Office of the Auditor General

SUPPLEMENT TO

264

REPORT ON THE SOUTH COAST AIR BASIN VEHICLE EMISSION INSPECTION PROGRAM BUREAU OF AUTOMOTIVE REPAIR

JUNE 1976

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SUMMARY

Olson Laboratories, Inc., under contract EST #77-107 performed a series of analyses and laboratory tests culminating in a recommended plan for implementing a Periodic Vehicle Emission Inspection Program for the six counties in the South Coast Air Basin. The study resulted in total inspection site operating procedures as well as site size and location by postal zip code. The operational phase of the Program covered the period 1976-1985 and the projected program cost for a typical site selection strategy was about $370 million for this ten-year period.

Olson's performance in Contract EST #77-107 was outstanding in many aspects, especially in terms of their laboratory and hardware work. However, some serious shortcomings in the analysis influenced the selected inspection procedures and grossly affect the program cost.

Assumptions early in the study phase of the Program required verification to select the best alternatives for use in the ultimate program concept. The most important assumption was that engine diagnostic testing beyond the Key Mode* emission tests must provide significant consumer protection while resulting in only a nominal increase in inspection cost. The

*Key Mode is identified by Olson as their minimum emission testing considered in response to SB 479.

recommended inspection approach was selected in the first few months of the study contract based on assumptions made very early in the Program. Laboratory work and subsequent analyses by Olson disproved many early assumptions, yet no additional analyses were made from updated data to determine if the selected inspection procedure was still the best for the State of California. Additional consumer protection due to engine diagnostic testing appears to be marginal, while the increased program costs are significant.

Some of the probable reasons for Olson not performing additional analyses based on updated assumptions are (1) this task was not specified in the contract, (2) state technical expertise was not available to direct Olson, and (3) this additional task would require more funding than was available in Contract EST #77-107. Olson's laboratory work was very good and provided essentially all the data necessary to perform the updated analyses. In fact, a technical specialist from the Auditor General's Office used these data to perform the final cycle of analysis which is the basis for recommendations and conclusions presented in this report.

Significant cost savings can be obtained without jeopardizing the objectives of the Periodic Vehicle Emission Inspection Program. Some of the cost-saving actions include: (1) eliminate the requirement for engine diagnostic measurements beyond Key Mode emission testing, (2) modify repair procedures for vehicles experiencing only marginal emission test failure, (3) eliminate desert inspection sites outside the South Coast Air Basin and (4) consider the elimination of computing equipment. Implementation of these items could save $163 million over the ten-year period 1976-1985 if the number of inspection sites are reduced, or $126 million if the number of inspection lanes are reduced. Cost savings could be significantly more if the inspection program is extended to other air basins.

Some oversights in the Olson cost calculations produced a cost projection understatement of 17 percent for a particular site acquisition strategy. Olson projected a ten-year cost of $367.47 million; however, our correction of math errors produced a cost of $369.47 million, and consideration of the oversights in Olson's cost analysis produced a cost projection of $433.34 million. These ten-year cost projections serve as data for budgets and planning activities. The percent-cost understatement and cost saving estimates should be valid for any site acquisition decision by the State.

The ten-year cost projection figures presented by Olson must be considered approximate since there are so many system unknowns which must be determined by operating experience. For example, if the operational vehicle inspection process takes 30 seconds longer at each station using state employees than predicted from laboratory tests, program costs could increase by 25 to 35 percent. Ten-year cost projection numbers should be used cautiously.

Significant progress has been made in the Periodic Vehicle Emission Inspection Program; but, due to its highly complex nature and large expenditures, it is imperative that highly competent technical personnel be associated with the agency responsible for operating the Program. Their task would be a continual reappraisal of alternatives to ensure the most cost-effective program practicable.

TECHNICAL DISCUSSION

A. Selection of Vehicle Inspection Regime

1. Vehicle Inspection Concepts

The design study by Olson Laboratories, Inc. considered four broad inspection concepts which were (a) Key Mode testing only, (b) Key Mode testing with engine analysis of vehicles which fail the emission test, (c) Key Mode testing with engine analysis of all vehicles and (d) Key Mode testing with simultaneous engine analysis of all vehicles. Within concepts (b) and (c) above, the level of sophistication of diagnostic equipment was further evaluated and included (1) dwell meter and tachometer, (2) dwell meter, tachometer and timing light, (3) engine oscilloscope and (4) automated diagnostic equipment. Each inspection concept involved a specific set of activities, each with a required performance time. These activities, along with their estimated performance time as presented in the Olson final report*, are repeated as Tables 1 through 5. The appropriate tasks were assigned among inspection stations to maximize throughput for the various vehicle inspection concepts.

*Final Report, South Coast Air Basin Vehicle Emission Program Study, Olson Laboratories, Inc., Anaheim, California, prepared under Department of Consumer Affairs Contract EST #77-107, May 1975.

TABLE 1

EMISSION TESTING FUNCTIONS

Tasks		Time Expended (Seconds)
Advance vehicle over dyno		15
Exit vehicle, set wheel chocks		15
Alternative:	Raise hood	5
	Refer to display system	15
	Check for required components	10
	Lower hood	5
Walk to vehicle rear, insert test probe		15
Enter vehicle		5
Grasp control pendant, lower dyno lift		5
Accel to high cruise, set load, maintain speed		25
Instruct system emission measurement		10
Decel to low cruise, set load, maintain speed		15
Instruct system emission measurement		10
Decel to idle, remove load, maintain speed		10
Instruct system emission measurement		10
Raise dyno lift, release control pendant		10
Exit vehicle, remove test probe		10
Move forward, remove wheel chocks		10
Enter vehicle, advance		10
	Total Average Time	175
	(With Alternative)	210

TABLE 2

MANUAL ENGINE ANALYSIS FUNCTIONS

Tasks	Time Expended (Seconds)
Alternative 1 - Dwell/Tachometer	
Exit vehicle, raise hood	10
Attach inductive pickup leads	10
Check PCV operation	10
Check heated-air control valve or heat riser	10
Remove air cleaner cover	5
Check carburetor choke operation	10
Check air cleaner element	10
Replace air cleaner cover	5
Enter vehicle, start engine	10
Measure idle rpm and dwell	10
Stop engine, exit vehicle	10
Remove test leads	10
Enter vehicle, start engine	10
Advance to next station	10
Total Average Time	130
Alternative 2 - Dwell/Tachometer/Timing	
Exit vehicle, raise hood	10
Attach dwell/tach inductive leads	10
Attach ignition timing inductive lead	10
Check PCV operation	10
Check heated-air control valve or heat riser	10
Remove air cleaner cover	5
Check carburetor choke operation	10
Check air cleaner element	10
Replace air cleaner cover	5
Enter vehicle, start engine	10
Measure idle rpm, dwell, and timing	15
Stop engine, exit vehicle	10
Remove test leads	15
Enter vehicle, start engine	10
Advance to next station	10
Total Average Time	150

TABLE 3

ENGINE ANALYSIS USING SCOPE ANALYZERS

Task	Time Expended (Seconds)
Exit vehicle, raise hood	10
Attach ignition scope leads	20
Check PCV operation	10
Check heated-air control valve or heat riser	10
Remove air cleaner cover	5
Check carburetor choke operation	10
Check air cleaner element	10
Replace air cleaner cover	5
Enter vehicle, start engine	10
Measure engine idle, dwell	10
Check spark plugs condition	20
Perform cylinder power drop test	40
Check other ignition components	20
Stop engine, exit vehicle	10
Remove test leads, lower hood	10
Enter vehicle, start engine	10
Advance to next station	10
Total Average Time	220

TABLE 4

AUTOMATED ENGINE ANALYSIS*

Task	Time Expended (Seconds)
Exit vehicle, raise hood	10
Attach test leads	180
Check PCV operation	10
Check heated-air control valve or heat riser	10
Remove air cleaner cover	5
Check carburetor choke operation	10
Check air cleaner element	10
Replace air cleaner cover	5
Enter vehicle, start engine	10
Perform automated engine analysis	180
Stop engine, exit vehicle	10
Remove test leads, lower hood	60
Enter vehicle, start engine	10
Advance to next station	10
Total Average Time	520

*These time estimates are based on currently available automated diagnostic equipment which were not designed for high volume testing and were more complex than that necessary for an inspection lane.

TABLE 5

VEHICLE CERTIFICATION FUNCTIONS

Tasks	Time Expended (Seconds)
Retrieve inspection results	10
Review data and information	10
Retrieve certificate of compliance	10
Issue C of C to owner	5
Issue copy of inspection results	5
Direct owner to vehicle	5
Owner enter vehicle, start engine, exit	15
Total Average Time	60
Alternative if failed:	
Retrieve inspection results	10
Review data and information	10
Issue owner copy of results	5
Discuss diagnostic information	60
Explain requirements for repair	30
Explain need for reinspection	30
Direct owner to vehicle	5
Owner enter vehicle, start engine, exit	15
Total Average Time	165

2. Analysis of Requirement for Diagnostic Test Equipment

Numerous factors contribute to and are related to vehicle exhaust emission levels including:

- Emission control devices
- Carburetion system
  - Idle mixture and balance
  - Choke operation
  - Carburetor main system
  - Manifold restrictions or leaks
  - Manifold vacuum
- Ignition system
  - Dwell angle
  - Ignition timing
  - Primary ignition system
    - Coil
    - Condenser
    - Points
  - Secondary ignition system
    - Coil
    - Spark plugs
    - Spark plug wires
    - Rotor
    - Distributor cap

Others
- Idle RPM
- Engine condition (rings, valves, gaskets, etc.)
- Cylinder power balance
- Catalytic converters

Each of these items can currently be analyzed and evaluated by commercial automotive repair stations which have equipment required for all state licensed Motor Vehicle Pollution Control (MVPC) stations.

Key Mode testing uses an exhaust gas analyzer to measure emissions under dynamometer (simulated) road loading conditions. All MVPC facilities have exhaust gas analyzers, but few have dynamometers and consequently can only effectively measure exhaust emissions when the engine is at idle. Key Mode loaded-mode testing produces significant information about which engine system is responsible when vehicles fail the emissions tests. The component or components failing within the system can be identified using diagnostic equipment available at commercial MVPC repair stations. The principal question is how much of this diagnostic testing can and should be done by the State, and how much should be left to the automotive repair industry?

The evaluation of the need for additional diagnostic measurements was intended to consider factors not included in the Key Mode measurements, or those things which supplement the Key Mode tests to further isolate causes of failures within the engine ignition systems. Criteria to determine if additional testing beyond the Key Mode emission tests should be included in the state-operated program were defined in the Olson proposal* which is part of Contract EST #77-107.

> The emission test results will provide the primary basis for recommended repairs. Additional steps in the inspection procedure will be evaluated on an incremental basis weighing the time and cost to perform each additional action against the information gained.

*Proposal to: Design a Mandatory Vehicle Emission Inspection Program Required by SB 479, Olson Laboratories, Inc., Anaheim, California, March 1974.

> Additional diagnostic steps will be used to confirm or further identify the problem area. Several or all of these steps may be performed at the inspection facility depending on the results of the cost-effectiveness analysis to be completed as part of the contracted study.
>
> Since more information is desirable in assisting the vehicle owner in isolating the probable cause(s) of inspection failure, incremental increases in instrumentation will be evaluated in terms of expected benefits in failure isolation and ultimate reductions in vehicle owner costs.

Measurement of many of the factors contributing to vehicle emission exhaust levels were dropped from further consideration early in the design study for reasons such as (a) the item contributed little to the diagnostic information, (b) some parameters could have several correct values depending on operating mode and engine design, (c) measurement presented a safety hazard, and (d) the item could not be measured by simple instrumentation. Statements from the study final report regarding rejection of two important factors are presented below.

> Basic timing was considered essential, but due to the difficulty in implementing the measurement and the safety hazards involved, the parameter was discarded.
>
> The manufacturer recommended procedures for using a vacuum gauge were evaluated and determined to be technically complex and operationally time consuming for an inspection lane.

The following list of six items survived the evaluation process in the contract study phase and were selected for measurement as additional diagnostic items for the Program:

(1) Point contact resistance
(2) Dwell, individual cylinder
(3) Idle RPM
(4) Spark plug peak firing voltage, individual cylinder
(5) Spark line firing time, individual cylinder
(6) Power balance test.

Relative to the first three items, the Olson final report finds:

> The parameters which appear to be least consistent and useful for diagnosis are dwell, point resistance and idle RPM. These parameters have been included as diagnostic parameters at this time with the recommendation that further evaluation of their significance and reliability to failure diagnosis be performed on a large-scale vehicle inspection program such as in the Riverside Trial Program.
>
> Dwell and point resistance measurements tend to be poorly correlated to emission failures and may not warrant measurements as diagnostic parameters.

The power balance test is only conducted when certain types of emission failures occur and other diagnostic measurements are normal.

In view of final selection of diagnostic measurements to be performed (beyond the Key Mode test), a reappraisal is appropriate to determine:

(a) Do the selected parameters provide test information such that the vehicle repair industry needs less diagnostic instrumentation, resulting in lower repair costs to the customer?

(b) Does the test information obtained relieve the repair facility of performing those tests, thereby reducing repair costs?

(c) Do the diagnostic tests pinpoint failures with accuracy and reliability beyond the Key Mode tests such that the consumer is further protected from excess costs due to unnecessary repairs?

(d) Above all, do the consumer savings in (a), (b) and (c) above more than offset the state vehicle inspection cost increase due to implementing engine diagnostic measurements beyond Key Mode testing?

Based on data presented in Olson's final report and obtained in interviews, the answer is negative to all four questions above.

Concerning question (a), the auto repair industry in general will need more, rather than less, diagnostic test equipment to perform emission-related repairs required by the Periodic Motor Vehicle Exhaust Emission Program. The two general classes of registered repair facilities are automotive repair dealers (ARD) and motor vehicle pollution control stations (MVPC). The ARDs can perform general repair work including engine tune-ups, while the MVPCs may perform this work plus install and maintain pollution control devices, perform compliance inspections and issue certificates of compliance. The significant difference between equipment presently maintained by the ARDs and MVPCs is the exhaust gas analyzer, which currently costs about $1,000 to $2,500. The recommended testing equipment for repair facilities performing low emission tune-ups required in the periodic inspection program is listed below:

(1) Ignition analyzer-oscilloscope
(2) Ammeter
(3) Ohmmeter
(4) Voltmeter
(5) Tachometer
(6) Vacuum gauge
(7) Pressure gauge (0-10 PSI)
(8) Cam angle dwell meter
(9) Ignition timing light
(10) Exhaust gas analyzer for carbon monoxide and hydrocarbons, California approved
(11) Compression tester
(12) Distributor advance tester.

To effectively capture a share of the million and a half yearly mandated engine tune-ups, the ARDs will need to purchase an exhaust gas analyzer. This additional cost of doing business will be passed on to the consumer, who should get a better quality tune-up.

Relative to question (b) above, additional diagnostic testing by the State does not benefit the consumer by reducing the time required for service facility diagnostic tests. All vehicles which fail any aspect of the emission testing will be required to have a minor tune-up consisting of (1) adjusting dwell angle to within manufacturer's specification, (2) check and reset timing, (3) adjust idle RPM, (4) adjust carburetor idle mixture and balance carburetor barrels. Most of the MVPC repair facilities use a multi-purpose tune-up instrument which contains circuitry to check dwell, point resistance, RPM, firing voltage and sometimes ignition timing. This instrument and an exhaust gas analyzer must be attached to the automobile to make the four adjustments required of all vehicles for which any repairs are specified. This instrument gives the auto repair facility all (and sometimes more) of the diagnostic measurements to be provided by the State and needs no additional hook-up to check point resistance or firing voltage. Should the power balance be required, this can normally be performed without additional wiring hook-up.

The limited diagnostics beyond the Key Mode testing by state facilities do not produce adequate new information to ensure the consumer of significant additional protection from unnecessary repairs. The MVPC stations currently possess much more diagnostic equipment than that proposed for use by the State. The repair stations not only have instruments for measuring the same items as those proposed for state use, but they also have a vacuum gauge, a pressure gauge, an ignition timing light, a compression tester, and a distributor advance tester. Once the State-supplied information obtained from the Key Mode test isolates the faulty automotive system, the MVPC repair facility is better able than the State to isolate the failing component.

Failure of a vehicle to pass the emission testing will result in selection of a repair procedure to inform the consumer (and repair station) of the probable causes of failure and provide a guide for repairs. The ten procedures presented in the Olson final report are reproduced as Enclosure 1. Six of these procedures are determined entirely from Key Mode testing while the other four (numbers 4, 5, 6 and 9) are obtained by supplementing Key Mode data with additional diagnostics. Procedures number 4, 5, 6 and 9 are merely a subset of repair procedure number 8, which is obtained from Key Mode testing. Table 6 shows the minor differences between test procedures resulting from Key Mode testing and those in which additional diagnostic testing is used. Repair procedure number 8 could be used to replace procedures 4, 5, 6 and 9, the cost of the additional testing is minimal, since the repair facility must connect the multi-purpose diagnostic tester to perform the mandatory adjustment checks.* If the intent of procedures 4, 5, 6 and 9 is to prevent dishonest repair facilities from performing excess work by excluding certain items from investigation (such as spark plugs and wires in repair procedure 5), then this also is not accomplished. Each of these four repair procedures contains numerous items to investigate, because the state diagnostic tests cannot isolate for certain the single failing component. A dishonest dealer could find a single faulty component, yet replace all items

*NOTE: Since this section of the report was first written, the VIP Program has established new repair procedures and are seen as Enclosure 2 Preliminary Vehicle Inspection Program Information Letter No. 1 of August 28, 1975. There are currently five repair procedures which are (1) idle air/fuel mixture (rich or lean), (2) faulty plug or wire, (3) rich carburetion, (4) ignition low emission tune-up, and (5) HC/CO low emission tune-up. The old repair procedures (5), (6) and (9) above have been included in the old procedure (8) which is also the new procedure (4), ignition low emission tune-up. The only new procedure which is not uniquely defined by the Key Mode test is (2) faulty plugs or wires. The faulty plugs or wires repair procedure is still a subset of the ignition low emission tune-up repair procedure.

TABLE 6

COMPARISON OF ITEMS TESTED FOR VARIOUS TESTING PROCEDURES

	Test Procedure Number[1]				
Item To Be Tested	4 Faulty Spark Plug Or Wire	5 Faulty Ignition Components	6 Faulty Exhaust Valve Action	8[2] HC Low Emission Tune-up	9 High Point Resistance
RPM[3]	yes	yes	yes	yes	yes
Plugs and plug wires	yes			yes	if necessary
Distributor	yes	yes		yes	yes
Coil		yes		yes	yes
Points	yes			yes	yes
Condensor		yes		yes	yes
Timing[3]	yes	yes	yes	yes	yes
Dwell[3]	yes	yes	yes	yes	yes
Valves			yes	if necessary	
Vacuum leaks				yes	

1/ Details of the repair procedures are in Enclosure 1.

2/ This procedure results from Key Mode testing.

3/ These tests are mandatory for any vehicle which fails emission tests.

investigated in that particular procedure -- and still be within the state guidelines. Another problem to be faced is that of differentiating between dishonesty and the good mechanic's practice of preventive maintenance. For example, suppose a consumer's car that has been driven 10 or 15 thousand miles since its last tune-up fails the emission test, and it is determined that his engine has a faulty condensor or points. The spark plugs were satisfactory at test time, but had deteriorated in use and might fail soon. If the repair facility advised new spark plugs, which is consistent with manufacturer's recommendations, is the mechanic dishonest (because he recommended parts replacement beyond that of state-recommended repair) or highly competent and conscientious (because he followed manufacturer's recommendations)?

To put the possible benefits of engine diagnostic testing into perspective, the population of automobiles affected must be considered. Key Mode testing provides useful information on vehicles experiencing emission failures due to ignition (hydrocarbons -- HC), carburetion (carbon monoxide -- CO), or oxides of nitrogen (NOx). Diagnostic engine measurements, on the other hand, are intended to provide additional information for emission failures involving only ignition problems (HC). Laboratory, pilot-lane emission inspections of 278 vheicles were conducted by Olson in Phase 6 of their test program. Ignition-caused emission failures (HC) were not common; only about five percent of the cars tested experienced this problem. About 39 percent of the vehicles experienced some type of emission failure, yet only 14 percent of the failing vehicles experienced ignition-related (HC) problems. Even if diagnostic testing produced valuable data, it would benefit only a small portion of vehicles tested.

On September 18, 1975 a 1970 Chevrolet was tested three times at the Riverside facility. The car was first driven through lane 2 of the 4-lane facility where it passed the emission tests. (The computer printout of this test is Figure 1.) The car was immediately reentered and driven through lane number 3 where it failed the emission tests. (Test results are in Figure 2.) Failure occurred due to excessive HC at idle with a measured value of 673 ppm compared to a maximum allowable value of 500 ppm. In the first test, the engine emitted only 481 ppm. The diagnostic message at the bottom of the computer printout indicates that there are faulty plugs or wires and further observation shows that seven of the eight cylinders were misfiring.

Such a condition would probably render an engine inoperable, yet the car was idling smoothly with no apparent misfire. It was speculated that the lane inspector made a faulty hookup of the diagnostic umbilical cord leads, a condition not detected by any of the lane inspectors. The car was then retested in the same lane (lane number 3) and again failed the HC idle emission test, this time at 739 ppm. The diagnostic message at the bottom of the computer printout for this run (Figure 3) indicates there may be faulty valves and a low emission tune-up is needed. We were informed that repair work was later performed on the automobile and the problem was found to be a faulty transmission-controlled spark switch (TCS) which is a vacuum spark advance disconnector (VSAD). Three inspections of the same vehicle produced one pass and two failures, each with a different diagnostic message. This illustrates that attempts of a high-throughput inspection station to pinpoint the ignition failure beyond the basic engine system may create serious problems.

Exhaust emission testing is being performed or evaluated in New York City, Chicago, Colorado, New Jersey, and Arizona. All use exhaust-gas analyzers, some use dynamometers, yet <u>none</u> of them performs additional engine diagnostics beyond emission testing.

The foregoing discussion illustrates that, even without considering added inspection costs, diagnostic testing beyond the Key Mode test is unjustified. The analysis on Page S-27 shows the significant cost penalties associated with additional diagnostic testing.

VEHICLE INSPECTION REPORT

INSPECTION DATE 09/18/75 0948 LANE 2

FACILITY # 00001

OWNER. HOUGHTON W

LICENSE NO. 272AZA YEAR: 70 MAKE: CHEV
WT CLASS: 02 CYL: 08 SPEC CODE: 00 ODOMETER: 42000
TEST NO. 01

EMISSION PARAMETERS

	IDLE			LOW CRUISE			HI CRUISE		
	STANDARD	ACTUAL		STANDARD	ACTUAL		STANDARD	ACTUAL	
HC, PPM	00500	00481	P	00500	00227	P	00500	00154	P
CO, PRCNT	7.00	3.19	P	4.50	0.32	P	4.00	0.34	P
NOX, PPM	04000	00038		04000	01613		04000	02073	

DIAGNOSTIC MESSAGES

PASSED. NO REPAIR REQUIRED.

Figure 1

VEHICLE INSPECTION REPORT

INSPECTION DATE 09/18/75 0959 LANE 3

FACILITY # 00001

OWNER. HOUGHTON W

LICENSE NO. 272AZA YEAR: 70 MAKE: CHEV
WT CLASS: 02 CYL: 08 SPEC CODE: 00 ODOMETER: 42000
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $150

EMISSION PARAMETERS

	IDLE			LOW CRUISE			HI CRUISE		
	STANDARD	ACTUAL		STANDARD	ACTUAL		STANDARD	ACTUAL	
HC, PPM	00500	00673	F	00500	00271	P	00500	00184	P
CO, PRCNT	7.00	3.43	P	4.50	0.36	P	4.00	0.34	P
NOX, PPM	04000	00166		04000	02189		04000	02903	

DIAGNOSTIC MESSAGES

FAILED. FAULTY PLUG OR WIRE.

ENGINE PARAMETERS

DWELL DEVIATION 01.8

DWELL IN DEGREES

HIGH	32.6	32.9	33.2	33.3	32.1	31.9	31.5	31.8
LOW	32.1	32.8	32.8	33.1	32.4	32.0	31.8	31.9
IDLE	32.3	32.6	32.8	33.1	32.6	32.4	32.4	32.2

POINT VOLTAGE DROP IN VOLTS

HIGH	0.21	0.22	0.22	0.22	0.23	0.24	0.24	0.24
LOW	0.16	0.18	0.18	0.17	0.17	0.17	0.17	0.18
IDLE	0.18	0.18	0.18	0.19	0.19	0.18	0.18	0.19

PEAK VOLTAGE IN KV

HIGH	12.9	03.2	03.0	04.9	03.4	03.4	03.7	03.3
LOW	12.2	03.1	03.2	04.9	03.4	03.3	03.4	03.5
IDLE	11.2	02.5	03.2	04.2	03.1	03.0	03.1	03.3

SPARK LINE VALUE IN MS

HIGH	1.41	0.12	0.23	0.76	0.22	0.19	0.10	0.11
LOW	1.53	0.05	0.07	0.30	0.15	0.08	0.07	0.09
IDLE	1.69	0.08	0.04	0.11	0.09	0.07	0.05	0.07

Figure 2

VEHICLE INSPECTION REPORT

INSPECTION DATE 09/18/75 1012 LANE 3

FACILITY # 00001

OWNER. HOUGHTON W

LICENSE NO. 272AZA YEAR: 70 MAKE: CHEV
WT CLASS: 02 CYL: 08 SPEC CODE: 00 ODOMETER: 42000
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $150

EMISSION PARAMETERS

	IDLE			LOW CRUISE			HI CRUISE		
	STANDARD	ACTUAL		STANDARD	ACTUAL		STANDARD	ACTUAL	
HC, PPM	00500	00739	F	00500	00275	P	00500	00186	P
CO, PRCNT	7.00	3.47	P	4.50	0.34	P	4.00	0.34	P
NOX, PPM	04000	00172		04000	02165		04000	02867	

DIAGNOSTIC MESSAGES

FAILED. LOW COMPRESSION.
FAILED. IGNITION LOW EMISSION TUNE-UP.

ENGINE PARAMETERS

DWELL DEVIATION 01.8

DWELL IN DEGREES

HIGH	32.7	32.9	33.0	33.3	32.1	32.0	31.5	31.8
LOW	32.1	32.7	32.8	33.1	32.5	32.0	31.8	32.0
IDLE	32.2	32.7	32.9	33.3	32.6	32.3	32.4	32.2

POINT VOLTAGE DROP IN VOLTS

HIGH	0.22	0.24	0.25	0.26	0.27	0.26	0.27	0.28
LOW	0.16	0.17	0.19	0.21	0.19	0.19	0.17	0.17
IDLE	0.18	0.17	0.17	0.18	0.18	0.18	0.19	0.19

PEAK VOLTAGE IN KV

HIGH	14.5	15.8	15.4	16.8	15.4	15.4	16.6	14.3
LOW	12.2	12.5	14.6	14.6	13.6	13.5	14.9	15.0
IDLE	11.4	12.1	13.4	13.4	13.3	10.5	13.5	13.0

SPARK LINE VALUE IN MS

HIGH	1.30	1.27	1.21	1.31	1.06	1.23	1.11	1.12
LOW	1.40	1.37	1.45	1.56	1.28	1.40	1.39	1.32
IDLE	1.74	1.66	1.68	1.59	1.54	1.66	1.61	1.68

POWER DROP PARAMETERS

BEGINNING RPM 01198

SHORTED RPM 01136 01140 01126 01152 01136 01160 01126 01132

Figure 3

3. Analysis of Number of Required Inspection Lanes

The Olson study recommended 84 inspection facilities (290 lanes) for the six counties in the Periodic Vehicle Inspection Program. The basic procedure used to determine the required number of lanes and facilities was to (a) determine the vehicle throughput rate per lane for the selected inspection regime, (b) predict the required number of inspections, then divide that by the inspection rate. Estimated vehicle population was distributed by postal zip code, and the number of inspection lanes and sites was refined considering driving distance, natural boundaries, and, to some extent, population growth.

To determine the required total inspection time for each regime, Olson selected a number of inspection stations (either 2 or 3) for each inspection alternative, then redistributed tasks until approximately the same inspection time was required at each station.* Since all stations will operate simultaneously, they assumed that the vehicle lane inspection rate was dictated by the time required to pass through the slowest station. Factors were applied for personnel efficiency, facility hours-of-

*Inspection regimes and task timings are summarized in Tables 1 through 5.

operation efficiency, and scheduling period efficiency. In our opinion, the simulation method of determining inspection throughputs was marginal for purposes of evaluating alternative inspection concepts. A much more sophisticated simulation method applicable to this type of analysis uses a Monte Carlo technique and queuing theory. This latter method was required by the contract but not used.

The heart of the entire South Coast Air Basin Vehicle Emission Inspection Program Design Study was the inspection lane throughput calculations that established site sizing and program costs. Casual comparisons between alternative inspection concepts and task times presented in the Olson final report revealed serious discrepancies. Of the 31 inspection concepts presented in the final report, we arbitrarily selected two concepts to analyze the apparent discrepancies. Both inspection concepts had three task stations in each inspection lane; essentially identical tasks were performed at station one for each concept and also at station three. Station two presented some differences. One inspection concept (No. KM4 in Olson's final report) performed Key Mode testing at task-station two. The other concept (No. 6A) performed Key Mode testing and diagnostic testing of all vehicles at task-station two. There is an inconsistency at station three where the inspector for each concept discusses test results and certifies passing vehicles. The time required for this same function was presented as 20 seconds for concept KM4 and 52 seconds for 6A. However, the minimum time for these functions (Table 5) was 60 seconds, based on task times in the final report. The task times for various functions in the final report (Tables 1-5) were in error and could not be used to reconstruct the inspection times for various concepts. A partial reconstruction of task timings was made from Olson's working papers and is shown as Table 7 for inspection concepts KM4 and 6A. The following discrepancies were observed in comparing these inspection concepts:

(a) Inspection Station 1. Test number 15 requires five seconds for one concept and ten seconds for the other.

(b) Inspection Station 2. Most differences are due to differences in concepts. Tests 11, 12 and 13 are performed for KM4 and should also be performed for 6A, but were omitted. Test 9 is shown as five seconds for concept 6A and omitted for KM4. Test 15/37 is a task already performed at Inspection Station 1.

TABLE 7

COMPARISON OF INSPECTION TASKS
AND TIMES FOR TWO CONCEPTS

Inspection Station 1. Check-In and Visual Equipment Check

Test No.[2]	Task Description and Time, Sec.	Inspection Concept[1] KM4	6A
1	Receive vehicle, retrofit inspection, complete inspection form	55	55
4	Set wheel chocks	15	15
5	Raise hood	5	5
6	Visual check of emission devices	15	15
7	Close hood	5	5
15	Remove test probe from tailpipe	5	10
2	Ask owner to exit vehicle	10	10
	Task Totals	110	115

Inspection Station 2. Testing (Vehicles Passing Tests)

Test No.[2]	Task Description and Time, Sec.	KM4	6A
3	Enter vehicle and drive to dyno	15	15
8	Insert test probe in tailpipe	15	15
9	Grasp control pendant and lower lift	0[3]	5
4	Set wheel chocks	15	15
5	Raise hood		0[3]
21	Attach inductive pick-up leads		10
10	Key Mode tests	80	80
26	Measure idle and dwell		0[3]
29	Visual check of PCV, heat riser, air pump, air cleaner, choke		70
32	Remove dwell/tack test leads		5
11, 12, 13	Determine if fail, put in neutral, set brakes	6	
38	Close hood		5
16, 39	Remove wheel chocks	10	10
14, 36	Raise lift and release control pendant	0[3]	0[3]
15, 37	Remove test probe from tailpipe	10	10
17	Move vehicle to next position and exit	0[3]	
	Task Totals	151	240

1/ Inspection concepts from Olson final report.
2/ Corresponds to task statement numbers in Olson working papers.
3/ Tasks performed in parallel with other tasks.

Test No.[2/]	Task Description and Time, Sec.	Inspection Concept[1/] KM4	6A
	Inspection Station 3. Discuss Results (Vehicles Passing Tests)		
46	Retrieve inspection reports		5
11	Determine if vehicle passed or failed		0[3/]
40	List diagnostic causes of failure on inspection report		15
12	Put transmission in park		0[3/]
13	Set parking brake		2
14	Raise lift and release control pendant		10
18	Give driver copy of inspection report	5	5
19	Attach certification sticker	10	10
20	Direct owner to depart	5	5
	Task Totals	20	52
	Inspection Station 3. Discuss Results (Vehicles Failing Tests)		
46	Retrieve inspection results	5	5
11	Determine if vehicle passed or failed		0[3/]
40	List diagnostic causes of failure on inspection report	15	15
37	Remove test probe from tailpipe	0[3/]	
12	Put transmission in park		0[3/]
13	Set parking brake		2
14	Raise lift and release control pendant		10
41	Give owner copy of inspection report	5	5
42	Explain results of diagnosis	30	30
43	Direct owner's attention to explanation of repair procedure	15	15
44	Explain retest requirements	10	10
45	Direct owner to depart	5	5
	Task Totals	85	97

1/ Inspection concepts from Olson final report.
2/ Corresponds to task statement numbers in Olson working papers.
3/ Tasks performed in parallel with other tasks.

(c) Inspection Station 3 (passed vehicles). Necessary tests 46, 13 and 14 were omitted from concept KM4, yet included in 6A. Item 40 was erroneously included in concept 6A.

(d) Inspection Station 3 (failed vehicles). Tests 13 and 14 were included in concept 6A which should also have been used in KM4, but were omitted.

Evaluation of the Olson working papers indicates similar problems exist in evaluations of the other inspection concepts. These inconsistencies between alternative concepts, such as indicating inspection times of two and one-half times as long to perform the same tasks (Inspection Station 3 passed vehicles), cast serious doubt on the entire analysis.

The inspection concept recommended by Olson and approved by the State was one using the Key Mode concept and simultaneous diagnostic engine measurements. This concept was not one of the 31 alternatives presented in detail in either the final report or in the working papers. Olson assumed the diagnostic engine measurements could be made simultaneously with Key Mode testing, with an increase in inspection time for vehicles failing emission testing.

A summary of inspection times from the interim report for the Key Mode only inspection concept and the selected concept is presented in the first two columns of Table 8. Station 2 requires more inspection time than either stations 1 or 3 and therefore establishes inspection throughput rate. Vehicles which fail the emission testing require close to half a minute more to inspect when using the concept requiring additional diagnostic measurements. This half minute extra is consistent with the time required if a power-drop test is performed on vehicles failing the emission testing. Power-drop is a test whereby engine cylinders are sequentially prevented from operating to determine valve condition. The vehicle inspection throughput rate of the two concepts used to select the recommended inspection regime was 190 and 184 vehicles per day; consequently, based on interim study results, there would be little total cost difference for either concept if used in the Periodic Vehicle Emission Inspection Program.

The last column in Table 8 shows that, for the recommended concept, the pilot lane inspection time (as measured later in the research and development phase of the contract) was two minutes for passing vehicles

TABLE 8

COMPARISON OF INSPECTION TIMES FOR KEY MODE TESTING AND KEY MODE TESTING WITH SIMULTANEOUS DIAGNOSTIC MEASUREMENTS

Inspection Station	Functions Performed	Interim Study Assumptions 1/ Key-Mode Testing	Interim Study Assumptions 1/ Key-Mode with Diagnostics	Data From Final Report 2/ Key-Mode Testing	Data From Final Report 2/ Key-Mode with Diagnostics
1	Check-in, visual check, minutes	1.8	1.8	3/	2.0
2	Testing (passed vehicles), minutes	2.5	2.5	3/	2.0
2	Testing (failed vehicles), minutes	2.6	3.0	3/	2.5
3	Discuss results (passed vehicles), minutes	0.3	0.9	3/	1.5
3	Discuss results (failed vehicles), minutes	1.4	1.6	3/	2.0
	Vehicle throughput, vehicles/day	190	184	3/	224

1/ These data were used prior to August 1974 and were contained in a handout during Olson's state presentation on August 8, 1974.

2/ These data were presented in Olson's final report and result from measurements during pilot lane operation.

3/ No estimates based on pilot lane operation were presented in the final report.

and two and one-half minutes for failing vehicles. Of major significance is the fact that, during the Research and Development phase, it was discovered that diagnostic measurements and Key Mode testing cannot be performed simultaneously. Data for the Key Mode test were not summarized in the final report but can be estimated. The inspection testing procedure is defined in the final report.

Emission Test, High Cruise
Command test advance, wait 7 seconds, check CO_2, select cylinder #1, wait 2 seconds, measure peak KV, line KV, dwell degrees, contact resistance. Disconnect cylinder #1. Command dump data, 20 milliseconds, select cylinder #2, wait 2 seconds, measure peak KV, line KV, dwell, disconnect cylinder #2. Command dump data, 20 milliseconds, continue through all cylinders, measure HC, CO, NO_x, proceed to next speed range.

Emission Test, Low Cruise
Same as high cruise sequence, except do not measure CO_2.

Emission Test Idle
Same as low cruise sequence. Add rpm, check during cylinder #2 test. If pass, prepare to print out. If fail, determine if power drop test required.

Ignition Test, Power Drop
Command power drop, select cylinder #1, wait 3 seconds, measure rpm, disconnect cylinder #1. Select cylinder #2, wait 3 seconds, measure rpm. Proceed through all cylinders. Prepare print out.

The diagnostic measurements consumed time in addition to the HC, CO, and NO_x measurements required in Key Mode testing. We were told that the HC, CO and NO_x tests were performed at the conclusion of the diagnostic testing, and if only HC, CO and NO_x were tested, it could be done in the initial 7-second wait period. Diagnostic testing for each speed and each cylinder consumes 2 seconds to stabilize the engine diagnostic measuring equipment and 1 more second to measure the parameters.

Using these task times, inspection time can be estimated for Key Mode testing by subtracting the diagnostic related time from the total inspection time.

$$DRT = T \times N \times S = 3 \times 8 \times 3 = 72 \text{ seconds}$$

where: DRT = diagnostic related time

T = time required to perform a single cylinder diagnostic test

N = number of cylinders in engine, 8 in this example

S = number of speeds at which tests are performed

The Key Mode test should therefore be performed in 48 seconds (120 seconds minus 72 seconds). The vehicle throughput rate of the selected inspection concept of 224 vehicles per day can be calculated as an average inspection time at station 2 of 127.5 seconds for Key Mode testing plus diagnostic measurements.

$$AIT = (1-F) \times TP + F \times TF$$

$$= (1-.25) \times 120 + .25 \times 150 = 127.5 \text{ seconds}$$

where: AIT = average inspection time

F = estimated failure rate for vehicles taking emission tests

TP = station inspection time for vehicles which pass the emission tests

TF = average inspection time for vehicles which fail the emission tests and must undergo power drop test

The average inspection time when using the Key Mode only inspection concept should be greater than the 48 seconds indicated above for station 2, since station 1 or 3 becomes the time-limiting inspection station. Most of the required tasks can be performed at any station. If tasks are redistributed evenly among stations, the time required to process a vehicle at a given station would be approximately 85 seconds, or about two-thirds of the 127.5 seconds required for the Key Mode plus diagnostic measurements concept. Therefore, Key Mode testing would require approximately two-thirds of the sites or lanes required by the selected inspection concept. The cost impact of reducing inspection facilities is presented later in this text.

B. Justification of Requirement for Computers at Each Site

The use of a digital mini-computer and associated equipment appears to be justified in the Periodic Vehicle Emission Inspection Program if the selected inspection concept (Key Mode testing plus diagnostic measurements) is used. We question the need for computing equipment if the Key Mode only inspection concept is adopted. The following is a brief description of the proposed tasks to be performed by the computing equipment.

1. Test set-ups

   a. Input data to computer through punched and magnetically marked cards. The punched cards are provided by DMV, while the marked cards are prepared at the site.

   b. Select the vehicle weight class (from data in step 1a above) and pick appropriate dynamometer loading.

   c. Select emission limits based on vehicle year, number of cylinders and smog device (from step 1a above).

2. Real-time operations

   a. Calibrate exhaust gas analyzer for span and zero every sixth test.

   b. Control dynamometer loading (only if required for specific dynamometers).

   c. Display test status.

   d. Capture measured results of various tests.

3. Data collection and printout

   a. Record the data measured in 2d above.

   b. Determine if vehicles pass or fail emission tests.

   c. Select the recommended repair procedure for failing vehicles as determined in item 3b above.

   d. Print the final results.

   e. Store the inspection results for later analysis at a central site.

Many of the above steps are not required and others are simplified if only Key Mode testing is adopted. Step 1a is information needed to perform the tests and is required whether or not a computer is used. Step 1b is simple since there are only three weight classes to be considered and a computer is not needed for this step. Step 1c selects emission limits and again does not need a computer. Table 9 is the proposed chart for selecting emission standards and its simplicity can be illustrated with an example. Exhaust measurement limits for a 1971 or newer model car with more than four cylinders are read from the bottom line on the chart.

TABLE 9

MANDATORY INSPECTION EXHAUST EMISSIONS*

<table>
<tr><th rowspan="3">VEHICLE MODEL YEAR</th><th rowspan="3">NO. OF CYLINDERS</th><th colspan="4">IDLE</th><th colspan="3">LOW CRUISE</th><th colspan="2">HIGH CRUISE</th></tr>
<tr><th colspan="2">HC (ppm)</th><th colspan="2">CO (%)</th><th rowspan="2">HC (ppm)</th><th rowspan="2">CO (%)</th><th rowspan="2">NOx ppm</th><th rowspan="2">HC (ppm)</th><th rowspan="2">CO (%)</th></tr>
<tr><th>AI</th><th>Others</th><th>AI</th><th>Others</th></tr>
<tr><td rowspan="2">1955-1965 & earlier</td><td>4 or less</td><td colspan="2">1900</td><td colspan="2">8.0</td><td>1200</td><td>7.0</td><td>2500</td><td>1200</td><td>6.5</td></tr>
<tr><td>5 or more</td><td colspan="2">1200</td><td colspan="2">8.0</td><td>1000</td><td>6.0</td><td>2500</td><td>1000</td><td>5.5</td></tr>
<tr><td rowspan="2">1966-1967</td><td>4 or less</td><td colspan="2">1900</td><td colspan="2">8.0</td><td>1200</td><td>7.0</td><td>2500</td><td>1200</td><td>6.5</td></tr>
<tr><td>5 or more</td><td>400</td><td>500</td><td>5.5</td><td>7.0</td><td>500</td><td>4.5</td><td>2500</td><td>500</td><td>4.0</td></tr>
<tr><td rowspan="2">1968-1970</td><td>4 or less</td><td>500</td><td>650</td><td>5.5</td><td>7.0</td><td>600</td><td>5.0</td><td>2500</td><td>600</td><td>4.5</td></tr>
<tr><td>5 or more</td><td>400</td><td>500</td><td>5.5</td><td>7.0</td><td>500</td><td>4.5</td><td>2500</td><td>500</td><td>4.0</td></tr>
<tr><td rowspan="2">1971 and later</td><td>4 or less</td><td>450</td><td>600</td><td>3.5</td><td>5.0</td><td>500</td><td>4.0</td><td>2500</td><td>500</td><td>3.5</td></tr>
<tr><td>5 or more</td><td>250</td><td>350</td><td>3.0</td><td>4.0</td><td>400</td><td>3.0</td><td>2500</td><td>400</td><td>2.5</td></tr>
</table>

*Extracted from ARB Resolution 75-2, 19 February 1975
AI - Air Injection emission control system

The real-time computer operations can also be simplified if diagnostic testing is eliminated and requirements are reevaluated. Step 2a uses the computer to recalibrate the exhaust gas analyzer after each sixth test. Assuming the computer is available, frequent calibrations can be easily performed regardless of need. The frequency of required calibration should be dictated by the overall desired accuracy of the inspection concept. Passing-level emission standards (Table 9) were selected to provide for approximately a 25 percent failure rate. The intent is to fail vehicles which have high emissions, and require that they be repaired. The Program is not designed to identify every vehicle which emits excessive pollutants. There are many uncertainties and problems beyond instrumentation accuracy* which make such a concept infeasible. For example, Olson found that (1) vehicles with small engines can produce erroneous emission measurements, (2) the recommended procedure will test only one exhaust of twin exhaust systems (in some cases, half the cylinders will not be evaluated), and (3) inspections will be performed yearly, yet vehicle engines failing shortly after inspection could be heavy emitters the greater part of the year.

The equipment specifications for the exhaust gas analyzer are such that extremely high quality instruments will be obtained and will experience very little drift in the zero and span measurements. The need for frequent instrument calibration should be weighed against the accuracy desired

*As described in the main body of this report, the same vehicle was tested three times within a one-half hour period at the Riverside four-lane test site and HC measurements at idle were 481, 673 and 739 ppm. No attempt was made to determine to what extent the variability was due to the car, test procedure, and/or instrumentation.

and cost involved. At least one manufacturer markets a dynamometer with a built-in loading curve that does not require external loading control either manually or with a computer. Item 2b above therefore does not necessarily dictate the use of a computer. Item 2c uses a computer to obtain test results as they are measured rather than reading values from conventional analog or digitized meters. The sample vehicle inspection computer printout in Olson's final report presents 50 items which were measured and recorded during vehicle testing. Nine result from the Key Mode test while the other 41 result from engine diagnostic measurements. Measuring and recording 50 test items may justify the use of a computer, but it is doubtful if recording nine items can necessitate its use.

Post-test activities also do not appear to justify the use of a mini-computer. Recording of test data was previously discussed along with considerations of measuring test data. Item 3b indicates the computer is used to determine if a vehicle fails one of the emission tests. Since there are only nine items to be measured in the emission test (only six are actually used since the three NO_x measurements are for information only), a series of preprinted forms can be developed for recording data which also show the acceptable values for each parameter. Item 3c indicates the computer is used to select a recommended repair procedure for vehicles which fail emission testing. Only six repair procedures are used for Key Mode testing, and as seen on Table 10, selection of the proper procedure is simple and need not be performed using a computer.* A final function of the computer is to store test results for later use (along with other data) in program evaluation analyses. Data collected by the computer during testing represent a small part of what is required for meaningful program evaluation, and it is questionable if computer collection of these data is economical.

TABLE 10

MANUAL EMISSION DIAGNOSIS

MODE	FAILURE			RECOMMENDED REPAIR PROCEDURE
	NO_x			
Low	F			Excess NO_x Emissions
		CO	HC	
High				Idle Air Fuel Mixture Rich
Low		(F)		Must fail Idle CO
Idle		F	(F)	May also fail low cruise CO and/or Idle HC
High				Idle Air Fuel Mixture Lean
Low				Must fail idle HC only
Idle			F	
High		F		Faulty Carburetion
Low		F		Must fail low and/or high cruise CO
Idle		(F)		May also fail Idle CO
High			F	HC Low Emission Tune-Up
Low			F	Must fail low and/or high cruise HC
Idle			(F)	May also fail Idle HC
High		F	F	HC-CO Low Emission Tune-Up
Low		F	F	Must fail HC and CO at low and/or high cruise
Idle		(F)	(F)	May also fail Idle HC and/or CO

F = mode must be failed

(F) = mode may also be failed

*Since this section was written, the Riverside Trial Program has adopted a program where only five repair procedures are used. Only four of these procedures remain for Key Mode testing.

If the vehicle emission inspection concept using Key Mode without diagnostic measurements is adopted for use in the periodic inspection program, a more detailed analysis should determine the cost effectiveness of the mini-computer.

C. Consideration of the Vehicle Population Growth

Olson used a fairly detailed cost model to perform program cost projections and to evaluate alternatives such as: (a) method of obtaining land and facilities, (b) influence of various interest and inflation rates, and (c) lane operation hours. The contract required projections of vehicle population growth in five-year increments to the year 2000.

The cost model had a significant shortcoming in that vehicle population growth was not a variable and all ten-year cost analyses were based on a fixed number of sites and lanes. The costs were estimated for a ten-year period, 1976 through 1985, and vehicle population growth during this time period was estimated to be about 30 percent for the six counties in the South Coast Air Basin. Unless vehicle population growth is a variable in the cost model, the following three conditions may occur: (a) the number of vehicles are based on 1976 projections which will produce the correct number of facilities initially, but an understatement of facilities (and cost) for the remaining years of the cost analysis,

(b) the number of vehicles are based on 1985 projections which will produce the correct number of facilities in the final year, but excess facilities (and cost) from 1976 through 1984, or (c) the number of vehicles are based on projections of an intermediate year between 1976 and 1985. In this latter instance excess facilities will exist prior to the selected year with insufficient facilities after that date.

The Olson study elected option (c). Population for each of the six counties was grouped by postal zip code and various 1, 2 and 4 lane sites were selected to account for an average growth of 4.6 years. No 3-lane facilities were proposed even though the cost model assumed 11 of the sites would have three lanes. The results produced a recommendation to construct 84 sites comprised of a total of 290* inspection lanes. If this concept is adopted, the State will be operating a system with excess capacity (and cost) for the first five years, and greater costs than estimated in the last five years of the costing time period.

A more appropriate method of costing the operation is to initiate the Program with the proper number of sites, adding new ones as required. The Olson final report listed proposed site and lane requirements by county and postal zip code.

*290 lanes were recommended, even though costs are based on 279 lanes.

Selection of these sites considered travel distance, general topography and natural travel constraints. We analyzed the individual site locations and the county projected growth rates, and calculated the time when individual inspection site capabilities would be exceeded. These calculated data summarized in Table 11 indicate that 16 sites will be inadequate by 1977, the time when the Program is scheduled to be fully operational. This table was used to upgrade the cost analysis since it indicates when lanes or sites should be added to process the projected increase in vehicle inspections due to population growth. We used Olson's cost equations to calculate cost impact of additional lanes or sites as inspection requirements exceed lane inspection capability as defined in Table 11. Olson's final report understates the ten-year program costs by about $56 million because vehicle population growth was not considered in the cost model. An additional cost understatement of $7.6 million results from using 3-lane sites in the cost analysis, but sizing the system with 4-lane sites. Information on these cost calculations is presented in Section D6.

TABLE 11

DETERMINATION OF TIME PERIOD
WHEN INSPECTION SITE
CAPABILITIES ARE EXCEEDED

Year 1/	Number 2/ of Sites	Year 1/	Number 2/ Of Sites
1976 and earlier	12	1985	2
1977	4	1986	3
1978	2	1987	5
1979	10	1988	0
1980	5	1989	2
1981	11	1990	4
1982	7	1991	1
1983	8	1992 and later	6
1984	2		84

1/ Year that site inspection capability is exceeded.

2/ Inspection sites where capability is exceeded in a particular year. Based on individual county projected growth rates and specific sites.

D. Revised Cost Analyses

Discussion in previous sections of this Supplement recommended areas of change in the periodic emission inspection program to effect cost savings without compromising program objectives of improved air quality. This section summarizes the detailed cost analysis used throughout the Supplement. The cost equations were obtained from Appendix C, Cost Analysis Model of the Olson final report. Olson presented cost data (and equations) for 15 different strategies of inspection facility creation. For purposes of cost calculations, we selected the single strategy that the buildings were constructed on leased land, which is a concept closest to that selected by the State for implementation.

1. Reduce Sites by One-Third

The following calculations are used to estimate ten-year program costs if the required number of inspection sites are reduced by one-third to be consistent with calculated inspection rates if engine diagnostic measurements are eliminated. Reducing the number of sites would require slightly longer average driving distances to accomplish vehicle inspections. Cost factors used in the equations are from the Olson final report. Equation terms not pertaining to the selected facility creation strategy have been deleted.

a. Initial Investment Costs

$$I_{2T} = \sum_{Y=1}^{6} (S_{1Y} + S_{2Y}) (P_{2YKSP} \cdot L_{2YKSP}) +$$

$$S_{1Y} \cdot I_1 + S_{2Y} \cdot I_2 \qquad (1)$$

where: I_{2T} = total investment cost for 1-lane and 2-lane facilities

Y = data for one of the six counties in the program

S_{1Y} = number of 1-lane facilities

S_{2Y} = number of 2-lane facilities

P_{2YKSP} = percent of 2-lane facilities in county Y that will be cleared and constructed by the state on privately owned land

L_{2YKSP} = average annual lease for land for 2-lane facilities in county Y that are cleared and constructed by the state on privately owned land

I_1 = Initial (1975) investment cost for a typical 2-lane facility for which only one lane will be in operation

I_2 = Initial (1975) investment cost for a typical 2-lane facility for which both lanes will be in operation

I_{2T} = (2/3) (3,413,000) = \$2,275,333

(for 2/3 of sites proposed by OLI)

$$I_{4T} = \sum_{Y=1}^{6} (S_{3Y} + S_{4Y}) (P_{4YKSP} \cdot L_{4YKSP}) +$$

$$S_{3Y} \cdot I_3 + S_{4Y} \cdot I_4 \qquad (2)$$

where: all terms have meanings similar to those of equation (1), except apply to 3-lane and 4-lane operation

I_{4T} = (2/3) (18,853,500) = \$12,569,000

(for 2/3 of sites proposed by OLI)

The initial investment cost for administration (I_A) is assumed unchanged at a value of \$14,900. The initial investment cost for support services (I_S) is assumed to be reduced by one-third.

$I_S = (2/3)(241{,}400) = \$160{,}933$

$$I_1 = I_{2T} + I_{4T} + I_A + I_S = \$15{,}020{,}166 \qquad (3)$$

where: I_1 = initial (1975) investment cost for entire program

b. Annual Operating Costs

$$O_{2T} = \sum_{S=1}^{6} (S_{1Y} + S_{2Y}) \quad (P_{2YKSP} \cdot R_{2YKSP} + P_{2YKPP} \cdot R_{2YKPP}) + S_{1Y} \cdot O_1 + S_{2Y} \cdot O_2 \qquad (4)$$

where: O_{2T} = total annual operating cost for 2-lane facilities

R_{2YKSP} = percent of 2-lane facilities in county Y that will be cleared and constructed by the state on privately owned land

P_{2YKPP} = percent of 2-lane facilities in county Y that will be cleared and constructed by a private owner on privately owned land

R_{2YKPP} = average annual lease for land and structures for 2-lane facilities in county Y that are cleared and constructed by a private owner on privately owned land

O_1 = annual (1975) operating cost for a typical 2-lane facility with only 1-lane in operation

O_2 = annual (1975) operating cost for a typical 2-lane facility with both lanes in operation

$O_{2T} = (2/3) \quad (3{,}242{,}600) = \$2{,}161{,}733$

(for 2/3 of sites proposed by OLI)

$$O_{4T} = \sum_{Y=1}^{6} (S_{3Y} + S_{4Y}) \quad (P_{4YKSP} \cdot R_{4KYSP} + P_{4YKPP} \cdot R_{4YKPP}) + S_{3Y} \cdot O_3 + S_{4Y} \cdot O_4 \qquad (5)$$

where: all terms have meanings similar to those of equation (3), except apply to 3-lane and 4-lane operation

(3) For calendar years subsequent to 1977

$$T_{oc}^{(t)} = (1+3/4j_t)(1+j_t)^{t-1}\ C_o^{(0)}\ (1+1/2j_t) \qquad (9)$$

d. Total payment for fixed costs

$$P^{(t)} = \frac{C_F^{(0)} + I_T}{n} \qquad (10)$$

where: $P^{(t)}$ = amount of fixed costs to be paid during year t

$C_F^{(0)}$ = fixed costs incurred during design and trial inspection stages of program

I_T = total investment costs

n = number of years over which program costs are being computed

$$C_F^{(t)} = (C_F^{(o)} + I_I^{'}) - t\ (P^{(t)}) \qquad (11)$$

where: $C_F^{(t)}$ = fixed cost debt at end of year t

$I_I^{'}$ = incurred investment cost

$$I^{(t)} = i_t\ (1/2)(C_F^{(t-1)} + C_F^{(t)}) \qquad (12)$$

where: $I^{(t)}$ = interest paid on fixed cost debt during year t

i_t = annual interest rate at year t = 8 percent

$$T_{FC}^{(t)} = P^{(t)} + I^{(t)} \qquad (13)$$

where: $T_{FC}^{(t)}$ = total payments for fixed costs in year t

$$T_C^{(t)} = T_{OC}^{(t)} + T_{FC}^{(t)} \qquad (14)$$

where: $T_C^{(t)}$ = total cost of program for year t

Table 12 presents the calculated total program cost for the proposed number of sites as well as the costs if one-third of the sites are deleted.

TABLE 12

CALCULATED TOTAL PROGRAM COSTS WHEN ONE-THIRD OF SITES ARE ELIMINATED

Year	Costs for Number of Sites Proposed by Olson	Costs for Two-Thirds of Sites Proposed by Olson	Cost Difference
1976	$ 8,431,811*	$ 5,742,927	$ 2,688,884
1977	27,832,030*	18,823,654	9,008,376
1978	32,950,515	22,272,743	10,677,772
1979	35,030,255	23,674,150	11,356,105
1980	37,293,392	25,199,306	12,094,086
1981	39,754,845	26,858,283	12,896,562
1982	42,430,265	28,661,636	13,768,629
1983	45,336,845	30,620,967	14,715,878
1984	48,493,046	32,748,737	15,744,309
1985	51,918,825	35,058,408	16,860,417
	$369,471,829*	$249,660,811	$119,811,018

*NOTE: These numbers erroneous in Olson final report and corrected here.

The above data indicate that almost $120 million can be saved over the ten-year calculation period if one-third of the sites are not required.

2. Reduce Lanes by One-Third

An alternative for reducing system capacity by one-third through site reduction would be to reduce the number of lanes by one-third while maintaining 84 sites. This option, though costlier than reducing the number of sites, has the advantage of reduced driving distance for inspections. Costs were calculated for this concept using the above equations and results are seen in Table 13.

TABLE 13

CALCULATED PROGRAM COSTS
WHEN ONE-THIRD OF LANES
ARE ELIMINATED

Year	Costs for Number of Lanes Proposed by Olson	Costs for Two-Thirds of Lanes Proposed by Olson	Cost Difference
1976	$ 8,431,811*	$ 6,565,947	$ 1,865,864
1977	27,832,030*	21,555,819	6,276,211
1978	32,950,515	25,508,982	7,441,533
1979	35,030,255	27,114,188	7,916,067
1980	37,293,392	28,861,136	8,432,256
1981	39,754,845	30,761,354	8,993,491
1982	42,430,265	32,826,940	9,603,325
1983	45,336,845	35,071,177	10,265,668
1984	48,493,046	37,508,339	10,984,707
1985	51,918,825	40,153,847	11,764,978
	$369,471,829*	$285,927,729	$83,544,100

*NOTE: These numbers erroneous in Olson final report and corrected here.

The above table indicates that about $83 million can be saved over the ten-year period if one-third of the lanes are eliminated.

3. <u>Ignition Analyzer Equipment</u>

Cost to implement ignition analyzer equipment (ERC_0) for the initial operation of the 279 lanes used in the Olson final report would be $1,116,000. Olson estimated that all equipment would be replaced each five years and this contribution to the Program would be:

$$ERC_5 = (1+3/4j_t)\ (1+j_t)^4\ (1+1/2j_t)\ (ERC_0) \qquad (15)$$

where: ERC_5 = ignition analyzer replacement cost after five years = $1,673,776

$$ERC_{10} = (1+3/4j_t)\ (1+j_t)^9\ (1+1/2j_t)\ (ERC_0) \qquad (16)$$

where: ERC_{10}= ignition analyzer replacement cost after ten years = $2,459,329

Total ignition analyzer replacement cost over the ten-year period is the sum of the above or $5,249,106. Since it is assumed above that one-third of the inspection lanes will be reduced, only two-thirds of the total ignition analyzer cost can be saved if they are removed from the remaining sites. The adjusted cost savings becomes $3,499,404.

4. Elimination of Desert Sites

An estimate was made of the ten-year total cost savings due to eliminating five of the desert single-lane inspection stations using equations presented in section D1 above with results summarized in Table 14.

TABLE 14

YEARLY COST SAVINGS
DUE TO REDUCTION OF
FIVE ONE-LANE STATIONS

Year	Operating Costs	Fixed Costs	Total Costs
1976	$ 152,410	$ 100,430	$ 252,840
1977	709,191	126,737	835,928
1978	858,311	131,534	989,845
1979	926,977	124,957	1,051,934
1980	1,001,132	118,381	1,119,513
1981	1,081,225	111,804	1,193,029
1982	1,167,723	105,227	1,272,950
1983	1,261,141	98,650	1,359,791
1984	1,362,032	92,074	1,454,106
1985	1,470,993	85,497	1,556,490
	$9,991,141	$1,095,291	$11,086,426

5. Elimination of Computing Equipment

Should elimination of the need for engine diagnostic measurements reduce data handling sufficiently, the need for computing equipment may also be eliminated. The program cost for the initial equipment procurement can be approximated by the following equation:

$$CEC = (S_{1Y})(CPC_1)+(S_{2Y})(CPC_2)+(S_{3Y})(CPC_3)+(S_{4Y})(CPC_4) \quad (17)$$

when: CEC = total computer equipment procurement cost

CPC = computer equipment procurement cost for a particular size site

$$CEC = 53{+}37{,}004{+}11{\times}32{,}793{+}14{\times}27{,}582{+}6{\times}23{,}371 = \$2{,}848{,}309$$

Equipment replacement costs for five and ten years respectively are $4,271,893 and $6,276,818 for a total ten-year program cost of $13,397,020.

6. Understatement of Costs Due to Population Growth

The Olson cost model, though sophisticated in some respects, was unable to account for the number of vehicle inspection increases over a ten-year program due to population growth. The contract required Olson to estimate vehicle population growth through the year 2000. This Olson did, but the data were not adequately applied in the cost analysis. A somewhat inconsistent site sizing resulted as presented in the Olson final report. We calculated the influence of program cost when vehicle population growth is considered. Unless augmentation of needed inspection capacity is considered as in Table 11, cost projections for program planning through 1985 will be understated. The magnitude of this cost understatement was calculated by adding lanes or sites as required. The results are summarized in Table 15.

TABLE 15

PROGRAM COST PROJECTIONS FOR ADDING NEEDED INSPECTION SITES OR LANES

Year New Units Added	Expense Incurred in Various Years									
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1976	$305,001	$1,045,987	$1,241,979	$1,322,598	$1,410,241	$1,505,478	$1,608,907	$1,721,188	$1,843,026	$1,975,187
1977		379,051	459,960	489,163	520,927	555,459	592,981	633,732	677,968	725,971
1978			262,450	288,181	306,429	326,281	347,864	371,317	396,790	424,444
1979				1,227,479	1,347,847	1,433,169	1,525,987	1,626,901	1,736,561	1,855,664
1980					602,193	660,874	703,082	748,983	798,876	853,077
1981						1,522,953	1,671,956	1,778,134	1,893,628	2,019,185
1982							1,088,234	1,195,234	1,270,609	1,352,617
1983								1,301,737	1,429,144	1,519,853
1984									438,122	480,909
1985										473,171
	$305,001	$1,425,038	$1,964,389	$3,327,421	$4,187,637	$6,004,214	$7,539,011	$9,377,226	$10,484,724	$11,680,078

Total ten-year program cost projections for adding needed inspection sites and lanes becomes $56,294,739.

7. Understatement of Cost Due to Inconsistent Inspection Site Sizing

Olson recommended a total of 84 inspection stations comprised of 64 four-lane, 14 two-lane and 6 one-lane facilities. Olson's cost data are actually based on 53 four-lane, 11 three-lane, 14 two-lane and 6 one-lane facilities. The site configurations and cost data presented in Section D6 above assumed there were no three-lane facilities. This assumption results in an additional understatement in ten-year program costs of $7.6 million as summarized in Table 16.

The total cost understatement due to this and the previous item is $63,870,074 ($56,294,739 + $7,575,335). The total ten-year program cost for the selected site procurement strategy becomes:

Olson projected cost	$369,471,829 1/
Understatement of costs	63,870,074 2/
Corrected cost projection	$433,341,903

1/ The Olson final report reported the cost for this item was $367.47 million. The figure of $369.47 million results after correcting the math errors.

2/ The understated cost becomes $65.9 million when considering the math error.

TABLE 16

UNDERSTATEMENT OF EXPENSES
DUE TO COSTING THREE-LANE
RATHER THAN FOUR-LANE SITES

Year	Change In Operating Costs	Change In Fixed Costs	Change In Total Costs
1976	$ 105,798	$ 58,666	$ 164,464
1977	492,297	74,033	566,330
1978	595,812	76,835	672,647
1979	643,478	72,993	716,471
1980	694,954	69,151	764,105
1981	750,552	65,309	815,861
1982	810,596	61,468	872,064
1983	875,444	57,626	933,070
1984	945,480	53,784	999,264
1985	1,021,117	49,942	1,071,059
	$6,935,528	$639,807	$7,575,335

8. Summary of Total Cost Savings

(a) Reduce Inspection Sites by One-Third

The following summarizes the potential cost savings which could accrue over a ten-year period if a series of recommendations are implemented and one-third of the sites are eliminated.

(1) Facilities investment and operating cost savings as calculated in Section D1 above are $119,811,018.

(2) Reduction of ignition analyzers for the remaining two-thirds of the sites based on Section D3 is \$3,499,404.

$$(2/3)(\$5,249,106) = \$3,499,404$$

(3) Savings due to eliminating five desert inspection stations based on Section D4 is \$7,390,950. This calculation assumes that one-third of all sites had already been eliminated.

$$(2/3)(\$11,086,426) = \$7,390,950$$

(4) Savings due to elimination of computing equipment for the remaining sites based on Section D5 is \$8,931,347.

$$(2/3)(\$13,397,020) = \$8,931,347$$

(5) Total ten-year cost savings is \$139,632,719 prior to correcting for the Olson cost understatement.

The cost savings figure can be adjusted for this latter item by multiplying \$139,632,719 by the ratio of the correct cost (\$433,341,903) to the cost prior to considering the understatement ($369,471,829) to produce $163,770,830, as seen in Table 17.

TABLE 17

ADJUSTED COST SAVINGS FOR SITE REDUCTION OF ONE-THIRD

Item	Uncorrected Cost Savings	Cost Savings Corrected for Understatement
Facilities reduction	$119,811,018	$140,522,579
Ignition analyzers	3,499,404	4,104,341
Subtotal	$123,310,422	$144,626,920
Desert sites	7,390,950	8,668,613
Computing equipment	8,931,347	10,475,296
Total	$139,632,719	$163,770,830

The total corrected cost savings over a ten-year period when implementing all of the recommended items is $163,770,830.

(b) Reduce Inspection Lanes by One-Third

Reduction in the number of inspection sites will increase the average driving distance for inspections and may contribute to poor public acceptance of the Program. Reducing the number of inspection lanes, however, matches inspection capability with demand yet does not increase driving distance over that proposed by Olson in their final report. This concept, although not the least costly, produces an estimated savings as follows:

(1) Facilities investment and operating cost savings as calculated in Section D2 are $83,544,100.

(2) Cost reductions due to elimination of ignition analyzers and desert inspection sites are the same as above and their values are $3,499,404 and $7,390,950.

(3) Savings due to elimination of computing equipment based on Section D5 and is $13,397,020.

(4) The total cost savings both prior to and after adjusting for the cost understatement becomes:

TABLE 18

ADJUSTED COST SAVINGS FOR LANE REDUCTION OF ONE-THIRD

Item	Uncorrected Cost Savings	Cost Savings Corrected for Understatement
Facilities reduction	$ 83,544,100	$ 97,986,250
Ignition analyzers	3,499,404	4,104,341
Subtotal	$ 87,043,504	$102,090,591
Desert sites	7,390,950	8,668,613
Computing equipment	13,397,020	15,712,945
Total	$107,831,474	$126,472,150

The above cost savings projections are based on implementation of the Periodic Vehicle Emission Program in only the South Coast Air Basin. There is considerable pressure from the Environmental Protection Agency to expand the inspection program to four other air basins in California. Should such an event occur, there will be an inspection requirement about twice that of the South Coast Air Basin and the above cost saving projections could conceivably double.

E. Marginal Emission Test Failures

A previous emission testing research project* by Olson tested emissions of a sample of 150 automobiles under a contract with the federal Environmental Protection Agency (EPA) and concluded, among other things, that 54 percent of the sample vehicles failing emission tests could subsequently pass the tests with only idle carburetion mixture and/or ignition timing adjustments. The state-recommended final adjustment procedure includes these two items plus ignition point (dwell) and RPM adjustment. The EPA study and the Vehicle Inspection Program both evaluated emissions using the Key Mode testing method. The emission test limits were more severe in the EPA study and were set to fail 50 percent of the vehicles instead of the 25 percent rate used in designing

*Effectiveness of Short Emission Inspection Tests in Reducing Emissions Through Maintenance, Olson Laboratories, Inc., prepared for EPA Office of Air Programs, Contract 68-01-0410, July 31, 1973.

the state program. In spite of these differences, the results of the EPA study illustrate that a substantial number of vehicles could be expected to pass the emission tests with only minor, low-cost adjustments.

In addition to automobiles which marginally fail emission tests due to engine maladjustments, numerous vehicles are expected to fail because of inherent car emission variability.

According to the Program's Technical Director, there is considerable inherent emission variability for cars even if they are in good mechanical condition. He indicated "new" cars might experience variability between 6 and 20 percent, while for older cars this may be up to 70 percent with an average of about 30 percent.

Examples for the Riverside test facility are presented in the main report and show up to 100 percent variability.

The table below summarized from data in a previous Olson report* shows the variability of carbon monoxide and hydrocarbon emissions over a ten minute idle period for a 1970 Ford with 19,300 miles.

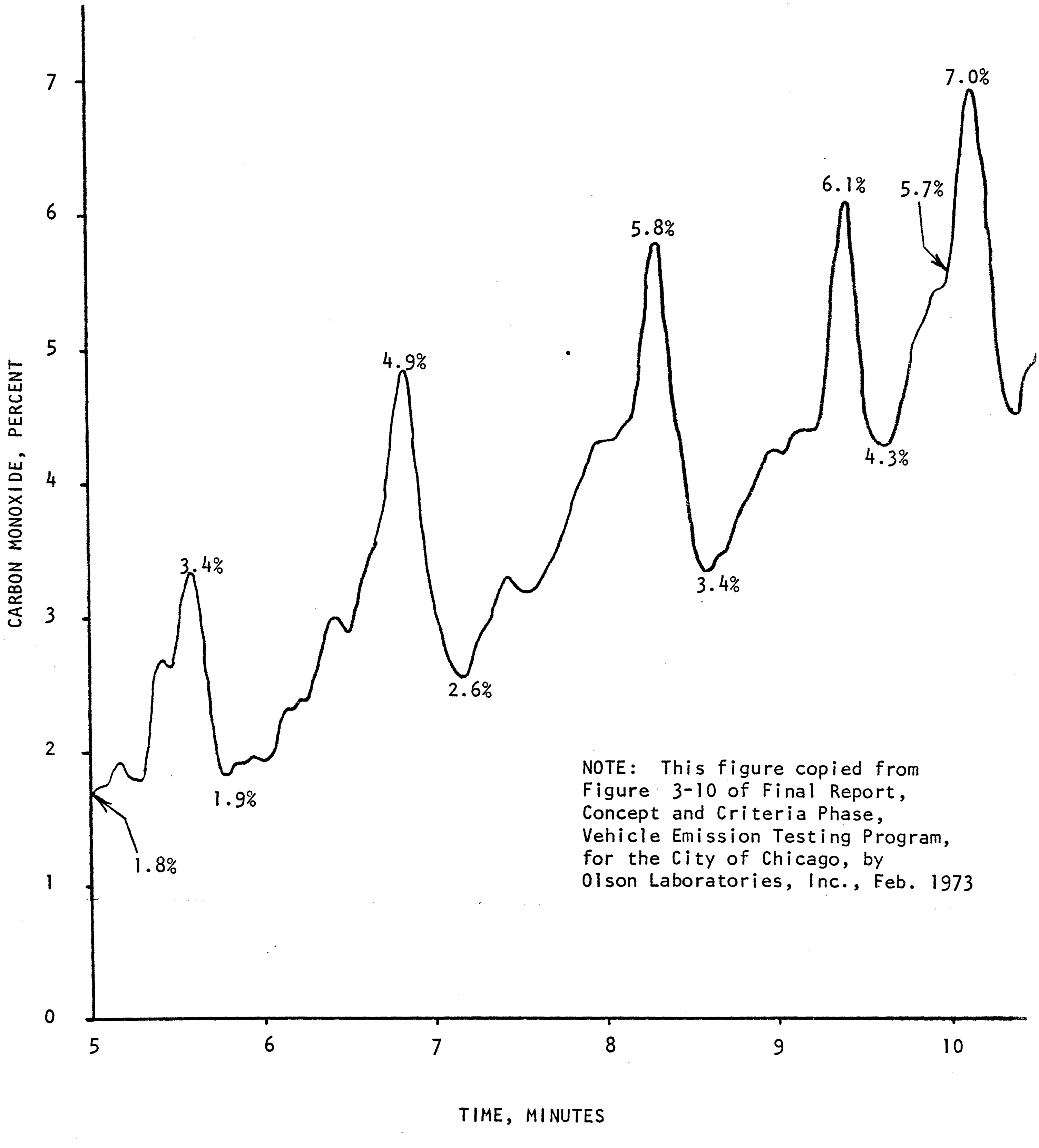
*Vehicle Emission Testing Program, prepared for the City of Chicago, by Olson Laboratories, Inc., February 1973.

Time, Min.	Percent Carbon Monoxide	Hydrocarbon Parts per Million
0	1.2	120
5	1.8	70
10	5.7	90

Also of interest is the following chart showing the cyclical nature of carbon monoxide emissions at idle. This chart, taken from the same study, covers the time interval between five and ten minutes of the above table and shows that measured values of carbon monoxide range between 1.8 and 7.0 percent. By contrast, the allowable values of carbon monoxide in the Vehicle Inspection Program are between 3.0 and 7.0 percent for 1968 and newer cars; the exact value depends upon year, number of cylinders, and emission control equipment for a particular car.

Data from the Olson Chicago study* indicate there is significant variability in vehicle emissions and that a single measured value depends in part upon "chance" sampling at a particular time period. Consequently, a relatively low exhaust emitter may fail emission testing if the sample is taken at an unfavorable time while a higher exhaust emitter may pass emission testing if the sample is from a favorable period.

*Vehicle Emission Testing Program, prepared for the City of Chicago, by Olson Laboratories, Inc., February 1973.



EXHAUST EMISSION RECORDING OF EXTENDED IDLE PERIOD

(1970 FORD, 302 CID, 2V CARBURETOR)

Final engine adjustment procedures should benefit the above consumers, but will not materially benefit those experiencing gross emission failures such as caused by engine misfire. Engine misfire may result in an increase of 1,000 to 2,000 percent in emission levels and, consequently, these vehicles should be subjected to the currently recommended repair procedures.

Studies* made in 1971-73 of vehicles experiencing emission failures determined that average repair costs ranged between $17 and $36. These values would have been higher if 1975 repair rates were used. Program personnel indicated they expect the final adjustment procedure to cost around $10 for the six southern counties under consideration.

Using the above data and assuming an eight-percent inflation rate, cost savings were estimated for the years 1976 through 1985. First-year cost savings are calculated between $7 million and $26 million while ten-year cost savings are estimated between $119 million and $445 million. Valid, directly applicable data were not available for use in cost estimating, but considering the magnitude of the possible consumer savings, even extensive changes in assumptions would still produce large cost savings.

*Vehicle Emission Testing Program, prepared for the City of Chicago, by Olson Laboratories, Inc., February 1973.

F. Potential Problems

There were many unknown factors and necessary assumptions made by Olson in their study such that cost projections were, at best, very crude. Actions beyond prediction capability could drastically affect future costs and should be continually monitored by state personnel in the Periodic Vehicle Inspection Program. Rapid response of state actions dictated by such monitoring could result in better public acceptance, reduced cost and updated projections of systems costs. Some of the more important variables whose accurate determination can only be made through experience are discussed below.

1. Vehicle Population

Data on vehicle population and distribution are such that projections for planning of future site size and locations can be in significant error. The influence of the energy crisis and mass transit on future vehicle population cannot be accurately predicted. Significant variations in actual data compared to that predicted by Olson could produce overutilized and underutilized inspection sites as well as surplus or inadequate overall system inspection capability.

2. Type of Vehicle Inspected

The current inspection program includes four wheel vehicles weighing less than 6,002 pounds. Should motorcycles be added to the Program, a significant cost impact will occur. Future vehicles designed to reduce exhaust emissions may affect inspection procedures and inspection requirements. For example, most 1975 and 1976 automobiles use catalytic converters to reduce emissions, yet there are no repair procedures directed expressly to this component. Test results indicate there may be problems in measuring exhaust emissions on small vehicles. The energy situation will influence automotive use and should increase use of small vehicles.

3. Inspection Throughput Capability

The inspection throughput capacity and consequently the determination of the total number of inspection lanes required was based on measured times in a sample laboratory lane using contractor personnel. The state-operated inspection sites will be of a different design, and their management and use by relatively low-salaried inspection personnel will obviously produce a different motivation than the pilot lane operation. A fully operational system inspection throughput capability different from that predicted by Olson can have a serious cost impact on the Periodic Vehicle Emission Inspection Program.

4. Cost Assumptions

The contractor made some rather speculative cost assumptions, by necessity, for projecting ten-year program costs. These included inflation rates, interest rates, salaries, equipment, building, and site acquisition costs.

Future unknown conditions exist, and any ten-year projections of total program cost are made with very little confidence. The relative percent of cost savings suggested in the previous section should be valid, however, regardless of the actual ten-year costs.

ENCLOSURE 1

RECOMMENDED REPAIR PROCEDURES

LICENSED REPAIR STATION HANDBOOK ON RECOMMENDED REPAIR PROCEDURES FOR LOW EMISSION TUNE-UPS

Prepared by

BUREAU OF AUTOMOTIVE REPAIR

DEPARTMENT OF CONSUMER AFFAIRS

Distributed by

BUREAU OF AUTOMOTIVE REPAIR

REPAIR PROCEDURE 1 - IDLE A/F MIXTURE RICH

The following procedures are to be completed in the order shown. Refer to service manuals for specific repair information. Complete all required repairs.

A. DIAGNOSIS

Rich A/F Mixture at only idle can be caused by PCV restriction, faulty idle mixture adjustment, or clogged carburetor idle air-bleed passages. Rich Idle A/F Mixture causes failing CO and high, possible failing HC emission at idle. Since this malfunction occurs only at idle, the air cleaner, carburetor choke, and carburetor mainsystems are satisfactory.

1. Carburetor Idle Adjustment - Make a gross adjustment of idle mixture to determine whether CO can be brought within the specification shown in ADJUSTMENT PROCEDURES. If CO can be corrected by adjustment, complete the final adjustments. If not, continue with diagnosis.

2. PCV System - Test PCV valve by disconnecting tube to crankcase and feeling for vacuum ahead of the valve at idle. Replace valve if vacuum cannot be detected. Check all components for free flow. Listen for clicking of valve to changes in vacuum.

3. Air Injection System (If Equipped) - Disconnect from air injection pump. Feel for pressure and flow. If no flow can be detected, service pump.

B. REPAIR PROCEDURE

1. PCV System - Replace or clean valve and other components if flow cannot be detected or if valve is stuck.

2. Air Injection System (if inoperative) - Service as required to ensure proper air flow.

3. Carburetor Idle Passages - In some cases, particularly with older vehicles, the idle air bleed passages may be clogged with dirt or varnish to such a degree that the idle CO cannot be set to specification. In this case, the carburetor should be boiled out and rebuilt or replaced.

C. Go To ADJUSTMENT PROCEDURES

ENCLOSURE 2

PRELIMINARY INSPECTION PROGRAM INFORMATION,
LETTER NO. 1, AUGUST 28, 1975

PRELIMINARY

VEHICLE INSPECTION PROGRAM
INFORMATION LETTER NO. 1

OF

AUGUST 28, 1975

SUBJECT: Preliminary specifications and repair procedures for use by repair facilities and mechanics performing repairs and adjustments recommended by the State Vehicle Inspection Station in the Riverside Pilot Emissions Inspection Program.

NOTE: A more complete handbook will be issued to replace this information letter after approximately three or four weeks of inspection station operation and coordination with the repair facilities in Riverside.

REPAIR PROCEDURE 2 - IDLE A/F MIXTURE LEAN

The following procedures are to be completed in the order shown. Refer to service manuals for specific repair information. Complete all required steps of this procedure.

A. DIAGNOSIS

Lean Idle A/F Mixture can be caused by excessive air leaking into the engine at idle or too lean an idle screw adjustment. Lean A/F Mixture results in normal or low CO emissions (may be less than 1 percent) and high fluctuating HC emissions. High HC emissions can also be caused by grossly advanced ignition timing which may not be detected by the BAR inspection procedure.

1. Gross Lean Adjustment of Idle Mixture - If idle CO emissions are less than 0.5 percent, richen idle mixture to determine if HC emissions can be brought within specification. If they can, then perform ADJUSTMENT PROCEDURES.

2. Vacuum Leak - Inspect for vacuum leaks in the induction system by spraying a heavy hydrocarbon onto the carburetor body and intake manifold. Idle speed will increase and engine idle will smooth out if vacuum leaks are present. Check for loose or missing vacuum hoses. Check PCV ventilation valve to determine if it is stuck in full flow position.

3. Ignition Timing - Check timing and advance with timing light. Check dwell with oscilloscope.

B. REPAIR PROCEDURES

1. Vacuum Leaks - (a) Replace loose, missing, or deteriorated vacuum tubes. Repair vacuum leaks diagnosed above. (b) Repair vacuum or mechanical advance if required. (c) Replace PCV valve if stuck in full flow position.

C. Go To ADJUSTMENT PROCEDURES

REPAIR PROCEDURE 3 - FAULTY CARBURETION

Faulty Carburetion results in excessive carbon monoxide emissions during low and high cruise and may contribute to excessive idle emissions. Faulty carburetion causes excessive quantities of fuel to be supplied to the engine. It may also be due to problems with the air induction system rather than the carburetor itself.

A. DIAGNOSIS

1. Air Cleaner - Inspect air cleaner element. Replace if CO emissions at 2500 rpm with and without air cleaner element installed change more than 1 percent CO.

2. Carburetor Choke - Check to ensure that the choke is not stuck partially closed. Repair or adjust if not fully open at normal engine temperature.

3. Carburetor Main System - With air cleaner removed and choke open, measure CO emissions at 2500 rpm. Carburetor main system is satisfactory if CO emissions decrease to less than one half of idle CO emission level; go to ADJUSTMENT PROCEDURE.

4. Fuel Pump Pressure - Check for excess fuel pressure. If excess pressure is present, check for restricted fuel return line and pump bypass valve.

B. REPAIR PROCEDURES

1. Float Chamber

a. Check for proper float level. Adjust to specification if necessary.

b. Check for loose, damaged, or leaky float or float valve. Replace if necessary.

c. Measure CO emissions at 2500 rpm. If CO emissions decrease to one half of idle CO emissions, carburetor malfunction has been corrected; go to ADJUSTMENT PROCEDURE.

2. Replace or Rebuild Carburetor

a. If one or more of the above defects are not found or do not decrease the CO emissions at 2500 rpm to no more than one half of the idle CO emissions, replace or rebuild the carburetor.

b. Check to be sure that all vacuum passages controlling the power enrichening valve are open and unrestricted. Check to ensure free operation of valve and responsiveness to vacuum signals. Replace if stuck or damaged.

c. Check to be sure that air passages are not plugged with varnish or deposits. If obviously plugged, perform a boil out or solvent cleaning.

d. Refer to manufacturer's specifications for carburetor rebuilding or replacement.

3. Perform any ignition system diagnostic and repair procedures which may also have been recommended by the BAR inspection.

C. Go To ADJUSTMENT PROCEDURE

REPAIR PROCEDURE 4 - FAULTY SPARK PLUG OR WIRE

Spark plug or wire failure was diagnosed by the BAR inspection facility. This failure results in secondary ignition misfire in at least one cylinder producing very high HC emissions.

A. DIAGNOSIS

1. Conduct an ignition system diagnosis to confirm the BAR diagnosis. Check for erroded plugs, incorrect gap, disconnected or open wires, crossfire, distributor cap and rotor condition.

B. REPAIR PROCEDURE

1. Replace spark plugs if misfiring, fouled, or required voltage exceeds 18 kV at 2,500 rpm no-load or road load. Replace wires if shorting or open.

2. Replace distributor cap or rotor if excessively worn or deteriorated. Air gap voltage should exceed 8 kV. Replace points if pitted, crossfiring, or bouncing.

3. Perform diagnostic and repair procedures for any other BAR diagnosed malfunctions.

C. Go To ADJUSTMENT PROCEDURES

REPAIR PROCEDURE 5 - FAULTY IGNITION COMPONENTS

Ignition Component Failure was diagnosed by the BAR inspection station. The failure was determined not to be the spark plugs, ignition wires or points. Conduct a diagnosis of the following components to determine where the expected fault is occurring; coil, condensor, distributor advance mechanisms, electronic ignition components.

A. DIAGNOSIS

1. Examine the BAR inspection report that was given to the vehicle's driver. If high point resistance and/or plug or wire failure were also indicated, perform a complete primary and secondary ignition system diagnosis. If these failures were not indicated, do not replace plugs, wires or points.

2. Perform any other diagnostic and repair procedures suggested by the BAR inspection.

B. REPAIR PROCEDURES

1. Perform repairs or replacements for spark plugs, wires or point malfunctions if any were recommended by BAR.

2. Perform needed repairs or part replacements of coil, condenser, distributor or other components which you diagnose as faulty.

C. Go To ADJUSTMENT PROCEDURE

REPAIR PROCEDURE 6 - FAULTY EXHAUST VALVE ACTION

Faulty Exhaust Valve Action was diagnosed by the BAR inspection station. This failure may also be caused by bad rings. You are to confirm the diagnosis and repair the failure if it can be completed for the amount specified under "NOT TO EXCEED" on the inspection report. If you determine that valve(s) repair is required but that the work cannot be performed within the indicated cost, you may still perform the work if the owner approves the work order. If the owner refuses, provide him with an itemized estimate of the cost of the repairs you determine are necessary. You should perform other ignition or carburetor repairs which are needed even if the valve repair is not performed. These repairs also must not exceed the indicated amount.

A. DIAGNOSIS

1. Conduct a compression check to determine if the valve(s) are seating. The compression check should show no more than 20 percent variation from highest to lowest cylinder and be within the manufacturer's recommended specification.

2. If the compression check is satisfactory, perform other diagnostic and repair procedures that may have been recommended by the BAR inspection.

3. If the compression check is not satisfactory, perform a cylinder leak down test to determine whether the rings or valves are at fault.

B. REPAIR PROCEDURE

1. Perform valve adjustments where applicable.

2. Perform the required repair if cost is within the allowable cost limit or if it is approved by the owner. Provide an estimate if the owner refuses to pay the estimated cost of repairs.

2. Perform other repairs suggested by the BAR inspection report.

C. Go To ADJUSTMENT PROCEDURES

REPAIR PROCEDURE 7 - EXCESS NO_x EMISSIONS

On NO_x system equipped vehicles, either original equipment or retrofit equipment, the ignition advance is modified to inhibit NO_x formation. Many vehicles also employ exhaust gas recirculation (EGR). These systems may malfunction resulting in excessive NO_x emissions for vehicles equipped to control NOx emissions.

A. DIAGNOSIS

1. Determine whether emission failure is due to NO_x system malfunction. Repair or replace the system according to applicable service procedures. Check for plugged EGR valves or disconnected hoses.

2. Check for vacuum or mechanical advance malfunction, incorrect basic timing or dwell. Repair and adjustment of the timing malfunction may correct the NO_x failure.

B. REPAIR PROCEDURE

1. If NO_x system malfunction occurs along with other suggested malfunctions, perform the suggested repairs for those failures first.

2. Repair or replace plugged EGR valves or hoses, malfunctioning transmission and speed sensors, vacuum disconnect, and vacuum retard switches if necessary.

3. Repair distributor advance mechanisms if necessary.

C. GO TO ADJUSTMENT PROCEDURES

REPAIR PROCEDURE 8 - HC LOW EMISSIONS TUNE-UP

The following procedures are to be completed in the order shown below. As a minimum, inspect each item but repair or replace only those which are defective.

The total repair cost on this vehicle (parts, labor, and tax) must not exceed the amount shown on the Vehicle Inspection Report unless the vehicle owner gives prior written approval.

A. DIAGNOSIS

This vehicle failed the inspection for excessive hydrocarbon emissions which can be caused by ignition misfire, grossly incorrect timing, vacuum leaks resulting in lean misfire or leaking exhaust valves.

1. Ignition Misfire

a. Use oscilloscope and BAR diagnostic information to determine if there are ignition misfires occurring. Replace spark plugs, points, distributor components, or wires if shown to be faulty. Check to ensure that wires go to correct plugs.

b. Adjust dwell and basic timing to manufacturer's specification.

c. Check mechanical and vacuum advance including speed, transmission, or deceleration spark advance control; thermal spark advance control, vacuum retard (at idle), or vacuum advance disconnect control which may be part of emissions control system installed on this particular vehicle.

2. Air Induction System

a. Examine intake manifold. Hidden vacuum leaks can be detected by spraying a light hydrocarbon onto the intake manifold and carburetor body and observing that the idle speed increases and smooths out.

3. Air Injection System

a. Determine that air injection pump is delivering air. If not, repair or replace pump.

4. Compression Test

If the above diagnosis does not detect a fault or if HC emissions are still high at idle or 2500 rpm, perform a power drop test to determine if a valve leak may be causing the excess emissions.

B. REPAIR PROCEDURE

1. Repair ignition misfire, replace ignition components, as required.

2. Adjust and/or repair dwell, timing advance systems, and basic timing, if required.

3. Repair vacuum leaks, if required.

4. Service air injection system, if required.

5. Correct valve problem, if required, and if within cost limitation.

C. Go To ADJUSTMENT PROCEDURE

REPAIR PROCEDURE 9 - HIGH POINT RESISTANCE

High point resistance can be caused by contact misalignment, foreign material in the distributor, and worn or pitted points.

A. DIAGNOSIS

1. Perform a primary ignition system diagnosis; check dwell, point open and close signal, and ground connections. Measure voltage drop or point resistance.

B. REPAIR PROCEDURE

1. Distributor - Replace points; repair or replace distributor cap or rotor if cracked or damaged. Check match of condenser to coil. Replace condenser if there is excess leakage.

2. Other components - Perform other ignition system diagnoses and repairs if components are faulty.

C. Go To ADJUSTMENT PROCEDURES

REPAIR PROCEDURE 10 - LOW EMISSION TUNE-UP FOR HC AND CO FAILURES

The following procedures are to be completed in the order shown. As a minimum, inspect each item but repair or replace only those which are defective. Refer to service manuals and BAR guidelines for detailed procedures.

The total repair cost on this vehicle (parts, labor and tax) must not exceed the amount printed on the Vehicle Inspection Report unless the vehicle owner gives prior written approval.

A. DIAGNOSIS

1. Air Induction System

a. Inspect for vacuum leaks by spraying light hydrocarbon onto carburetor body and manifold. Rough idle should smooth out and idle speed should increase as oil vapors are drawn into engine through vacuum leaks. Ensure that all vacuum lines are connected.

b. Test air filter by measuring CO at 2500 rpm with and without filter installed. Replace if CO with filter installed is more than 1 percent higher than without.

c. Test PCV valve by disconnecting tube to crankcase and feeling for vacuum at idle and listening for clicking sound. Replace valve if vacuum cannot be detected and no sound is heard. Check for free flow through hoses and orifices.

2. Ignition Misfires (failures for HC during any mode)

a. Use oscilloscope and BAR diagnostic information to determine if there are ignition misfires occurring. Replace spark plugs, points, distributor components or wires if shown to be faulty.

3. Carburetion (failures for CO during low or high cruise)

a. Check choke action and adjustment to ensure that choke opens fully and operates freely when engine is hot.

b. Check float level; adjust if necessary.

c. With air cleaner removed, measure CO at idle and 2500 rpm. CO should decrease at 2500 rpm to no more than 50 percent of the idle value if carburetor main system is satisfactory. If CO does not decrease substantially, the carburetor should be rebuilt or replaced per manufacturer's specifications.

4. Air Injection System

a. For vehicles equipped with air injection, determine that air injection pump is delivering air. If not, repair or replace. NOTE: Repair or replacement of air injection system is to be completed only after ignition and carburetion repairs are performed.

B. REPAIR PROCEDURE

1. Replace air cleaner and/or service PCV system, if required.

2. Repair vacuum leaks, if required.

3. Adjust carburetor choke, if required.

4. Replace ignition components, if required.

5. Adjust carburetor float level, if required.

6. Rebuild or replace carburetor, if required.

7. Service emissions control equipment including air injection system, if required.

8. Perform major mechanical repairs, if required.

C. Go To ADJUSTMENT PROCEDURE

PROCEDURE C - FINAL ADJUSTMENT PROCEDURES

1. Ignition Timing

Adjust dwell to within manufacturer's specification. Check and reset basic timing to manufacturer's specification.

2. Idle Speed

Adjust idle rpm within -50 or +100 rpm of manufacturer's specification.

3. Idle A/F Mixture

Disconnect air injection pump outlet hose if vehicle is equipped with air injection. Adjust idle mixture so that CO and HC are both less than:

	CO	HC
Pre-1966	4%	700 ppm
1966-1970	3%	500 ppm
post-1970	manufacturer's specification	300 ppm

Balance carburetor barrels if more than 1 barrel. Final CO reading must be made with air cleaner installed and all vacuum lines connected. Reconnect air injection hose.

ENCLOSURE 2

PRELIMINARY INSPECTION PROGRAM INFORMATION,
LETTER NO. 1, AUGUST 28, 1975

PRELIMINARY

VEHICLE INSPECTION PROGRAM
INFORMATION LETTER NO. 1

OF

AUGUST 28, 1975

SUBJECT: Preliminary specifications and repair procedures for use by repair facilities and mechanics performing repairs and adjustments recommended by the State Vehicle Inspection Station in the Riverside Pilot Emissions Inspection Program.

NOTE: A more complete handbook will be issued to replace this information letter after approximately three or four weeks of inspection station operation and coordination with the repair facilities in Riverside.

TABLE OF CONTENTS

I. INTRODUCTION

The first State-operated vehicle emission inspection station will commence operations on September 2, 1975, at 3195 Motor Circle Drive in Riverside. Owners' vehicles that fail the exhaust emission standards will be requested to have repairs or adjustments performed at repair facilities that have proper tuneup equipment and at least one mechanic qualified under the State of California Vehicle Inspection Program criteria.

Owners of vehicles that fail the emission test will bring to the repair facility, two forms provided by the inspection station:

One is a "Failed Vehicle Inspection Report" which is a computer printout showing the results of the emissions test as well as engine diagnostic information such as dwell, point voltage, etc.

The second form is a "Failed Vehicle Inspection Repair Form" for recording parts used, labor requirements, costs, etc. (see Attachment 1).

The vehicle owner is requested to provide these two forms to the repair facility performing the recommended repairs.

II. GENERAL

A. Failed Vehicle Inspection Report Form

The failed vehicle inspection report form will contain one or more of five diagnostic messages as follows:

1. Idle air/fuel mixture (rich or lean).
2. Faulty plug or wire.
3. Rich carburetion.
4. *Ignition low emission tuneup.
5. *HC/CO low emission tuneup.

*If the condition exists, the words "low compression" may be added to this message.

There are five corresponding specific repair and/or adjustment procedures identified by the same wording as in the above diagnostic messages. These specific repair procedures are described in a following section of this information letter entitled "Repair Procedures". For example, you will note that Repair Procedure "1" is entitled "Idle Air-Fuel Mixture (Rich or Lean)" which applies for the diagnostic message using this same language; Repair Procedure "2" is entitled "Faulty Plug or Wire" which corresponds to the same wording used in another diagnostic message, etc.

Qualified mechanics should match the name of the repair procedure to the corresponding diagnostic message and then proceed to perform the repair or adjustment as prescribed.

B. Failed Vehicle Inspection Repair Form (Attachment 1)

The law requires cost effectiveness evaluations be conducted as a part of this program. Repair costs are a significant part of such evaluations and the data on this form is essential. Please complete this report and return to the vehicle owner who is to return the form to the inspection station when returning for retest.

Under the section "Material Used", list the parts that were replaced. If replaced as a result of the diagnostic message and the associated procedures identified in section IV of this letter identify such parts in the left-hand column entitled "Required". Should the vehicle owner request or authorize any additional parts replacements identify such parts in the second column entitled "Voluntary". Show the unit cost of replaced parts as well as the total cost in the column entitled "Sale Amount" on the right side of the report form.

Under the section "Labor Actions" show the labor time used. Just as in the case above under "Material Used" the "Labor Actions" should be identified in the "Required" column if performed as a result of the diagnostic message and its associated repair procedures as identified in section IV.

Labor performed for work performed at the request of the owner on the other hand, should be identified under the "Voluntary" column. Generally speaking there should be a correlation between "Voluntary Parts" and "Voluntary Labor" just as there should be a correlation between "Required Parts" and "Required Labor".

Show the "Voluntary" and "Required" labor costs in the column at the right side of the report form and the total costs in the box provided at the bottom of the "Labor Actions" section.

Finally, sign the repair report in the space provided and entitled "Authorized Signature". Do not sign in the space marked "Owner's Signature".

III. FINAL ADJUSTMENT PROCEDURES

Although these adjustments are made after performing the appropriate repair procedure described in section IV below, they are discussed first to emphasize that they are common to all the section IV specific repair procedures marked "1" through "5". In other words after performing any one of the repairs and procedures described under section IV, it is necessary that these final adjustments be made before the repairs are considered completed.

Make final adjustments after repairs as follows:

A. Check and, if necessary, adjust dwell to within the auto manufacturers' specifications.

B. Check and, if necessary, reset basic timing to the auto manufacturers' specifications. If the car is equipped with an approved retrofit device required by law, adjust basic timing to retrofit manufacturers' specifications.

C. Adjust final idle RPM to vehicle or retrofit device manufacturers' specifications.

D. Adjust idle air fuel mixture (with air injection pump outlet hose disconnected) to or below CO and HC specifications for the model and year vehicle being repaired (see next section IV). The final CO and HC specifications shall be made with air cleaner installed and all vacuum lines connected. Reconnect the air injection pump hose.

E. Record the final HC/CO emission measurement at idle on the "Failed Vehicle Inspection Report" form with the air pump hose connected.

IV. REPAIR PROCEDURES

This section describes the steps that should be taken to perform the proper repairs for each of the five diagnostic messages. The mechanic is to make only those repairs necessary to correct the emission problem unless the vehicle owner authorizes additional repairs. (Refer to Attachment 1 for separate costing of "voluntary" and "required" repairs.) You are again reminded that the five numbered repair codes which follow, match the wording of the five diagnostic messages.

The steps under any of the following five repair procedures are to be performed in sequence until the car meets the specifications contained in Attachment 2. After completing any step that accomplishes this, omit the remaining steps and proceed directly to the FINAL ADJUSTMENT PROCEDURES shown in section III. For example, under repair procedure "1" Idle Air/Fuel Mixture (Rich or Lean) if the car is returned within limits after the adjustments in step "a" below, omit steps "b" through "e" and perform only step "f" which calls for the FINAL ADJUSTMENTS (section III). If the failure is cleared after step "b" proceed directly to "f", etc. Because of the legal cost limitations discussed in section V, in some cases it may not be possible to carry out all the steps that would be necessary to bring a car within passing emission limits. In such cases perform only as many steps in the sequence as the legal cost restrictions will permit, thereby reducing emissions as low as possible within these cost constraints and always allowing for the cost of performing the FINAL ADJUSTMENTS (section III).

1. <u>Idle Air/Fuel Mixture (Rich or Lean)</u>

   The diagnostic message (see Figure 1) indicates that the car failed carbon monoxide and/or hydrocarbons at the idle condition only and passed the low and high cruise tests. The message will be printed out either "Idle Air/Fuel Mixture Rich" for the rich misfire condition or "Idle Air/Fuel Mixture Lean" for the lean misfire condition. The specific repair steps are:

   a. Determine whether the idle mixture is adjustable by attempting to adjust the carburetor idle mixture to the CO specifications shown in the BAR idle adjustment specifications (Attachment 2).

   b. In the cars which fail idle air/fuel mixture lean, check for intake manifold vacuum leaks by using an appropriate leak detector or fluid. Observe the change in emission levels and watch for the possible smoothing up of the idle condition. In addition, check all vacuum lines for leaks.

   c. For either lean or rich failure, test the PCV valve by disconnecting at the crankcase side and placing thumb over end of valve, and then remove thumb. If clicking of valve is heard, valve is okay. If no clicking is heard, clean or replace valve. Check for free flow through system passages by disconnecting the valve at the intake manifold (on carburetor base) side. If the engine dies or idles very rough, the passage is open. If the idle does not change, it is plugged up. Clean out the passage and reassemble.

d. Check carburetor idle air bleed passages; and if clogged clean the carburetor and install new gaskets or replace with a new or rebuilt unit.

e. Disconnect hose from air injection pump and note air flow. If no flow can be detected, diagnose and service air injection system components. Replace pump if defective.

f. Make final ignition and idle mixture adjustments as specified in section III.

2. Faulty Plug or Wire

This diagnostic message indicates that the car failed HC in the low and/or high cruise mode of operation at the inspection facility. CO emission levels were normal. (See Fig. 5.)

In this case two or less plugs and/or wires were misfiring and the diagnostic routine performed at the inspection lane indicated no other major distributor and/or ignition component failures. Therefore, repair only the cylinders indicated on the Inspection Test Report as follows:

a. Check for fouled or shorted plug, incorrect plug gap, disconnected or open wires and spark plug wire crossfire on the cylinders indicated on Failed Vehicle Inspection Report. Replace only those wires found defective and replace or clean only those plugs found fouled or defective unless requested or authorized by the vehicle owner to do more see section II "B" on "required" and "voluntary" procedures.

b. Make final ignition and carburetion adjustments as specified in section III.

3. Rich Carburetion

This diagnostic message indicates that the car failed CO in the low and/or high cruise modes of operation. In addition the ca r may have also failed idle CO. HC emissions were normal in all modes of operation. (See Fig. 3.)

Repairs are only required in the induction or carburetion systems. However, due to time constraint at the time of inspection, the mechanic must conduct some additional diagnosis to locate the problem area. Diagnosis and repair steps are:

a. Inspect carburetor air cleaner element. With air cleaner element installed run engine for 10 seconds at a steady 2500 RPM in neutral and note CO%.

Remove air cleaner element; and run at 2500 RPM, note the CO% without the element. Replace air cleaner element if there is an increase of more than 1% CO between the two measurements.

b. On a warmed up engine, visually check to ensure that the choke is wide open and the linkage is free. Repair or adjust if not fully open at normal operation temperature.

c. With the air cleaner removed and the choke fully open, measure the CO emissions at 2500 RPM. The carburetor high speed circuit is satisfactory if CO emissions do not exceed the idle specification in Attachment 2 when operating at a steady 2500 RPM. If CO emissions at 2500 RPM do exceed the idle specifications in Attachment 2, check for oversize jets, correct float level, damaged or leaky float. If the above mentioned items are satisfactory and the problem is internal, then overhaul or replace carburetor. Check for internal fuel leaks such as leaking power valve diaphragms. Following repair, recheck CO at 2500 RPM to confirm that the repairs reduced CO as outlined above.

d. Test the PCV valve by disconnecting at the crankcase side and placing thumb over end of valve, and then remove thumb. If clicking of valve is heard, valve is okay. If no clicking is heard, clean or replace valve. Check for free flow through system passages by disconnecting the valve at the intake manifold (on carburetor base) side. If the engine dies or idles very rough, the passage is open. If the idle does not change, it is plugged up. Clean out the passage and reassemble.

e. Make final ignition and idle mixture adjustments as specified in section III.

4. Ignition Low Emission Tuneup (See Fig. 4 and 6.)

This message indicates that the car failed HC in low and/or high cruise modes of operation. All CO emissions are normal. In this case, the values of the engine parameter measurements on the inspection report form should also indicate some ignition defects such as:

a. Excessive point resistence in terms of voltage drop (greater than 1 volt).

b. Excessive dwell variation (greater than four distributor degrees).

This "Ignition Low Emission Tuneup" diagnostic message will be printed out, if more than two cylinders are misfiring.

If the car fails HC at idle or 2500 RPM and no apparent reasons for ignition failure is found in the inspection facility diagnosis, a "power drop" cylinder balance test will be conducted at the inspection station to locate a weak cylinder and the results printed out on the vehicle inspection report. The mechanic is instructed to check the ignition system to verify nonmisfire and then proceed to diagnosing the probable cause for low compression.

The ignition low emission tuneup steps are:

a. Use vehicle manufacturer procedures to determine that distributor advance is operative. Measure the mechanical and vacuum advance, and compare measurements to specifications. Replaçe defective vacuum advance units and repair mechanical advance systems.

b. Check for fouled or shorted plug, disconnected or open wires and spark plug wire crossfire. Replace defective ignition wires. If upon testing spark plugs, the required voltage exceeds 18 kv at 2500 RPM, and/or there is misfiring, replace all spark plugs. On newer, "high energy" model type ignition systems, replace plugs if firing voltage exceeds 25 kv at 2500 RPM.

c. Check and replace, if necessary, points and condenser. Inspect distributor cap and rotor for wear, cracks or corrosion. Replace if defective.

d. Verify the cause of low engine cylinder compression. Record and estimate on the Vehicle Inspection Repair Report, the costs for repair. If the cost of engine repair to clear the low compression problem exceeds the maximum legal repair cost shown on the Vehicle Inspection Report verify that the ignition system is operating properly as outlined in steps 1, 2, and 3, and make the final adjustments and direct motorist for reinspection.

   If the cost of engine repairs to clear the low compression problem is less than the cost constraints, provided on the Vehicle Inspection Report, conduct the engine repairs.

e. Make the final adjustments as outlined in section III.

5. HC/CO Low Emission Tuneup

The diagnostic message indicates that the car failed HC and CO in the low and/or high cruise modes of operation. The probable cause(s) of malfunction is both carburetion and ignition system failures.

This procedure incorporates and combines the basic repair procedures outlined in repair procedures "C" and "D" (Rich Carburetion and Ignition Low Emission Tuneup). The repair steps are as follows:

a. Use vehicle manufacturer procedures to determine the distributor advance is operative. Measure the mechanical and vacuum advance, and compare measurements to specifications. Replace defective vacuum advance units and repair mechanical advance systems.

b. Inspect carburetor air cleaner element. With air cleaner element installed run engine for 10 seconds at a steady 2500 RPM in neutral and note CO%. Remove air cleaner element, and run at 2500 RPM, note the CO% without the element. Replace air cleaner element if there is an increase of more than 1% CO between the two measurements.

c. On a warmed up engine, visually check to ensure that the choke is wide open and the linkage is free. Repair or adjust if not fully open at normal operation temperature.

d. With the air cleaner removed and the choke fully open, measure the CO emissions at 2500 RPM. The carburetor high speed circuit is satisfactory if CO emissions do not exceed the idle specification in Attachment 2 when operating at a steady 2500 RPM. If CO emissions at 2500 RPM do exceed the idle specifications in Attachment 2, check for oversize jets, correct float level, damaged or leaky float. If the above mentioned items are satisfactory and the problem is internal, overhaul or replace the carburetor. Check for internal fuel leaks such as leaking power valve diaphragms. Following repair, recheck CO at 2500 RPM to confirm that the repairs reduced CO as outlined above.

e. Check for fouled or shorted plug, disconnected or open wires and spark plug wire crossfire. Replace defective ignition wires. If upon testing spark plugs, the required voltage exceeds 18 kv at 2500 RPM and/or there is misfiring replace all spark plugs. On newer, "High energy" model type ignition systems, replace plugs if firing voltage exceeds 25 kv at 2500 RPM.

f. Check and replace, if necessary, points and condenser. Inspect distributor cap and rotor for wear, cracks or corrosion. Replace if defective.

g. Disconnect hose from air injection pump and note air flow. If no flow can be detected, diagnose and service air injection system components. Replace pump if defective.

EXAMPLE OF VEHICLE INSPECTION REPORT WITH DIAGNOSTIC MESSAGE "IDLE AIR FUEL MISTURE RICH".

VEHICLE INSPECTION REPORT

INSPECTION DATE 00/00/00 0013 LANE 2

FACILITY # 00000 (1.)

OWNER STATE OF CALIF

LICENSE NO. 816111 YEAR: 71 MAKE: AMC
WT CLASS: 03 CYL: 08 SPEC CODE: 00 ODOMETER: 057000 (2.)
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $120 → (3.)

EMISSION PARAMETERS

	IDLE STANDARD	IDLE ACTUAL		LOW CRUISE STANDARD	LOW CRUISE ACTUAL		HI CRUISE STANDARD	HI CRUISE ACTUAL	
HC.PPM	00350	00116	P	00400	00162	P	00400	00098	P
CO.PRCNT	4.00	4.01	F	3.00	0.70	P	2.50	0.74	P
NOX.PPM	04000	00040		02500	01523		04000	02491	

(4.)

DIAGNOSTIC MESSAGE

FAILED IDLE AIR FUEL MIXTURE RICH (5.)

ENGINE PARAMETERS

DWELL DEVIATION 03.6 → (6.)

DWELL IN DEGREES
44.4 44.3 44.4 45.0 43.4 42.3 41.4 42.3

POINT VOLTAGE DROP IN VOLTS
0.15 0.16 0.17 0.18 0.18 0.18 0.18 0.18

PEAK VOLTAGE IN KV
18.9 15.5 16.7 13.8 14.8 12.1 11.9 10.0

SPARK LINE VALUE IN MS
1.13 1.06 0.97 1.06 0.99 1.01 1.00 1.04

(7.)

← (8.)

NOTE: The explanation corresponding to the circled numbers by the brackets above is contained in the attached "Table of Explanation" on the reverse side. In general the "Table of Explanation" applies to all the sample "Vehicle Inspection Reports" included herein and therefore is not attached to each of the following figures. Of course, neither these circled numbers nor the table will appear on the "Vehicl Inspection Report" brought in by the individual car owner.

THIS IS A SAMPLE REPORT AND SOME OF THE NUMERICAL VALUES INDICATED ABOVE ARE "DUMMY NUMBERS" RATHER THAN REAL VALUES.

TABLE OF EXPLANATION

(1.) Identifies where and when State inspection was conducted and the vehicle owner's name. (In this case the State of California owned the car.)

(2.) Vehicle identification information.

(3.) This is not an estimate of repair costs for the vehicle. It is not related to the repairs required for this vehicle. It is a legal limit which cannot be exceeded for this particular vehicle no matter what is wrong. See section V on "COST CONSTRAINTS".

(4.) Shows State inspection station standards for pass (P) or fail (F) and actual measurements on this car. NO_x standards are on a trial basis and not used to determine (P) or (F) at this time. See section VI of this letter.

(5.) With this message you would go to repair procedure "1" in section IV of this information letter.

(6.) This is the maximum dwell deviation observed in this case. It is the difference between the readings of the two underlined cylinders in the line below.

(7.) The first cylinder reading (furthest to the left) is always the cylinder to which the inspection station connects its leads. In all "V" type engines it is always the Front cylinder in the Left bank as viewed from the driver's seat. In a straight in-line engine type it is always the front cylinder. In rear engine types it is the lower right cylinder as you face the engine. We refer to this cylinder to which the leads are attached as the trigger cylinder. The columns, reading from left to right, are in firing order beginning with the "trigger" cylinder in the left hand column.

(8.) Power drop readings are printed out in this location when there is an HC idle failure, and the automated inspection detected no malfunction in the ignition system measurements. Since there is no HC failure indicated in this car, no power drop test is made at the inspection station (see Figure 6 for power drop printout).

EXAMPLE OF A PASSED VEHICLE INSPECTION REPORT WITH "NO" DIAGNOSTIC MESSAGE.

VEHICLE INSPECTION REPORT

INSPECTION DATE 00/00/00 0011 LANE 2.

FACILITY #- 00000

OWNER [illegible]DAVID

LICENSE NO. 55288P YEAR: 73 MAKE: GMC
WT CLASS: 03 CYL: 08 SPEC CODE: 00 ODOMETER: 35000
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $150

EMISSION PARAMETERS

	IDLE			LOW CRUISE			HI CRUISE		
	STANDARD	ACTUAL		STANDARD	ACTUAL		STANDARD	ACTUAL	
HC, PPM	00350	00043	P	00400	00079	P	00400	00064	P
CO, PRCNT	4.00	1.72	P	3.00	2.11	P	2.50	1.25	P
NOX, PPM	04000	00002		02500	00148		04000	01334	

DIAGNOSTIC MESSAGE

PASSED. NO REPAIR REQUIRED.

NOTE: 1. Refer to Figure 1 "Table of Explanation" for meaning of most information shown above.

2. Normally you would not expect to see this report since the car has passed the inspection and no repairs are required. However, it is possible that at some later time the car owner might be having car trouble and decide to bring the above report with him. This is just to let you know what a "Passed" inspection report looks like.

THIS IS A SAMPLE REPORT AND SOME OF THE NUMERICAL VALUES INDICATED ABOVE ARE "DUMMY NUMBERS" RATHER THAN REAL VALUES.

Fig. 2

EXAMPLE OF VEHICLE INSPECTION REPORT WITH DIAGNOSTIC MESSAGE "RICH CARBURETION".

VEHICLE INSPECTION REPORT

INSPECTION DATE 08/28/75 2039 LANE 4

FACILITY # 00000

OWNER FRANKLIN BILL

LICENSE NO. GYB123 YEAR: 75 MAKE: FORD
WT CLASS: 03 CYL: 08 SPEC CODE: 00 ODOMETER: 320000
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $110

EMISSION PARAMETERS

	IDLE			LOW CRUISE			HI CRUISE		
	STANDARD	ACTUAL		STANDARD	ACTUAL		STANDARD	ACTUAL	
HC, PPM	00350	00071	P	00400	00221	P	00400	00142	P
CO, PRCNT	4.00	1.38	P	3.00	4.41	F	2.50	4.21	F
NOX, PPM	04000	00117		02500	00449		04000	00638	

DIAGNOSTIC MESSAGE →

FAILED RICH CARBURETION ←

This explanation does not appear on actual report. With this message you would go to repair procedure "3" in section IV of this letter.

ENGINE PARAMETERS

DWELL DEVIATION 04.3

DWELL IN DEGREES
40.7 37.0 39.2 38.8 37.2 36.9 37.7 36.3

POINT VOLTAGE DROP IN VOLTS
0.36 0.32 0.39 0.40 0.37 0.35 0.34 0.37

PEAK VOLTAGE IN KV
10.7 09.2 10.1 08.9 07.7 07.5 07.5 06.7

SPARK LINE VALUE IN MS
1.37 1.29 1.45 1.54 1.45 1.35 1.30 1.32

NOTE: See Figure 1 "Table of Explanation" for explanation of most information shown above.

THIS IS A SAMPLE REPORT AND SOME OF THE NUMERICAL VALUES INDICATED ABOVE ARE "DUMMY NUMBERS" RATHER THAN REAL VALUES.

EXAMPLE OF VEHICLE INSPECTION REPORT WITH DIAGNOSTIC MESSAGE "IGNITION-LOW EMISSION TUNEUP".

VEHICLE INSPECTION REPORT

INSPECTION DATE 08/28/75 2048 LANE 4

FACILITY # 00000

OWNER STATE OF CALIF

LICENSE NO. 816111 YEAR: 71 MAKE: AMC
WT CLASS: 03 CYL: 08 SPEC CODE: 00 ODOMETER: 66000
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $

EMISSION PARAMETERS

	IDLE STANDARD	IDLE ACTUAL		LOW CRUISE STANDARD	LOW CRUISE ACTUAL		HI CRUISE STANDARD	HI CRUISE ACTUAL	
HC, PPM	00350	00250	F	00400	00121	P	00400	00102	P
CO, PRCNT	4.00	3.43	P	3.00	0.45	P	2.50	0.48	P
NOX, PPM	04000	00103		02500	01140		04000	01528	

DIAGNOSTIC MESSAGE →

FAILED IGNITION LOW EMISSION TUNE-UP

This explanation does not appear on actual report. With this message you would go to repair procedure "4" in section IV of this letter.

ENGINE PARAMETERS

DWELL DEVIATION 03.6

DWELL IN DEGREES
44.3 44.5 44.7 48.4 44.2 43.0 41.8 42.6

POINT VOLTAGE DROP IN VOLTS
0.18 0.19 0.20 0.20 0.21 0.20 0.20 0.20

PEAK VOLTAGE IN KV
17.6 13.1 12.9 09.2 13.0 11.4 09.8 10.9

SPARK LINE VALUE IN MS
1.28 1.23 1.16 1.39 1.26 1.22 1.20 1.23

NOTE: See Figure 1 "Table of Explanation" for explanation of most information shown above.

THIS IS A SAMPLE REPORT AND SOME OF THE NUMERICAL VALUES INDICATED ABOVE ARE "DUMMY NUMBERS" RATHER THAN REAL VALUES.

Fig. 4

EXAMPLE OF VEHICLE INSPECTION REPORT WITH DIAGNOSTIC MESSAGE "FAULTY PLUG WIRE".

VEHICLE INSPECTION REPORT

INSPECTION DATE 08/23/75 1408 LANE 2

FACILITY # 00001

OWNER M6GM&DAEID

LICENSE NO: 55288P YEAR: 73 MAKE: GMC
WT CLASS: 03 CYL: 08 SPEC CODE: 00 ODOMETER: 25000
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $150

EMISSION PARAMETERS

	IDLE			LOW CRUISE			HI CRUISE		
	STANDARD	ACTUAL		STANDARD	ACTUAL		STANDARD	ACTUAL	
HC.PPM	00350	01935	F	00400	01935	F	00400	01935	F
CO.PRCNT	4.00	2.26	P	3.00	1.93	P	2.50	1.08	P
NOX.PPM	04000	00003		02500	00243		04000	00741	

DIAGNOSTIC MESSAGE ⟶

FAILED: FAULTY PLUG OR WIRE

This explanation does not appear on actual report. With this message you would go to repair procedure "2" in section IV of this letter.

ENGINE PARAMETERS

DWELL DEVIATION 01.6

DWELL IN DEGREES
38.4 39.5 38.8 39.0 39.1 40.0 39.9 39.2

POINT VOLTAGE DROP IN VOLTS
0.30 0.34 0.32 0.31 0.31 0.29 0.31 0.36

PEAK VOLTAGE IN KV
13.4 12.9 16.0 36.2 14.8 16.0 19.1 12.4

SPARK LINE VALUE IN MS
0.98 1.19 1.19 0.18 1.10 1.11 1.11 1.01

NOTE: See Figure 1 "Table of Explanation" for explanation of most information shown above.

THIS IS A SAMPLE REPORT AND SOME OF THE NUMERICAL VALUES INDICATED ABOVE ARE "DUMMY NUMBERS" RATHER THAN REAL VALUES.

Fig. 5

EXAMPLE OF VEHICLE INSPECTION REPORT WITH DIAGNOSTIC MESSAGE "IGNITION LOW EMISSION TUNEUP, LOW COMPRESSION".

INSPECTION DATE 8/23/75 2000 LANE 3
FACILITY # 00000

OWNER HAMILTON TOM

LICENSE NO. THR634 YEAR: 72 MAKE: CHEVY
WT CLASS: 00 CYL: 00 SPEC CODE: 00 ODOMETER: 350000
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $150

EMISSION PARAMETERS

	IDLE			LOW CRUISE			HI CRUISE		
	STANDARD	ACTUAL		STANDARD	ACTUAL		STANDARD	ACTUAL	
HC, PPM	00600	01275	F	00500	01269	F	00500	01199	F
CO, PRCNT	5.00	0.66	P	4.00	0.30	P	3.50	0.69	P
NOX, PPM	04000	00151		02500	00249		04000	00589	

DIAGNOSTIC MESSAGE →

This explanation does not appear on actual report. Note that there is an idle HC failure (as well as in the low and high cruise condition). Since the inspection did not identify any specific ignition failure, the system performs a power drop test and "failed-low compression" is added to the diagnostic message. With this message you would go to repair procedure 4 in section IV of this letter.

FAILED IGNITION LOW EMISSION TUNE-UP.
FAILED LOW COMPRESSION.

ENGINE PARAMETERS

DWELL DEVIATION 02.9

DWELL IN DEGREES
41.0 39.0 39.1 38.1 38.3 38.3 39.1 39.0

POINT VOLTAGE DROP IN VOLTS
0.11 0.11 0.11 0.12 0.11 0.11 0.10 0.11

PEAK VOLTAGE IN KV
16.6 17.7 34.3 17.9 19.1 17.4 15.0 18.7

SPARK LINE VALUE IN MS
1.33 1.14 0.33 1.16 1.31 1.16 1.32 1.23

POWER DROP PARAMETERS

BEGINNING RPM 01394

SHORTED RPM
01384 00768 00810 00764 00746 00782 00710 00782

The results of the power drop test are printed out here and indicates that the compression problem is in the underlined cylinder.

NOTE: See Figure 1 "Table of Explanation" for explanation of most information shown above.

THIS IS A SAMPLE REPORT AND SOME OF THE NUMERICAL VALUES INDICATED ABOVE ARE "DUMMY NUMBERS" RATHER THAN REAL VALUES.

Fig. 6

EXAMPLE OF VEHICLE INSPECTION REPORT WITH DIAGNOSTIC MESSAGE "IGNITION LOW EMISSION TUNEUP, LOW COMPRESSION".

INSPECTION DATE 8/28/75 2000 LANE 3
FACILITY # 00000

OWNER HAMILTON TOM

LICENSE NO. THR654 YEAR: 72 MAKE: CHEVY
WT CLASS: 00 CYL: 00 SPEC CODE: 00 ODOMETER: 350000
TEST NO. 01

MAXIMUM LEGAL REPAIR COST: $150

EMISSION PARAMETERS

	IDLE			LOW CRUISE			HI CRUISE		
	STANDARD	ACTUAL		STANDARD	ACTUAL		STANDARD	ACTUAL	
HC, PPM	00600	01275	F	00500	01269	F	00500	01199	F
CO, PRCNT	5.00	0.66	P	4.00	0.30	P	3.50	0.69	P
NOX, PPM	04000	00151		02500	00249		04000	00589	

DIAGNOSTIC MESSAGE →

FAILED. IGNITION LOW EMISSION TUNE-UP.
FAILED. LOW COMPRESSION.

This explanation does not appear on actual report. Note that there is an idle HC failure (as well as in the low and high cruise condition). Since the inspection did not identify any specific ignition failure, the system performs a power drop test and "failed-low compression" is added to the diagnostic message. With this message you would go to repair procedure 4 in section IV of this letter.

ENGINE PARAMETERS

DWELL DEVIATION 02.9

DWELL IN DEGREES
41.0 39.0 39.1 38.1 38.3 38.3 39.1 39.6

POINT VOLTAGE DROP IN VOLTS
0.11 0.11 0.11 0.11 0.11 0.11 0.10 0.11

PEAK VOLTAGE IN KV
16.6 17.7 24.3 17.9 19.1 17.4 15.0 18.7

SPARK LINE VALUE IN MS
1.33 1.14 0.33 1.16 1.31 1.16 1.32 1.23

POWER DROP PARAMETERS

BEGINNING RPM 01394

SHORTED RPM
01384 00768 00810 00764 00746 00782 00710 00782

The results of the power drop test are printed out here and indicates that the compression problem is in the underlined cylinder.

NOTE: See Figure 1 "Table of Explanation" for explanation of most information shown above.

THIS IS A SAMPLE REPORT AND SOME OF THE NUMERICAL VALUES INDICATED ABOVE ARE "DUMMY NUMBERS" RATHER THAN REAL VALUES.

Fig. 6

h. Verify the cause of low engine cylinder compression. Record and estimate on the Vehicle Inspection Report costs for repair. If the cost of engine repair to clear the low compression problem exceeds the maximum legal repair shown on the Vehicle Inspection Report, verify that the ignition system is operating properly as outlined in steps 1, 2, and 3 and make the final adjustments and direct motorist for reinspection.

   If the cost of engine repairs to clear the low compression problem is less than the cost constraints provided on the Vehicle Inspection Report, conduct the engine repairs.

i. Make the final adjustments as outlined in section III.

V. COST CONSTRAINTS

The law states that the consumer cannot be required to pay more than a total of $150 or 20% of the low current market value, whichever is lower, in having repairs accomplished as a result of these inspections. The law also requires the Department to define this "low current market value".

For purposes of the Riverside pilot program the low market value has been established from the Department of Motor Vehicles "Vehicle Value Table" and "Vehicle License Fee Rate Table (VLF)", since the license fees are tied to the value of the vehicle. They are basically comparable to the low Kelley Blue Book values. However to establish a practical floor, representing the lowest market value of any in-use vehicle on California's highways, we made a survey of used car dealers' wholesale purchasing costs and determined that average minimum wholesale cost (low market value) is $150, with a corresponding "maximum legal repair cost" of $30.00. Using this as the lowest authorized "maximum repair cost" we then proceed to establish our cost limitations in accordance with the Department of Motor Vehicles' tables discussed above.

The above are the "maximum legal repair costs" which appear on the "Failed Vehicle Inspection Report" and serve to inform the vehicle owner of his rights as well as informing the repair industry of its restrictions. You are cautioned that these are not estimated costs of repairs and have no relationship to the work recommended as a result of any particular diagnostic message. The $150 limitation would apply to any car valued at $750 or more whereas the 20% criteria applies to cars valued at less than $750. Based on the assigned value of the car the computer automatically prints out the maximum legal repair costs that can be required of a vehicle owner.

It is important to reemphasize that even though the "maximum legal repair cost" might be shown as $150, the work recommended might only call for $20 or $30 worth of labor and parts. Our computerized monitoring and evaluation system will be compiling statistics on costs charged for work performed. In this connection you are advised that according to the law we are to publish and make available to consumers at quarterly intervals a summary of repair performance and costs including the percentage of repaired vehicles which passed inspection. We will attempt to publish such a summary on a trial basis in the Riverside Pilot Program.

It is also pointed out that the vehicle owner may request and authorize additional repairs beyond those "required". These must be identified as "owner authorized", "voluntary" and so indicated on the Failed Vehicle Inspection Repair form (see section II "B" and Attachment 1).

Since this Riverside pilot program is of a trial nature, and repairs are voluntary, we will attempt to evaluate the practicability and cost effectiveness of the above approach during the next several months. Your comments and recommendations on this approach, as well as those of the general public, will be requested and considered during this pilot program and will be sought throughout the South Coast Air Basin as well as the City of Riverside.

VI. NO_x STANDARDS

When the Air Resources Board established standards for the Vehicle Inspection Program, it defined the NO_x standards as "screening standards" and indicated they were not to be used to "pass" or "fail" a car. At the same time it is desired to accumulate data on NO_x measurements during this pilot program.

The Air Resources Board set these "screening standards" at 2500 PPM as a point at which the NO_x emission control system, for example: EGR valve might warrant checking. We wished to retain the software programming capability to add meaningful NO_x standards later in the program, should we so desire. The NO_x standards appearing on the Vehicle Inspection Report are arbitrarily raised to 4000 PPM. This ensures that the computer will not print a pass ("P") or fail ("F") after the NO_x measurements as this might cause considerable confusion. At the same time, it enables us to print and record the desired NO_x measurements for evaluation purposes.

MATERIALS USED

RE-QUIRED	VOLUN-TARY	QTY	DESCRIPTION	SALE AMOUNT
			PCV VALVE	
			AIR FILTER	
			SPARK PLUGS	
			POINTS	
			CONDENSER	
			ROTOR	
			WIRES	
			CARBURETOR OVERHAUL KIT	
			REPLACEMENT CARBURETOR ☐ NEW ☐ REBUILT	

LABOR ACTIONS

RE-QUIRED	VOLUN-TARY	DESCRIPTION	LABOR CHARGE
		PERFORM FINAL ADJUSTMENT IDLE 2500	
		HC ____ HC ____	
		CO ____ CO ____	
		REPAIR CHOKE	
		REPAIR HEAT RISER/HEATED AIR INLET	
		REPAIR A.I.R. SYSTEM/COMPONENTS	
		TEST COMPRESSION ( )( )( )( )( )( )( )( )	
		OVERHAUL CARBURETOR	
		REPLACE CARBURETOR	

TOTAL VOLUNTARY LABOR	
TOTAL VOLUNTARY PARTS	
TOTAL REQUIRED LABOR	
TOTAL REQUIRED PARTS	
TAX	
TOTAL	

DESCRIPTION OF ADDITIONAL RECOMMENDED REPAIRS	ESTIMATE

DATE ____________ LICENSE NO. ____________ ODOMETER ____________

☐ I certify that the required maintenance indicated on the reverse side was performed by me or at my request by a mechanic not licensed by the Bureau of Automotive Repair.

OWNER'S SIGNATURE ____________

☐ I certify that the required maintenance indicated on the reverse side and in the procedures defined by the BAR have been performed.

MATERIALS USED

RE-QUIRED	VOLUN-TARY	QTY	DESCRIPTION	SALE AMOUNT
			PCV VALVE	
			AIR FILTER	
			SPARK PLUGS	
			POINTS	
			CONDENSER	
			ROTOR	
			WIRES	
			CARBURETOR OVERHAUL KIT	
			REPLACEMENT CARBURETOR ☐ NEW ☐ REBUILT	

LABOR ACTIONS

RE-QUIRED	VOLUN-TARY	DESCRIPTION	LABOR CHARGE
		PERFORM FINAL ADJUSTMENT IDLE 2500	
		HC ______ HC ______	
		CO ______ CO ______	
		REPAIR CHOKE	
		REPAIR HEAT RISER/HEATED AIR INLET	
		REPAIR A.I.R. SYSTEM/COMPONENTS	
		TEST COMPRESSION ( )( )( )( )( )( )( )( )	
		OVERHAUL CARBURETOR	
		REPLACE CARBURETOR	

TOTAL VOLUNTARY LABOR	
TOTAL VOLUNTARY PARTS	
TOTAL REQUIRED LABOR	
TOTAL REQUIRED PARTS	
TAX	
TOTAL	

DESCRIPTION OF ADDITIONAL RECOMMENDED REPAIRS	ESTIMATE

DATE ______________ LICENSE NO. ______________ ODOMETER ______________

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OWNER'S SIGNATURE ______________________

☐ I certify that the required maintenance indicated on the reverse side and in the procedures defined by the BAR have been performed.

AUTHORIZED SIGNATURE ______________________ MVPC/ARD LIC.NO. __________

RE-QUIRED	VOLUN-TARY	QTY	MATERIALS USED DESCRIPTION	SALE AMOUNT
			PCV VALVE	
			AIR FILTER	
			SPARK PLUGS	
			POINTS	
			CONDENSER	
			ROTOR	
			WIRES	
			CARBURETOR OVERHAUL KIT	
			REPLACEMENT CARBURETOR ☐ NEW ☐ REBUILT	

RE-QUIRED	VOLUN-TARY	LABOR ACTIONS DESCRIPTION	LABOR CHARGE
		PERFORM FINAL ADJUSTMENT IDLE 2500	
		HC ____ HC ____	
		CO ____ CO ____	
		REPAIR CHOKE	
		REPAIR HEAT RISER/HEATED AIR INLET	
		REPAIR A.I.R. SYSTEM/COMPONENTS	
		TEST COMPRESSION ( )( )( )( )( )( )( )( )	
		OVERHAUL CARBURETOR	
		REPLACE CARBURETOR	
		TOTAL VOLUNTARY LABOR	
		TOTAL VOLUNTARY PARTS	
		TOTAL REQUIRED LABOR	
		TOTAL REQUIRED PARTS	
		TAX	
		TOTAL	

DESCRIPTION OF ADDITIONAL RECOMMENDED REPAIRS	ESTIMATE

DATE ____________ LICENSE NO. ____________ ODOMETER ____________

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OWNER'S SIGNATURE ____________

☐ I certify that the required maintenance indicated on the reverse side and in the procedures defined by the BAR have been performed.

AUTHORIZED SIGNATURE ____________ MVPC/ARD LIC.NO. ____________