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Technical Report

I/M Test Variability

By

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ABSTRACT

This report summarizes an effort to study the emissions of vehicles that had exhibited variability on I/M tests and then to determine the effects of various preconditioning cycles on the I/M tests of those vehicles. The FTP HC and CO emissions of the vehicles which continued to fail the I/M test even after loaded preconditioning tended to be higher than the emissions of the I/M-failing vehicles which passed after that loaded preconditioning. Among the closed-loop vehicles, the fuel injected cars appeared to be more likely to produce consistent I/M results than were the carbureted cars.

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EXECUTIVE SUMMARY

1. Objectives of Work

The primary objective of this program was to determine the effects of various preconditioning cycles on I/M tests of vehicles that had exhibited variability on I/M tests (i.e., those vehicles which after failing at Maryland's centralized I/M lane would pass a similar test with heavy preconditioning).

A secondary objective of this program was to characterize the FTP emissions of those I/M variable vehicles.

This report summarizes the effort to study the FTP emissions of the new technology vehicles (i.e., 1983 and newer) which had exhibited variability on I/M tests and the effects of various preconditioning cycles on I/M scores (i.e., pass/fail).

2. Conclusions Reached

Closed-loop, fuel injected cars equipped with AIR appear to be more likely to produce consistent I/M results (i.e., cars that initially failed an I/M test would continue to fail again even after heavy preconditioning) than are closed-loop, carbureted cars equipped with AIR (cf. page 9).

Among the 1983-85 model year vehicles which initially failed the official Maryland I/M test, the FTP HC and CO emissions of those vehicles which also failed an I/M idle test following loaded preconditioning tended to be substantially higher than the FTP emissions of those vehicles which passed an I/M idle test following loaded preconditioning (cf. page 21).

The cars which fail both the official Maryland I/M test as well as an I/M idle test which followed loaded preconditioning accounted for 84% of the HC in excess of the standard (0.41 g/mi) and 80% of the excess CO of the standard (3.40 g/mi) of all the 1983-85 cars which failed the official I/M test (cf. page 22).

The I/M test following three minutes of 2500 rpm no-load preconditioning cycle and the I/M test following 30 seconds of 30 mph loaded preconditioning cycle were equally effective in identifying I/M variable vehicles. Each cycle identified 90 percent of these cars (cf. pg 27). However, due to the limited amount of FTP data, we cannot be confident in comparing the excess emissions that each cycle will identify (cf. page 29).

Nearly one-fourth of the cars tested in this study exhibited substantial increases in idle emissions after idling for only a short time (but longer than 30 seconds). A small number of models account for most of these cars (cf. page 17).

While this program was not designed to study the possibility of using the vehicle's on-board diagnostics to identify high emitting cars, and hence did not examine any vehicles that had stored trouble codes but did not fail the official I/M test, we note that of the twenty GM cars in this study whose trouble codes were read, only one (5%) was reported to have had a computer trouble code stored in its on-board malfunction/diagnostic system, and that car had passing FTP emissions (cf. page 6). These observations, while far from conclusive, do not strengthen the case for using only on-board diagnostics (OBD) to identify high emitting cars.

3. Assumptions on Which the Work Was Accomplished

The assumption on which this testing program was designed was that a major factor controlling I/M test variability is the type of preconditioning the vehicle is given just prior to the I/M test.

4. Options for Additional Work

Two new test programs began shortly after this program was completed. One of these studies the use of computer trouble codes (i.e., OBD) to identify vehicles with high emissions. A second program studies the effects of several preconditioning cycles on the official I/M test scores in the Louisville program.

1.0 INTRODUCTION

In 1985, EPA conducted an emissions test program in Maryland.[1]* That study provided data which will be useful in the development of mobile source models and public policy regarding inspection and maintenance (I/M) programs. Among these data is information about the emissions behavior of a fleet of late-model year cars influenced by I/M and the costs and effectiveness of emission-related repairs. While performing that study, we found that a significant percentage of the new technology cars which failed at the Maryland I/M test lanes would pass the same test conducted at the Contractor's laboratory. To obtain information about those new technology cars which exhibited variability in their I/M test emissions, EPA conducted this program during the summer of 1986 in Maryland. This program was limited to the 1983 and newer model year cars.

This report summarizes the effort to study the emissions variability of these new technology cars. In this program, the target was to recruit and test approximately 100 late-model year (i.e., 1983 and newer) cars which failed the Maryland I/M program. (The actual test results along with a description of the associated repairs can be found in the appendices of this report.) This project had several objectives, but the primary one was to characterize the emissions of those cars which failed the Maryland test and then passed a similar test after heavy preconditioning at the Contractor's laboratory. (Those cars which failed the I/M test at both the Maryland inspection lane and at the Contractor's laboratory were examined in that earlier Maryland study.) EPA hopes to use this information to formulate cost-effective policy towards repair cost waivers in I/M programs and to support development of emission reduction estimates for I/M programs.

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* Numbers in brackets denote references at the end of this report (page 36).

2.0 TEST FLEET SELECTION

The contractor, EG&G Automotive Research, Inc. (EG&G), recruited 1983 and later model year passenger cars that failed the official Maryland I/M test* at Stations #7 and #8 (in Prince George's County) and #9 and #10 (in Montgomery County). These stations were selected because of their proximity to the EG&G testing laboratory in Virginia. The I/M station personnel gave the drivers of all such cars a letter stating the purpose of this program and inviting them to call EG&G if they wished to participate. At the same time, the Maryland Division of Motor Vehicles forwarded lists of I/M failures at stations #7 and #8 to EG&G.

In order to assure that the selection of cars for this program was a representative cross-section, EG&G used a random number generator in a Hewlett-Packard 9825A computer to rearrange the full list of eligible vehicles including the volunteers. The vehicles were numbered prior to the list being randomized, which explains why the numbers of the 106 vehicles in this program ranged from "001" to "421." The contractor was asked to give priority in recruiting to fuel injected vehicles.

2.1 Screening the Incoming Cars

All incoming vehicles were screened to remove cars which had already received some repairs or cars which were identified as having mechanical problems which could interfere with testing. Three of the 106 cars recruited for this program were rejected:

- One car (a 1985 Dodge Diplomat, vehicle number IV5/109) was rejected because it had been repaired prior to being recruited.

- Two cars (a 1984 Cadillac Eldorado and a 1983 Honda Accord, vehicles numbered IV4/289 and IV3/293, respectively) were rejected because they had damaged exhaust systems. (The Contractor decided that, with the very limited time and limited number of loaner cars available for this program, it would be preferable to simply recruit other cars.)

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* The official Maryland test results are the stabilized idle emissions (within 15 to 30 seconds) after the vehicle has been preconditioned at about half throttle for about 15 seconds.

2.2 Description of Test Fleet

The 103 cars which completed this program are described in Appendices A and B. The distribution of those 103 is given below in Table 2.1. All of the 69 carbureted cars described in Table 2.1 are equipped with a supplementary air (AIR) system, and all of the 34 fuel injected cars in that table are closed-loop.

Table 2.1

Distribution of the Cars Which Completed the Program

Model Year	-- Carbureted -- Open-Loop	Closed-Loop	Fuel Injected AIR	No AIR
1983	30	10	-	4
1984	4	15	3	13
1985	3	7	11	3
Totals:	37	32	14	20

The distribution of the 103 test vehicles by manufacturer and by basic engine is given below in Table 2.2. The term "FTP Eligible" refers to those cars which passed the 220 ppm HC and 1.2 percent CO cutpoints (and is described in Section 3.1, on page 5).

Table 2.2

Composition of Sample Fleet

Manufacturer	CID	Fuel Metering	-------- Number -------- Recruited	FTP Eligible
AMC	85	FI	1	0
BMW	108	FI	1	1
	164	FI	1	0
Chrysler	135	2 bbl	2	2
	135	FI	3	1
	156	2 bbl	6	5

-- Table 2.2 Continued on Next Page --

Table 2.2 (continued)

Composition of Sample Fleet

Manufacturer	CID	Fuel Metering	Number Recruited	Number FTP Eligible
Ford	98	2 bbl	6	3
	118	2 bbl	2	2
	140	1 bbl	4	3
	140	FI	8	4
	200	1 bbl	1	0
	231	2 bbl	1	1
	302	4 bbl	1	1
	302	FI	3	3
GM	98	2 bbl	5	4
	151	FI	7	5
	173	FI	1	1
	231	2 bbl	3	2
	231	FI	1	1
	305	4 bbl	1	1
	307	4 bbl	2	2
Honda	81	3 bbl	1	0
	82	3 bbl	1	1
	91	3 bbl	5	3
	107	3 bbl	3	3
	112	2 bbl	3	2
	112	3 bbl	3	3
Isuzu	119	FI	1	0
Mitsubishi	86	2 bbl	1	1
	122	2 bbl	2	0
	156	2 bbl	1	1
Nissan	98	2 bbl	4	3
	120	2 bbl	7	4
	146	FI	1	1
	168	FI	1	1
	181	FI	2	1
Peugeot	120	FI	1	0
Toyota	89	2 bbl	3	3
	97	2 bbl	1	1
Volvo	141	FI	2	0

3.0 VEHICLE TESTING

3.1 Testing Program

The testing and vehicle repair for this contract were performed at the Virginia Test Laboratory (VTL) operated by EG&G Automotive Research, Inc. For this task, EG&G performed the following five (5) to ten (10) steps:

1. Recruit late-model year (i.e., 1983 and newer) passenger cars which failed the Maryland I/M program (which has cut- points of 220 ppm HC and 1.20 percent CO).

2. Screen those cars (to remove cars which have already received some repairs and cars which were identified as having problems which would interfere with testing).

3. Test those cars for evidence of the use of leaded gasoline by using Plumbtesmo brand lead-sensitive paper in the exhaust pipe and by using a wet chemistry lead detection kit to measure the level of lead in the car's gasoline.

4. Examine the cars to determine:

   A. whether the catalyst was in place,

   B. the condition of the fuel inlet (filler neck) restrictor, and

   C. whether any computer trouble codes were present.

5. Test those cars for emissions over the first nine (9) steps of the extended special I/M test (described in Appendix C).

   A. For those vehicles whose idle emissions, in Step 9 (on page C-1), exceeded the Maryland cut-points after 30 seconds (which would approximate the Maryland test preceded by heavy preconditioning), the testing was terminated and the cars returned to their owners (since vehicles of this type were extensively studied in the earlier Maryland program).

   B. For those vehicles whose idle emissions, in Step 9, were less than the Maryland cut-points after 30 seconds (which would correspond to the Maryland test preceded by heavy preconditioning), the testing continued through the remaining 16 steps of the procedure. These vehicles are referred to as "FTP Eligible" in Table 2.2 (pages 3 and 4).

6. Perform an FTP test the next day on each of the cars which completed the entire 25 steps of the extended special I/M procedure (i.e., on those cars which failed the Maryland I/M test but were able to pass with heavy preconditioning).
   We originally anticipated that about 40 to 50 percent of the cars would fall into this category. When we discovered that almost 70 percent of the recruited cars were meeting this criterion, we allocated the available FTP testing slots to those cars at random, testing 48 of the eligible 70 cars.

7. Examine the cars whose FTP emissions exceed twice the standard (i.e., HC > 0.82 or CO > 6.80) for malfunctions.

8. For up to five of those cars whose FTP emissions exceeded twice the standards, repair those malfunctions which appeared responsible for the I/M failure and which could reasonably be expected to be part of a competent I/M field repair. (A description of those repairs can be found in Appendix F.)

9. Return those cars which were repaired to one of the Maryland I/M lanes for a passing retest.

10. Retest those repaired cars for emissions.

Testing began on August 5, 1986 and continued through September 17, 1986.

3.2 Results of Initial Examination

The examinations of the 103 test vehicles revealed:

1. The catalyst was in place for each of the 103 cars.

2. The fuel inlet restrictor was intact and in place for all but one car. It was missing on vehicle number IV5/045.

3. Vehicle number IV4/222 displayed a computer trouble code "45" (rich oxygen sensor). (As shown in Appendices D & E, the FTP emissions of that vehicle are within the standards.) No other codes were reported except for a code "12" for GM cars, indicating normal operation.

4. Plumbtesmo brand test paper was used to examine the exhaust pipes of all of the cars except for vehicle IV4/005. Of the 102 cars tested, the results were negative (i.e., no lead detected) for all but two (2) cars: IV3/103 and IV3/225.

5. The levels of lead in the vehicles' fuel tanks (in grams of lead per gallon of gasoline) were measured with the wet chemistry lead detection kit for 100 of the 103 cars. (The fuel was not sampled for three of the cars.) Only one car was determined to have a lead level greater than 0.039 g/gal. The lead level of the fuel in vehicle IV5/361 was estimated to be 0.114 g/gal (well above the limit of 0.050 g/gal for unleaded gasoline). However, an examination of the work sheets suggests that the technician probably interchanged the absorptance reading for that fuel sample with the reading of the known solution (which was at 0.040 g/gal). If that did in fact occur, then the correct lead level for that vehicle should have been about 0.018 g/gal.

3.3 The Extended Special I/M Test Sequence

For this task, the extended special I/M test sequence, described in Appendix C, was to be performed on each vehicle recruited by the Contractor. This test sequence required about 70 minutes to perform and consists of 25 steps, or 27 minutes if testing ended after step number 9. This 25-step sequence is designed to simulate several I/M short tests, each with different preconditionings:

- the 2500 rpm/idle test (40 CFR §85.2209),
- the engine restart 2500 rpm/idle test (§85.2210),
- the engine restart idle test (§85.2211),
- the idle test (§85.2212), and
- the loaded test (§85.2214).

In addition, this sequence examines the effects on emissions of:

- extended periods of 2500 rpm operation (up to 3 minutes),
- extended periods of idle in neutral (up to 31 minutes), and
- loaded operations (both steady state 30 mph for 30 seconds and 3.6 miles of transient operations).

It is important to note that the dynamometer calibrations used for steps 23 and 24 were designed to simulate the single curve Clayton dynamometer used for the loaded test (40 CFR §85.2216). Those calibrations included using only a 1000 pound trim weight and an actual road load of 7.0 horsepower at 30 mph and were, therefore, different from those used for step 6 and for the FTP.

4.0 TEST RESULTS

4.1 Results from the Extended Special I/M Test Sequence

4.1.1 Comparison with Earlier Study

Of the 103 cars in this program, 33 of them (32.0%) failed both at the Maryland I/M lane and at the Contractor's laboratory. ("Failure" at the Contractor's laboratory means that, after 30 seconds into Step 9 of the Extended Special I/M Test, either the vehicle's idle HC emissions exceeded 220 ppm or the CO exceeded 1.20%.) The remaining 70 cars (68.0%) which failed at the Maryland lane were able to pass with heavy preconditioning (i.e., the first 505 seconds of the FTP which is about 3.6 miles).

This testing program was designed to answer questions raised during the study described in Reference 1. In that study, 178 late-model year cars were tested (by the same Contractor and at the same laboratory that was used for this program) using a Restart Idle Test (as a screening test) which immediately followed a 10-minute road test. Of those 178 cars recruited for the earlier study, a total of 73 were 1983 and 1984 model year vehicles. Since each of those 73 cars failed the official Maryland I/M test and were recruited and tested prior to being repaired, that sample of 73 cars is comparable to the 103 cars in this study. Of those 73 cars, 26 of them (35.6%) failed both at the Maryland I/M lane and at the Contractor's laboratory. ("Failure" at the Contractor's laboratory means that, after the 10-minute road test, either the vehicle's idle HC emissions, as measured on a Restart Idle Test, exceeded 220 ppm or the CO exceeded 1.20%.) Thus, the remaining 47 cars (64.4%) which failed at the Maryland lane were able to pass after being preconditioning with a 10-minute road test. Combining the results of these two studies, we find that about two-thirds (117 out of 176) of the 1983 and newer cars that failed at the Maryland lane were able to pass after loaded (transient) preconditioning.

These results were repeated in a recent California study [2,3], which concluded:

> "Some vehicles that have no significant defects will fail the Smog Check test if they are not fully warmed up by driving immediately before testing. To prevent unintentional failures, the [I/M Review] Committee recommends that BAR require failing 1980 and later model vehicles to be driven about one mile and retested."

The vehicles in this program which were tested through the entire 25 step sequence (i.e., the 70 cars which passed at EG&G's laboratory after a '505' preconditioning) are described

in Table 4.1. The corresponding results from the earlier program are also included in Table 4.1. A comparison of the data in Table 4.1 with those in Table 2.1 and in Appendix H suggest that, of the cars which initially failed at the Maryland I/M lanes:

- The fuel-injected, closed loop cars, equipped with AIR would pass a second test 64% of the time if the test were preceded by either a 3.6 mile road-test or a '505' preconditioning cycle.

- The carbureted, closed loop cars, equipped with AIR would pass a second test 78% of the time if the test were preceded by either a 3.6 mile road-test or a '505' preconditioning cycle.

- The carbureted, open loop cars, equipped with AIR would pass a second test 70% of the time if the test were preceded by a '505' preconditioning cycle, and 43% of the time if the test were preceded by a 3.6 mile road-test.

- The fuel-injected, closed loop cars, without AIR would pass a second test 50% of the time if the test were preceded by a '505' preconditioning cycle, and 80% of the time if the test were preceded by a 3.6 mile road-test.

This suggests that closed-loop, fuel injected cars equipped with AIR are more likely to produce consistent I/M results (i.e., cars initially failing an I/M test would fail again even after heavy preconditioning) than are closed-loop, carbureted cars equipped with AIR.

Table 4.1

Distribution of the Cars "Passing" After Preconditioning

Preconditioning Cycle	----- Carbureted ----- Open-Loop	Closed-Loop	--- Fuel Injected -- ---- Closed Loop --- AIR	No AIR
'505'	26 (70.3%)	25 (78.1%)	9 (64.3%)	10 (50%)
Road-Test	9 (42.9%)	18 (78.3%)	12 (63.2%)	8 (80%)
Totals:	35 (60.3%)	43 (78.2%)	21 (63.6%)	18 (60%)

4.1.2 Comparison with Official I/M Test

Since no portion of the extended special I/M test exactly matches the official Maryland I/M test (described in the footnote on page 2), our primary purpose in using the extended special I/M test was not to try to replicate the official Maryland I/M test results. However, we did expect that, for each of those vehicles which failed the official I/M test, we would find some operating mode that would produce another idle test failure, but we found that we were unable to reproduce almost one-half (44.7%) of the official I/M failures.

As shown in Appendix C, there are six instances during the Extended Special I/M Test in which 30 seconds of idle (in neutral) follow 30 seconds of 2500 rpm (no load) operation. Specifically:

- Steps 4 - 5, 10 - 12, and 16 - 18 each corresponds to a Restart 2500 rpm/Idle Test,
- Steps 8 - 9 and 14 - 15 each corresponds to a 2500 rpm/ Idle Test, and
- Steps 21 - 22 corresponds to a Restart 2500 rpm/Idle Test for only Fords and 1984 Preludes and corresponds to a 2500 rpm/Idle Test for all other models.

Of the 103 vehicles which failed the official Maryland I/M test and were then tested in this program:

- 33 of them (32.0%) also "failed" (i.e., had either idle HC emissions in excess of 220 ppm or idle CO emissions in excess of 1.20%) on Step 9 (and were thus excluded from any additional testing),
  - •• Of those 33, 20 also "failed" on Step 5.
- Of the 70 cars which "passed" on Step 9, 24 of them "failed" on at least one of the other five idle modes which followed 2500 rpm no-load operation, and
- 46 of the 103 cars (44.7%), did not "fail" on <u>any</u> of the six idle modes following 2500 rpm no-load operation.

Examining all of the idle emissions (rather than restricting ourselves to only the 30 seconds of idle following 30 seconds of 2500 rpm no-load operation), we note that 33 measurements of idle emissions were performed. Comparing the

official Maryland I/M results with those 33 measurements, we found that:

- Of the 82 cars which had exceeded the CO standard (1.20%) at the Maryland I/M lane, 24 (29.3%) of them never had idle CO emissions in excess of 1.20% at any of the 33 idle measurement points of the extended special I/M test.

- Of the 52 cars which had exceeded the HC standard (220 ppm) at the Maryland I/M lane, 14 (26.9%) of them never had idle HC emissions in excess of 220 ppm at any of the 33 idle measurement points of the extended special I/M test.

- Of the 103 cars in this study, 28 (27.2%) of them never had idle emissions (neither HC nor CO) in excess of the standard, even after 31 minutes of idling.

Those vehicles are identified in Tables 4.2 through 4.4, and the results are summarized in Table 4.5.

Table 4.2

Vehicles 'Passing' Only HC in Each of the 33 Idle Measurements of the Extended Special I/M Test Sequence

Vehicle Number	Maryland I/M HC (ppm)	Maryland I/M CO (%)	FTP Emissions HC (g/mi)	FTP Emissions CO (g/mi)
IV3/120	80	1.56	.68	3.03
IV4/146	239	1.88	.24	5.42
IV4/167*	261	3.21	.16	1.90
IV3/214	77	1.32	N/A	N/A
IV3/220	207	3.08	N/A	N/A
IV3/225**	168	6.70	1.08	37.59
IV3/268	84	3.10	N/A	N/A
IV3/288	201	2.07	N/A	N/A
IV3/421	132	4.75	.26	6.03
Overall:	Mean:		.484	10.794
	Excess:		.188	7.768

* Error of Commission Car (See Table 4.10)

** High Emitting Car (See Table 4.11)

Table 4.3

Vehicles 'Passing' Both HC & CO in Each of the 33 Idle Measurements of the Extended Special I/M Test Sequence

Vehicle Number	Maryland I/M HC (ppm)	Maryland I/M CO (%)	FTP Emissions HC (g/mi)	FTP Emissions CO (g/mi)
IV4/005*	379	0.16	.17	2.19
IV5/026	273	7.36	N/A	N/A
IV5/035*	228	1.58	.27	2.73
IV3/046*	172	2.10	.30	3.01
IV4/047	39	1.86	.63	3.73
IV4/064	131	1.62	N/A	N/A
IV3/103	223	1.85	.39	3.77
IV3/105	378	1.72	.44	8.32
IV3/148	59	1.61	.25	5.35
IV3/171	119	1.22	.22	4.06
IV3/197	113	3.23	.26	7.75
IV3/205	241	.24	N/A	N/A
IV5/226	141	1.43	N/A	N/A
IV3/236	127	1.44	.34	4.40
IV5/239	600	.13	N/A	N/A
IV3/260**	163	1.71	.99	22.10
IV5/274*	241	.19	.14	2.07
IV4/276	193	3.31	N/A	N/A
IV4/291*	483	.11	.31	1.85
IV3/294	167	3.36	.23	4.90
IV5/312	325	.43	N/A	N/A
IV4/316	173	1.49	1.09	8.90
IV3/323**	122	1.43	1.38	28.00
IV5/355	152	1.71	N/A	N/A
IV5/359	284	.01	N/A	N/A
IV4/364	315	6.50	N/A	N/A
IV3/395	38	2.04	.46	8.66
IV3/401	113	1.25	.54	4.96
Overall:	Mean:		.467	7.042
	Excess:		.148	3.928

* Error of Commission Car (See Table 4.10)

** High Emitting Car (See Table 4.11)

Table 4.4

Vehicles 'Passing' Only CO in Each of the 33 Idle Measurements of the Extended Special I/M Test Sequence

Vehicle Number	Maryland I/M HC (ppm)	Maryland I/M CO (%)	FTP Emissions HC (g/mi)	FTP Emissions CO (g/mi)
IV4/011*	243	9.71	.39	2.05
IV5/025*	542	.04	.21	2.57
IV5/031*	287	1.82	.14	2.28
IV4/149	306	.40	.36	4.08
IV3/163	345	.55	.69	4.11
IV4/222*	419	7.05	.34	2.98
IV5/279	271	.00	.46	2.87
IV3/283	221	.27	N/A	N/A
IV3/297	222	.03	N/A	N/A
IV4/360	313	.05	N/A	N/A
Overall:	Mean:		.370	2.991
	Excess:		.047	.199

* Error of Commission Car (See Table 4.10)

Table 4.5

Comparison of Reason for the Original I/M Failure with Behavior over the Extended I/M Test Sequence

Behavior on Extended I/M Test	Reason for Maryland I/M Failure: Only HC	Both HC & CO	Only CO	Totals
'Passing' HC (only) at each of the 33 idle measurements	-	2	7	9
'Passing' both HC & CO at each of the 33 idle measurements	7	5	16	28
'Passing' CO (only) at each of the 33 idle measurements	7	3	-	10
Cars Completing the Entire Extended I/M:	17	18	35	70
Total Population:	21	31	51	103

Of the 48 cars which were FTP tested in this program, six of them had FTP HC emissions of at least 0.99 g/mi. Two-thirds of those six "HC dirtiest" cars never had idle HC emissions in excess of 220 ppm at any of the 33 idle measurement points of the extended special I/M test. Those four cars, which always had "passing" idle HC emissions, accounted for 34.1% of the total (for the entire test fleet of 48 cars) HC emissions in excess of the 0.41 g/mi standard.

Similarly, of the 48 cars which were FTP tested in this program, six of them had FTP CO emissions of at least 20.00 g/mi. One-third of those six "CO dirtiest" cars never had idle CO emissions in excess of 1.20 percent at any of the 33 idle measurement points of the extended special I/M test. Those two cars, which always had "passing" idle CO emissions, accounted for 18.9% of the total CO emissions in excess of the 3.40 g/mi standard. Also, one of the 23 cars which always had "passing" idle HC emissions (but did have "failing" idle CO only on the 2500 rpm/Idle Test which followed 31 minutes of idle operation) had high FTP CO emissions of 37.59 g/mi; the emissions from that car combined with the emissions from the two preceding cars accounted for 31.3% of the total excess FTP CO emissions.

Thus, there is no guarantee that a car with high FTP emissions must also have consistently (i.e., repeatedly) high idle emissions during at least one operating mode.

4.1.3 Effects of Heavy Preconditioning

Three different types of heavy preconditioning were used in the extended special I/M test. To determine the relative effects of each of those three, compare the emissions at the end of the 30 seconds of idling:

- for the first 505 seconds of the FTP (about 3.6 miles) (Step 6 in Appendix C), compare the "cold" 2500 rpm/Idle Test with those of the 2500 rpm/Idle Test following the '505' (i.e., comparing the results from Steps 5 and 9 in Appendix C),

- for the 3 minutes of operation at 2500 rpm (Step 19 in Appendix C), compare:

  - for Fords and 1984 Preludes: the Restart/Idle Test after the 3 minutes of 2500 rpm operation with those of the Restart/Idle Test preceding the 3 minutes of2500 rpm operation (i.e., comparing the results from Steps 18 and 22 in Appendix C), and

  - for all other vehicles: the 2500 rpm/Idle Test after the 3 minutes of 2500 rpm operation with those of the 2500 rpm/Idle Test preceding the 3

minutes of 2500 rpm operation (i.e., comparing the results from Steps 15 and 22 in Appendix C, however that comparison could produce questionable results due to the Restart/Idle Test between them), and

- for the 30 seconds of loaded operation at 30 mph (Step 23 in Appendix C), compare the Loaded Test with those of the preceding idle modes (i.e., comparing the results from Step 24 with Steps 15, 18, or 22 in Appendix C).

Using the data in Appendix E, we can identify the cars whose idle emissions were significantly affected by heavy preconditioning. Those cars are given below in Table 4.6.

Table 4.6

Cars Affected by Heavy Preconditioning

Vehicle Number	Model	Precondi-tioning	Effect
IV4/001	84 Chevette	3 min of 2500 rpm	Possible** Decrease in CO
IV4/004	84 Tempo	'505'	Decrease in both HC and CO
IV5/031*	85 Fiero	'505'	Decrease in CO
IV3/034	83 Prelude	'505'	Decrease in both HC and CO
IV4/072	84 Colt	'505'	Decrease in both HC and CO
IV4/158	84 Escort	'505'	Increase in CO
IV3/163	83 Tercel	3 min of 2500 rpm	Possible** Decrease in HC

-- Table 4.6 Continued on Next Page --

* Error of Commission Car (See Table 4.10)

** Comparison between Steps 15 and 22 is questionable.

Table 4.6 (continued)

Cars Affected by Heavy Preconditioning

Vehicle Number	Model	Precondi-tioning	Effect
IV3/214	83 Escort	3 min of 2500 rpm	Decrease in CO
IV4/221	84 Fiero	'505'	Decrease in CO
IV3/225	83 NewYorker	3 min of 2500 rpm	Possible** Decrease in CO
IV3/236	83 Accord	'505' 30 MPH	Increase in CO Increase in CO
IV3/264	83 Corolla	'505'	Decrease in both HC and CO
IV5/265	85 Cordia	'505'	Increase in both HC and CO
IV3/268	83 NewYorker	3 min of 2500 rpm	Possible** Decrease in CO
IV3/277	83 Aries	'505'	Increase in CO
IV4/280	84 Cordia	'505'	Increase in CO
IV3/283	83 Tercel	'505'	Decrease in HC
IV5/284	85 Tempo	'505'	Decrease in both HC and CO
IV4/285	84 Chevette	'505'	Decrease in HC
IV3/314	83 Escort	'505'	Increase in both HC and CO
IV4/360	84 Mustang	3 min of 2500 rpm	Decrease in HC
IV3/382	83 GranPrix	'505'	Increase in both HC and CO
IV4/389	84 T&C Wgn	3 min of 2500 rpm	Possible** Decrease in both HC and CO
IV3/421	83 Stanza	'505'	Decrease in both HC and CO

** Comparison between Steps 15 and 22 is questionable.

4.1.4 Effects of Extended Period of Idling

Of the 103 cars in this program, 23 (22.3%) of them exhibited a substantial jump in idle emissions sometime after 30 seconds of idling. Fifteen (15) of those cars exhibited a substantial jump in idle emissions during the 31 minutes of idling (Steps 12 and 13 in Appendix C). Those cars are given in Table 4.7 (page 18).

The eight (8) remaining cars (two of which were not tested over the entire extended special I/M test) exhibited substan- tial increases in idle emissions between 30 and 60 seconds of idle (other than on that 31 minute stretch used in Table 4.7). Those cars are given in Table 4.8 (page 18). An examination of those two tables reveals that only five models account for most of the cars which exhibited significant increases in idle emissions after a short period of idling:

- two of the four 1984 Chevrolet Chevettes,
- all three of the 1984 Pontiac Fieros,
- three of the seven 1985 Ford Topaz/Tempos with 140/FI,
- both of the 1985 Fords with 302/FI, and
- two of the three 1984-85 Honda Preludes. (The idle CO of the third Prelude, IV4/215, exceed 1.20% at Step 9, and, therefore, that car was not tested over the remainder of the Extended Special I/M Test.)

Some of those increases can be explained by the vehicle's design. For example:

- The 1984-85 Honda Preludes (1.8L/2bbl) were designed so that, after three minutes of operation below 15 miles per hour, the vehicle operates open-loop with enriched fuel metering and diverts the secondary AIR to the atmosphere.

- The 1981-86 Ford vehicles divert secondary AIR to the atmosphere after extended periods of idle. Depending on the engine family, the diversion is controlled by either a mechanical or an electronic timer. The diversion times are reported to range from 15 seconds to 3.5 minutes, depending upon the specific calibration and the duration of the last period of off-idle operation. The Restart Idle Test was designed to accommodate this situation since the effect of either the restart or loaded operation is to prevent the diversion of secondary AIR by resetting the diversion timer.

After completing the 31 minutes of idle (Steps 12 and 13 of the Extended Special I/M Test), the vehicle's engine speed was increased to 2500 rpm (Step 14). At that point in the test sequence, seven of the vehicles exhibited substantial increases

Table 4.7

Cars Exhibiting a Jump in Idle Emissions During an Extended Period of Idle

Vehicle Number	Model	Emission Jump
IV4/001	84 Chevette	HC from 120 to 270 between 60 & 90 sec. CO from 0.30 to 1.40 betw. 3 & 3.5 min.
IV4/004	84 Tempo	HC from 130 to 1,100 betw. 60 & 90 sec. CO from 0.06 to 4.80 betw. 4 & 5 min.
IV5/008*	85 LTD	HC from 50 to 260 betw. 90 & 120 sec. CO from 0.02 to 2.20 betw. 90 & 120 sec.
IV3/034	83 Prelude	HC from 45 to 350 betw. 3 & 3.5 min. CO from 0.02 to 3.50 betw. 3 & 3.5 min.
IV4/072	84 Colt	CO from 0.80 to 1.20 betw. 30 & 60 sec.
IV4/165	84 LTD	HC from 50 to 255 betw. 4 & 5 min. CO from 0.02 to 1.30 betw. 4 & 5 min.
IV4/167*	84 Prelude	CO from 0.02 to 1.50 betw. 2 & 2.5 min.
IV3/168	83 280 ZX	HC from 75 to 240 betw. 20 & 22 min. CO from 0.22 to 1.30 betw. 9 & 11 min.
IV5/170*	85 T-Bird	HC from 10 to 340 betw. 60 & 90 sec. CO from 0.01 to 5.40 betw. 60 & 90 sec.
IV3/214	83 Escort	CO from 0.01 to 2.00 betw. 4 & 7 min.
IV5/218	85 Accord	CO from 0.03 to 1.00 betw. 9 & 11 min.
IV4/221	84 Fiero	HC from 110 to 280 betw. 90 & 120 sec. CO from 0.20 to 2.00 betw. 3.5 & 5 min.
IV4/285	84 Chevette	HC from 15 to 225 betw. 30 & 60 sec. CO from 0.01 to 0.80 betw. 30 & 60 sec.
IV4/309	84 Fiero	HC from 170 to 300 betw. 30 & 60 sec. CO from 0.45 to 1.70 betw. 30 & 60 sec.
IV5/361*	85 Prelude	HC from 30 to 190 betw. 2 & 2.5 min. CO from 0.02 to 2.20 betw. 2 & 2.5 min.

* Error of Commission Car (See Table 4.10)

Table 4.8

Other Cars Exhibiting a Jump in Idle Emissions Between 30 and 60 Seconds of Idle

Vehicle Number	Model	Emission Jump
IV4/003	84 Fiero	CO from 0.23 to 4.50 on the "Cold" Restart/Idle Test and from 0.20 to 2.80 on the 2500 RPM/Idle Test which followed the '505' (Steps 5 and 9, respectively, in Appendix C)
IV5/143	85 Tempo	CO from 0.70 to 2.30 on the "Cold" Restart/Idle Test (Step 5 in App. C)
IV4/149	84 Civic	HC from 150 to 380 on the "Cold" Restart/ Idle Test (Step 5 in Appendix C)
IV3/224	83 Regal	CO from 0.02 to 1.40 on the 2500 RPM/ Idle Test which followed the '505' and from 0.02 to 2.40 on the 2500 RPM/Idle Test which followed the 3 min of idle (Steps 9 and 22, respectively, in Appendix C)
IV4/280	84 Cordia	HC from 110 to 250 on the 2500 RPM/Idle Test which followed the '505' (Step 9 in Appendix C)
IV5/284	85 Tempo	CO from 0.02 to 1.20 on the Loaded Test (Step 24 in Appendix C)
IV5/363*	85 Tempo	HC from 150 to 270 on the "Cold" Restart/ Idle Test (Step 5 in Appendix C)
		CO from 0.25 to 2.50 on the "Cold" Restart/Idle Test (Step 5 in App. C)
IV3/421	83 Stanza	CO from 0.02 to 5.40 on the 2500 RPM/ Idle Test which followed the 3 min of idle (Step 22 in Appendix C)

* Error of Commission Car (See Table 4.10)

in emissions. (In this context, "substantial" means that the emissions during that 2500 rpm mode were more that twice those of <u>any</u> previous mode.) Those seven vehicles were:

- Four of the five Chrysler 156 CID (2.6L) vehicles so tested (i.e., IV3/150, IV3/182, IV3/225, and IV4/389),
- Two of the three Toyota 89 CID (1.5L) vehicles so tested (i.e., IV3/046 and IV3/163), and
- One of the two Chrysler 135 CID (2.2L), carbureted vehicles (i.e., IV3/297).

Those Toyota and 156 CID Chrysler models were designed so that the evaporative canister will purge during the 2500 rpm, no-load operating conditions. It appears that the 31 minutes of idling in neutral was sufficient to load the individual canisters and that purging the canisters during the 2500 rpm mode resulted in:

- substantial increases in CO emissions for all six of those cars, and those increases continued beyond the end of that 30-second mode, as well as,
- large increases in HC for both of the Toyotas.

Two GM cars equipped with 307 CID (5.0L) engines were recruited and tested in this program (IV4/291 and IV5/035). Both those cars exhibited passing FTP HC and CO emissions as well as "passing" emissions at each of the 33 idle measurements. However, both exhibited "failing" emissions at most of the 2500 rpm measurement points. These vehicles were designed to divert secondary AIR after 25 seconds of no-load operation above 1200 rpm.

These observations also occurred in a recent California study [2,3], which noted that some vehicles have "emission control design features that result in relatively high emissions during idle operation even when no defects are present. There are some vehicles that can pass the more rigorous Federal Test Procedure but fail a simple idle emission test."

4.2 <u>FTP Test Results</u>

4.2.1 <u>Comparison with Earlier Study</u>

Of the 70 cars which were eligible to be tested over the FTP, only 48 were actually FTP tested due to the limited number of both loaner cars and test slots. The FTP results are given in Appendix D. The average FTP emissions appear in Table 4.9, which also includes, for comparison, the FTP results for the 35

1983 and 1984 model year cars from the earlier study. All of the 35 cars from that earlier study had failed the Maryland I/M test; 21 of them had also exceeded the Maryland cut-points on a screening test (which followed a 10-minute road test), while the remaining 14 had passed those cut-points after the road test. Also, an additional 34 1983 and later model year cars were recruited in that earlier study but were not FTP tested because:

1. the idle HC emissions on the screening test were less than 120 ppm,

2. the idle CO emissions on the screening test were less than 0.70 percent, and

3. no apparent mechanical or electrical problems were found which could account for the high idle emissions exhibited at the Maryland I/M lane.

Table 4.9

Average FTP (Total/Excess) Emission Results

	Size	FTP (g/mi) HC (g/mi)	FTP (g/mi) CO (g/mi)	FTP (g/mi) NOx (g/mi)
Cars "Passing" I/M After '505'	48	0.505/ 0.177	8.180/ 5.161	0.873/ 0.471
Cars "Failing" I/M After Road-Test *	21	2.152/ 1.749	42.467/ 39.170	0.594/ 0.250
Approximation of Fleet of I/M Failures	--	1.065/ 0.711	19.838/ 16.724	0.778/ 0.396

* These cars were used in Reference 1 and identified in Appendix H of this report.

Thus, the cars which failed at the Maryland I/M lane but which passed after a 3.6 mile loaded preconditioning cycle (i.e., the first 505 seconds of the FTP) were substantially cleaner than the cars which were FTP tested in the earlier Maryland program.

The discussion in Section 4.1 suggests that between 32 to 36 percent of 1983-85 model year cars that failed the official Maryland I/M test would also fail at the Contractor's laboratory even after loaded preconditioning. Weighting those data from both studies to approximate a 34 percent rate, we obtain the "Approximation of Fleet I/M Failures" in Table 4.9. These approximations suggest that the cars which fail both the official Maryland I/M test as well as an I/M idle test which follows heavy loaded preconditioning account for 83.6% of the HC in excess of the standard (0.41 g/mi) and 79.6% of the excess CO of the standard (3.40 g/mi) of all the 1983-85 cars which failed the official I/M test.

4.2.2 Error of Commission Cars

Fourteen (14) of the 48 FTP tested cars had FTP HC emissions less than 0.41 g/mi and CO less than 3.40 g/mi (i.e., 29.2% of those I/M failures which pass after heavy preconditioning are Error of Commission cars). Those cars are identified below in Table 4.10.

Table 4.10

Error of Commission Cars

Vehicle Number	Make/Model	HC (g/mi)	CO (g/mi)	NOx (g/mi)
IV4/005	84 Buick Skylark	0.17	2.19	0.32
IV5/008	85 Ford LTD	0.31	1.08	0.94
IV4/011	84 Buick Regal	0.39	2.05	0.87
IV5/025	85 Mercury Topaz	0.21	2.57	0.80
IV5/031	85 Pontiac Fiero	0.14	2.28	0.33
IV5/035	85 Olds Delta 88	0.27	2.73	0.52
IV3/046	83 Toyota Tercel	0.30	3.01	1.16
IV4/167	84 Honda Prelude	0.16	1.90	0.50
IV5/170	85 Ford T-Bird	0.37	2.63	0.79
IV4/222	84 Buick Regal	0.34	2.98	0.48
IV5/274	85 Pontiac Fiero	0.14	2.07	0.34
IV4/291	84 Olds Toronado	0.31	1.85	1.07
IV5/361	85 Honda Prelude	0.16	1.99	0.52
IV5/363	84 Chev Chevette	0.17	2.55	0.70
Means:		0.246	2.277	0.667

4.2.3 High Emitting Cars

Six (6) of the 48 FTP tested cars had FTP HC emissions greater than 1.50 g/mi or CO greater than 20.00 g/mi (i.e., 12.5% of those I/M failures which pass after heavy preconditioning are High Emitting* cars). Those cars are identified below in Table 4.11. (The subject of "High Emitters" is discussed on page 6 of Reference 5.)

Two of those six high emitters are 1983 model year Chrysler New Yorkers with 156 CID engines, also a third such 1983 model year Chrysler New Yorker (vehicle number IV3/182) had FTP CO emissions of 18.80 g/mi. All three of those 1983 Chrysler New Yorkers had the same characteristic idle emissions; all had "passing" idle emissions until the 2500/Idle Test which followed 31 minutes of idling in neutral. Also, two other high emitters are 1984-85 Ford Tempos with 140 CID (2.3L) engines.

Table 4.11

High Emitters* Cars

Vehicle Number	Make/Model	--- FTP Emissions --- HC (g/mi)	CO (g/mi)	NOx (g/mi)
IV4/004	84 Ford Tempo	1.80	56.07	.93
IV5/045	85 Ford Tempo	.77	20.25	.74
IV3/150	83 Chry New York	.98	22.31	.67
IV3/225	83 Chry New York	1.08	37.59	.76
IV3/260	83 Chev Caprice	.99	22.10	.56
IV3/323	83 Honda Prelude	1.38	28.00	.37
Means:		1.167	31.053	.672

* "High Emitters" produce:
FTP HC > 1.5 g/mi or
FTP CO > 20.0 g/mi.

4.2.4 Distribution of FTPs

Another approach to examining the FTP emissions is to classify the types of FTP failures. (In all of these instances, only the FTP HC and CO emissions will be used to determine "failure.") The FTP will be considered to "pass" if both the HC $\leq$ 0.41 and the CO $\leq$ 3.40 (i.e., Error of Commission cars); otherwise, it fails. Among the failing FTPs, we will consider five (5) levels of failure:

- Neither the HC > 0.61 nor the CO > 5.10 (i.e., a marginal failure, which does not exceed 150% of the standards). These will be denoted: "MARG.150" emitters.

- Either the HC > 0.61 or the CO > 5.10, but neither the HC > 0.82 nor the CO > 6.80 (i.e., a marginal failure, which does not exceed 200% of the standards, but does exceed 150% of the standards). These will be denoted: "MARG.200" emitters.

- Either the HC > 12.00 or the CO > 180.00. These will be denoted: "SUPER" emitters.

- Either the HC > 1.50 or the CO > 20.00, but neither the HC > 12.00 nor the CO > 180.00 (i.e., cleaner than a "SUPER" emitter). These will be denoted: "HIGH" emitters.

- Either the HC > 0.82 or the CO > 6.80, but neither the HC > 1.50 nor the CO > 20.00 (i.e., dirtier than a marginal emitter, but cleaner than a "HIGH" emitter). These will be denoted: "FAIL".

Using those designations, we can compare the FTPs of the 48 cars in this study which passed the I/M test after heavy preconditioning (i.e., the '505') to the FTPs of the 21 1983-85 cars in the earlier study which failed the (screening) I/M test after heavy preconditioning (i.e., 10-minute road-test). That breakdown is given below in Table 4.12. Duplicating the procedure used in Section 4.2.1, we obtain the distribution of FTPs of an "Approximation of Fleet of I/M Failures."

Table 4.12

Projected Distribution (%) of FTPs

		---------- FTP Failures				---------
	PASS	MARG 150	MARG 200	FAIL	HIGH	SUPER
Official I/M Failures Which "Pass" I/M After '505'	29.2	22.9	16.7	18.8	12.5	0.0
Official I/M Failures Which "Fail" I/M After Road-Test *	4.8	9.5	9.5	19.0	52.4	4.8
Approx. of Fleet of I/M Failures:	20.9	18.4	14.2	18.9	26.1	1.6

* These cars were used in Reference 1 and identified in Appendix H of this report.

Repeating the assumptions made in Section 4.2.1 that only 34% of the I/M failures would continue to fail following loaded preconditioning, we can estimate that those vehicles that continued to fail the I/M test even after loaded preconditioning account for most of the HIGH and all of the SUPER emitters that the official Maryland I/M test identified (among the 1983-85 fleet), but practically none of the cleaner cars.

4.3 Comparisons of Preconditioning Cycles

As discussed in Section 4.1.3, three different types of heavy preconditioning were used in the extended special I/M test:

- the first 505 seconds of the FTP (about 3.6 miles) (Step 6 in Appendix C),
- 3 minutes of operation at 2500 rpm (Step 19 in Appendix C), and
- 30 seconds of loaded operation at 30 mph (Step 23 in Appendix C).

Using these three cycles, we can estimate the effectiveness of different preconditioning cycles to detect I/M variable vehicles (i.e., those vehicles which, after failing a Maryland-type idle test, passed a similar test following a '505' preconditioning cycle). Specifically, we can examine the following five idle modes:

1. the idle mode of the 2500rpm/idle test which followed the "505" cycle (Step 9 in Appendix C),
2. the idle mode of the "cold" restart 2500rpm/idle test which followed 15 minutes of soak (Step 4),
3. the idle mode that immediately followed the "505" cycle (Step 7),
4. the idle mode of the 2500rpm/idle test which followed the three minutes of 2500 rpm operation (Step 22), and
5. the idle mode of the loaded test (Step 24).

The distribution, relative to those five idle modes, of the 103 vehicles in the fleet is summarized in Table 4.13. Also summarized in Table 4.13 are the average FTP emissions.

Table 4.13

Distribution of Test Fleet and FTP Test Results
Stratified by Pass/Fail Scores on Five Idle Modes

Pass/Fail Result on Idle Mode, Step Number: 9	4	7	22	24	Strata Size	No. FTPs	Avg FTP (g/mi) HC	CO
P	P	P	P	P	52	35	0.467	6.947
	P	P	P	F	3	2	0.520	3.555
	P	P	F	P	0	0	NA	NA
	P	P	F	F	4	4	0.568	12.200
P	P	F	P	P	0	0	NA	NA
	P	F	P	F	0	0	NA	NA
	P	F	F	P	0	0	NA	NA
	P	F	F	F	0	0	NA	NA
P	F	P	P	P	6	4	0.328	5.470
	F	P	P	F	0	0	NA	NA
	F	P	F	P	2	1	1.80	56.07
	F	P	F	F	1	0	NA	NA
P	F	F	P	P	2	2	0.740	7.820
	F	F	P	F	0	0	NA	NA
	F	F	F	P	0	0	NA	NA
	F	F	F	F	0	0	NA	NA
F	P	P	NA	NA	5	0	NA	NA
F	P	F	NA	NA	8	0	NA	NA
F	F	P	NA	NA	3	0	NA	NA
F	F	F	NA	NA	17	0	NA	NA
			Overall:		103	48	0.505	8.180

From the values in Table 4.13, we observe that:

1. None of the 59 vehicles that passed at both Steps 9 and 4 then failed at Step 7.

2. Of the 70 vehicles that passed at Step 9, only two (2.9%) failed at Step 7. (More on the correlation between Steps 9 and 7 appears in Table 4.14.)

3. The highest FTP emitter in this study (IV4/004) was the single vehicle that was tested on the FTP in either stratum of vehicles that:

   - failed at Step 22 and then passed Step 24, or
   - failed at both Steps 4 and 22.

   Thus, there is a possibility that any weighted average containing either of those strata may be skewed. Specifically, it will be difficult to compare the relative effectiveness of identifying high emitters of the three minutes of 2500 rpm preconditioning with 30 seconds at 30 mph.

The first of the five idle modes (Step 9) in Table 4.13 was used in this study to identify the I/M variable vehicles. We can determine the relative effectiveness of the other four idle modes by comparing the pass/fail scores of each (where "pass" indicates that neither the HC nor the CO exceed 220 ppm or 1.20 percent, respectively.) Those comparisons appear in Table 4.14.

Table 4.14

Distribution of Pass/Fail Scores of Four Idle Modes Relative to the Pass/Fail Scores on the "505" Preconditioned 2500rpm/Idle

Results on Idle Part 2500/Idle After 505	"Cold" 2500/Idle		Idle After 505		2500/Idle After 3-min of 2500		Idle Part of Loaded	
	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Pass (70)	59	11	68	2	63	7	62	8
Fail (33)	13	20	8	25	N.A.	N.A.	N.A.	N.A.

From the preceding table, we observe:

- The idle mode of the cold 2500/idle test agrees with the idle mode of the variability defining 2500/idle test (i.e., the idle mode of the 2500rpm/idle test which followed the "505" cycle) on 79 out of 103 vehicles (76.7%) overall and on 59 of the 70 variable vehicles (84.3%).

- The idle mode immediately following the 505 cycle agrees with the idle mode of the variability defining 2500/idle test on 93 out of 103 vehicles (90.3%) overall and on 68 of the 70 variable vehicles (97.1%).

- The idle mode of the 2500/idle test that followed three minutes of 2500 rpm operation agrees with the idle mode of the variability defining 2500/idle test on 63 of the 70 variable vehicles (90.0%).

- The idle mode of the loaded test agrees with the idle mode of the variability defining 2500/idle test on 62 of the 70 variable vehicles (88.6%).

Comparisons between the variability defining mode (i.e., Step 9) and each of the last two idle modes is difficult because not all the data were collected (i.e., limited test data on vehicles that failed at Step 9). The three minutes of 30 mph loaded preconditioning and the 30 seconds of 2500 rpm no-load preconditioning both identified the same proportion of the 70 vehicles that were identified as I/M variable (i.e., no statistical difference between 88.6% and 90.0%). (Even though the identification rates are the same, the idle modes followed by each of these two preconditioning cycles do not identify the same vehicles.)

Since the idle mode that immediately followed the "505" (i.e., Step 7) correlates very well with the variability defining mode, we can compare that mode with the two remaining idle modes (see Table 4.15) to partially compensate for the lack of data on the vehicles that failed at Step 9.

Table 4.15

Distribution of Pass/Fail Scores
Among Preconditioned Idle Tests

Idle Mode Following 505 Cycle (Step 7)	Step 22 / Step 24 P/P	P/F	F/P	F/F
Pass (68)	58	3	2	5
Fail (2)	2	0	0	0

Since no FTP data were gathered from vehicles that failed at Step 9, and since Table 4.14 demonstrates a high correlation between the pass/fail scores in Steps 7 and 9, we will use Step 7 to identify the I/M variable vehicles. Using the same stratification as in Table 4.15, the "as received" FTP emissions of vehicles are given in Table 4.16 (next page). Combining the average emissions in Table 4.16 by using the values in Table 4.15 as weighting factors, we can estimate (in Table 4.17) the average FTP emissions of vehicles which pass or fail an idle

test that was preconditioned by: a "505" cycle, three minutes of 2500 rpm no-load operation, or 30 seconds of 30 mph loaded operation.

Table 4.16

Average FTP Emissions (HC/CO) by Strata

Step 7	Step 22 / Step 24 P/P	P/F	F/P	F/F
Pass	0.434/ 5.614	0.520/ 3.555	1.80*/ 56.07*	0.568/ 12.200
Fail	0.740/ 7.820	N.A./ N.A.	N.A./ N.A.	N.A./ N.A.

* Based on only a single FTP.

Table 4.17

Weighted FTP Emissions (g/mi) by Preconditioning Cycle

Preconditioning Cycle		Avg HC	Avg CO
"505" Cycle	- Pass	0.488	7.491
	- Fail	0.740	7.820
3-Min 2500 RPM	- Pass	0.448	5.586
	- Fail	0.920	24.734
30-Sec at 30 MPH	- Pass	0.488	7.313
	- Fail	0.550	8.958

The values in Table 4.17 suggest:

1. The vehicles that passed on any of those three preconditioned idle tests have lower FTP emissions that the vehicles that failed the corresponding test.

2. The three minutes of 2500 rpm no-load preconditioning appears superior to loaded preconditioning in being able to identify excess emissions. However, most of that difference in emission levels is based on a single test vehicle. (See the discussion at the bottom of page 26.)

5.0 VEHICLE INSPECTIONS

A thorough, non-altering inspection of the vehicle's emission control components was planned for each car in this program whose FTP emissions exceed twice the standard (i.e., HC > 0.82 or CO > 6.80). That inspection was performed on 14 of the 48 FTP tested cars. A fifteenth car (a 1983 Plymouth Sapporo, vehicle number IV3/395) was also eligible for that inspection but was not inspected. The results of those detailed inspections are summarized below in Table 5.1 (and appear in Appendix I) and the mechanic's comments on those 14 cars appear in Appendix G. In Table 5.1, the "Induction System"

Table 5.1

Frequency (%) of Problems by Control System

Control System	Open-Loop Carb	--- Closed-Loop--- Carb	FI
Induction:	0.0%	25.0%	50.0%
Fuel Metering:			
Idle Speed	100.0%	75.0%	0.0%
Idle Mixture	50.0%	75.0%	100.0%
Choke	12.5%	0.0%	N.A.
Total:	100.0%	75.0%	100.0%
Ignition (Timing):	37.5%	0.0%	50.0%
EGR:	12.5%	25.0%	0.0%
Supplementary AIR	12.5%	50.0%	0.0%
PCV:	0.0%	25.0%	0.0%
Exhaust (Cat):	0.0%	25.0%	0.0%
Evaporative:	0.0%	50.0%	50.0%
Feedback Electronics:			
Sensors	N.A.	25.0%	50.0%
Solenoids	N.A.	50.0%	0.0%
Total:	N.A.	50.0%	50.0%
Engine Assembly:	12.5%	0.0%	0.0%
Sample Size:	8	4	2

includes the fresh air duct, heated air door, air filter, air filter housing, and associated temperature sensors and vacuum lines.

The data in Table 5.1 suggest that the most common problems identified were with the fuel metering system (13 out of the 14 cars inspected); however, only two of these 13 cars had problems only with the fuel metering system. The idle mixture plugs were missing in three of the 14 inspected cars, and the idle mixture was set rich in each of those three. (Those three vehicles were a 1983 fuel-injected Nissan, numbered 168, and two 1983 open-loop carbureted Chryslers, numbered 150 and 182.)

6.0 EFFECTS OF MAINTENANCE

Of the 48 cars which were FTP tested in this study, 15 of them had FTP emissions which exceeded twice the standard (i.e., HC > 0.82 g/mi or CO > 6.80 g/mi). Five of those 15 cars were then repaired to pass the Maryland I/M retest; only four of those five were retested over the FTP. (A description of those "I/M targetted" repairs can be found in Appendix F.) All of the cars which were repaired are carbureted. The effects of the repairs on FTP emissions and idle emissions (at the Maryland I/M lane) are given in Table 6.1.

Table 6.1

Effects of Maintenance
On Both FTP Emissions and Official I/M Test Results

Vehicle Number	Test Sequence	--I/M Lane-- HC (ppm)	CO (%)	FTP Emissions (g/mi) HC	CO	NOx	Fuel** Econ (mpg)
IV4/001	As Received	599	7.91	1.08	10.53	.61	27.34
	Aftr Repair	87	.15	.87	10.29	.67	27.01
IV4/004	As Received	114	3.39	1.80	56.07	.93	18.84
	Aftr Repair	1	.00	.41	9.77	1.41	18.68
IV3/197	As Received	113	3.23	.26	7.75	.56	25.15
	Aftr Repair	16	.01	.24	8.06	1.20	26.58
IV3/225	As Received	168	6.70	1.08	37.59	.76	18.82
	Aftr Repair*	53	.02	---	---	---	---
IV3/260	As Received	163	1.71	.99	22.10	.56	14.85
	Aftr Repair	3	.00	.33	5.96	.69	15.53
Average:	As Received			1.032	24.112	.665	20.33
	Aftr Repair			.462	8.520	.992	20.77
% Increase:				-55%	-65%	+49%	+2%

* Vehicle IV3/225 was not FTP tested after the repairs.
** "Fuel Economy" averages are harmonic means.

The overall effect of the repairs was to reduce the average FTP HC emissions by 55% and the CO by 65%. However, most of that reduction results from only two of those cars. In

that earlier study [1], "I/M targetted" repairs on the 19 carbureted, 1983-85 cars in that program resulted in:

- reducing overall FTP HC emissions by 42%,
- reducing overall FTP CO emissions by 66%,
- increasing overall FTP NOx emissions by <1%, and
- increasing overall FTP fuel economy by 2%.

Thus, except for the effect on NOx emissions, the overall effects of I/M targetted repairs were similar in both studies. Also, in both studies, the larger the initial FTP emissions, the larger were the percentage reductions of FTP HC and CO.

7.0 CONCLUSIONS

Of the twenty GM cars examined in this study, only one (5%) was reported to have a computer trouble code displayed in its on-board malfunction/diagnostic system, and that car had passing FTP emissions. Also, of the 10 GM cars which did not display trouble codes and were FTP tested in this program (hence, all 10 had passing idle emissions after heavy preconditioning), two had FTP HC or CO emissions in excess of twice the standard. These observations do not strengthen the case for using only on-board diagnostics to identify high emitting cars. (A new test program to study the use of computer trouble codes to identify vehicles with high emissions is scheduled to begin in August 1987.)

Closed-loop, fuel injected cars appear to be more likely to produce consistent I/M results (i.e., cars initially failing an I/M test would fail again even after heavy preconditioning) than are closed-loop, carbureted cars.

Among the 1983-85 model year vehicles which initially failed the official Maryland I/M test, the FTP emissions of those vehicles which also failed an I/M idle test following loaded preconditioning tended to be substantially higher than the FTP emissions of those vehicles which passed an I/M idle test following loaded preconditioning. We estimated that the cars which failed both the official Maryland I/M test as well as an I/M idle test which followed loaded preconditioning would account for 84% of the HC in excess of the standard (0.41 g/mi) and 80% of the excess CO of the standard (3.40 g/mi) of all the 1983-85 cars which failed the official I/M test.

Nearly one-fourth (22.3%) of the cars tested in this study exhibited substantial increases in idle emissions after idling for only a short time (but longer than 30 seconds). A small number of models account for most of these cars.

8.0 REFERENCES

1. L. Landman, "Inspection and Maintenance of New Technology Vehicles in Maryland," U.S. EPA, Emission Control Technology Division, Technical Support Staff, Paper No. EPA-AA-TSS-I/M-86-06, September 1986.

2. "Evaluation of the California Smog Check Program," prepared for the California Legislature by the California I/M Review Committee, April 1987, pp 29 & 30.

3. "Evaluation of the California Smog Check Program, Technical Appendix," prepared for the California I/M Review Committee by Sierra Research, Inc., April 1987, pp 188 & 189.

4. K. G. Duleep, "Future Automotive Emission Control Technology and Strategy," SAE Technical Paper Number 841244, October 1984, pg 7.

5. D. Brzezinski, "Tech IV Credit Model: Estimates for Emission Factors and Inspection and Maintenance Credits for 1981 and Later Vehicles for MOBILE3," U.S. EPA, Emission Control Technology Division, Technical Support Staff, Paper No. EPA-AA-IMG-85-6, October 1985.

APPENDIX A

Description of the 103 Vehicles Tested

(Sorted by Vehicle Number)

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata-lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV4/001	84	Chev Chevette	98/2	L-3	PUMP	OX+3W	Closed	E1G1.6V2NEA1	.017	Neg.	OK	None
IV4/003	84	Pont Fiero 2M4	151/FI	M-4	NO	3W	Closed	E2G2.5V5TPG7	.017	Neg.	OK	None
IV4/004	84	Ford Tempo GL	140/1	A-3	PUMP	OX+3W	Closed	EFM2.3V1HRFX	.018	Neg.	OK	None
IV4/005	84	Buic Skylark	151/FI	L-3	NO	3W	Closed	E2G2.5V5TPG7	.011	N.A.	OK	None
IV3/006	83	Hond Civic	81/3	M-5	PULS	OX	Open	DHN1.3V3AAF1	.017	Neg.	OK	None
IV5/008	85	Ford LTD Crn Vct	302/FI	L-4	PUMP	OX+3W	Closed	FFM5.OV5HBF8	.032	Neg.	OK	None
IV4/011	84	Buic Regal Limit	231/2	L-3	PUMP	3W	Closed	E4G3.8V2NEYO	.013	Neg.	OK	None
IV3/018	83	Niss Stanza	120/2	L-3	PULS	OX	Open	DNS2.OV2AAF7	.023	Neg.	OK	None
IV5/025	85	Merc Topaz GS	140/FI	A-3	PULS	OX+3W	Closed	FFM2.3V5HCF4	.017	Neg.	OK	None
IV5/026	85	Ford Escort GL	113/2	A-3	PUMP	OX+3W	Open	FFM1.9V2GDF8	.015	Neg.	OK	None
IV5/031	85	Pont Fiero 2M4	151/FI	M-5	NO	3W	Closed	F2G2.5V5TPG8	.018	Neg.	OK	None
IV3/034	83	Hond Prelude	112/3	M-5	PULS	OX	Open	DHN1.8VOAGF9	.015	Neg.	OK	None
IV5/035	85	Olds Delta 88 R	307/4	L-4	PUMP	OX+3W	Closed	F3G5.OV4NLAO	.025	Neg.	OK	None
IV3/036	83	Buic Century	151/FI	L-3	NO	3W	Closed	D2G2.5V5TPG6	.015	Neg.	OK	None
IV3/043	83	Chev Chevette	98/2	L-3	PUMP	OX+3W	Closed	D1G1.6V2NEAO	.017	Neg.	OK	None
IV5/045	85	Ford Tempo GL	140/FI	A-3	PULS	OX+3W	Closed	FFM2.3V5HCF4	N.A.	Neg.	Miss	None
IV3/046	83	Toyo Tercel	89/2	A-3	PULS	OX+3W	Closed	DTY1.6V2HFF1	.012	Neg.	OK	None
IV4/047	84	Ford Escort	98/2	M-4	PUMP	OX+3W	Open	EFM1.6V2GDK7	.053	Neg.	OK	None
IV4/064	84	BMW 318i	108/FI	M-5	NO	3W	Closed	EBM1.8V5FAB4	.025	Neg.	OK	None
IV4/072	84	Dodg Colt	86/2	M-4	PULS	3W	Closed	EMT1.4V2FFD2	.035	Neg.	OK	None
IV3/103	83	Niss Maxima	146/FI	L-4	NO	3W	Closed	DNS2.8V5FAAO	.026	Pos.	OK	None
IV3/105	83	Hond Accord	107/3	M-5	PULS	OX	Open	DHN1.8V3AEF6	.017	Neg.	OK	None
IV3/120	83	Ford EXP	98/2	M-5	PUMP	OX+3W	Open	DFM1.6V2GDK6	.018	Neg.	OK	None
IV5/143	85	Ford Tempo GL	140/FI	A-3	PULS	OX+3W	Closed	EFM2.3V5HCF4	.008	Neg.	OK	None
IV3/144	83	Niss Stanza	120/2	L-3	PULS	OX	Open	DNS2.OV2AAF7	.010	Neg.	OK	None
IV3/145	83	Hond Civic Wgn	91/3	A-3	PULS	OX	Open	DHN1.5V3ACF6	.021	Neg.	OK	None

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata- lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV4/146	84	Dodg 600	135/FI	A-3	PULS	OX+3W	Closed	ECR2.2V5HCF1	.013	Neg.	OK	None
IV4/147	84	Ford Mustang GT	140/FI	M-5	NO	3W	Closed	EFM2.3V5FGT2	.029	Neg.	OK	None
IV3/148	83	Niss Stanza	120/2	M-5	PULS	OX	Open	DNS2.OV2AAF7	.026	Neg.	OK	None
IV4/149	84	Hond Civic	82/3	M-5	PULS	3W	Open	EHN1.3V3EAF3	N.A.	Neg.	OK	None
IV3/150	83	Chry New Yorker	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	.006	Neg.	OK	None
IV4/151	84	Volv Volvo DL	141/FI	A-4	NO	3W	Closed	EVV2.3V5FEL8	.017	Neg.	OK	None
IV3/157	83	Ford Escort L	98/2	A-3	PUMP	OX+3W	Open	DFM1.6V2GDK6	.016	Neg.	OK	None
IV4/158	84	Ford Escort L	98/2	A-3	PUMP	OX+3W	Open	EFM1.6V2GDK7	.012	Neg.	OK	None
IV4/160	84	Hond Civic	91/3	M-5	PULS	3W	Closed	EHN1.5V3FCFO	.012	Neg.	OK	None
IV3/163	83	Toyo Tercel	89/2	M-5	PULS	OX+3W	Closed	DTY1.6V2HFF1	.025	Neg.	OK	None
IV4/165	84	Ford LTD Brou	231/2	L-3	PUMP	3W	Open	EFM3.8V2GXF1	.012	Neg.	OK	None
IV4/167	84	Hond Prelude	112/2	L-4	PULS	3W	Closed	EHN1.8VOFGF3	.019	Neg.	OK	None
IV3/168	83	Dats 280 ZX	168/FI	A-3	NO	3W	Closed	DNS2.8V5FBF7	.023	Neg.	OK	None
IV4/169	84	Isuz Impulse	119/FI	M-5	NO	3W	Closed	ESZ119V5FGG6	.015	Neg.	OK	None
IV5/170	85	Ford T-Bird	302/FI	L-4	PUMP	OX+3W	Closed	FFM5.OV5HBF8	.020	Neg.	OK	None
IV3/171	83	Niss Stanza	120/2	L-3	PULS	OX	Open	DNS2.OV2AAF7	.022	Neg.	OK	None
IV3/182	83	Chry New Yorker	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	.020	Neg.	OK	None
IV3/197	83	Niss Pulsar NX	98/2	A-3	PULS	OX	Open	DNS1.6V2AAF2	.035	Neg.	OK	None
IV3/205	83	Hond Accord	107/3	M-5	PULS	OX	Open	DHN1.8V3AEF6	.021	Neg.	OK	None
IV3/214	83	Ford Escort L	98/2	A-3	PUMP	OX+3W	Open	DFM1.6V2GDK6	.017	Neg.	OK	None
IV4/215	84	Hond Prelude	112/2	M-5	PULS	3W	Closed	EHN1.8VOFGF3	.023	Neg.	OK	None
IV3/216	83	Hond Civic DX	91/3	M-5	PULS	OX	Open	DHN1.5V3ACF6	.023	Neg.	OK	None
IV3/217	83	Niss Stanza	120/2	L-3	PULS	OX	Open	DNS2.OV2AAF7	.015	Neg.	OK	None
IV5/218	85	Hond Accord LX	112/3	L-4	PULS	3W	Closed	FHN1.8V3FXF5	.034	Neg.	OK	None
IV3/219	83	Merc Marquis Wg	200/1	L-3	PUMP	OX+3W	Open	DFM3.3V1GEF6	.015	Neg.	OK	None
IV3/220	83	Niss Pulsar NX	98/2	M-5	PULS	OX	Open	DNS1.6V2AAF2	.021	Neg.	OK	None

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata- lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV4/221	84	Pont Fiero	151/FI	M-4	NO	3W	Closed	E2G2.5V5TPG7	.013	Neg.	OK	None
IV4/222	84	Buic Regal Trbo	231/FI	L-4	NO	3W	Closed	E4G3.8V9XEB6	.019	Neg.	OK	Yes
IV3/224	83	Buic Regal	231/2	L-3	PUMP	OX+3W	Closed	D4G3.8V2NEA3	.039	Neg.	OK	None
IV3/225	83	Chry New Yorker	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	.039	Pos.	OK	None
IV5/226	85	Hond Civic	91/3	M-5	PULS	3W	Closed	FHN1.5V3FCF1	.015	Neg.	OK	None
IV3/236	83	Hond Accord	107/3	L-3	PULS	OX	Open	DHN1.8V3AEF6	.022	Neg.	OK	None
IV5/239	85	Chev Celebrity GL	173/FI	L-3	NO	3W	Closed	F1G2.8V8XGZ9	.018	Neg.	OK	None
IV3/260	83	Chev Caprice Clas	305/4	L-4	PUMP	OX+3W	Closed	D1G5.7V4NDAO	.019	Neg.	OK	None
IV3/264	83	Toyo Corolla	97/2	A	PULS	OX+3W	Closed	DTY1.6V2HFF1	.017	Neg.	OK	None
IV5/265	85	Mits Cordia L	122/2	M-5	PULS	3W	Closed	FMT2.OV2FFD9	.018	Neg.	OK	None
IV3/268	83	Chry New Yorker	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	.018	Neg.	OK	None
IV5/274	85	Pont Fiero 2M4	151/FI	L-3	NO	3W	Closed	F2G2.5V5TPG8	.012	Neg.	OK	None
IV4/276	84	Ford T-Bird	302/FI	L-4	PUMP	OX+3W	Closed	EFM5.OV5HBF7	.016	Neg.	OK	None
IV3/277	83	Dodg Aries	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	N.A.	Neg.	OK	None
IV5/279	85	Ford Mustang LX	140/1	M-4	PUMP	3W	Closed	FFM2.3V1HAK2	.020	Neg.	OK	None
IV4/280	84	Mits Cordia	122/2	M-5	PULS	3W	Closed	EMT2.OV2FFD8	.015	Neg.	OK	None
IV4/281	84	Niss Sentra	98/2	L-3	PULS	3W	Closed	ENS1.6V9HAF8	.012	Neg.	OK	None
IV4/282	84	Dodg Daytona Trbo	135/FI	M-5	NO	3W	Closed	ECR2.2V5FAA8	.021	Neg.	OK	None
IV3/283	83	Toyo Tercel	89/2	M-4	PULS	OX+3W	Closed	DTY1.6V2HFF1	.020	Neg.	OK	None
IV5/284	85	Ford Tempo	140/FI	A-3	PULS	OX+3W	Closed	FFM2.3V5HCF4	.028	Neg.	OK	None
IV4/285	84	Chev Chevette	98/2	M-4	PUMP	OX+3W	Closed	E1G1.6V2NEA1	.037	Neg.	OK	None
IV5/286	85	Ford Tempo GL	140/FI	M-5	PULS	OX+3W	Closed	FFM2.3V5HCF4	.021	Neg.	OK	None
IV3/288	83	Niss Sentra	98/2	L-3	PULS	OX	Open	DNS1.6V2AAF2	.016	Neg.	OK	None
IV3/290	83	Hond Civic	91/3	A-3	PULS	OX	Open	DHN1.5V3ACF6	.018	Neg.	OK	None
IV4/291	84	Olds Toronado	307/4	L-4	PUMP	OX+3W	Closed	E3G5.OV4NLAX	.009	Neg.	OK	None
IV3/292	83	BMW 528e	164/FI	M-5	NO	3W	Closed	DBM2.7V5FAB5	.022	Neg.	OK	None

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata- lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV3/294	83	Niss Stanza	120/2	M-5	PULS	OX	Open	DNS2.OV2AAF7	.013	Neg.	OK	None
IV4/295	84	Dats 300 ZX	181/FI	A-4	NO	3W	Closed	ENS3.OV5FAFX	.029	Neg.	OK	None
IV5/296	85	Ford Mustang	140/1	A-3	PUMP	OX+3W	Closed	FFM2.3V1HAK2	.025	Neg.	OK	None
IV3/297	83	Dodg Aries	135/2	A-3	PUMP	OX+3W	Closed	DCR2.2V2HAC3	.016	Neg.	OK	None
IV4/309	84	Pont Fiero SE	151/FI	L-3	NO	3W	Closed	E2G2.5V5TPG7	.013	Neg.	OK	None
IV5/311	85	Chry Laser	135/FI	A-4	PULS	OX+3W	Closed	FCR2.2V5HCF2	.032	Neg.	OK	None
IV5/312	85	Niss Maxima	181/FI	L-4	PULS	3W	Closed	FNS3.OV5HAF6	.013	Neg.	OK	None
IV3/314	83	Ford Escort L	98/2	M-4	PUMP	OX+3W	Open	DFM1.6V2GDK6	.035	Neg.	OK	None
IV4/316	84	Chev Chevette	98/2	L-3	PUMP	OX+3W	Closed	E1G1.6V2NEA1	.011	Neg.	OK	None
IV3/323	83	Hond Prelude	112/3	M-5	PULS	OX	Open	DHN1.8VOAGF9	.011	Neg.	OK	None
IV5/355	85	Merc Caprice GS	302/4	M-5	PUMP	OX+3W	Open	FFM5.OV4GMF5	.024	Neg.	OK	None
IV5/356	85	Ford Tempo GL	140/FI	M-5	PULS	OX+3W	Closed	FFM2.3V5HCF4	.013	Neg.	OK	None
IV4/357	84	Volv Volvo DL	141/FI	A-4	NO	3W	Closed	EVV2.3V5FEL8	.011	Neg.	OK	None
IV5/359	85	Ford Escort L	118/2	M-5	PUMP	OX+3W	Open	FFM1.9V2GDF8	.020	Neg.	OK	None
IV4/360	84	Ford Mustang L	140/1	A-3	PUMP	OX+3W	Closed	EFM2.3V1HPK2	.015	Neg.	OK	None
IV5/361	85	Hond Prelude	112/2	M-5	PULS	3W	Closed	FHN1.8VOFGF4	.114	Neg.	OK	None
IV5/363	85	Ford Tempo GL	140/FI	A-3	PULS	OX+3W	Closed	FFM2.3V5HCF4	.011	Neg.	OK	None
IV4/364	84	Chev Chevette CS	98/2	L-3	PUMP	OX+3W	Closed	E1G1.6V2NEA1	.018	Neg.	OK	None
IV3/382	83	Pont Gran Prix LJ	231/2	L-3	PUMP	OX+3W	Closed	D4G3.8V2NEA3	.031	Neg.	OK	None
IV4/389	84	Chry T & C Wagon	156/2	A-3	PULS	3W	Closed	ECR2.6V2FAJ9	.022	Neg.	OK	None
IV3/395	83	Plym Sapporo	156/2	M-5	PULS	OX	Open	DMT2.6V2BFD9	.016	Neg.	OK	None
IV3/401	83	Plym Horizon	135/2	A-3	PUMP	OX+3W	Closed	DCR2.2V2HAC3	.031	Neg.	OK	None
IV4/403	84	Peug 505 GL	120/FI	A-3	PULS	3W	Closed	EPE2.OV6FAB5	.036	Neg.	OK	None
IV3/421	83	Niss Stanza	120/2	A-3	PULS	OX	Open	DNS2.OV2AAF7	.028	Neg.	OK	None
IV4/422	84	AMC Encore	85/FI	M-4	NO	3W	Closed	EAM1.4V5FFA1	.025	Neg.	OK	None

APPENDIX B

Description of the 103 Vehicles Tested

(Sorted by Make/Model)

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata- lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV4/422	84	AMC Encore	85/FI	M-4	NO	3W	Closed	EAM1.4V5FFA1	.025	Neg.	OK	None
IV4/064	84	BMW 318i	108/FI	M-5	NO	3W	Closed	EBM1.8V5FAB4	.025	Neg.	OK	None
IV3/292	83	BMW 528e	164/FI	M-5	NO	3W	Closed	DBM2.7V5FAB5	.022	Neg.	OK	None
IV3/297	83	Dodg Aries	135/2	A-3	PUMP	OX+3W	Closed	DCR2.2V2HAC3	.016	Neg.	OK	None
IV3/401	83	Plym Horizon	135/2	A-3	PUMP	OX+3W	Closed	DCR2.2V2HAC3	.031	Neg.	OK	None
IV4/282	84	Dodg Daytona Trbo	135/FI	M-5	NO	3W	Closed	ECR2.2V5FAA8	.021	Neg.	OK	None
IV4/146	84	Dodg 600	135/FI	A-3	PULS	OX+3W	Closed	ECR2.2V5HCF1	.013	Neg.	OK	None
IV5/311	85	Chry Laser	135/FI	A-4	PULS	OX+3W	Closed	FCR2.2V5HCF2	.032	Neg.	OK	None
IV3/150	83	Chry New Yorker	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	.006	Neg.	OK	None
IV3/182	83	Chry New Yorker	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	.020	Neg.	OK	None
IV3/225	83	Chry New Yorker	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	.039	Pos.	OK	None
IV3/268	83	Chry New Yorker	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	.018	Neg.	OK	None
IV3/277	83	Dodg Aries	156/2	A-3	PULS	OX	Open	DCR2.6V2BAP2	N.A.	Neg.	OK	None
IV4/389	84	Chry T & C Wagon	156/2	A-3	PULS	3W	Closed	ECR2.6V2FAJ9	.022	Neg.	OK	None
IV3/120	83	Ford EXP	98/2	M-5	PUMP	OX+3W	Open	DFM1.6V2GDK6	.018	Neg.	OK	None
IV3/157	83	Ford Escort L	98/2	A-3	PUMP	OX+3W	Open	DFM1.6V2GDK6	.016	Neg.	OK	None
IV3/214	83	Ford Escort L	98/2	A-3	PUMP	OX+3W	Open	DFM1.6V2GDK6	.017	Neg.	OK	None
IV3/314	83	Ford Escort L	98/2	M-4	PUMP	OX+3W	Open	DFM1.6V2GDK6	.035	Neg.	OK	None
IV4/047	84	Ford Escort	98/2	M-4	PUMP	OX+3W	Open	EFM1.6V2GDK7	.053	Neg.	OK	None
IV4/158	84	Ford Escort L	98/2	A-3	PUMP	OX+3W	Open	EFM1.6V2GDK7	.012	Neg.	OK	None
IV5/026	85	Ford Escort GL	113/2	A-3	PUMP	OX+3W	Open	FFM1.9V2GDF8	.015	Neg.	OK	None
IV5/359	85	Ford Escort L	118/2	M-5	PUMP	OX+3W	Open	FFM1.9V2GDF8	.020	Neg.	OK	None
IV4/004	84	Ford Tempo GL	140/1	A-3	PUMP	OX+3W	Closed	EFM2.3V1HRFX	.018	Neg.	OK	None

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata-lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV4/360	84	Ford Mustang L	140/1	A-3	PUMP	OX+3W	Closed	EFM2.3V1HPK2	.015	Neg.	OK	None
IV5/279	85	Ford Mustang LX	140/1	M-4	PUMP	3W	Closed	FFM2.3V1HAK2	.020	Neg.	OK	None
IV5/296	85	Ford Mustang	140/1	A-3	PUMP	OX+3W	Closed	FFM2.3V1HAK2	.025	Neg.	OK	None
IV4/147	84	Ford Mustang GT	140/FI	M-5	NO	3W	Closed	EFM2.3V5FGT2	.029	Neg.	OK	None
IV5/025	85	Merc Topaz GS	140/FI	A-3	PULS	OX+3W	Closed	FFM2.3V5HCF4	.017	Neg.	OK	None
IV5/045	85	Ford Tempo GL	140/FI	A-3	PULS	OX+3W	Closed	FFM2.3V5HCF4	N.A.	Neg.	Miss	None
IV5/143	85	Ford Tempo GL	140/FI	A-3	PULS	OX+3W	Closed	EFM2.3V5HCF4	.008	Neg.	OK	None
IV5/284	85	Ford Tempo	140/FI	A-3	PULS	OX+3W	Closed	FFM2.3V5HCF4	.028	Neg.	OK	None
IV5/286	85	Ford Tempo GL	140/FI	M-5	PULS	OX+3W	Closed	FFM2.3V5HCF4	.021	Neg.	OK	None
IV5/356	85	Ford Tempo GL	140/FI	M-5	PULS	OX+3W	Closed	FFM2.3V5HCF4	.013	Neg.	OK	None
IV5/363	85	Ford Tempo GL	140/FI	A-3	PULS	OX+3W	Closed	FFM2.3V5HCF4	.011	Neg.	OK	None
IV3/219	83	Merc Marquis Wg	200/1	L-3	PUMP	OX+3W	Open	DFM3.3V1GEF6	.015	Neg.	OK	None
IV4/165	84	Ford LTD Brou	231/2	L-3	PUMP	3W	Open	EFM3.8V2GXF1	.012	Neg.	OK	None
IV4/276	84	Ford T-Bird	302/FI	L-4	PUMP	OX+3W	Closed	EFM5.OV5HBF7	.016	Neg.	OK	None
IV5/008	85	Ford LTD Crn Vct	302/FI	L-4	PUMP	OX+3W	Closed	FFM5.OV5HBF8	.032	Neg.	OK	None
IV5/170	85	Ford T-Bird	302/FI	L-4	PUMP	OX+3W	Closed	FFM5.OV5HBF8	.020	Neg.	OK	None
IV5/355	85	Merc Caprice GS	302/4	M-5	PUMP	OX+3W	Open	FFM5.OV4GMF5	.024	Neg.	OK	None
IV3/043	83	Chev Chevette	98/2	L-3	PUMP	OX+3W	Closed	D1G1.6V2NEAO	.017	Neg.	OK	None
IV4/001	84	Chev Chevette	98/2	L-3	PUMP	OX+3W	Closed	E1G1.6V2NEA1	.017	Neg.	OK	None
IV4/285	84	Chev Chevette	98/2	M-4	PUMP	OX+3W	Closed	E1G1.6V2NEA1	.037	Neg.	OK	None
IV4/316	84	Chev Chevette	98/2	L-3	PUMP	OX+3W	Closed	E1G1.6V2NEA1	.011	Neg.	OK	None
IV4/364	84	Chev Chevette CS	98/2	L-3	PUMP	OX+3W	Closed	E1G1.6V2NEA1	.018	Neg.	OK	None
IV3/036	83	Buic Century	151/FI	L-3	NO	3W	Closed	D2G2.5V5TPG6	.015	Neg.	OK	None
IV4/005	84	Buic Skylark	151/FI	L-3	NO	3W	Closed	E2G2.5V5TPG7	.011	N.A.	OK	None

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata-lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV4/003	84	Pont Fiero 2M4	151/FI	M-4	NO	3W	Closed	E2G2.5V5TPG7	.017	Neg.	OK	None
IV4/221	84	Pont Fiero	151/FI	M-4	NO	3W	Closed	E2G2.5V5TPG7	.013	Neg.	OK	None
IV4/309	84	Pont Fiero SE	151/FI	L-3	NO	3W	Closed	E2G2.5V5TPG7	.013	Neg.	OK	None
IV5/031	85	Pont Fiero 2M4	151/FI	M-5	NO	3W	Closed	F2G2.5V5TPG8	.018	Neg.	OK	None
IV5/274	85	Pont Fiero 2M4	151/FI	L-3	NO	3W	Closed	F2G2.5V5TPG8	.012	Neg.	OK	None
IV5/239	85	Chev Celebrity GL	173/FI	L-3	NO	3W	Closed	F1G2.8V8XGZ9	.018	Neg.	OK	None
IV3/224	83	Buic Regal	231/2	L-3	PUMP	OX+3W	Closed	D4G3.8V2NEA3	.039	Neg.	OK	None
IV3/382	83	Pont Gran Prix LJ	231/2	L-3	PUMP	OX+3W	Closed	D4G3.8V2NEA3	.031	Neg.	OK	None
IV4/011	84	Buic Regal Limit	231/2	L-3	PUMP	3W	Closed	E4G3.8V2NEYO	.013	Neg.	OK	None
IV4/222	84	Buic Regal Trbo	231/FI	L-4	NO	3W	Closed	E4G3.8V9XEB6	.019	Neg.	OK	Yes
IV3/260	83	Chev Caprice Clas	305/4	L-4	PUMP	OX+3W	Closed	D1G5.7V4NDAO	.019	Neg.	OK	None
IV4/291	84	Olds Toronado	307/4	L-4	PUMP	OX+3W	Closed	E3G5.OV4NLAX	.009	Neg.	OK	None
IV5/035	85	Olds Delta 88 R	307/4	L-4	PUMP	OX+3W	Closed	F3G5.OV4NLAO	.025	Neg.	OK	None
IV3/006	83	Hond Civic	81/3	M-5	PULS	OX	Open	DHN1.3V3AAF1	.017	Neg.	OK	None
IV4/149	84	Hond Civic	82/3	M-5	PULS	3W	Open	EHN1.3V3EAF3	N.A.	Neg.	OK	None
IV3/145	83	Hond Civic Wgn	91/3	A-3	PULS	OX	Open	DHN1.5V3ACF6	.021	Neg.	OK	None
IV3/216	83	Hond Civic DX	91/3	M-5	PULS	OX	Open	DHN1.5V3ACF6	.023	Neg.	OK	None
IV3/290	83	Hond Civic	91/3	A-3	PULS	OX	Open	DHN1.5V3ACF6	.018	Neg.	OK	None
IV4/160	84	Hond Civic	91/3	M-5	PULS	3W	Closed	EHN1.5V3FCFO	.012	Neg.	OK	None
IV5/226	85	Hond Civic	91/3	M-5	PULS	3W	Closed	FHN1.5V3FCF1	.015	Neg.	OK	None
IV3/105	83	Hond Accord	107/3	M-5	PULS	OX	Open	DHN1.8V3AEF6	.017	Neg.	OK	None
IV3/205	83	Hond Accord	107/3	M-5	PULS	OX	Open	DHN1.8V3AEF6	.021	Neg.	OK	None
IV3/236	83	Hond Accord	107/3	L-3	PULS	OX	Open	DHN1.8V3AEF6	.022	Neg.	OK	None
IV4/167	84	Hond Prelude	112/2	L-4	PULS	3W	Closed	EHN1.8VOFGF3	.019	Neg.	OK	None

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata-lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV4/215	84	Hond Prelude	112/2	M-5	PULS	3W	Closed	EHN1.8VOFGF3	.023	Neg.	OK	None
IV5/361	85	Hond Prelude	112/2	M-5	PULS	3W	Closed	FHN1.8VOFGF4	.114	Neg.	OK	None
IV3/034	83	Hond Prelude	112/3	M-5	PULS	OX	Open	DHN1.8VOAGF9	.015	Neg.	OK	None
IV3/323	83	Hond Prelude	112/3	M-5	PULS	OX	Open	DHN1.8VOAGF9	.011	Neg.	OK	None
IV5/218	85	Hond Accord LX	112/3	L-4	PULS	3W	Closed	FHN1.8V3FXF5	.034	Neg.	OK	None
IV4/072	84	Dodg Colt	86/2	M-4	PULS	3W	Closed	EMT1.4V2FFD2	.035	Neg.	OK	None
IV4/280	84	Mits Cordia	122/2	M-5	PULS	3W	Closed	EMT2.OV2FFD8	.015	Neg.	OK	None
IV5/265	85	Mits Cordia L	122/2	M-5	PULS	3W	Closed	FMT2.OV2FFD9	.018	Neg.	OK	None
IV3/395	83	Plym Sapporo	156/2	M-5	PULS	OX	Open	DMT2.6V2BFD9	.016	Neg.	OK	None
IV3/197	83	Niss Pulsar NX	98/2	A-3	PULS	OX	Open	DNS1.6V2AAF2	.035	Neg.	OK	None
IV3/220	83	Niss Pulsar NX	98/2	M-5	PULS	OX	Open	DNS1.6V2AAF2	.021	Neg.	OK	None
IV3/288	83	Niss Sentra	98/2	L-3	PULS	OX	Open	DNS1.6V2AAF2	.016	Neg.	OK	None
IV4/281	84	Niss Sentra	98/2	L-3	PULS	3W	Closed	ENS1.6V9HAF8	.012	Neg.	OK	None
IV3/018	83	Niss Stanza	120/2	L-3	PULS	OX	Open	DNS2.OV2AAF7	.023	Neg.	OK	None
IV3/144	83	Niss Stanza	120/2	L-3	PULS	OX	Open	DNS2.OV2AAF7	.010	Neg.	OK	None
IV3/148	83	Niss Stanza	120/2	M-5	PULS	OX	Open	DNS2.OV2AAF7	.026	Neg.	OK	None
IV3/171	83	Niss Stanza	120/2	L-3	PULS	OX	Open	DNS2.OV2AAF7	.022	Neg.	OK	None
IV3/217	83	Niss Stanza	120/2	L-3	PULS	OX	Open	DNS2.OV2AAF7	.015	Neg.	OK	None
IV3/294	83	Niss Stanza	120/2	M-5	PULS	OX	Open	DNS2.OV2AAF7	.013	Neg.	OK	None
IV3/421	83	Niss Stanza	120/2	A-3	PULS	OX	Open	DNS2.OV2AAF7	.028	Neg.	OK	None
IV3/103	83	Niss Maxima	146/FI	L-4	NO	3W	Closed	DNS2.8V5FAAO	.026	Pos.	OK	None
IV3/168	83	Dats 280 ZX	168/FI	A-3	NO	3W	Closed	DNS2.8V5FBF7	.023	Neg.	OK	None
IV4/295	84	Dats 300 ZX	181/FI	A-4	NO	3W	Closed	ENS3.OV5FAFX	.029	Neg.	OK	None
IV5/312	85	Niss Maxima	181/FI	L-4	PULS	3W	Closed	FNS3.OV5HAF6	.013	Neg.	OK	None

Vehicle Number	Mdl Yr	Make/Model	CID/ # bbl	TRN	Supp AIR	Cata- lyst	Contrl Config	Engine Family	Fuel Lead	Plumb tesmo	Fill Neck Rstr	Trbl Codes
IV4/403	84	Peug 505 GL	120/FI	A-3	PULS	3W	Closed	EPE2.0V6FAB5	.036	Neg.	OK	None
IV4/169	84	Isuz Impulse	119/FI	M-5	NO	3W	Closed	ESZ119V5FGG6	.015	Neg.	OK	None
IV3/046	83	Toyo Tercel	89/2	A-3	PULS	OX+3W	Closed	DTY1.6V2HFF1	.012	Neg.	OK	None
IV3/163	83	Toyo Tercel	89/2	M-5	PULS	OX+3W	Closed	DTY1.6V2HFF1	.025	Neg.	OK	None
IV3/283	83	Toyo Tercel	89/2	M-4	PULS	OX+3W	Closed	DTY1.6V2HFF1	.020	Neg.	OK	None
IV3/264	83	Toyo Corolla	97/2	A	PULS	OX+3W	Closed	DTY1.6V2HFF1	.017	Neg.	OK	None
IV4/151	84	Volv Volvo DL	141/FI	A-4	NO	3W	Closed	EVV2.3V5FEL8	.017	Neg.	OK	None
IV4/357	84	Volv Volvo DL	141/FI	A-4	NO	3W	Closed	EVV2.3V5FEL8	.011	Neg.	OK	None

APPENDIX C

Description of the Extended Special I/M Test

The Extended Special I/M Test

As soon as possible after the vehicle arrived, the following test sequence was performed. During this test sequence, HC and CO emission levels and engine rpm were continuously recorded on a strip chart recorder.

1. Drive vehicle into test bay.

2. Turn engine off.

3. Let vehicle soak for 15 minutes. (During this step, the technician opened the vehicle's hood, attached the tachometer, and inserted the probe into the tailpipe. To avoid the exhaust associated with starting the engine, the analyzer's pump was shut off until after the engine was started.)

4. Start vehicle and run at 2500 rpm in neutral for 30 seconds.

5. Idle in neutral for 60 seconds.

6. Run the vehicle through the first 505 seconds of the Federal Test Procedure. The fan shall be on for this step only.

7. Idle in neutral for 30 seconds.

8. 2500 rpm in neutral for 30 seconds.

9. Idle in neutral for 60 seconds.

   If, after the first 30 seconds of Step 9, either the HC emissions > 220 ppm or CO > 1.20%, then the testing ended. Otherwise, testing continued with the remaining 16 steps, followed by the LA-4 preconditioning cycle, and the FTP the next day.

10. Turn engine off, and then restart after 10 seconds. (Again, the analyzer's pump was turned off until after the engine was restarted.)

11. 2500 rpm in neutral for 30 seconds.

12. Idle in neutral for 60 seconds.

13. Idle in neutral for 30 minutes.

14. 2500 rpm in neutral for 30 seconds.

15. Idle in neutral for 60 seconds.

16. Turn engine off, and then restart after 10 seconds. (Again, the analyzer's pump was turned off until after the engine was restarted.)

17. 2500 rpm in neutral for 30 seconds.

18. Idle in neutral for 60 seconds.

19. 2500 rpm in neutral for 3 minutes.

20. Idle in neutral for 5 seconds.

21. A. For all Fords and for 1984 Honda Preludes, turn engine off and restart, followed by 2500 rpm in neutral for 30 seconds. (Again, the analyzer's pump was turned off until after the engine was restarted.)

    B. For all other vehicles, 2500 rpm in neutral for 30 seconds.

22. Idle in neutral for 60 seconds.

23. 30 $\pm$ 2 mph on dynamometer for 30 seconds at a loading of 7.0 HP (as measured at 30 mph).

24. Idle in neutral for 60 seconds.

25. Turn engine off.

Data Recorded During the Extended Special I/M Test Sequence

Readings were to be made during the last 5 to 10 seconds of each indicated time period.

Step* Number	HC (ppm)	CO (%)	Engine Speed (rpm)
4 (after 30 sec)	X	X	X
5 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X
7 (after 30 sec)	X	X	X
8 (after 30 sec)	X	X	X
9 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X
11 (after 30 sec)	X	X	X
12 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X
13 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X
(after 90 sec)	X	X	X
(after 120 sec)	X	X	X
(after 150 sec)	X	X	X
(after 3 min)	X	X	X
(after 4 min)	X	X	X
(after 5 min)	X	X	X
(after 6 min)	X	X	X
(after 8 min)	X	X	X
(after 10 min)	X	X	X
(after 12 min)	X	X	X
(after 14 min)	X	X	X
(after 16 min)	X	X	X
(after 18 min)	X	X	X
(after 20 min)	X	X	X
(after 25 min)	X	X	X
(after 30 min)	X	X	X
14 (after 30 sec)	X	X	X

* "Step Number" refers to the steps given on pages C-1 and C-2.

Step* Number	HC (ppm)	CO (%)	Engine Speed (rpm)
15 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X
17 (after 30 sec)	X	X	X
18 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X
19 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X
(after 90 sec)	X	X	X
(after 120 sec)	X	X	X
(after 150 sec)	X	X	X
(after 3 min)	X	X	X
21 (after 30 sec)	X	X	X
22 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X
23 (after 30 sec)	X	X	X
24 (after 30 sec)	X	X	X
(after 60 sec)	X	X	X

* "Step Number" refers to the steps given on pages C-1 and C-2.

APPENDIX D

FTP Results for the 48 Cars Tested

Vehicle Number	Test Sequence	Odometer (mile)	-- Emissions (g/mi)-- HC	CO	NOx	Fuel Econ (mpg)
IV4/001	As Received:	31,553	1.08	10.53	.61	27.34
	After Repairs:	31,600	.87	10.29	.67	27.01
IV4/004	As Received:	34,354	1.80	56.07	.93	18.84
	After Repairs:	34,415	.41	9.77	1.41	18.68
IV4/005	As Received:	33,222	.17	2.19	.32	23.12
IV5/008	As Received:	31,564	.31	1.08	.94	16.15
IV4/011	As Received:	28,029	.39	2.05	.87	18.54
IV5/025	As Received:	15,430	.21	2.57	.80	25.14
IV5/031	As Received:	26,109	.14	2.28	.33	29.65
IV3/034	As Received:	37,479	.59	9.02	.63	25.14
IV5/035	As Received:	8,266	.27	2.73	.52	17.11
IV5/045	As Received:	36,202	.77	20.25	.74	22.64
IV3/046	As Received:	57,867	.30	3.01	1.16	29.41
IV4/047	As Received:	28,261	.63	3.73	.40	24.94
IV3/103	As Received:	42,476	.39	3.77	1.34	20.72
IV3/105	As Received:	49,732	.44	8.32	.40	26.42
IV3/120	As Received:	32,492	.68	3.03	1.61	21.98
IV4/146	As Received:	17,784	.24	5.42	.99	24.00
IV3/148	As Received:	42,032	.25	5.35	.38	25.25
IV4/149	As Received:	46,869	.36	4.08	1.18	42.75
IV3/150	As Received:	53,787	.98	22.31	.67	18.58
IV4/160	As Received:	24,308	.57	4.19	.84	28.26
IV3/163	As Received:	48,337	.69	4.11	2.43	27.26
IV4/165	As Received:	29,722	.91	12.82	.58	17.92
IV4/167	As Received:	18,499	.16	1.90	.50	24.66
IV3/168	As Received:	28,695	.96	7.34	2.01	19.06

Vehicle Number	Test Sequence	Odometer (mile)	-- Emissions (g/mi)-- HC	CO	NOx	Fuel Econ (mpg)
IV5/170	As Received:	20,074	.37	2.63	.79	16.99
IV3/171	As Received:	19,658	.22	4.06	.68	23.26
IV3/182	As Received:	83,800	.53	18.80	.98	18.72
IV3/197	As Received:	55,548	.26	7.75	.56	25.15
	After Repairs:	55,601	.24	8.06	1.20	26.58
IV5/218	As Received:	8,384	.19	3.50	.69	24.96
IV4/222	As Received:	21,599	.34	2.98	.48	16.80
IV3/224	As Received:	23,738	.48	1.72	.95	18.91
IV3/225	As Received:	41,541	1.08	37.59	.76	18.82
IV3/236	As Received:	49,435	.34	4.40	.89	26.78
IV3/260	As Received:	58,226	.99	22.10	.56	14.85
	After Repairs:	58,290	.33	5.96	.69	15.53
IV3/264	As Received:	41,789	.32	4.55	1.17	28.79
IV5/274	As Received:	20,242	.14	2.07	.34	26.43
IV5/279	As Received:	18,473	.46	2.87	.85	25.43
IV5/284	As Received:	25,065	.40	5.11	.70	24.62
IV4/291	As Received:	25,532	.31	1.85	1.07	15.18
IV3/294	As Received:	25,694	.23	4.90	2.32	26.53
IV4/316	As Received:	53,455	1.09	8.90	1.25	26.48
IV3/323	As Received:	45,967	1.38	28.00	.37	21.36
IV5/361	As Received:	21,704	.16	1.99	.52	23.90
IV5/363	As Received:	14,681	.17	2.55	.70	23.76
IV4/389	As Received:	43,180	.25	6.51	1.14	21.52
IV3/395	As Received:	48,781	.46	8.66	1.34	18.41
IV3/401	As Received:	43,085	.54	4.96	1.10	22.91
IV3/421	As Received:	32,353	.26	6.03	.52	23.65

APPENDIX E

Selected Extended Special I/M Test Results

For each of the 103 vehicles in the program, this appendix contains:

- a brief vehicle description,
- the initial Maryland I/M test results,
- the initial FTP test results,
- the idle emissions of a "cold" Restart Idle Test (following a 15 minute soak) (i.e., 30 seconds into Step 5, from Appendix B).
- the idle emissions after preconditioning by performing the first 505 seconds of the FTP (i.e., Step 7, from Appendix B).
- the idle emissions of a 2500 RPM/Idle Test (following the '505') (i.e., 30 seconds into Step 9, from Appendix B).
- the idle emissions of a Restart Idle Test (i.e., 30 seconds into Step 12, from Appendix B).
- the idle emissions after 31 minutes of idling in neutral (i.e., 5 to 10 seconds from the end of Step 13, from Appendix B).
- the idle emissions of a 2500 RPM/Idle Test (following the 31 minutes of idling) (i.e., 30 seconds into Step 15, from Appendix B).
- the idle emissions of a Restart Idle Test (i.e., 30 seconds into Step 18, from Appendix B).
- following a 3 minute preconditioning at 2500 rpm, either the idle emissions of a Restart Idle Test (for all Fords and for 1984 Honda Preludes, identified by an asterisk) or the idle emissions of a 2500 RPM/Idle Test (for all other cars) (i.e., 30 seconds into Step 22, from Appendix B).
- the idle emissions of a Loaded Test (i.e., 30 seconds into Step 24, from Appendix B).

Vehicle Number	MDL YR	MFG	MDL	CID/ Carb	--MD I/M-- CO (%)	HC (ppm)	--- FTP (g/mi) -- HC	CO	NOx	IDLE EMISSIONS (CO/HC) 'Cold' Rest. Idle	Idle After '505'	2500/ Idle	Rest. 2500/ Idle	After 31min Idle	2500/ Idle	Rest. 2500/ Idle	After 3 min 2500	Loaded
IV4/001	84	GM	CHEV	98/2	7.91	599	1.08	10.53	.61	.55	.20	.15	.15	1.40	.40	.30	.05	1.10
										260	230	120	130	410	220	220	130	160
IV4/003	84	GM	FIER	151/FI	8.87	738	N/A	N/A	N/A	.23	3.90	.20	N/A	N/A	N/A	N/A	N/A	N/A
										290	680	250	N/A	N/A	N/A	N/A	N/A	N/A
IV4/004	84	FORD	TEMP	140/1	3.39	114	1.80	56.07	.93	6.40	.02	.05	.05	8.60	9.00	7.60	7.00*	1.00
										2000	50	45	45	2000	2000	360	290*	170
IV4/005	84	GM	SKYL	151/FI	.16	379	.17	2.19	.32	.00	.05	.05	.05	.05	.05	.07	.05	.07
										15	30	30	30	45	65	50	45	50
IV3/006	83	HOND	CIVI	81/3	.67	657	N/A	N/A	N/A	1.50	1.70	.70	N/A	N/A	N/A	N/A	N/A	N/A
										2000	2000	2000	N/A	N/A	N/A	N/A	N/A	N/A
IV5/008	85	FORD	LTD	302/FI	3.16	198	.31	1.08	.94	.05	.02	.02	.02	2.50	.02	.02	.02*	.02
										50	60	50	50	320	70	50	45*	40
IV4/011	84	GM	REGA	231/2	9.71	243	.39	2.05	.87	.02	.02	.02	.02	.50	.30	.02	.02	.02
										90	50	55	60	200	200	90	55	50
IV3/018	83	NISS	STAN	120/2	1.29	20	N/A	N/A	N/A	.02	2.80	2.40	N/A	N/A	N/A	N/A	N/A	N/A
										15	25	22	N/A	N/A	N/A	N/A	N/A	N/A
IV5/025	85	FORD	TOPA	140/FI	.04	542	.21	2.57	.80	.05	.05	.05	.02	.60	.09	.05	.05*	.05
										30	30	25	25	350	200	60	30*	25
IV5/026	85	FORD	ESCO	118/2	7.36	273	N/A	N/A	N/A	.02	.05	.15	.03	.05	.08	.10	.25*	.30
										45	15	35	30	25	40	40	25*	5
IV5/031	85	GM	FIER	151/FI	1.82	287	.14	2.28	.33	.10	.02	.02	.04	.15	.04	.10	.17	.11
										320	12	11	20	30	24	50	27	21
IV3/034	83	HOND	PREL	112/3	2.82	266	.59	9.02	.63	1.70	.02	.05	.05	4.00	2.50	1.80	.05	.05
										200	50	60	65	510	460	390	140	65
IV5/035	85	GM	ROYA	307/4	1.58	228	.27	2.73	.52	.05	.05	.05	.05	.02	.05	.02	.05	.02
										80	50	45	50	45	45	45	50	35

Vehicle Number	MDL YR	MFG	MDL	CID/ Carb	--MD I/M-- CO (%)	HC (ppm)	--- FTP (g/mi) -- HC	CO	NOx	IDLE EMISSIONS (CO/HC) 'Cold' Rest. Idle	Idle After '505'	2500/ Idle	Rest. 2500/ Idle	After 31min Idle	2500/ Idle	Rest. 2500/ Idle	After 3 min 2500	Loaded
IV3/036	83	GM	CENT	151/FI	1.93	466	N/A	N/A	N/A	1.90	2.10	2.10	N/A	N/A	N/A	N/A	N/A	N/A
										720	700	800	N/A	N/A	N/A	N/A	N/A	N/A
IV3/043	83	GM	CHEV	98/2	5.76	289	N/A	N/A	N/A	3.20	4.20	4.00	N/A	N/A	N/A	N/A	N/A	N/A
										285	312	327	N/A	N/A	N/A	N/A	N/A	N/A
IV5/045	85	FORD	TEMP	140/FI	3.29	265	.77	20.25	.74	.90	.45	.10	.06	.80	1.30	.05	.03*	.22
										150	85	70	90	180	330	110	50*	80
IV3/046	83	TOYO	TERC	89/2	2.10	172	.30	3.01	1.16	.35	.10	.08	.05	.07	.20	.20	.07	.18
										210	60	65	70	80	120	170	80	60
IV4/047	84	FORD	ESCO	98/2	1.86	39	.63	3.73	.40	.10	.06	.04	.04	.03	.04	.03	.05*	.06
										68	30	30	30	35	30	35	37*	22
IV4/064	84	BMW	318I	108/FI	1.62	131	N/A	N/A	N/A	.16	.10	.10	.06	.50	.20	.65	.08	.17
										75	11	8	10	85	48	45	18	20
IV4/072	84	MITS	COLT	86/2	3.72	246	N/A	N/A	N/A	2.20	.02	.40	.80	1.30	1.40	1.50	1.90	2.20
										110	32	58	100	170	195	150	160	175
IV3/103	83	NISS	MAXI	146/FI	1.85	223	.39	3.77	1.34	.04	.03	.03	.02	.05	.05	.04	.03	.06
										30	20	15	18	35	28	25	20	35
IV3/105	83	HOND	ACCO	107/3	1.72	378	.44	8.32	.40	.02	.02	.02	.02	.02	.02	.02	.02	.02
										40	35	25	15	25	25	21	15	13
IV3/120	83	FORD	EXP	98/2	1.56	80	.68	3.03	1.61	.05	.03	.02	.02	.03	.03	.03	.03*	1.70
										55	25	30	30	25	35	30	40*	65
IV5/143	85	FORD	TEMP	140/FI	7.92	552	N/A	N/A	N/A	.70	8.80	7.40	N/A	N/A	N/A	N/A	N/A	N/A
										810	1000	1000	N/A	N/A	N/A	N/A	N/A	N/A
IV3/144	83	NISS	STAN	120/2	2.87	96	N/A	N/A	N/A	.11	.05	1.35	N/A	N/A	N/A	N/A	N/A	N/A
										200	50	70	N/A	N/A	N/A	N/A	N/A	N/A
IV3/145	83	HOND	CIVI	91/3	1.41	266	N/A	N/A	N/A	1.40	.03	1.10	N/A	N/A	N/A	N/A	N/A	N/A
										380	45	250	N/A	N/A	N/A	N/A	N/A	N/A

Vehicle Number	MDL YR	MFG	MDL	CID/ Carb	--MD I/M-- CO (%)	HC (ppm)	--- FTP (g/mi) -- HC	CO	NOx	IDLE EMISSIONS (CO/HC) 'Cold' Rest. Idle	Idle After '505'	2500/ Idle	Rest. 2500/ Idle	After 31min Idle	2500/ Idle	Rest. 2500/ Idle	After 3 min 2500	Loaded
IV4/146	84	CHRY	600	135/FI	1.88	239	.24	5.42	.99	.90	.40	.05	.80	.90	.40	.65	.40	.20
										115	25	25	60	115	70	65	40	30
IV4/147	84	FORD	MUST	140/FI	8.23	300	N/A	N/A	N/A	7.40	7.30	10.00	N/A	N/A	N/A	N/A	N/A	N/A
										460	380	1400	N/A	N/A	N/A	N/A	N/A	N/A
IV3/148	83	NISS	STAN	120/2	1.61	59	.25	5.35	.38	.15	.05	.01	.01	.02	.01	.02	.02	.02
										68	47	45	44	45	45	51	50	45
IV4/149	84	HOND	CIVI	82/3	.40	306	.36	4.08	1.18	.04	.01	.00	.00	.02	.02	.02	.02	.05
										150	40	15	8	22	15	15	10	250
IV3/150	83	CHRY	NEWY	156/2	9.82	608	.98	22.31	.67	.50	.40	.50	.80	.50	8.80	7.00	1.40	6.20
										32	18	30	30	25	300	160	45	160
IV4/151	84	VOLV	VOLV	141/FI	5.63	265	N/A	N/A	N/A	4.70	4.90	4.80	N/A	N/A	N/A	N/A	N/A	N/A
										300	320	320	N/A	N/A	N/A	N/A	N/A	N/A
IV3/157	83	FORD	ESCO	98/2	4.47	149	N/A	N/A	N/A	2.65	4.80	4.60	N/A	N/A	N/A	N/A	N/A	N/A
										150	160	160	N/A	N/A	N/A	N/A	N/A	N/A
IV4/158	84	FORD	ESCO	98/2	5.57	211	N/A	N/A	N/A	.05	3.90	2.80	N/A	N/A	N/A	N/A	N/A	N/A
										105	250	140	N/A	N/A	N/A	N/A	N/A	N/A
IV4/160	84	HOND	CIVI	91/3	3.95	166	.57	4.19	.84	.07	.15	.12	.02	.40	1.00	.55	1.90	5.20
										150	110	100	90	220	185	170	200	220
IV3/163	83	TOYO	TERC	89/2	.55	245	.69	4.11	2.43	.06	.03	.02	.04	.20	.20	.08	.02	.02
										110	20	25	30	190	230	180	55	30
IV4/165	84	FORD	LTD	231/2	1.65	120	.91	12.82	.58	.02	.02	.02	.02	1.10	.02	.01	.01*	.01
										17	5	8	9	272	30	20	12*	11
IV4/167	84	HOND	PREL	112/2	3.21	261	.16	1.90	.50	.05	.01	.02	.02	1.60	1.50	.20	.02*	.02
										15	10	10	25	170	165	45	40*	30
IV3/168	83	NISS	280	168/FI	2.72	253	.96	7.34	2.01	.60	.05	.07	.05	.70	.50	.40	.80	.10
										185	35	40	55	210	190	190	97	80

Vehicle Number	MDL YR	MFG	MDL	CID/ Carb	--MD I/M-- CO (%)	HC (ppm)	--- FTP (g/mi) -- HC	CO	NOx	IDLE EMISSIONS (CO/HC) 'Cold' Rest. Idle	Idle After '505'	2500/ Idle	Rest. 2500/ Idle	After 31min Idle	2500/ Idle	Rest. 2500/ Idle	After 3 min 2500	Loaded
IV4/169	84	ISUZ	IMPU	119/FI	10.01	482	N/A	N/A	N/A	10.00	10.00	10.00	N/A	N/A	N/A	N/A	N/A	N/A
										660	410	450	N/A	N/A	N/A	N/A	N/A	N/A
IV5/170	85	FORD	THUN	302/FI	7.03	416	.37	2.63	.79	.02	.01	.01	.01	5.20	.01	.01	.01*	.01
										20	10	10	10	360	35	30	20*	20
IV3/171	83	NISS	STAN	120/2	1.22	119	.22	4.06	.68	.08	.05	.02	.02	.05	.05	.05	.05	.08
										40	20	20	20	25	30	40	30	25
IV3/182	83	CHRY	NEWY	156/2	2.46	60	.53	18.80	.98	.05	.25	.12	.05	.45	8.80	8.00	6.40	7.60
										70	25	35	35	35	330	300	150	230
IV3/197	83	NISS	PULS	98/2	3.23	113	.26	7.75	.56	.02	.02	.01	.05	.09	.02	.02	.05	.05
										5	5	7	10	35	20	10	10	20
IV3/205	83	HOND	ACCO	107/3	.24	241	N/A	N/A	N/A	.05	.05	.05	.05	.05	.05	.05	.05	.05
										35	15	15	15	25	25	20	20	20
IV3/214	83	FORD	ESCO	98/2	1.32	77	N/A	N/A	N/A	.84	.01	.01	.02	1.90	1.20	1.10	.02*	.02
										95	20	28	32	112	105	100	50*	24
IV4/215	84	HOND	PREL	112/2	3.35	131	N/A	N/A	N/A	.02	.02	2.60	N/A	N/A	N/A	N/A	N/A	N/A
										24	15	170	N/A	N/A	N/A	N/A	N/A	N/A
IV3/216	83	HOND	CIVI	91/3	.11	314	N/A	N/A	N/A	.10	.50	.40	N/A	N/A	N/A	N/A	N/A	N/A
										215	235	260	N/A	N/A	N/A	N/A	N/A	N/A
IV3/217	83	NISS	STAN	120/2	2.26	84	N/A	N/A	N/A	.17	.08	1.40	N/A	N/A	N/A	N/A	N/A	N/A
										72	70	95	N/A	N/A	N/A	N/A	N/A	N/A
IV5/218	85	HOND	ACCO	112/3	2.48	171	.19	3.50	.69	.02	.02	.02	.02	1.20	2.20	.60	2.80	4.20
										20	18	18	18	180	180	60	180	265
IV3/219	83	FORD	MARQ	200/1	4.13	288	N/A	N/A	N/A	.01	2.60	2.70	N/A	N/A	N/A	N/A	N/A	N/A
										41	255	280	N/A	N/A	N/A	N/A	N/A	N/A
IV3/220	83	NISS	PULS	98/2	3.08	207	N/A	N/A	N/A	.01	.01	.01	.20	.30	.05	.01	.01	.01
										10	0	0	0	45	15	8	0	0

Vehicle Number	MDL YR	MFG	MDL	CID/ Carb	--MD I/M-- CO (%)	HC (ppm)	--- FTP (g/mi) -- HC	CO	NOx	IDLE EMISSIONS (CO/HC) 'Cold' Rest. Idle	Idle After '505'	2500/ Idle	Rest. 2500/ Idle	After 31min Idle	2500/ Idle	Rest. 2500/ Idle	After 3 min 2500	Loaded
IV4/221	84	GM	FIER	151/FI	.12	313	N/A	N/A	N/A	.02 245	.04 30	.04 55	.10 110	.06 170	.09 148	.07 240	.12 140	.02 0
IV4/222	84	GM	REGA	231/FI	7.05	419	.34	2.98	.48	.09 75	.10 55	.20 150	.13 165	.12 250	.09 240	.08 210	.18 170	.15 75
IV3/224	83	GM	REGA	231/2	2.15	184	.48	1.72	.95	.02 25	.02 35	.02 35	.02 32	.20 200	.04 50	.02 20	.02 45	.02 25
IV3/225	83	CHRY	NEWY	156/2	6.70	168	1.08	37.59	.76	.08 47	.05 32	.04 25	.05 40	.08 48	2.00 65	.05 30	.05 27	.02 37
IV5/226	85	HOND	CIVI	91/3	1.43	141	N/A	N/A	N/A	.05 35	.07 40	.10 45	.15 60	.05 35	.15 70	.08 50	.10 55	.35 95
IV3/236	83	HOND	ACCO	107/3	1.44	127	.34	4.40	.89	.12 80	1.10 150	1.10 140	.90 150	.21 145	.55 140	.50 130	.64 135	1.10 150
IV5/239	85	GM	CELE	173/FI	.13	600	N/A	N/A	N/A	.01 15	.01 10	.01 9	.01 10	.01 14	.02 22	.01 9	.01 10	.01 10
IV3/260	83	GM	CAPR	305/4	1.71	163	.99	22.10	.56	.02 0	.02 5	.02 6	.02 6	.01 15	.01 5	.01 5	.10 15	.01 5
IV3/264	83	TOYO	CORO	97/2	2.63	185	.32	4.55	1.17	2.45 230	.16 40	.12 40	.10 45	.04 50	.10 60	.16 80	.15 60	.12 40
IV5/265	85	MITS	CORD	122/2	1.46	172	N/A	N/A	N/A	.05 40	2.10 195	1.30 165	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
IV3/268	83	CHRY	NEWY	156/2	3.10	84	N/A	N/A	N/A	.10 35	.50 20	.60 20	.40 20	.25 15	3.00 100	1.20 50	.40 20	.05 20
IV5/274	85	GM	FIER	151/FI	.19	241	.14	2.07	.34	.12 140	.08 27	.10 28	.12 27	.10 140	.10 105	.12 55	.07 30	.05 25
IV4/276	84	FORD	THUN	302/FI	3.31	193	N/A	N/A	N/A	.01 15	.01 8	.01 5	.01 8	.88 155	.02 24	.01 15	.01* 10*	.01 15

Vehicle Number	MDL YR	MFG	MDL	CID/ Carb	--MD I/M-- CO (%)	HC (ppm)	--- FTP (g/mi) -- HC	CO	NOx	IDLE EMISSIONS (CO/HC) 'Cold' Rest. Idle	Idle After '505'	2500/ Idle	Rest. 2500/ Idle	After 31min Idle	2500/ Idle	Rest. 2500/ Idle	After 3 min 2500	Loaded
IV3/277	83	CHRY	ARIE	156/2	4.14	114	N/A	N/A	N/A	.90	1.50	2.40	N/A	N/A	N/A	N/A	N/A	N/A
										60	30	50	N/A	N/A	N/A	N/A	N/A	N/A
IV5/279	85	FORD	MUST	140/1	.00	271	.46	2.87	.85	.02	.01	.00	.00	.01	.01	.01	.01*	.01
										75	9	10	11	15	20	20	10*	10
IV4/280	84	MITS	CORD	122/2	4.44	193	N/A	N/A	N/A	.08	.90	3.20	N/A	N/A	N/A	N/A	N/A	N/A
										40	60	110	N/A	N/A	N/A	N/A	N/A	N/A
IV4/281	84	NISS	SENT	98/2	3.70	162	N/A	N/A	N/A	3.90	4.20	4.10	N/A	N/A	N/A	N/A	N/A	N/A
										215	205	205	N/A	N/A	N/A	N/A	N/A	N/A
IV4/282	84	CHRY	DAYT	135/FI	.15	282	N/A	N/A	N/A	.28	.14	.18	N/A	N/A	N/A	N/A	N/A	N/A
										190	200	230	N/A	N/A	N/A	N/A	N/A	N/A
IV3/283	83	TOYO	TERC	89/2	.27	221	N/A	N/A	N/A	.20	.02	.03	.03	.14	.17	.18	.08	.03
										350	75	85	150	300	420	460	200	130
IV5/284	85	FORD	TEMP	140/FI	3.38	189	.40	5.11	.70	4.70	1.80	.80	.03	.50	.01	.01	.02*	.02
										420	140	130	42	45	48	60	38*	30
IV4/285	84	GM	CHEV	98/2	1.14	251	N/A	N/A	N/A	.11	.01	.01	.01	.30	.30	.37	.01	1.70
										120	15	15	15	205	170	170	50	310
IV5/286	85	FORD	TEMP	140/FI	2.59	126	N/A	N/A	N/A	2.10	1.50	1.30	N/A	N/A	N/A	N/A	N/A	N/A
										80	30	230	N/A	N/A	N/A	N/A	N/A	N/A
IV3/288	83	NISS	SENT	98/2	2.07	201	N/A	N/A	N/A	.02	.01	.01	1.20	.45	.50	.01	.02	.02
										85	27	30	85	132	141	40	28	32
IV3/290	83	HOND	CIVI	91/3	3.60	210	N/A	N/A	N/A	.60	.71	.70	1.40	.44	.58	.18	.65	.77
										195	160	165	185	220	210	140	120	140
IV4/291	84	GM	TORO	307/4	.11	483	.31	1.85	1.07	.04	.03	.03	.03	.02	.03	.02	.03	.03
										35	20	20	18	55	25	15	20	15
IV3/292	83	BMW	528E	164/FI	4.61	369	N/A	N/A	N/A	2.70	2.80	2.90	N/A	N/A	N/A	N/A	N/A	N/A
										190	170	170	N/A	N/A	N/A	N/A	N/A	N/A

Vehicle Number	MDL YR	MFG	MDL	CID/ Carb	--MD I/M-- CO (%)	HC (ppm)	--- FTP (g/mi) -- HC	CO	NOx	IDLE EMISSIONS (CO/HC) 'Cold' Rest. Idle	Idle After '505'	2500/ Idle	Rest. 2500/ Idle	After 31min Idle	2500/ Idle	Rest. 2500/ Idle	After 3 min 2500	Loaded
IV3/294	83	NISS	STAN	120/2	3.36	167	.23	4.90	2.32	.11 105	.01 38	.01 38	.01 40	.01 35	.01 32	.01 28	.01 30	.01 28
IV4/295	84	NISS	300	181/FI	2.19	147	N/A	N/A	N/A	1.35 150	.05 30	1.35 110	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
IV5/296	85	FORD	MUST	140/1	.83	667	N/A	N/A	N/A	1.00 820	1.20 605	1.60 720	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
IV3/297	83	CHRY	ARIE	135/2	.03	222	N/A	N/A	N/A	.01 80	.01 80	.01 37	.01 15	.01 135	.10 105	.01 35	.01 25	.01 48
IV4/309	84	GM	FIER	151/FI	6.12	486	N/A	N/A	N/A	.70 350	.60 170	.80 170	.45 170	7.40 920	1.70 340	.15 260	.18 240	.18 195
IV5/311	85	CHRY	LASE	135/FI	2.12	108	N/A	N/A	N/A	6.60 460	.04 50	9.20 600	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
IV5/312	85	NISS	MAXI	181/FI	.43	325	N/A	N/A	N/A	.03 50	.02 55	.02 55	.04 60	.40 210	.05 85	.04 75	.04 65	.04 65
IV3/314	83	FORD	ESCO	98/2	3.43	178	N/A	N/A	N/A	.05 85	2.50 245	2.20 230	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
IV4/316	84	GM	CHEV	98/2	1.49	173	1.09	8.90	1.25	.45 95	.13 60	.15 60	.16 60	.32 98	.38 85	.27 80	.20 70	.12 55
IV3/323	83	HOND	PREL	112/3	1.43	122	1.38	28.00	.37	.25 80	.01 20	.05 30	.01 30	.70 180	.02 40	.01 30	.40 70	.01 25
IV5/355	85	FORD	CAPR	302/4	1.71	152	N/A	N/A	N/A	.02 42	.02 45	.02 45	.02 25	.01 15	.02 20	.02 22	.02* 15*	.02 20
IV5/356	85	FORD	TEMP	140/FI	6.25	627	N/A	N/A	N/A	4.60 800	3.60 230	3.20 225	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
IV4/357	84	VOLV	VOLV	141/FI	4.43	286	N/A	N/A	N/A	3.60 450	4.20 400	4.20 365	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A

Vehicle Number	MDL YR	MFG	MDL	CID/ Carb	--MD I/M-- CO (%)	HC (ppm)	--- FTP (g/mi) -- HC	CO	NOx	IDLE EMISSIONS (CO/HC) 'Cold' Rest. Idle	Idle After '505'	2500/ Idle	Rest. 2500/ Idle	After 31min Idle	2500/ Idle	Rest. 2500/ Idle	After 3 min 2500	Loaded
IV5/359	85	FORD	ESCO	118/2	.01	284	N/A	N/A	N/A	.01	.01	.01	.01	.01	.01	.01	.01*	.01
										30	10	10	10	70	20	15	10*	10
IV4/360	84	FORD	MUST	140/1	.05	313	N/A	N/A	N/A	.02	.01	.02	.02	.10	.05	.03	.02*	.02
										110	60	75	75	510	310	240	100*	100
IV5/361	85	HOND	PREL	112/2	.00	232	.16	1.99	.52	.02	.20	.02	.02	1.30	1.10	.01	.01	.01
										40	20	25	30	208	195	72	30	28
IV5/363	85	FORD	TEMP	140/FI	2.33	85	.17	2.55	.70	.25	.90	.01	.10	.30	.05	.04	.04*	.10
										150	65	15	50	120	65	60	35*	35
IV4/364	84	GM	CHEV	98/2	6.50	315	N/A	N/A	N/A	.02	.00	.00	.00	.35	.35	.04	.01	.01
										55	18	20	20	110	105	55	30	25
IV3/382	83	GM	GRAN	231/2	2.51	155	N/A	N/A	N/A	.80	2.70	2.60	N/A	N/A	N/A	N/A	N/A	N/A
										175	310	290	N/A	N/A	N/A	N/A	N/A	N/A
IV4/389	84	CHRY	TOWN	156/2	1.66	199	.25	6.51	1.14	.20	.04	.40	.20	.60	1.70	.90	.15	.70
										50	5	20	20	70	240	150	35	10
IV3/395	83	MITS	SAPP	156/2	2.04	38	.46	8.66	1.34	.03	.02	.02	.02	.05	.02	.02	.00	.00
										40	25	25	28	42	32	15	1	0
IV3/401	83	CHRY	HORI	135/2	1.25	113	.54	4.96	1.10	.02	.02	.01	.02	.21	.03	.03	.02	.04
										35	50	45	50	155	10	10	45	55
IV4/403	84	PEUG	505	120/FI	1.39	91	N/A	N/A	N/A	1.70	1.40	1.50	N/A	N/A	N/A	N/A	N/A	N/A
										125	100	105	N/A	N/A	N/A	N/A	N/A	N/A
IV3/421	83	NISS	STAN	120/2	4.75	132	.26	6.03	.52	1.70	.04	.03	.05	.20	.70	.02	.09	.02
										110	20	22	25	35	50	20	30	40
IV4/422	84	AMC	ENCO	85/FI	5.49	468	N/A	N/A	N/A	2.50	2.50	1.00	N/A	N/A	N/A	N/A	N/A	N/A
										240	275	250	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX F

Description of the Repairs Performed on the 5 Cars Repaired in This Program

Vehicle Number	Initial I/M Lane HC / CO	I/M After Repair HC / CO	Type of Repairs
IV4/001	599 / 7.91	12 / 0.05	Replaced air filter. Reset idle speed and mixture to spec (after drilling out plugs). Repaired loose hose connection at canister purge TVS.
IV4/004	114 / 3.39	1 / 0.00	Replaced solenoid to air pump bypass.
IV3/197	113 / 3.23	16 / 0.01	Replaced back pressure transducer valve.
IV3/225*	168 / 6.70	53 / 0.02	Reset idle mixture using curb idle screw only. (The mixture plug was in place but did not have to be removed.)
IV3/260	163 / 1.71	3 / 0.00	Freed frozen TPS plunger.

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* Vehicle IV3/225 was not FTP tested after the repairs.

APPENDIX G

EG&G Mechanic's Narrative Comments on the 14 Cars Which Were Inspected

Vehicle Number	Test Sequence	Mechanic's Comments
IV4/001	As Received:	The idle mixture dwell is pegged at 54 deg. The air pump is making bearing noise. The canister purge TVS is not opening up to purge the canister. This signal line also allows the torque convertor to be locked up. The PCV purge hose is collapsed at the tee to the canister purge line which has no signal anyway.
	After Repairs:	Air pump still has bearing noise. New air filter installed. Idle plug was drilled out and idle speed and dwell reset to spec. New purge hose was installed. Corrected the 5-way hose loose connection at the TVS switch.
IV4/004	As Received:	The electric solenoid that controls vacuum to the dump valve is closed with engine on. Air pump dumps continuously. The tailpipe CO is OK under idle conditions, but goes to about 5% at anything off idle speed.
	After Repairs:	Replaced solenoid to air pump bypass. The pump no longer dumps air continuously. Car is clean at 2500 rpm as well as at normal idle condition.
IV3/034	As Received:	Both carbs or just one carb could be too rich. Propane spec is 100 rpm. Gain as received is zero. Also the curb idle is 160 rpm too high. The hose to the vacuum advance unit has been left off. Carbs require special tool to synchronize settings.
IV5/045	As Received:	The signal hose from manifold vacuum to the air cleaner TVS was left off. The O2 sensor would see the air leak and send out a rich command.
IV3/105	As Received:	No major problem found. The curb idle is too fast and the timing is retarded 2 deg. The carb mixture is OK. The car does smoke a little oil.

Vehicle Number	Test Sequence	Mechanic's Comments
IV3/150	As Received:	The timing is 5 advanced degrees. The mixture plug has been drilled out, and the idle mixture richened. The air injection valves are so sensitive that the idle CO is twice as much in drive as in neutral due to the speed change.
IV4/165	As Received:	The hose connector at the air management solenoid has been left off one nipple. This would create a manifold vacuum leak and also permit air switching to pump down-stream only. The upstream would never work. The catalyst would take a lot longer to light off.
IV3/168	As Received:	The mixture plug is missing and the idle CO is a little high. The O2 sensor may not be 100%. A couple of the plugs are fouled.
IV3/182	As Received:	The mixture plug has been removed and the carb richened up. HC is a little higher than CO respectively. The idle speed is too high by 350 rpm. This may affect the aspirator/reed valve system during the FTP.
IV3/197	As Received:	EGR opens at about 1800 rpm instead of about 3500 rpm due to a bad back pressure transducer. During FTP, more throttle would be used than necessary.
	After Repairs:	New back pressure transducer valve installed. The EGR valve does not work until about 3000 rpm; this will reduce throttle during the FTP. MD reinsp: 16 ppm HC, 0.01% CO.

Vehicle Number	Test Sequence	Mechanic's Comments
IV3/225	As Received:	The idle speed is just high enough to make the pulse air system act irrationally. The tailpipe CO does not differ very much with the AIR system connected vs disconnected.
	After Repairs:	With pulse air hoses disconnected, the idle mixture is set to 0.5% CO. This was done using the curb idle screw only; the mixture plug did not have to removed. MD reinsp: 53 ppm HC, 0.02% CO. The car did not receive a second FTP because the owner wanted it back.
IV3/260	As Received:	EGR solenoid is bad (EGR does not move), the throttle position sensor (TPS) is stuck in the up position, and the dwell is frozen at 22 degrees.
	After Repairs:	Freed frozen TPS plunger. Idle dwell is now allowed to vary. MD reinspection: 3 ppm HC, 0% CO.
IV4/316	As Received:	Everything appears OK. Carb and feedback systems are good. May be the catalyst.
IV3/323	As Received:	The carbs have gone rich. There is not propane gain at all. The carbs are also out of balance since the scope pattern shows two high and two low cylinders.

APPENDIX H

Data on Comparable Vehicles from the Reference 1 Study

Distribution of the Comparable Cars
from the Reference 1 Study

Model Year	-- Carbureted -- Open-Loop	Closed-Loop	Fuel Injected AIR	No AIR
1983	12	9	10	8
1984	8	14	9	2
1985	1	-	-	-
Totals:	21	23	19	10

IM8/103	83	CHRY	OMNI	135	CARB	YES	CLOSD	35	1.32	125	.05	15,327	.91	10.97	.70
IM7/105	83	GM	CAVA	121	FI	YES	CLOSD	175	5.74	50	.02	49,038	.26	7.76	.34
IM7/106	83	GM	CAVA	121	FI	YES	CLOSD	190	3.23	40	.03	N/A	N/A	N/A	N/A
IM7/107	84	GM	CHEV	98	CARB	YES	CLOSD	177	2.34	190	2.3	17,023	.27	2.05	.63
IM7/108	84	GM	T100	98	CARB	YES	CLOSD	168	3.58	160	1.5	11,797	.77	5.75	.58
IM7/112	83	GM	CAVA	121	FI	YES	CLOSD	252	5.29	200	2.1	N/A	N/A	N/A	N/A
IM8/113	83	FORD	ESCO	98	FI	YES	CLOSD	234	.49	125	.60	40,596	1.78	3.72	2.39
IM7/114	83	GM	CHEV	98	CARB	YES	CLOSD	298	7.02	380	8.0	36,876	2.15	42.37	.43
IM7/115	83	GM	DEVI	249	FI	YES	CLOSD	251	.00	190	.08	35,628	.50	4.55	.46
IM8/116	83	NISS	MAXI	168	FI	NO	CLOSD	221	.30	35	.03	N/A	N/A	N/A	N/A
IM7/117	83	GM	CAMA	151	FI	NO	CLOSD	233	.03	130	.05	60,621	2.11	5.21	1.95
IM8/118	83	FORD	ESCO	98	FI	YES	CLOSD	160	1.92	150	3.6	N/A	N/A	N/A	N/A
IM8/119	84	FORD	ESCO	98	CARB	YES	CLOSD	208	3.79	100	1.0	9,084	2.28	40.41	1.23
IM7/120	83	GM	CAVA	121	FI	YES	CLOSD	240	.04	25	.02	N/A	N/A	N/A	N/A
IM8/121	83	FORD	COUG	231	CARB	YES	OPEN	67	1.98	30	.02	N/A	N/A	N/A	N/A
IM8/123	84	CHRY	LASE	135	FI	YES	CLOSD	321	7.77	450	6.0	6,523	8.89	189.11	.19
IM7/124	83	GM	2000	110	FI	NO	CLOSD	199	1.53	125	.50	54,264	.88	7.60	.68
IM7/126	83	GM	CHEV	98	CARB	YES	CLOSD	212	6.24	295	6.4	N/A	N/A	N/A	N/A
IM8/127	84	FORD	THUN	140	FI	NO	CLOSD	158	5.69	55	.1	N/A	N/A	N/A	N/A
IM7/128	83	GM	CUTL	231	CARB	YES	CLOSD	245	.35	70	.02	N/A	N/A	N/A	N/A
IM8/129	83	FORD	LYNX	98	CARB	YES	OPEN	97	1.75	45	.04	N/A	N/A	N/A	N/A
IM8/130	84	NISS	PULS	98	CARB	YES	CLOSD	151	2.64	25	.03	N/A	N/A	N/A	N/A
IM8/133	84	MITS	TRED	122	CARB	YES	CLOSD	251	.26	30	.06	N/A	N/A	N/A	N/A
IM8/134	84	FORD	EXP	98	CARB	YES	OPEN	315	4.89	250	5.3	23,613	.72	5.55	.38
IM8/136	83	HOND	CIVI	91	CARB	YES	OPEN	251	.26	320	.4	37,073	.54	2.66	1.25

Number	Yr	Mfr	Model	CID	Mech	[illegible]	Cont	(ppm)	(%)	(ppm)	(%)	(mile)	g/mi	(g/mi)	g/mi
IM8/138	83	TOYO	STAR	79	FI	NO	CLOSD	240	.01	150	.12	29,809	.22	2.95	.57
IM8/141	83	CHRY	NEWY	156	CARB	YES	OPEN	161	7.74	140	6.8	33,846	.74	30.68	.82
IM8/142	83	TOYO	TERC	89	CARB	YES	CLOSD	222	.08	55	.03	N/A	N/A	N/A	N/A
IM7/143	83	GM	CAVA	121	FI	YES	CLOSD	205	4.16	240	3.4	35,289	3.46	50.14	.30
IM8/147	83	MITS	SAPP	156	CARB	YES	OPEN	41	1.68	125	.4	24,009	.35	5.97	.89
IM7/150	83	GM	CAVA	121	FI	YES	CLOSD	273	.18	50	.1	30,746	.50	8.33	.26
IM8/151	83	NISS	810	146	FI	NO	CLOSD	104	2.98	170	2.5	28,497	1.50	45.07	.49
IM8/152	83	FORD	ESCO	98	FI	YES	CLOSD	145	2.50	60	.03	N/A	N/A	N/A	N/A
IM8/154	83	CHRY	NEWY	156	CARB	YES	OPEN	36	3.25	50	3.2	41,532	.56	19.82	.86
IM8/155	83	HOND	CIVI	91	CARB	YES	OPEN	470	.36	40	.04	N/A	N/A	N/A	N/A
IM8/156	83	FORD	ESCO	98	CARB	YES	OPEN	395	10.01	550	7.5	N/A	N/A	N/A	N/A
IM8/157	84	FORD	ESCO	98	FI	YES	CLOSD	294	.51	35	.03	N/A	N/A	N/A	N/A
IM8/160	83	FORD	THUN	140	FI	NO	CLOSD	154	3.21	60	.1	N/A	N/A	N/A	N/A
IM8/161	83	FORD	EXP	98	CARB	YES	OPEN	112	1.37	60	.03	N/A	N/A	N/A	N/A
IM8/163	84	HOND	PREL	112	CARB	YES	CLOSD	139	3.18	40	.05	N/A	N/A	N/A	N/A
IM7/164	83	GM	CHEV	98	CARB	YES	CLOSD	492	8.05	220	2.3	24,590	.80	8.28	.66
IM7/165	84	GM	CELE	173	CARB	YES	CLOSD	24	1.39	40	.04	N/A	N/A	N/A	N/A
IM8/166	83	HOND	CIVI	91	CARB	YES	OPEN	300	2.04	330	.5	46,483	.53	3.43	.87
IM8/168	84	FORD	LYNX	98	CARB	YES	OPEN	181	4.68	195	3.2	17,931	2.13	52.76	.29
IM7/174	84	GM	CAVA	121	FI	YES	CLOSD	292	.11	25	.02	N/A	N/A	N/A	N/A
IM7/176	84	GM	CHEV	98	CARB	YES	CLOSD	272	2.81	30	.02	N/A	N/A	N/A	N/A
IM7/177	83	GM	REGA	231	CARB	YES	CLOSD	326	.01	45	.03	N/A	N/A	N/A	N/A
IM8/178	83	NISS	280Z	168	FI	NO	CLOSD	540	8.29	130	.04	52,420	1.08	6.50	1.41
IM8/179	83	NISS	PULS	91	FI	NO	CLOSD	177	2.92	0	.0	N/A	N/A	N/A	N/A
IM8/183	84	FORD	ESCO	98	CARB	YES	OPEN	156	2.62	480	4.8	17,513	1.34	4.37	.52

IM8/184	83	FORD	ESCO	98	CARB	YES	OPEN	81	2.30	200	1.8	58,890	.56	8.94	.52
IM7/185	83	GM	CUTL	231	CARB	YES	CLOSD	389	.51	40	.04	N/A	N/A	N/A	N/A
IM8/186	84	FORD	EXP	98	CARB	YES	OPEN	457	3.31	130	.05	29,769	.73	6.35	.76
IM8/188	84	NISS	SENT	98	CARB	YES	CLOSD	720	8.89	80	.12	N/A	N/A	N/A	N/A
IM8/189	84	FORD	EXP	98	CARB	YES	OPEN	431	3.36	40	.02	N/A	N/A	N/A	N/A
IM8/191	84	MITS	COLT	98	FI	YES	CLOSD	442	.23	1000	.35	34,351	2.50	8.89	.24
IM8/192	84	SUBA	4-WD	109	CARB	YES	OPEN	53	1.97	380	3.8	N/A	N/A	N/A	N/A
IM8/196	84	CHRY	DAYT	135	FI	YES	CLOSD	644	9.46	350	4.8	31,427	5.96	115.54	.70
IM8/197	83	NISS	SENT	98	CARB	YES	OPEN	286	1.91	30	.05	N/A	N/A	N/A	N/A
IM7/198	84	GM	CAVA	121	FI	YES	CLOSD	193	5.19	50	.04	N/A	N/A	N/A	N/A
IM8/199	84	FORD	MARQ	231	FI	YES	CLOSD	336	.15	30	.02	N/A	N/A	N/A	N/A
IM8/202	84	CHRY	DAYT	135	FI	YES	CLOSD	843	8.54	800	7.2	33,578	4.70	123.45	.71
IM8/204	84	FORD	EXP	98	FI	YES	CLOSD	84	2.55	80	.4	N/A	N/A	N/A	N/A
IM8/205	84	CHRY	GRAN	318	CARB	YES	CLOSD	910	1.20	50	.4	N/A	N/A	N/A	N/A
IM7/207	83	GM	REGA	231	CARB	YES	CLOSD	88	1.89	20	.0	N/A	N/A	N/A	N/A
IM8/209	84	AMC	ALLI	85	FI	NO	CLOSD	170	3.02	200	4.0	64,749	2.00	67.03	.46
IM8/210	84	FORD	LTD	231	CARB	YES	OPEN	952	9.53	520	9.0	19,810	2.57	47.00	1.00
IM8/211	85	FORD	MUST	302	CARB	YES	OPEN	110	1.75	20	.01	N/A	N/A	N/A	N/A
IM8/212	84	FORD	TEMP	140	CARB	YES	CLOSD	271	.01	150	.02	48,745	3.63	59.61	1.52
IM8/216	84	FORD	TOPA	140	CARB	YES	CLOSD	151	2.56	120	.02	25,697	.81	16.16	1.44
IM8/217	84	FORD	TEMP	140	CARB	YES	CLOSD	181	1.47	15	.0	N/A	N/A	N/A	N/A
IM7/218	84	GM	CIER	231	CARB	YES	CLOSD	114	2.13	30	.05	N/A	N/A	N/A	N/A
IM8/221	84	FORD	ESCO	98	CARB	YES	OPEN	368	8.35	300	5.5	35,863	2.50	58.98	.57

APPENDIX I

Results of Detailed Vehicle Inspections

Vehicle Number	Results of Detailed Vehicle Inspections
IV4/001	• Induction system is improperly maintained (air filter is dirty). • Fuel metering system is defective (idle mixture adjustment is rich and idle speed is 125 rpm below spec). • Air pump assembly improperly maintained (air pump is making bearing noise). • PCV system is defective (hose collapsed). • Evaporative control system is defective (canister is saturated with fuel and purge valve is disabled).
IV4/004	• Supplementary AIR system is defective (electric solenoid to the air bypass valve is defective causing air pump to dump continuously).
IV3/034	• Fuel metering system is defective (idle mixture adjustment is rich and idle speed is 160 rpm above spec). • Ignition system is improperly maintained (vacuum hose to vacuum advance is disconnected).
IV5/045	• Induction system is improperly maintained (vacuum hose to heated air door assembly is missing). • Fuel metering system is improperly maintained (idle mixture adjustment is rich due to vacuum leak).
IV3/105	• Fuel metering system is maladjusted (idle speed is 130 rpm above spec). • Ignition system is maladjusted (idle timing retarded 2 degrees from spec).

Vehicle Number	Results of Detailed Vehicle Inspections
IV3/150	• Fuel metering system is maladjusted (mixture plugs drilled out, idle mixture adjusted rich, and idle speed is 150 rpm above spec). • Choke adjustment limiting device has been disabled (sawed off). • Ignition system is maladjusted (idle timing advanced 5 degrees from spec).
IV4/165	• Fuel metering system is maladjusted (idle speed is 150 rpm above spec). • Supplementary AIR system is disabled (vacuum hose to air diverter solenoid disconnected).
IV3/168	• Fuel metering system is maladjusted (mixture plug is missing and idle mixture adjusted rich). • Ignition system is improperly maintained (spark plugs are a little fouled). • Evaporative control system is improperly maintained (canister filter is dirty). • Feedback system is defective (oxygen sensor is intermittent).
IV3/182	• Fuel metering system is maladjusted (mixture plug missing, idle mixture adjusted rich, and idle speed is 350 rpm above spec).
IV3/197	• Fuel metering system is maladjusted (idle speed is 130 rpm above spec). • EGR system is defective (back pressure transducer is bad).
IV3/225	• Fuel metering system is maladjusted (idle speed is 200 rpm above spec).

Vehicle Number	Results of Detailed Vehicle Inspections
IV3/260	• Fuel metering system is maladjusted (idle mixture adjustment is defective and idle speed is 110 rpm above spec). • EGR system is improperly maintained (delay solenoid is inoperative). • Evaporative control system is improperly maintained (canister filter is dirty). • Feedback system is defective (TPS is stuck and EGR solenoid does not work).
IV4/316	• Fuel metering system is maladjusted (idle mixture adjustment is rich and idle speed is 105 rpm above spec). • Exhaust system (catalyst) may be defective.
IV3/323	• Fuel metering system is maladjusted (idle mixture adjustment is rich and idle speed is 190 rpm above spec). • Engine assembly may be improperly maintained (valves are noisy).