72	15.48
GM	940E2LU	438	SPEC	3500	9.1	49350	.29	3.62	1.11	16.86
GM	940E2LU	441	SPEC	3500	12.5	42514	.27	3.50	3.54	17.78
GM	940E2LU	441	RM	3500	12.5	42534	.28	3.68	1.08	17.02
GM	940E2LU	449	SPEC	3500	9.1	41203	.64	2.72	1.38	15.86
GM	940E2LU	449	RM	3500	9.1	41225	.58	2.93	1.43	16.07
GM	940E2LU	528	SPEC	3500	11.3	45085	.33	4.02	1.31	17.49
GM	940E2LU	530	SPEC	3500	11.3	47990	.41	4.48	.99	18.62
GM	940E2LU	531	SPEC	3500	11.3	45613	.31	4.16	1.03	17.55
GM	940E4DVT	509	SPEC	3500	12.2	40542	1.71	18.13	1.79	18.02
GM	940E4DVT	509	RM	3500	12.2	40564	.77	6.00	1.64	17.30
GM	940E4DVY	510	SPEC	3500	12.2	44528	.55	8.65	2.22	17.12
GM	940E4DVY	510	RM	3500	12.2	44556	.63	8.53	2.24	16.83
FORD	1.6G1X128	416	SPEC	2000	7.3	46195	.22	1.50	2.32	25.46
FORD	1.6G1X128	416	RM	2000	7.3	46218	.25	1.64	2.65	25.19
FORD	1.6G1X128	504	SPEC	2000	7.3	41709	.28	1.40	1.50	24.91
FORD	2.3A1X150	403	SPEC	3000	9.2	41277	.33	2.87	.90	16.67
FORD	2.3A1X150	405	SPEC	3000	9.2	41293	.35	2.07	3.47	19.59
FORD	2.3A1X150	405	RM	3000	9.2	41315	.38	2.66	1.52	19.65
FORD	2.3A1X150	407	SPEC	3000	9.1	41550	1.07	6.36	4.73	18.85
FORD	2.3A1X150	407	RM	3000	9.1	41572	1.07	7.32	.92	18.90
FORD	2.3A1X150	408	SPEC	3000	10.2	46963	.37	2.15	3.84	18.85
FORD	2.3A1X150	408	RM	3000	10.2	47003	.33	4.15	.92	18.21
FORD	2.3A1X150	412	SPEC	3000	10.5	45101	.34	2.81	3.00	20.55
FORD	2.3A1X150	412	RM	3000	10.5	45123	.37	3.97	1.06	19.98
FORD	2.3A1X150	507	SPEC	3000	11.0	44540	.34	1.79	1.54	19.39
FORD	2.3A1X150	517	SPEC	3000	9.1	40725	.43	12.05	.51	17.45
FORD	2.3A1X150	517	RM	3000	9.1	40747	.53	14.69	.52	17.13
FORD	2.3A1X150	520	SPEC	3000	9.1	43418	.60	5.18	2.33	19.61
FORD	2.3A1X150	520	RM	3000	9.1	43439	.69	5.44	.84	19.61
FORD	2.3A1X150	521	SPEC	3000	9.2	45511	.39	2.71	1.75	19.81

1979 MODEL YEAR CALIFORNIA VEHICLE TEST RESULTS

MFG	ENG.	VEH	TEST	INER	HP	MILE	HC	CO	NOX	MPG
FORD	2.3A1X150	521	RM	3000	9.2	45533	.44	2.41	1.04	19.58
FORD	2.3A1X150	522	SPEC	3000	9.1	47541	.40	2.38	1.07	20.23
FORD	2.3A1X150	525	SPEC	3000	9.2	45717	.27	2.04	1.78	20.85
FORD	2.3A1X150	525	RM	3000	9.2	45739	.33	4.47	.85	18.76
FORD	2.3A1X150	529	SPEC	3000	9.2	41995	.26	2.29	1.75	18.91
FORD	2.3A1X150	529	RM	3000	9.2	42040	.32	3.59	.61	17.23
FORD	2.3B1TR80XR80	413	SPEC	3000	9.7	47449	.48	5.30	1.53	20.50
FORD	2.3B1TR80XR80	414	SPEC	3000	9.4	45187	.53	3.72	2.76	21.45
FORD	2.3B1TR80XR80	414	RM	3000	9.4	45207	.49	3.84	1.61	21.15
FORD	2.3B1TR80XR80	417	SPEC	3000	9.7	41181	.56	5.07	1.91	19.26
FORD	2.3B1TR80XR80	417	RM	3000	9.7	41202	1.31	13.01	1.54	19.56
FORD	2.3B1TR80XR80	535	SPEC	3000	9.4	40465	.35	2.58	2.20	22.08
FORD	2.3B1TR80XR80	535	RM	3000	9.4	40486	.39	3.42	1.34	21.13
FORD	2.8BV1X150	402	SPEC	3000	10.1	41737	.63	5.83	1.36	17.52
FORD	2.8BV1X150	402	RM	3000	10.1	41765	.63	5.27	2.06	18.16
FORD	2.8BV1X150	505	SPEC	3000	10.1	41018	1.08	20.83	1.35	16.54
FORD	2.8BV1X150	505	RM	3000	10.1	41040	.93	17.29	1.28	16.40
FORD	3.3B1X150	401	SPEC	3500	12.1	47074	.69	8.29	.85	13.98
FORD	3.3B1X150	401	RM	3500	12.1	47092	.74	8.67	.83	13.39
FORD	3.3B1X150	406	SPEC	3000	11.6	45140	.60	5.06	2.37	17.91
FORD	3.3B1X150	406	RM	3000	11.6	45161	.65	5.38	1.39	17.34
FORD	3.3B1X150	512	SPEC	3000	11.6	43039	.57	8.13	1.19	21.19
FORD	3.3B1X150	512	RM	3000	11.6	43061	.63	6.71	1.64	21.97
FORD	3.3B1X150	519	SPEC	3500	12.1	43309	.63	3.59	.86	15.56
FORD	3.3B1X150	519	RM	3500	12.1	43334	.57	2.95	1.08	16.17
FORD	4.1A1X150	404	SPEC	3500	10.1	40988	.55	1.49	1.31	16.70
FORD	4.1A1X150	404	RM	3500	10.1	41009	.58	2.03	1.18	15.53
FORD	4.1A1X150	511	SPEC	3500	11.1	42080	.56	3.66	1.73	17.55
FORD	4.1A1X150	511	RM	3500	11.1	42100	.48	2.87	1.90	17.29
FORD	5.0AV1X150	409	SPEC	3500	10.1	48148	1.03	1.71	1.28	16.39
FORD	5.0AV1X150	409	RM	3500	10.1	48168	.77	4.53	.98	15.47
FORD	5.0AV1X150	410	SPEC	3500	12.1	48709	1.10	5.65	1.40	15.00
FORD	5.0AV1X150	410	RM	3500	12.1	48727	1.62	9.81	1.40	14.61
FORD	5.0AV1X150	411	SPEC	3500	10.1	43350	.68	3.87	1.27	15.65
FORD	5.0AV1X150	411	RM	3500	10.1	43371	.80	5.23	1.32	15.92
FORD	5.0AV1X150	418	SPEC	4000	11.1	40381	.87	2.07	1.83	15.40
FORD	5.0AV1X150	418	RM	4000	11.1	40410	.82	2.52	1.34	15.13
FORD	5.0AV1X150	501	SPEC	3500	11.9	42365	.72	2.01	1.62	15.16
FORD	5.0AV1X150	501	RM	3500	11.9	42386	.91	4.26	1.27	14.98
FORD	5.0AV1X150	506	SPEC	3500	10.1	43469	.79	1.05	1.27	16.49
FORD	5.0AV1X150	506	RM	3500	10.1	43490	.82	1.26	1.16	16.30
FORD	5.0AV1X150	524	SPEC	3500	10.0	42884	.70	4.69	1.27	16.60
FORD	5.0AV1X150	524	RM	3500	10.0	42905	.62	3.15	1.39	16.64
CHRY	9CD-318/360-4-GP	453	SPEC	4000	11.8	45470	.67	8.21	1.01	15.29
CHRY	9CD-318/360-4-GP	453	RM	4000	11.8	45491	.68	8.45	1.00	15.55
CHRY	9CD-318/360-4-GP	454	SPEC	4000	14.1	42880	1.20	21.75	1.05	14.46
CHRY	9CD-318/360-4-GP	454	RM	4000	14.1	42900	.63	9.97	1.31	14.63
CHRY	9CD-318/360-4-GP	459	SPEC	4000	11.4	44199	1.00	31.42	.52	14.05
CHRY	9CD-318/360-4-GP	459	RM	4000	11.4	44221	1.10	32.17	.54	14.09
CHRY	9CF-105-2-BP	452	SPEC	2750	7.2	41019	.45	5.05	2.83	24.48
CHRY	9CF-105-2-BP	452	RM	2750	7.2	41040	.49	4.20	1.99	24.94
CHRY	9CF-105-2-BP	460	SPEC	2500	8.2	43956	.58	6.86	1.50	22.77
CHRY	9CF-105-2-BP	460	RM	2500	8.2	43978	.56	8.09	.87	22.28
CHRY	9CF-105-2-BP	523	SPEC	2500	7.6	42171	.66	13.62	1.19	24.03

1979 MODEL YEAR CALIFORNIA VEHICLE TEST RESULTS

MFG	ENG.	VEH	TEST	INER	HP	MILE	HC	CO	NOX	MPG
CHRY	9CF-105-2-BP	523	RM	2500	7.6	42200	.49	8.83	1.25	23.09
CHRY	9CF-105-2-BP	532	SPEC	2500	8.4	42274	.62	6.42	1.58	23.04
CHRY	9CF-105-2-BP	532	RM	2500	8.4	42296	.59	7.23	1.34	22.75
MITS	4G3M-C	446	SPEC	2250	8.7	42516	1.27	17.66	1.21	27.98
MITS	4G3M-C	446	RM	2250	8.7	42572	1.53	16.04	3.32	30.09
MITS	4G3M-C	508	SPEC	2250	8.8	48852	1.18	23.32	1.03	25.32
MITS	4G3M-C	508	RM	2250	8.8	48872	1.66	26.68	2.66	28.17
MITS	4G3P-C	451	SPEC	2500	8.7	47660	4.40	38.86	3.35	25.57
MITS	4G3P-C	451	RM	2500	8.7	47683	3.80	27.95	4.10	25.89
MITS	4G3P-C	457	SPEC	2250	8.7	46720	1.71	12.56	2.26	29.16
MITS	4G3P-C	457	RM	2250	8.7	46742	1.50	12.27	1.47	28.03

Appendix 3

Test Vehicle Procurement, Inspection, Maintenance Procedures, and Maintenance Summary

A. Vehicle Procurement

The vehicle procurement process used in this test program was similar to the procurement processes used to procure test vehicles from the public in the OMS' emission factors and recall programs. An owner registration list was purchased and randomized. Certified letters were mailed to all individuals on the list. This initial mailing was followed up by a second, first class mailing and a telephone contact. When an individual responded favorably to one of these contacts they were asked a series of questions to evaluate the acceptability of their vehicle. If the responses to the questions indicated that the vehicle was acceptable it was brought to the laboratory for inspection and testing. A vehicle was considered acceptable for this program if the vehicle met the following criteria (minor deviations were permitted where, in the opinion of EPA engineers, no significant emission level difference would result):

1. Was still owned by the original purchaser.

2. Had accumulated between 40,000 and 50,000 miles.

3. Had not been operated in an atypical manner (taxi, racing, overheated, etc.).

4. Had not been operated using leaded fuel if unleaded fuel was required.

5. Had not received accident damage to the engine or emission control systems.

6. Had not been altered by the installation of non-OEM equipment (exhaust headers, ignition system, aftermarket air-conditioning, etc.).

7. Had received proper scheduled maintenance in accordance with the manufacturers' recommendations.

8. Had not received unscheduled maintenance repairs to the engine, drivetrain, or emission control system by other than an appropriate dealer.

9. Had not had any alterations or modifications made to any emission control system components.

Vehicles that met these criteria were accepted into the program.

B. Vehicle Inspection and Maintenance

Vehicles that were determined to be acceptable for the program by the procurement screening process were brought to the AESI facility for inspection and testing. Each vehicle was inspected and test driven prior to testing. Vehicles were rejected from the program during the inspection/test drive if they:

1. Had in excess of 0.05g/gal of lead in their fuel, or failed the plumbtesmo tailpipe patch test.

2. Had an obvious engine, transmission, or braking problem requiring major/expensive repair.

3. Had a major emission control system disablement (e.g., system removed).

Also during the vehicle inspection the operational status of the vehicle and its emission control systems were determined. Prior to the initial test each vehicle received a complete mechanical inspection and limited maintenance consisting of the following operations if necessary:

1. Adjust the idle mixture if the adjustment plugs have been removed or obviously tampered. If equipped with limiter caps, adjust within the range of control.

2. Set the idle RPM, ignition timing, dwell, and choke rod adjustment if outside of the EPA specified tolerance range (e.g., $\pm$ 2° ignition timing, $\pm$ 100 idle rpm).

3. Replace the spark plugs and secondary wiring as required to obtain the proper firing voltage.

4. Repair exhaust system leaks.

5. Reroute misrouted vacuum lines.

6. Replace non-OEM equivalent spark plugs.

7. Unplug blocked vacuum lines.

8. Replace non-OEM PCV valves and/or EGR valves.

The actual maintenance performed prior to the initial test on each vehicle is shown in the attachment to this Appendix. Following the initial inspection and maintenance sequence each vehicle was tested for emissions. If the vehicle failed to meet the 1979 California emission standards the vehicle was given a second much more extensive repair sequence consisting of the following operations if necessary:

1. Change the oil and filter.

2. Change the spark plugs.

3. Set the ignition timing, dwell, idle rpm, and choke rod adjustment to specification.

4. Set the idle mixture to specification. Utilize the manufacturer's artificial enrichment (propane gain) procedure if specified.

5. Repair any emission control system malfunctions.

6. Service the carburetor, choke and hoses.

7. Check and correct the Early Fuel Evaporation System.

8. Check and correct the carburetor bolt torque.

9. Check and correct the vacuum advance and hoses.

10. Replace the fuel filter.

11. Replace the PCV valve and service the hoses.

12. Replace the oxygen sensor.

13. Check and correct the idle stop solenoid.

14. Replace the air cleaner element.

15. Check and correct the carburetor vacuum break.

16. Check and correct the Evaporative Control system and replace the filter.

17. Check and correct the fuel line.

18. Check and correct the engine valve clearance.

19. Repair all emission control system malfunctions except those requiring carburetor replacement, internal engine component replacement, or catalyst replacement. (Some vehicles had their carburetors replaced at the manufacturer's request. However carburetors were not replaced routinely.)

The restorative maintenance performed on each vehicle following the initial test is also shown in the attachment to this Appendix. The restorative maintenance performed after the initial test was somewhat different than the maintenance performed before the initial test in that many routine procedures were performed (see the restorative maintenance list of procedures). Also as part of the restorative maintenance tune-up all engine parameters were reset to the exact manufacturer's specifications. These adjustments were made as necessary on all vehicles and are not shown individually in the attachment because those parameters that were outside of the specification tolerance range were reset prior to the initial test leaving only minor adjustments to be made for these parameters during the restorative maintenance tune-up procedure. These types of items are simply indicated in the attachment as a tune-up. Any significant non-routine maintenance operations that were performed during restorative maintenance are shown individually in the attachment to the Appendix. Following the second maintenance sequence the vehicles were retested.

ATTACHMENT

Appendix 3

1979 Model Year California
AESI Test Vehicle
Maintenance

Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
General Motors	910L4RU	415	Initial	Adjust idle speed
General Motors	910L4RU	415	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture Replace fuel tank vent hose at canister
General Motors	910L4RU	419	Initial	Adjust idle speed
General Motors	910L4RU	421	Initial	Adjust idle speed
General Motors	910L4RU	422	Initial	Adjust choke Adjust idle mixture Replace spark plugs
General Motors	910L4RU	422	Res Mnt	Tune-up Adjust carburetor float level
General Motors	910L4RU	426	Initial	Adjust idle speed Replace No. 4 spark plug
General Motors	910L4RU	435	Initial	Adjust ignition timing Adjust choke pull-off
General Motors	910L4RU	435	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	910L4RU	442	Initial	Adjust idle speed
General Motors	910L4RU	442	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	910L4RU	456	Initial	Adjust ignition timing Adjust fast idle speed Adjust idle speed Replace spark plugs
General Motors	910L4RU	458	Initial	Adjust fast idle speed Unplug EGR vacuum line
General Motors	910L4RU	458	Res Mnt	Tune-up Replace choke pull-off Remove idle mixture plugs and adjust idle mixture

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
General Motors	910L4RU	503	Initial	Adjust choke pull-off
General Motors	910L4RU	503	Res Mnt	Tune up Remove idle mixture plugs and adjust idle mixture
General Motors	910L4RU	536	Initial	Adjust idle speed Adjust fast idle speed Adjust choke pull-off Adjust air pump belt Replace fuel filter
General Motors	910L4RU	536	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture Repair fresh air duct
General Motors	910L4RU	537	Initial	Adjust idle speed Adjust fast idle speed Adjust choke
General Motors	910L4RU	537	Res Mnt	Tune-up Adjust carburetor float level Remove idle mixture plugs and adjust idle mixture Replace fresh air duct
General Motors	910W2KQU	427	Initial	Adjust idle speed Adjust fast idle speed Replace spark plugs
General Motors	910W2KQU	427	Res Mnt	Tune-up Replace choke pull-off diaphram Remove idle mixture plugs and adjust idle mixture
General Motors	910W2KQU	432	Initial	Replace spark plugs
General Motors	910W2KQU	432	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	910W2KQU	443	Initial	Adjust idle speed Replace spark plugs Reconnect crankcase vent tube

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
General Motors	910W2KQU	443	Res Mnt	Tune-up Adjust carburetor float level Remove idle adjustment plugs and adjust idle mixture
General Motors	910W2KQU	447	Initial	Adjust idle mixture Adjust idle speed Replace spark plugs Unplug EGR vacuum line
General Motors	910W2KQU	447	Res Mnt	Tune-up
General Motors	910W2KQU	513	Initial	Replace spark plugs Adjust ignition timing
General Motors	910W2KQU	513	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	910W2KQU	515	Initial	Adjust ignition timing Adjust idle speed Adjust fast idle speed
General Motors	910W2KQU	515	Res Mnt	Tune-up Replace carburetor
General Motors	910Y2V	433	Initial	Adjust choke
General Motors	910Y2V	434	Initial	Adjust choke pull-off Adjust fast idle speed
General Motors	910Y2V	437	Initial	Adjust ignition timing Adjust fast idle speed Unplug EGR vacuum line Repair PCV vent filter Replace carburetor air horn gasket
General Motors	910Y2V	437	Res Mnt	Tune-up Replace EGR valve Adjust choke

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
General Motors	910Y2V	444	Initial	Adjust idle mixture Adjust idle speed Repair TAC heat tube
General Motors	910Y2V	445	Initial	None
General Motors	910Y2V	445	Res Mnt	Tune-up Replace EGR valve Replace PCV hose
General Motors	910Y2V	448	Initial	Adjust ignition timing Replace spark plugs
General Motors	910Y2V	514	Initial	Adjust ignition timing Adjust fast idle speed
General Motors	910Y2V	514	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	910Y2V	518	Initial	Adjust ignition timing Adjust fast idle speed
General Motors	910Y2V	527	Initial	Repair choke linkage Adjust choke
General Motors	910Y2V	527	Res Mnt	Tune-up Adjust carburetor float level Remove idle mixture plugs and adjust idle mixture
General Motors	910Y2V	533	Initial	Replace No. 3 spark plug
General Motors	910Y2V	534	Initial	Adjust choke pull-off
General Motors	910Y2V	534	Res Mnt	Tune-up Replace vacuum hose for PCV and canister purge
General Motors	920X2CEU	428	Initial	Adjust idle speed
General Motors	930H2AU	436	Initial	Adjust ignition timing Replace spark plugs

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
General Motors	930H2AU	436	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	930H2AU	439	Initial	Adjust ignition timing
General Motors	930H2AU	439	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	930H2AU	440	Initial	Adjust idle speed Replace spark plugs
General Motors	930H2AU	440	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	930H2AU	450	Initial	Adjust idle speed
General Motors	930H2AU	455	Initial	Adjust idle speed Adjust fast idle speed
General Motors	930H2AU	455	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	930H2AU	502	Initial	Adjust fast idle speed
General Motors	930H2AU	502	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	930H2AU	526	Initial	Adjust ignition timing Replace spark plugs Adjust fast idle speed
General Motors	930H2AU	538	Initial	Repair fuel leak at the carburetor
General Motors	930H2AU	538	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
General Motors	940E2CYU	420	Initial	Adjust carburetor
General Motors	940E2CYU	420	Res Mnt	Tune-up Replace EGR valve Replace canister purge hose
General Motors	940E2CYU	516	Initial	Adjust fast idle
General Motors	940E2CYU	516	Res Mnt	Tune-up Replace EGR valve Replace choke pull-off Replace O_2 sensor
General Motors	940E2LU	423	Initial	Adjust ignition timing Replace spark plugs Adjust idle speed Adjust fast idle speed
General Motors	940E2LU	423	Res Mnt	Tune-up
General Motors	940E2LU	424	Initial	Adjust ignition timing Adjust secondary choke pull-off Adjust fast idle speed
General Motors	940E2LU	424	Res Mnt	Tune-up Replace EGR valve Replace canister Replace carburetor
General Motors	940E2LU	424	Extra Test	Accumulate 50 miles
General Motors	940E2LU	425	Initial	Adjust ignition timing Adjust fast idle speed Replace PCV vent valve Adjust choke pull-off Repair carburetor vent hose at canister
General Motors	940E2LU	425	Res Mnt	Tune-up Replace EGR valve Replace secondary choke pull-off Remove idle mixture plugs and adjust idle mixture

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
General Motors	940E2LU	429	Initial	Adjust secondary choke pull-off Adjust fast idle speed Replace spark plugs
General Motors	940E2LU	430	Initial	Adjust ignition timing Adjust secondary choke pull-off Reconnect air pump delay valve vacuum line
General Motors	940E2LU	431	Initial	Adjust ignition timing Adjust idle speed Adjust primary choke pull-off Reconnect PCV vent filter to air cleaner
General Motors	940E2LU	431	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture Replace EGR valve
General Motors	940E2LU	438	Initial	Replace TAC air heat hose
General Motors	940E2LU	441	Initial	Replace No. 6 spark plug wire
General Motors	940E2LU	441	Res Mnt	Tune-up Replace EGR valve Remove idle mixture plugs and adjust idle mixture
General Motors	940E2LU	449	Initial	Adjust idle speed Install air horn gasket
General Motors	940E2LU	449	Res Mnt	Tune-up Remove idle mixture plugs and adjust idle mixture
General Motors	940E2LU	528	Initial	Adjust ignition timing
General Motors	940E2LU	530	Initial	Adjust fast idle speed
General Motors	940E2LU	531	Initial	Adjust ignition timing Replace secondary choke pull-off Adjust idle speed Adjust fast idle speed

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
General Motors	940E4DVT	509	Initial	Adjust idle speed Adjust idle mixture Replace spark plugs Replace incorrect EGR valve
General Motors	940E4DVT	509	Res Mnt	Tune-up Replace turbo wastegate actuator
General Motors	940E4DVY	510	Initial	Adjust ignition timing Adjust idle speed Replace incorrect EGR valve Replace No. 2 spark plug wire
General Motors	940E4DVY	510	Res Mnt	Tune-up Replace choke pull-off Replace power enrichment vacuum regulator
Ford	1.6G1X128	416	Initial	Adjust ignition timing Adjust idle mixture Repair fuel leak
Ford	1.6G1X128	416	Res Mnt	Tune-up Clean EGR passage
Ford	1.6G1X128	504	Initial	Adjust idle mixture Adjust idle speed Connect TAC sensor vacuum hose
Ford	2.3A1X150	403	Initial	Adjust ignition timing Adjust idle mixture Replace PCV vent hose and connector on air cleaner
Ford	2.3A1X150	405	Initial	Repair distributor cap
Ford	2.3A1X150	405	Res Mnt	Tune-up Replace EGR valve Clean plugged EGR passage
Ford	2.3A1X150	407	Initial	Adjust ignition timing Connect vacuum advance hose

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
Ford	2.3A1X150	407	Res Mnt	Tune-up Clean plugged EGR passage
Ford	2.3A1X150	408	Initial	None
Ford	2.3A1X150	408	Res Mnt	Tune-up Clean plugged EGR passage
Ford	2.3A1X150	412	Initial	Adjust idle mixture
Ford	2.3A1X150	412	Res Mnt	Tune-up Replace EGR backpressure transducer
Ford	2.3A1X150	507	Initial	Adjust idle mixture Adjust idle speed Adjust choke
Ford	2.3A1X150	517	Initial	Adjust idle mixture
Ford	2.3A1X150	517	Res Mnt	Tune-up Replace air duct
Ford	2.3A1X150	520	Initial	Replace vacuum line to TAC unit Replace vacuum line to choke pull-off
Ford	2.3A1X150	520	Res Mnt	Tune-up Replace EGR valve Replace air duct Replace PCV vent hose connector
Ford	2.3A1X150	521	Initial	Adjust ignition timing Adjust idle mixture
Ford	2.3A1X150	521	Res Mnt	Tune-up Replace air duct Replace PCV vent valve
Ford	2.3A1X150	522	Initial	Adjust idle mixture
Ford	2.3A1X150	525	Initial	Adjust ignition timing Adjust idle mixture
Ford	2.3A1X150	525	Res Mnt	Tune-up Replace air duct Clean plugged EGR passage

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
Ford	2.3A1X150	529	Initial	Adjust idle mixture Adjust choke pull-off
Ford	2.3A1X150	529	Res Mnt	Tune-up Replace EGR backpressure transducer
Ford	2.3B1TR80XR80	413	Initial	Adjust idle mixture Replace gas cap
Ford	2.3B1TR80XR80	414	Initial	None
Ford	2.3B1TR80XR80	414	Res Mnt	Tune-up Clean plugged EGR passage Replace EGR valve Replace O_2 sensor
Ford	2.3B1TR80XR80	417	Initial	Adjust idle speed
Ford	2.3B1TR80XR80	417	Res Mnt	Tune-up Clean rust from plugged TVS
Ford	2.3B1TR80XR80	535	Initial	Adjust ignition timing Adjust idle speed Adjust idle mixture
Ford	2.3B1TR80XR80	535	Res Mnt	Tune-up Replace canister purge control vacuum line Clean plugged EGR passage
Ford	2.8BV1X150	402	Initial	Adjust ignition timing Adjust idle speed Tighten fuel line
Ford	2.8BV1X150	402	Res Mnt	Tune-up Tighten fuel line Repair carburetor linkage
Ford	2.8BV1X150	505	Initial	Adjust venturi control vacuum
Ford	2.8BV1X150	505	Res Mnt	Tune-up

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
Ford	3.3B1X150	401	Initial	None
Ford	3.3B1X150	401	Res Mnt	Tune-up Replace choke pull-off Repair fuel line Replace carburetor fresh air inlet hose
Ford	3.3B1X150	406	Initial	Adjust idle mixture Adjust idle speed Replace EGR vacuum line
Ford	3.3B1X150	406	Res Mnt	Tune-up Replace EGR and vacuum advance TVS Replace EGR valve
Ford	3.3B1X150	512	Initial	Adjust idle speed Adjust idle mixture
Ford	3.3B1X150	512	Res Mnt	Tune-up
Ford	3.3B1X150	519	Initial	Adjust idle mixture
Ford	3.3B1X150	519	Res Mnt	Tune-up
Ford	4.1A1X150	404	Initial	None
Ford	4.1A1X150	404	Res Mnt	Tune-up
Ford	4.1A1X150	511	Initial	Adjust ignition timing Adjust idle mixture Adjust spark plug gaps
Ford	4.1A1X150	511	Res Mnt	Tune-up
Ford	5.0AV1X150	409	Initial	Adjust carburetor venturi bypass vacuum Adjust idle speed Free stuck fast idle cam Repair vacuum leak
Ford	5.0AV1X150	409	Res Mnt	Tune-up Replace distributor vacuum advance

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
Ford	5.0AV1X150	410	Initial	Adjust ignition timing Tighten air pump belt Adjust carburetor venturi bypass vacuum
Ford	5.0AV1X150	410	Res Mnt	Tune-up Replace distributor vacuum advance
Ford	5.0AV1X150	411	Initial	Adjust carburetor venturi bypass vacuum Free stuck fast idle cam
Ford	5.0AV1X150	411	Res Mnt	Tune-up Replace air duct vacuum motor Replace heated air duct
Ford	5.0AV1X150	418	Initial	Adjust idle mixture Adjust ignition timing
Ford	5.0AV1X150	418	Res Mnt	Tune-up Replace distributor vacuum advance
Ford	5.0AV1X150	501	Initial	Adjust carburetor venturi bypass vacuum
Ford	5.0AV1X150	501	Res Mnt	Tune-up Replace distributor vacuum advance
Ford	5.0AV1X150	506	Initial	Replace TAC heat tube Adjust carburetor venturi bypass vacuum
Ford	5.0AV1X150	506	Res Mnt	Tune-up
Ford	5.0AV1X150	524	Initial	Adjust ignition timing Reconnect air bypass valve vacuum hose Adjust choke Replace spark plugs Adjust idle mixture
Ford	5.0AV1X150	524	Res Mnt	Tune-up Replace TAC vacuum motor

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
Chrysler	9CD-318/ 360-4-GP	453	Initial	Adjust idle mixture
Chrysler	9CD-318/ 360-4-GP	453	Res Mnt	Tune-up
Chrysler	9CD-318/ 360-4-GP	454	Initial	Adjust idle mixture Adjust idle speed Replace spark plugs Repair fuel line
Chrysler	9CD/318 360-4-GP	454	Res Mnt	Tune-up
Chrysler	9CD/318 360-4-GP	459	Initial	Adjust ignition timing Adjust idle mixture Adjust idle speed Replace spark plugs
Chrysler	9CD/318 360-4-GP	459	Res Mnt	Tune-up
Chrysler	9CF-105- 2-BP	452	Initial	Adjust idle mixture Adjust idle speed Reconnect vacuum source for TAC, choke pull-off, and spark control transducer
Chrysler	9CF-105- 2-BP	452	Res Mnt	Tune-up Clean plugged EGR passage Replace carburetor mounting spacer
Chrysler	9CF-105- 2-BP	460	Initial	Adjust idle mixture Adjust idle speed
Chrysler	9CF-105- 2-BP	460	Res Mnt	Tune-up Clean plugged EGR passage
Chrysler	9CF-105- 2-BP	523	Initial	Adjust idle mixture Adjust idle speed
Chrysler	9CF-105- 2-BP	523	Res Mnt	Tune-up
Chrysler	9CF-105- 2-BP	532	Initial	Adjust idle speed Adjust idle mixture
Chrysler	9CF-105- 2-BP	532	Res Mnt	Tune-up Clean plugged EGR passage

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Manufacturer	Engine Family	Veh	Test	Maintenance Performed Prior to Testing
Mitsubishi	4G3M-C	446	Initial	Adjust idle speed Adjust idle mixture
Mitsubishi	4G3M-C	446	Res Mnt	Tune-up Replace distributor vacuum aovance unit
Mitsubishi	4G3M-C	508	Initial	Adjust idle speed Adjust idle mixture
Mitsubishi	4G3M-C	508	Res Mnt	Tune-up Repair stuck sub EGR valve Replace distributor vacuum advance unit
Mitsubishi	4G3P-C	451	Initial	Adjust idle speed Adjust idle mixture Adjust ignition timing Replace spark plugs
Mitsubishi	4G3P-C	451	Res Mnt	Tune-up Clean EGR passage Repair stuck sub EGR valve
Mitsubishi	4G3P-C	457	Initial	Adjust distributor dwell Adjust ignition timing Secure distributor cap Regap No. 3 spark plug Adjust idle speed Adjust idle mixture
Mitsubishi	4G3P-C	457	Res Mnt	Tune-up