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INFORMATION DOCUMENTS ON AUTOMOBILE EMISSIONS INSPECTION AND MAINTENANCE PROGRAMS

Final Report

by

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DISCLAIMER

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PREFACE

The Clean Air Act Amendments of 1977 (Public Law 95-95) require the Environmental Protection Agency to make available to appropriate Federal agencies, states, and air pollution control agencies information regarding processes, procedures, and methods to reduce or control motor vehicle emissions by inspection and maintenance programs (Section 108 (f) (1) (A) (i)). This document therefore is intended to provide basic and current information to those who have little knowledge of the subject area and to provide reference information and guidance for those who wish to pursue specific inspection/maintenance topics further. A bibliography is included.

ABSTRACT

This document provides information on motor vehicle emissions testing programs, usually referred to as inspection/maintenance programs. Based upon the most recent and reliable information available, background information on these programs and a review of the major issues in this area are presented More specifically, the effectiveness, costs, and the environmental, energy, and economic impacts of inspection/maintenance programs are discussed.

In addition to the main text, a comprehensive bibliography area is presented. Fact sheets on existing inspection/maintenance programs are also included.

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Advanced spark timing increases hydrocarbons.

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The following metropolitan areas do not currently have SIP requirements for I/M.

Missouri	-	St. Louis
Nevada	-	Las Vegas (rulemaking is proceeding) Reno (rulemaking is proceeding)
New Jersey	-	Remainder of state outside New York City, Philadelphia, and Trenton metropolitan areas
Rhode Island	-	All
Texas	-	Dallas

The following metropolitan area has had both a SIP requirement and preliminary review or research.

Texas - San Antonio

The following metropolitan area has had preliminary review or research.

Georgia - Atlanta

SECTION 1

INTRODUCTION

This document presents information on inspection/maintenance programs, a means of reducing vehicular emissions which has been successfully adopted by several states. The increased interest in this strategy has led to a need for an inspection/maintenance primer. It is this need to which this report is addressed.

The objectives or purposes of this compendium are twofold. First, it is to provide basic information on a number of both the technical and nontechnical aspects of I/M and, second, to do so in a manner which is virtually free of esoteric terms. Such information will hopefully be of use to both policy makers and interested citizens.

RESEARCH METHODOLOGY

The discussion which follows is based upon a review of literature obtained from a variety of sources. Among those contacted were the following:

- agencies and individuals responsible for the planning, implementation, operation, and analyses of existing and proposed I/M programs for various locales throughout the country;
- individuals at private facilities responsible for the conduct of research programs involved with the technical issues of I/M;
- manufacturers of vehicle emission inspection instrumentation;
- individuals at those federal, state, and local government agencies responsible for enforcement, technical, and policy issues.

From the articles, data, and miscellaneous information thus obtained, key topics were selected for review. The resulting discussions present the major elements essential to the understanding of each of the topics covered.

REPORT ORGANIZATION

The report is organized as follows. Section 2 discusses the purpose of inspection/maintenance programs and Section 3 presents the benefits which result from their implementation. The various approaches to I/M programs are discussed in Section 4. The implementation of I/M programs is presented in Section 5. Section 6 discusses some of the problems associated with I/M.

Section 7 provides fact sheets on existing I/M programs. A bibliography and glossary are included as appendices to the report.

SECTION 2

PURPOSE OF INSPECTION/MAINTENANCE PROGRAMS

Inspection/maintenance (I/M) is a program designed to check pollutant emission levels of motor vehicles with respect to certain emission standards and to adjust to those standards or below the vehicles which fail. The resulting emission reductions can be an important contribution towards the meeting of National Ambient Air Quality Standards (NAAQS) for transportation-related pollutants. Thirty-three Air Quality Control Regions (AQCR's) have been found by EPA to need automotive inspection/maintenance (I/M) programs in order to meet air quality requirements under Section 110 of the Clean Air Act. Recently acquired data suggests that many more AQCRs may eventually need such programs to meet the clean air requirements.

Inspection/maintenance is, of course, only one of several options available for the control of automobile-related pollutants. Given the extent of air pollution in many areas of the United States, no one measure can be expected to completely solve a given air pollution problem. Therefore, the key question to be asked about any given control is not whether it alone can solve the problem, but rather can the strategy act to reduce pollution in a relatively nondisruptive manner. As discussed below, I/M programs represent a reliable and common sense approach to cleaner air.

One of the first things to bear in mind concerning inspection/maintenance is that it supplements the existing Federal Motor Vehicle Emission Control Program (FMVCP). The FMVCP is composed of the following three primary elements:

- Certification Program - Certification of new vehicles prototypes to show that they are designed to meet Federal emissions standards.
- Selective Enforcement Auditing - Assembly-line testing to assure that production copies of vehicles meet standards when new.
- Recall - Requirement that manufacturers recall vehicle types found through in-use surveillance to fail standards because of defects in design.

The objective of these programs is to provide consumers with motor vehicles which can meet emission standards when the motor vehicles are properly maintained and operated.

While it is the manufacturers' responsibility to produce motor vehicles engines with emission control devices and systems with no defects, the warranty provisions of the Clean Air Act do not provide for pollution-free or maintenance-free vehicles. Emission control devices, like other components of an automobile, require periodic maintenance and adjustment.

Even with these federal enforcement programs, many vehicles are not meeting emissions standards for the following reasons:

- Many in-use vehicles are found with disabled control systems. Emission control equipment may be deliberately disconnected and adjustments varied to affect vehicle performance.
- Many owners are not aware of proper vehicle maintenance schedules and requirements. Emission-controlled vehicles which meet manufacturers' specifications would generally be low emitters.
- Not all vehicles can be inspected at the end of the assembly line. Vehicle types that pass certification may be assembled within reasonable tolerances. However, some vehicles may still not meet standards.

In short, if motor vehicles are to continue to meet emission standards after they have been in use, they must receive periodic maintenance. An inspection/maintenance program would ensure that vehicles are properly maintained. Thus, inspection/maintenance is an integral part of a comprehensive motor vehicle emission control program. Its goal is to increase the frequency and quality of the maintenance of motor vehicles and thereby reduce average emissions per vehicle mile traveled. Implementation of I/M is also attractive for the following reasons.

First, the proper implementation of an inspection/maintenance program ensures that, other things being equal, total automobile related pollutants for a given fleet will decline. This is important since it has, at least in the past, been relatively difficult to induce people to make less use of their automobiles. This is not to say that strategies such as transit improvements, carpooling and vanpooling, and parking control have not been proven to be successful in several instances. However, the extent of their success is limited to the number of people who actually stop using their automobiles. This is difficult to predict. On the other hand, the success of I/M in reducing emissions can be determined given the number of vehicles inspected, the emission standards established, and the frequency of inspection. In short, there are fewer unknowns associated with an I/M program.

Secondly, I/M provides an incentive for an individual to keep his automobile in good operating condition. It requires only that necessary maintenance be performed. As such, it provides a payoff to automobile owners in terms of improved fuel economy and the potential for long-term improved vehicle performance and longer vehicle life.

Lastly, the ability to administer I/M has been demonstrated in several different areas already. It involves a number of different agencies and thus allows for certain managerial economies. Typically, the state air pollution control agency can run an I/M program in conjunction with the department of motor vehicles or the state police. This limits any major problems involving overlapping functions. In addition, few additional administrative staff are required. Approximately nine new hires, including clerical workers, are needed to administer a centralized I/M program covering approximately one million vehicles.[1]

In conclusion, I/M would appear to be a very reasonable control measure. It does not interfere with existing socioeconomic patterns but instead acts only as an inducement to keep motor vehicles in good operating condition. Of all of the air pollution control measures, I/M is one of the most intuitively appealing.

REFERENCES

1. Kincannon, B. F., A. H. Castaline, K. U. Hill, and D. A. Lynn. Viable Alternative Types of Inspection/Maintenance Program for St. Louis. Prepared by GCA/Technology Division for U.S. EPA under Contract No. 68-02-1376, Task Order No. 28. June 1977.

SECTION 3

BENEFITS OF INSPECTION/MAINTENANCE PROGRAMS

The extent to which an inspection/maintenance program reduces the emissions from motor vehicles depends upon the specific features incorporated into the program. Moreover, the rate at which emissions-related repair work deteriorates also how a major bearing upon the magnitude of emission reductions. This section discusses these two major determinants of the benefits of an I/M program. In addition, the costs associated with I/M are presented and a further benefit is discussed - namely the warranty provisions under the Clean Air Act.

PROGRAM DETERMINANTS OF EMISSION REDUCTION POTENTIAL

Minimal Program Requirements

In order to obtain full emission reduction benefits from an I/M program, certain minimum requirements must be met:

- All vehicles for which emission reductions are claimed must receive regular, periodic inspections
- To ensure that failed vehicles receive the maintenance necessary to achieve compliance with the inspection standards, they should be required to pass a retest following maintenance
- Quality control measures, such as routine maintenance, calibration and inspection of all I/M equipment, and routine auditing of inspection results, must be followed to ensure the reliability of the inspection system and accuracy of the equipment.

Program Options

Beyond the minimum requirements, various other facets of a program can influence the emissions reductions to be achieved.

Type of Inspection--

While currently available data indicate no overall difference in the CO or HC emission reductions obtained through the use of loaded or idle mode testing, loaded mode testing is considered to be a better indicator of the actual emissions of the vehicle in-use and it provides better diagnostic information. In addition, a loaded mode emission test has the potential to measure oxides of nitrogen from automobile emissions and should therefore be considered in areas where there is a defined NO_x problem.

Tampering Inspection--

Various engine components and emission control devices can deteriorate or be disabled and have no noticeable effect on the way the car drives or its fuel consumption. Such conditions, however, will lead to major adverse effect on vehicular emissions. Malfunctioning vehicles may go unrepaired for thousands of miles before overt indications of disrepair are noticed by the operator. In many cases, these malfunctions result from deliberate actions of the operator or an operator's agent to vary the operation of the motor vehicle.

To guard against deliberate tampering, the Federal Government and many states have adopted Motor Vehicle Emission Control legislation which includes clauses prohibiting the operation of motor vehicles when air pollution control devices have been removed, altered or rendered inoperative. The status of state antitampering laws are presented in Table 1. These laws are virtually ineffective in most situations, since the existence of a strong deterrent to tampering does not exist.

The performance of a tampering inspection as part of an I/M program could represent a suitable deterrent to tampering since there exists the threat of not meeting the I/M emission standards. In this respect, a tampering inspection program in conjunction with an emissions inspection could result in additional reduction in total vehicular emissions. The exact amount of such reduction would depend upon the sophistication of the tampering inspection.

Mechanics Training--

The air quality benefit from an I/M program is dependent, in part, on the ability of the service industry to properly perform the repair work necessary to lower emissions. Depending on the level of service industry training, emissions could be reduced just to the levels which would pass the I/M test or well below them. Some savings in repair costs may also result from the training since the mechanics would be familiar with the problems and the best solutions.

Vehicle Exemptions--

The total emission reductions that result from the program are directly dependent on the number and types of vehicles inspected and the requirement that maintenance be performed. I/M programs are generally designed around automobiles and other light-duty vehicles; however, motorcycles and heavy-duty trucks can also be included to provide additional emission reductions. In some cases, it may be desirable not to require repairs on old cars when the repair work would cost a major percentage of the car's value.

Frequency of Testing--

In order to determine how frequently vehicles should be inspected for emissions, it is necessary to know about how long emission-related repair work - such as correction of carburetion - is likely to last. The increase

TABLE 1. STATUS OF STATE MOTOR VEHICLE ANTITAMPERING LAWS*

State	Antitampering law		State	Antitampering law	
	Yes	No		Yes	No
Alabama	X		Nebraska		X
Alaska		X	Nevada	X	
Arizona	X		New Hampshire	X	
Arkansas	X		New Jersey	X	
California	X		New Mexico		X
Colorado		X	New York	X	
Connecticut	X		North Carolina	X	
Delaware		X	North Dakota		X
Florida		X	Ohio		X
Georgia		X	Oklahoma	X	
Hawaii	X		Oregon	X	
Idaho	X		Pennsylvania	X	
Illinois	X		Rhode Island		X
Indiana		X	South Carolina		X
Iowa		X	South Dakota	X	
Kansas	X		Tennessee		X
Kentucky		X	Texas	X	
Louisiana		X	Utah	X	
Maine	X		Vermont		X
Maryland	X		Virginia	X	
Massachusetts	X		Washington	X	
Michigan		X	West Virginia		X
Minnesota		X	Wisconsin	X	
Mississippi		X	Wyoming	X	
Missouri	X		District of Columbia		X
Montana	X				

*This information is current as of September 1977.

in emissions from the time of repair or tune-up is known as deterioration. Obviously, once pretune-up levels are reached, further maintenance is required to offset continued deterioration. Several studies have been conducted in the area of deterioration, and a fairly broad range of estimates on the length of time emission related repairs last has resulted.

Most existing I/M programs require annual inspection. This frequency is justified on the basis that it minimizes costs and maximizes public acceptance while maintaining a reasonably high level of emission reduction. A semi-annual program would involve substantially higher program costs arising from the need for a greater number of inspection lanes, as compared to an annual inspection program. A biannual program, while certainly providing some emission benefits, will lose some of the effectiveness of an annual program because cars are allowed to deteriorate to a higher level.

Emission Standards--

Most importantly, the I/M emission standards, or "cut points," determine the overall emission reduction potential of the program. The cut point is the level of emissions which distinguishes between those vehicles requiring emissions-related maintenance and those that do not. The cut points that are selected define a "stringency factor" which is a measure of the rigor of the program based on the estimated fraction of the vehicle population whose emissions would exceed cut points for either or both carbon monoxide and hydrocarbons.

There are two basic concerns that constrain the selection of I/M emission standards. As mentioned previously, the I/M emission standards determine the emission reduction potential. As such, I/M standards or "cut points" should be set to achieve a desired emission reduction. On the other end, the cut point should be limited to a level that will be acceptable to both the general public and the repair industry. As experienced by other programs, negative public sentiments may result if an excessive volume of vehicles do not comply with I/M standards at first inspection. Further difficulties will arise if the total of the noncomplying vehicles exceed the available capacity of the repair industry. The necessary vehicle maintenance will be compromised under these conditions. Cut points must be set at a level where potential emission reduction benefits are maximized while impacts to the public are minimized.

Appendix A provides a compliation of emission standards for the existing I/M programs. Details on specific state I/M programs can be found in the Fact Sheets of Section 7. Each state currently conducting an I/M program has spent considerable time and effort, either by conduct of demonstration programs or by evaluation of standards developed by others, analyzing data to develop an optimal set of emission standards. When developing standards, these states were concerned with achieving certain emission reductions while still gaining full public acceptance. These standards are continuously being reviewed for appropriate revisions.

As stated above, emission reductions achieved with any particular I/M program are a result of a combination of the emission reductions obtained through the optimal selection of various options. Tables 2 and 3 list, for HC and CO respectively, credits in percent emission reductions that can be achieved through inspection/maintenance programs. The "basic" reductions (i.e., those that are achieved through an annual inspection of light-duty vehicles) are broken down by Technology I and Technology II vehicles. Technology I vehicles include those light-duty vehicles subject to pre-1975 federal emission standards; Technology II vehicles are subject to 1975 and later model year federal exhaust emission standards. The percent reductions given in Tables 2 and 3 for mechanics training and semi-annual inspections (as opposed to annual) are additive to the other emission reductions. The percent reductions for Technology I, Technology II, heavy duty, and motorcycles and light duty trucks must be applied separately to each class of vehicle included in the I/M program and then a weighted average, based on the vehicle type distribution, is used to provide the overall emission reductions obtained through the I/M program. (The reader is referred to the proposed revision of Appendix N (FR 24(89): 22177-22183, May 2, 1977) for a more detailed discussion. The final revised Appendix N should be consulted when it appears in the Federal Register.

EMISSION DETERIORATION

Emission deterioration refers to the increase in vehicle emission rates over time from the levels at which the vehicles were intended to emit when new. Emission deterioration includes changes in emissions due to normal wear of engine/emission control components as well as changes in emissions due to tampering or poor maintenance. Since both vehicles exposed and not exposed to an I/M program will experience emission deterioration, the question is how much less deterioration occurs as a result of an I/M program.

Not only is the absolute emission level to which vehicles rise important, and the time it takes them to rise to it, but the shape of the deterioration curve can be quite significant in affecting the benefits from the emission control devices and the I/M program. For example, there could be a very rapid initial deterioration (possibly due to tampering) with a gradual leveling off. Such deterioration would negate most of the benefits of the I/M program. Conversely, the deterioration could be very slow for most of the year with a rapid climb at the end. This would mean much larger benefit as a result of the program. Possible deterioration rates are diagrammed in Figure 1.

The only major study to date has indicated that deterioration is more likely to be very slow for most of the year with a rapid climb at the end.[1] Thus, the overall effectiveness of I/M in the first year of the program would be approximately 70 percent of the immediate reduction following repair at the start of the year. Although this study is not definitive, it concludes that previous deterioration estimates with I/M may be too high.

A subjective analysis was done of the theoretical differences between I/M and non-I/M fleets that could affect deterioration rates. It is felt that a lower deterioration rate could be achieved by an I/M fleet because of better and more frequent maintenance. The emissions of vehicles not meeting cut points should improve, while the emissions of all vehicles across the board should benefit because the quality of maintenance services should

TABLE 2. FIRST YEAR PERCENT EMISSION REDUCTION OF HYDROCARBONS THROUGH INSPECTION/MAINTENANCE PROGRAMS

First year

Stringency factor	Vehicle type: Technology I	Vehicle type: Technology II	Vehicle type: Motorcycles and light-duty trucks	Vehicle type: Heavy-duty trucks	Additional benefits: Mechanics training Technology I	Additional benefits: Mechanics training Technology II	Additional benefits: Semiannual inspection
0.10	1	1	1		1	3	0.2
0.20	5	3	5	11.4	3	5	0.2
0.30	7	9	7	12.3	4	4	0.2
0.40	10	16	10	15.6	6	1	0.2
0.50	11	24	11	17.2	7	1	0.2

Subsequent years program credits

Number of inspections	Additive credit HC (percent)	Additional benefits: Stringency factor	Additive credit HC (percent), Mechanics training: Technology I, Inspections 2	Technology I, Inspections 3 or more	Technology II, Inspections 2 or more
2	7	0.10	3	15	10
3	14	0.20	4	10	8
4	20	0.30	6	9	2
5	25	0.40	5	5	1
6	30	0.50	3	3	1
7	33				
8 or more	36				

Source: U.S. Environmental Protection Agency; Appendix N Emission Reduction Achievable Through Inspection and Maintenance of Light-Duty Vehicles, Motorcycles, and Light and Heavy-Duty Trucks. Proposed Rule. Federal Register, 24(84): 22177-22183. Monday, May 2, 1977.

TABLE 3. FIRST YEAR PERCENT EMISSION REDUCTION OF CARBON MONOXIDE THROUGH INSPECTION/MAINTENANCE PROGRAMS

First year

Stringency factor	Vehicle type: Technology I	Vehicle type: Technology II	Vehicle type: Motorcycles and light-duty trucks	Vehicle type: Heavy-duty trucks	Additional benefits: Mechanics training Technology I	Additional benefits: Mechanics training Technology II	Additional benefits: Semiannual inspection
0.10	3	8	3		5	7	0.2
0.20	8	20	8	8.3	7	10	0.2
0.30	13	28	13	9.2	9	10	0.2
0.40	19	33	19	10.5	8	7	0.2
0.50	22	37	22	12.0	7	5	0.2

Subsequent years program credits

Number of inspections	Additive credit CO (percent)	Additional benefits: Stringency factor	Additive credit CO (percent) Mechanics training: Technology I Inspections 2	Technology I Inspections 3 or more	Technology II Inspections 2 or more
2	8	0.10	3	13	4
3	15	0.20	8	15	2
4	19	0.30	5	9	1
5	23	0.40	5	5	3
6	27	0.50	2	2	1
7	30				
8 or more	35				

Source: U.S. Environmental Protection Agency; Appendix N - Emission Reduction Achievable Through Inspection and Maintenance of Light-Duty Vehicles, Motorcycles, and Light and Heavy-Duty Trucks. Proposed Rule. Federal Register, 24(84): 22177-22183. Monday, May 2, 1977.

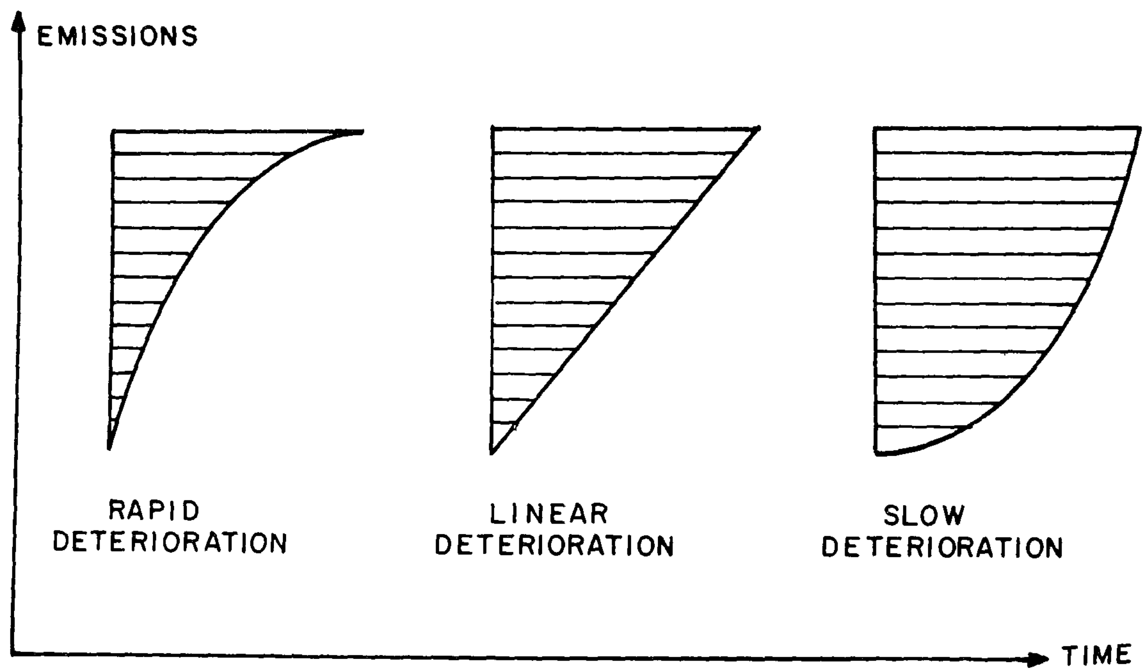

Figure 1. Possible post maintenance deterioration functions.

gradually improve. It is also believed that secondary deterioration (i.e., malfunctions that occur due to the existence of other defects) will decrease in relative proportion to the extent that defective vehicle components exist and are identified and repaired properly. Affecting these benefits, is the possibility of increased tampering in response to driveability problems occuring when the vehicles are adjusted to low emission levels.

To be on the conservative side while not refuting available information, deterioration over time is assumed to be a linear function. In other words, the rate of deterioration (grams/kilometer/year) for a given pollutant and vehicle is constant over time. However, a further study is currently proceeding to collect additional data to confirm or reject present beliefs.[2]

COST EFFECTIVENESS OF INSPECTION/MAINTENANCE

Cost

The costs of inspection facilities vary according to the elaborateness of the program and the existing nature of any safety program in the area. In terms of capacity, for a state or contractor-operated program, one idle mode inspection lane is required for every 30,000 vehicles coming under the program.[3] Given the longer time required for a loaded test, one loaded mode facility is needed for every 25,000 vehicles.[3] In Arizona, which has a very elaborate program with loaded mode capabilities, the average capital cost per inspection lane was approximately $250,000. The program operating cost in Arizona is $500,000 per year. The Portland, Oregon idle mode program is an example of a less costly approach. Only one station was actually built for the program, with construction costing $77,000. Located on a State right-of-way this station has loaded-mode and safety testing capabilities. The other four permanent facilities are leased. Four mobile vans are used in addition to the permanent sites, each van, complete with equipment, costing $40,000. The total cost of the 29 analyzers purchased for these permanent and mobile facilities was approximately $200,000. Operating costs in Portland vary from $1.45 million in an "on" year, to $0.8 million in an "off" year. Inspection in Portland is biennial at this time. Other costs mentioned in the fact sheets on existing I/M programs in Section 7 of this report point up the fact that a wide range of program costs exist. Whatever they are, however, these costs are borne by the state or, if a contractor approach is selected, by the private firm. In either case, however, the operating costs and repayment of the initial investment would be covered by revenues derived from a fee charged the motorist having his vehicle inspected. Experience has shown that most inspections cost between $4 and $10, with the higher figure including both emissions and safety inspection.[4]

This same range of fees would also apply to a privately-run system where service stations and garages are performing the emissions test. Here the fee would be used to offset the cost of an emission analyzer and the labor required to do the testing.

In addition to the inspection fee, those individuals whose vehicles do not meet the emission standards will incur repair costs. The available data show that costs of the repair have been reasonable in those areas where I/M

TABLE 4. FUEL SAVINGS FROM INSPECTION/MAINENTANCE PROGRAMS*

Failure rate (x)	Annual fuel savings-serviced vehicles only* (y) (%)	Annual fuel savings-serviced vehicles only* (y) (gallons)	Dollar savings per serviced vehicle	Annual fuel savings-all vehicles (%)	Annual fuel savings-all vehicles (gallons)	Dollar savings per vehicle-all vehicles
50%	4.2	36	21.40	2.1	18	10.70
40%	4.73	40	24.00	1.89	16	9.60
30%	5.5	47	28.00	1.65	14	8.40
20%	6.76	57	34.40	1.35	11	6.85
10%	9.66	82	49.30	0.97	8	4.90

*All savings based on national averages of 11,500 vehicle-miles per year and 13.58 mpg. Cost of fuel assumed at $0.60 per gallon.

Source: U.S. Environmental Protection Agency. Inspection/Maintenance Binder of Background Materials. April 1976.

programs have been established. In New Jersey, the average cost of repairs has been under $35 while in Arizona and Portland, Oregon the average costs have been less than $25 and $15, respectively.[5] The actual number of vehicles requiring maintenance as well as the cost is determined by the stringency of the emissions standards established by the state.

The improved fuel economy resulting from a well-maintained vehicle will offset, in many cases, the costs incurred by motorists under an I/M program. Information on this is contained in Table 4. This shows dollar savings for several vehicles and for the entire vehicle population under an I/M program.

Effectiveness

Approximately one-half of the hydrocarbon and virtually all of the carbon monoxide emissions come from mobile sources. An I/M program can reduce these emissions substantially. The extent to which these are reduced is presented in Tables 2 and 3 which appear in the preceding pages.

WARRANTY PROVISIONS

The Emission Control System Performance Warranty contained in Section 207(b) of the Clean Air Act provides warranty coverage to motorists in areas having an I/M program. The Emission Performance Warranty, upon promulgation of regulation by EPA, will require the automobile manufacturer to bear the cost of repair of any properly maintained and operated vehicle which fails an EPA established emissions test within 24 months or 24,000 miles, whichever occurs first, of the original sale to the ultimate purchaser. After this period, the warranty applies only to catalytic converters, thermal reactors or other components installed on or in a vehicle for the sole or primary purpose of reducing vehicle emissions. These warranty provisions are thus an additional benefit to individuals residing in areas with an I/M program.

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4. U.S. Environmental Protection Agency, Region I. A Citzens Guide to Automotive Inspection. 1977.

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SECTION 4

ALTERNATE APPROACHES TO INSPECTION/MAINTENANCE

TYPES OF INSPECTION APPROACHES

The following are the five recognized inspection alternatives for an inspection/maintenance program.*

- Idle mode test conducted at state inspection stations.
- Idle mode test conducted at inspection stations operated by a contractor to the state.
- Idle mode test conducted at privately owned service stations and garages.
- Loaded mode test conducted at state inspection stations.
- Loaded mode test conducted at inspection stations operated by a contractor to the state.

As displayed by the above listing, there are two major features to the inspection phase of an I/M system. There are the nature of the test and the way in which the test is administered.

Nature of the Emissions Test

The minimum requirements of an in-use vehicle emissions test are that it be short, applicable to warmed-up vehicles, and able to identify high emitting vehicles. Two distinct emission testing procedures which satisfy these criteria have been developed for measuring exhaust emissions. These are the idle mode and the loaded mode tests. Table 5 provides a comparison of the short test procedures. They have been the only short tests used in programs directly affecting the inspection of vehicles owned and operated by the general public.

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*Mandatory maintenance, to the extent that it does not require periodic inspection of motor vehicles, has been omitted from this list. A mandatory maintenance program requires that all vehicles undergo specific maintenance procedures designed to ensure compliance with emissions standards. The maintenance is performed by authorized garages.

TABLE 5. COMPARISON OF SHORT TEST PROCEDURES FOR EMISSION INSPECTION

Short test	Cycle description	Cycle test time	Special test equipment required	Instrumentation required	Applications to date
Idle mode	Idle in drive and/or freewheeling at 2500 rpm	< 30 sec	None	HC and CO exhaust gas analyzers	N.J. Test lane; Nevada, Portland, Ore., Chicago, Cincinnati, Calif.-roadside: Calif.-end of assembly line
Loaded mode: steady state (Clayton Key mode, Federal Three mode)	Steady-state at high cruise, low cruise, idle in drive	60 sec	Chassis dynamometer (single power absorption curve)	HC, CO, and NO_x exhaust gas analyzers	Arizona, Riverside, Calif., Washington, D.C. test lanes
Loaded mode: transient (NJ/NY composite cycle, Federal short cycle)	Consist of accelerations, cruise, decelerations, and idle in drive	75 to 125 sec	Chassis dynamometer (variable inertia and power absorption with automatic test settings)	CVS sampling system – HC, CO, and NO_x gas analyzers with computerized data reduction	

The idle mode test is the test of the exhaust emissions with the vehicle in a neutral gear and the engine at idle. Often, hydrocarbon (HC) and carbon monoxide (CO) levels are recorded at both a normal and high idle speed. The test at the normal idle speed is taken at the manufacturers' recommended idle, measured in revolutions per minute (rpm), and then the engine speed is increased to 2,250 (±10 percent) rpm for the high idle speed test. The standards must be at both levels.

The loaded mode test is the test of the exhaust emissions with the vehicle in a forward drive gear and operating at simulated driving conditions. Pollutants are measured at various test conditions as specified by a testing procedure. Two types of testing procedures exist: steady state and transient. The steady state loaded mode test is a test of emissions at high cruise, low cruise, and idle mode operating states. A chassis dynanometer loads the vehicle to simulate these driving conditions. Both the Clayton Key mode and the Federal Three mode are acceptable steady state tests. The specifications for each test aggregate all light-duty vehicles by weight classes. The actual performance of the test depends upon the speed and load factors specified for each testing state for each weight class. Emissions are measured by the volumetric procedure; i.e., by a standard exhaust emission analyzer. The vehicle is operated in each mode until the emissions stabilize.

The transient loaded mode test collects a composite emission sample from a specified driving schedule. The composite sample is collected into a Constant Volume Sample (CVS) unit for further analysis to determine pollutant concentration. Again, a chassis dynamometer loads the vehicle to simulate the desired driving schedule. However, for this test, the dynamometer must be capable of performing at variable inertia weights and road load settings. The driving schedule for the transient test simulates a portion of an urban driving cycle. Two acceptable cycles are the Composite New Jersey/New York test and the Federal Short Cycle test. The Federal Short Cycle is a 9-mode CVS test of 125 second duration while the New Jersey/New York Composite test is a 6-mode CVS test requiring 75 seconds as specified below:

New Jersey/New York composite test

Mode	Time in mode, seconds
Idle	22
0 to 30 mph acceleration	15
30 mph cruise	15
30 to 10 mph deceleration	12
10 mph cruise	7
10 to 0 mph deceleration	4
	75

Loaded mode testing is a better indicator of actual emissions since it involves the simulation of actual driving conditions. In addition, the simulation has the capability to provide better diagnostic information to a mechanic in terms of actual engine maladjustments and malfunctions. These advantages come at the expense of greater testing cost due to the need for a chassis dynamometer. The time required to test a vehicle is also increased.

In addition, the transient test is expected to yield better correlation than the steady state test with respect to Federal Test Procedure (FTP) emissions. However, the transient type test is more expensive to perform and requires more time.

The idle mode test also provides a viable method for identifying vehicles with high emission levels. This test procedure is simple to perform and requires relatively little technician training. Inspection lanes which use the idle mode test will have a greater capacity and thus will result in lower costs per vehicle inspection. An additional advantage of this test is that it can be easily duplicated at service garages to confirm that emission-related maintenance has been successful. While the idle mode test does not give as much diagnostic information as the loaded test, other considerations, such as cost, may justify the selection of this test procedure.

Table 6 summarizes the characteristics of idle and loaded mode testing procedures. The U.S. EPA and private research organizations have found idle mode testing to be virtually as effective as the loaded mode test in identifying gross emitters, and thus a viable inspection technique.

Administration of the Test

An I/M program can be conducted at either a network of centralized inspection lanes or a network of certified private garages. A public authority can be delegated the responsibility of establishing the network of centralized inspection lanes, or a contractor may be commissioned to design, finance, construct and operate the program. The contractor is selected through a competitive bid process and is monitored by and accountable to the responsible state agency. A third alternative is to license and certify private service stations and garages to operate the program using their existing facilities. These facilities would also be monitored by and accountable to the public authority responsible for overall program administration. A fourth alternative is to have a system with some combination of testing at both central lanes and private garages. In New Jersey, for example, the initial testing is performed at the state operated lane while the retesting of vehicles is done either at central lanes or certified garages. Rhode Island's program has testing done at private garages with a central station run by the state serving as a referee lane.

Each alternative has its advantages. The private garage approach provides the greatest convenience to the public. Since inspection and maintenance can be accomplished with one stop, indirect costs to the consumer are minimized. Test lanes constructed by governmental authority are designed for high capacity. This high capacity and the economy of constructing multilane testing centers

TABLE 6. CHARACTERISTICS OF IDLE MODE AND LOADED MODE TESTING

Idle mode testing	Loaded mode: steady state test	Loaded mode: transient test
1. Simple test procedure which requires minimum training for inspectors	1. Engine operated under simulated road cruise conditions	1. Engine operated under simulated urban driving cycle
2. Carburetor adjustments can be made during test	2. Includes idle test	2. Expected to provide closest correlation with FTP CVS emissions
3. Diagnosis of some engine maladjustments and malfunctions	3. Additional diagnostic information to repair facility	3. Variable inertial and power absorption dynamometer required
4. Can be duplicated by either public or private test systems	4. Requires dynanometers and other additional equipment	4. Driving cycle difficult to repeat accurately: cycles cannot be averaged
5. Requires minimal test time and equipment	5. Test cannot be duplicated in most repair facilities due to lack of dynamometer	5. Test cannot be duplicated in most repair facilities
6. Malfunctions that occur under loaded conditions may not be detected	6. Requires more test time	6. Computer needed for rapid on-line data analysis; i.e., high initial costs

can result in lower inspection costs. In addition, a central test lane approach lends itself to simplied data handling and greater quality control. A private firm contracted by governmental authority to construct and operate the facilities reduces the financial burden of raising public funds for capital investments

EMISSION TESTING INSTRUMENTATION

The emission testing instrumentation required is dependent upon the emission testing procedure selected for use. As mentioned previously, an idle mode test requires only an exhaust gas analyzer while the loaded mode test has the additional requirement of a chassis dynamometer.

Exhaust Gas Analyzers

The exhaust gas analyzer is central to the objectives of an Inspection and Maintenance program. The instrument must be reliable and be easily calibrated in order to assure the quality of emission testing. Accuracy and repeatability of all inspection lane and repair industry analyzers is crucial to system efficiency.

The use of the basic analyzer is quite simple. A probe is inserted into the vehicle tail pipe. Sensors on the probe detect the presence of pollutants in the vehicle exhaust and relay their relative quantities to the analyzing mechanism of the instrument. The actual pollutant concentrations are then displayed by two meters located on the instrument's face. One meter indicates the carbon monoxide concentration, and the other the concentration of hydrocarbons in the vehicle exhaust.

The potential for significant variability in emission measurements exists among instruments manufactured by either the same or different manufacturers. Because of this variability, basic specification criteria have been developed to minimize the effects. Various public agencies have performed analyzer certification programs, distributing to the repair industry and others their lists of approved exhaust gas analyzers.

As with other types of analytic equipment, periodic maintenance and calibration is essential if accurate measures of emissions are to be obtained from the analyzer.

Chassis Dynamometer

A chassis dynamometer is required, in addition to an emission analyzer, if a loaded mode test is performed. The dynamometer consists of two rollers, upon which a vehicle's driving wheels are placed. As the wheels of the vehicle are rotated, the dynamometer produces a drag on the engine, thus simulating actual on-the-road operation.

Instrumentation Availability and Cost

The necessary technology for conducting vehicle inspections and required maintenance has reach a point where a full range of alternate systems are available. These instruments have been developed by the industry in response to the recent demand for low cost exhaust analyzers. At the present time, nearly 100 exhaust analyzer models are marketed by more than 25 different manufacturers and distributors. There are a large number of good instruments available to the repair industry within a cost range of $2,200 to $2,800 each. States no longer need to sponsor an extensive instrument development and evaluation effort.

Chassis dynamometers were developed before vehicle emissions testing became necessary and are used for a number of purposes. For example, they are used to evaluate new and reconditioned engines, braking systems, transmissions and drive chains, and to measure engine efficiency. Dynamometers are available from a number of manufacturers at a cost of approximately $10,000 per unit.

EMISSION MAINTENANCE REQUIREMENTS

The other major aspect of an I/M program is, of course, the maintenance phase. This involves the repair of those vehicles which were identified during inspection as high emitters. The quantity of repair work is dependent upon, in addition to the I/M emission standards, the level of preventive maintenance provided by vehicle owners. The quality of repair is the responsibility of the automobile service industry.

Preventive maintenance is required on a regular basis if a motor vehicle is to remain in top operating condition. The recommended maintenance materials provided by automobile manufacturers include timetables for the inspection, maintenance, and adjustment of critical components. The malfunctioning or maladjustment of certain of these components can cause the vehicle to be a high emitter. Unfortunately, because of oversight or cost considerations, many vehicle owners do not have this preventive maintenance done as scheduled. Instead, some wait until degradation in vehicle reliability, driveability, or performance is noticeable. One result of this is that vehicle emissions may increase. To the extent that many owners do not have preventive maintenance work performed on their vehicles, more may have to have repair work done until an I/M program. Thus, an I/M program provides the mechanism for identifying substandard vehicle operations and provides the impetus for vehicle owners to maintain the operating efficiency of their vehicles.

It is the responsibility of the automobile service industry to locate and repair any malfunction or maladjustments in the engine or emission control system which cause a vehicle to have excessive emissions. Automobile mechanics must be knowledgeable of and proficient in the use of diagnostic tests in order to identify any improperly operating engine component or system. Further, mechanics must also be capable of providing the repair needed to bring a vehicle into compliance with the I/M emission standards. Obviously, mechanics play a central role in the maintenance aspect of an I/M program. The possible consequences of having unknowledgeable mechanics include higher than necessary repair bills, lower than anticipated emissions reduction, or a combination of both.

Effect of Vehicle Systems on Emissions

A change in the operation of many vehicle systems and vehicle components can effect a change in emissions. Table 7 lists the most common of these systems and components, their mode of operation causing the change in emissions, and the resultant effect on carbon monoxide and hydrocarbon emissions. Carburetor problems and air-fuel mixture imbalance have proven to be the major causes of high carbon monoxide emissions. Malfunctions in the ignition system or associated components primarily result in high hydrocarbon emissions. Malfunction of the emission control devices including breakdown of the catalytic converter affect both pollutants. Table 8 summarizes the major causes of exhaust emissions.

Costs of Repair

Data on the types of repairs required to comply with an I/M program and the costs of these repairs have been compiled by the existing I/M programs. Table 9 presents the distribution of the types of repair as reported by the Portland, Oregon I/M program. Most repairs focus on carburetor and ignition systems malfunctions. These data are typical of reports emanating from I/M programs elsewhere. As reported by four programs, the overall average cost of repairs is approximately $27.00, though well over half these repairs fell under this figure. Detailed cost information from various programs is presented in Table 10.

TABLE 7. EFFECT OF ENGINE COMPONENT OPERATION ON EMISSIONS

Component	Change in emissions	
	Carbon monoxide	Hydrocarbon
Decreased air-fuel ratio	Increase	Increase
Decreased engine idle speed	Increase	Increase
Restricted PCV valve	Increase	Increase
Restricted air filter	Increase	Increase
Choke malfunctions	Increase	Increase
Carburetor malfunctions	Large increase	Increase
Ignition system malfunctions		Large increase
Advanced spark timing		Decrease
Stuck heat riser valve	Increase	
Exhaust valve leak		Increase
Intake manifold leaks	Increase	Increase
Emission control device malfunction	Increase	Increase
Catalytic converter breakdown	Large increase	Large increase

TABLE 8. MAJOR CAUSES OF EXHAUST EMISSIONS

Major causes of high carbon monoxide emissions are:

- Carburetor out of adjustment
- Air-fuel mixture imbalances
- Malfunction of emission control devices

Major causes of high hydrocarbon emissions are:

- Improper timing
- Ignition system malfunctions
- Malfunction of emission control devices

TABLE 9. TYPES OF REPAIRS REQUIRED*

Repair type	Percent undergoing repair
Carburetor adjustment	78
Tune-up	14
Engine overhaul	1
Valves	1
Other	6

*Reported by Portland, Oregon I/M program.

TABLE 10. REPAIR COST SUMMARY FOR EXISTING I/M PROGRAMS

New Jersey		Oregon	
Less than $10	29.7%	No cost	27%
$10 to $25	26.4%	Less than $10	37%
$25 to $50	22.1%	$10 to $30	18%
$50 to $100	16.1%	$30 to $50	8%
More than $100	5.6%	$50 to $75	5%
		More than $100	2%

New Jersey:

N = 16,000
Avg. repair cost = $32.40
Median: 50% of repairs cost less than $20
65% of repairs cost less than average

Oregon:

N = 1, 400 (primarily newer cars)
Avg. repair cost = 16.00
Median: 50% or repairs cost less than $8
71% of repairs cost less than average

Arizona	
Less than $5	27%
$5 to $10	17%
$10 to $25	24%
$25 to $50	20%
$50 to $100	10%
More than $100	2%

N = 2000
Avg. repair cost = $23.40
Median: 50% of repairs cost less than $15
64% of repairs cost less than average

Other data which have been collected indicate that the service mechanics have gradually improved their skills in emission related repairs. The fact that failure rate upon reinspection in New Jersey and elsewhere has declined supports this idea.

INSPECTION/MAINTENANCE OF HEAVY DUTY VEHICLES

Because of the overwhelming number of automobiles in urban areas, I/M programs have generally been considered primarily for light-duty vehicles. In addition, since many trucks are part of fleets and their proper running is important for business reasons, trucks are often better maintained. However, in some areas it may be desirable to include heavy-duty vehicles (gross weight greater than 8500 pounds) in the I/M program to obtain additional emissions reduction. Although the importance of truck emissions to overall vehicle emissions is dependent upon a number of factors (such as vehicle mix and miles traveled by each vehicle class), projections show that in the next 20 years truck emissions will become more important as the standards for light-duty vehicles become more stringent.

In assessing the applicability of various I/M approaches to heavy-duty vehicles, the following factors and special circumstances pertinent to the use and maintenance of such vehicles are important and should be considered:

- The number and density of heavy-duty vehicles in the region being considered, including the number registered outside the state(s) involved.
- The range of sizes, shapes, and weights included in the vehicle population.
- The Federal emission standards and test procedures applicable to the in-use vehicles at the time they were produced.
- A large part of the heavy-duty population is operated for commercial purposes. Lost time and the cost of unscheduled maintenance are more significant to the owners of heavy-duty vehicles than for most owners of light-duty vehicles.
- Fleet operation and maintenance are more common with heavy-duty than with light-duty vehicles.
- Heavy-duty chassis dynamometers are expensive and their availability is limited; therefore, experience with dynamometer testing of heavy-duty vehicles is quite limited.

New York City Department of Air Resources has been testing heavy-duty vehicles for several years to determine the effectiveness of I/M and retrofits for reducing heavy-duty emissions. The primary short test being used is the idle. Results should be available in 1978. Other approaches for controlling heavy duty emissions include spot checks on highways and mandatory maintenance of fleets.

INSPECTION/MAINTENANCE AND THE REPAIR INDUSTRY

The success of an I/M program is heavily dependent upon the quality of the work provided by the automobile repair industry. Consumer concerns with the industry include the chance of being exploited and the frustration of being rejected during reinspection. It is important that maintenance services be convenient, be of reasonable cost and be of quality workmanship. A great deal can be accomplished in the latter areas. Programs to improve the quality and cost of the mechanic's work include:

- training of emission inspectors
- mechanic training and certification
- repair facility certification

Training of Emission Inspectors

There are two major types of emissions inspectors. The first is the centralized lane inspector. This individual is employed by the locale or contractor to perform vehicular emission tests. His competence should be demonstrated by completion of a training program or examination. The emission inspector must be knowledgeable of such things as the operation and care for the inspection instrumentation, type and operation of emission control devices and engine components which contribute to excess emissions of HC and CO, and other test procedures; for example, safety and smoke detection. An EPA sponsored program conducted by Colorado State University developed an Emissions Inspectors Course for the training of emission inspectors. This course has been adopted by many vocational schools and community colleges, and has been used by I/M program personnel to train their inspectors.

The private service station inspector is the second group. Typically, these inspectors would be the mechanics who work regularly at these automobile repair facilities. These mechanics must become familiar with the above mentioned topics. The Colorado State University program is also applicable as an instructional program to qualify mechanics as emission inspectors. The proper training and certification of inspection personnel facilitates an objective and competent emission testing of motor vehicles.

Mechanic Training and Certification

Mechanic training increases the efficiency of the repair industry performance and is prerequisite to the effective testing and proper maintenance of vehicles. Familiarity with the emission test procedure and equipment promotes objective and competent testing as well as insuring that emission testing is uniform and consistent among stations. Mechanics need to understand the functioning and maintenance of emission control devices in addition to knowing which engine parameters affect emissions and how to tune minimize emissions.

Mechanic training helps alleviate the problems of ineffective repairs and excessive repair. The latter is caused by overadjustment by an uniformed mechanic in an effort to avoid missing the problem. For instance, California has developed a mechanics' handbook which describes a repair sequence, or step-by-step procedure, for each type of emissions failure. Mechanics are instructed to proceed only as far as the step that corrects the malfunction. This California program was developed to meet a legislative requirement that mechanics repair vehicles according to specifications established by the Bureau of Automotive Repair. The specifications are an attempt to eliminate the guess-work involved in repairs and also serve as a basis for the evaluation of repair work.

The training program should be composed of an informational seminar and technical workshops in which mechanics can gain practical experience. Mechanic certification could be contingent on the successful completion of an examination administered by the cognizant government agency. Preparation for the exam would involve participation in a technical training session or course-work at a local technical school. Materials from the Colorado State University Automotive Emission Control Technician Course can be applied to a program of this type.

Repair Facility Certification and Information Dissemination

The certification of repair shops for emission work serves two purposes. First, it gives vehicle owners some guarantee of the credibility and competence of the repair facility. Second, to retain its certification, a repair facility would be required to perform quality work. Certain criteria could be established upon which to base decisions concerning certification. Minimum criteria should include the employment of a certified mechanic and ownership (or leasing) of approved emission analyzer instrumentation. Additional requirements could be established with regard to the availability of tools and service manuals required to perform effective repairs. If certification of repair shops is impractical, the following alternatives are possibilities for implementation.

- The agency administering the I/M program can keep a record of complaints voiced by vehicle owners and investigate any problems which arise.
- Records of vehicles which fail reinspection upon maintenance can serve to identify those shops with a high incidence of inadequate repair work.
- Lists of service establishments with approved emission analyzers can be published to maximize the patronage of repair shops that can check the results of their work.
- Repair facilities can be merely licensed on the basis that the facility (1) employs at least one mechanic who is trained in the use of emissions analyzer and (2) owns one operational analyzer on the premises.

By limiting the chance of exploitation of vehicle owners a major concern on the part of the public can be mitigated.

REFERENCES

1. Walsh, Michael P. The Need For and Benefits of Inspection and Maintenance of In-Use Motor Vehicles. U.S. Environmental Protection Agency, Mobile Source Enforcement Division. November 9, 1976.

SECTION 5

IMPLEMENTATION OF INSPECTION/MAINTENANCE PROGRAMS

LEGAL AUTHORITY

The first stage in the implementation of an I/M program is the development of appropriate enabling legislation. For the drafting of the enabling legislation, a preliminary description of the major program components should be prepared and the organizational option (centrally-located or service station) should be decided upon. Program objectives, operating rules, program dimensions, and major agency responsibilities should be specified. The conduct of the initial planning and tradeoff studies should result in the identification of the technical, social, and economic characteristics of the desired I/M program. This aids in the structuring of the legislation.

A considerable period of time can be involved in assuring that such legislation adequately treats all aspects of the desired I/M program. To help expedite matters, EPA has prepared model I/M legislation formats that can greatly assist the states in the development of their own legislation. In addition, other states that currently have legal authority can be used as models. Some of the provisions that should be considered for incorporation in enabling legislation are:

- Adequate authority to adopt rules and regulations concerning:
  - Requirements for periodic inspection
  - Establishment of fees for providing the inspection service
  - Withholding vehicle registration for those vehicles that do not satisfactorily complete the inspection or that do not comply with an applicable variance
  - Prohibition of tampering
- Provisions for providing adequate funds for implementing, monitoring, and enforcing the I/M program
- Adequate authority to obtain pertinent data and information, and require periodic reporting of emission information

- Authority to make emission reports and information available for public inspection

- Authority to compel compliance with rules and regulations, supported by civil or criminal penalties

- Provisions for injunctive relief where deemed necessary.

The legislation should also designate the lead agency for the program, most probably the state air pollution control agency, and work out cooperative arrangements with other groups such as the motor vehicle bureau, the department of revenues, the district attorney's office, and other enforcement agencies. State or local consumer protection offices may be included in the program design for surveillance of the service industry. Where the intent is to combine the I/M program with an existing safety inspection program, amendments to existing statutes may be needed.

The product of these efforts is the initial legislation to authorize program development and operation. As the program development advances it is likely that other issues will surface which require legislative action. The result will be the revision or modification of the initial legislation. Both Arizona and New Jersey, two states with established inspection programs, have required changes to their original legislation.

The current status of legal authority in areas where I/M is required as part of the transportation control plan is summarized in Table 11.

ADMINISTRATIVE FACTORS

In addition to the usual functions of program evaluation and supervision, there are three further areas requiring administrative efforts. There are public relations, consumer protection, and consumer convenience.

Public Relations

The function of a public relation program is to familiarize the public and the repair establishments with an I/M program. This includes the explanation of the purpose and objectives of the program, the program benefits, and the practical workings of the program. Under this latter category, the actual testing procedure should be explained. In addition, information regarding station locations, inspection times, and consumer protection measures should be made available.

A public relations program may take a variety of forms. Advertisements, public service announcements on radio and television, and brochures have all proven to be useful.

Directors of current I/M programs recomend that a public relations program be started 6 months to a year before any mandatory testing is begun in order to allow vehicle owners to become accustomed to the concept of I/M. In Arizona such a program was not fully established until after the start of

TABLE 11. EXTENT OF STATES' CONSIDERATION OF INSPECTION/ MAINTENANCE

State	City	Strategy requirement SIP	Preliminary review or research	Enabling legislation	I/M implementation*
Alaska	Fairbanks	X	X		
Arizona	Phoenix	X	X	X	X
	Tucson	X	X	X	X
California	Los Angeles	X	X	X	X
	Sacramento	X	X		
	San Diego	X	X		
	San Francisco	X	X		
	San Joaquin	X	X		
Colorado	Denver	X	X	X	
Connecticut	All		X		
District of Columbia		X	X	X	
Florida	Tampa		X		
Illinois	Chicago	X	X	X	X
Indiana	Indianapolis	X	X		
Kentucky	Covington		X		
	Louisville		X		
Maryland	Baltimore	X	X		
	D.C. Metro Area	X	X		
Massachusetts	Boston	X	X		
	Springfield	X	X		
Minnesota	Twin Cities		X		
Missouri	St. Louis	X	X		
Nevada	Las Vegas	X	X	X	X
	Reno	X	X	X	X
New Jersey	All	X	X	X	X
New York	New York City	X	X		
North Carolina	Charlotte		X		
Ohio	Cincinnati	X	X	X	X
	Dayton		X		
Oregon	Portland	X	X	X	X
Pennsylvania	Philadelphia	X	X	X	
	Pittsburgh	X	X	X	
	Remainder of State		X		
Rhode Island	All	X	X	X	X
Tennessee	Nashville		X		
Texas	Dallas	X	X		
	Houston	X	X		
Utah	Salt Lake City	X	X	X	
Virginia	D.C. Metro Area	X	X		
Washington	Seattle	X	X		
	Spokane	X	X		

*Refer to fact sheets in Section 7 for details on the implementation of these programs.

mandatory testing. As a consequence of this, the Arizona I/M program experienced considerable public opposition in its early stages.

Careful planning of a voluntary maintenance phase before the full mandatory maintenance phase can be very effective in terms of familiarizing the public with goals and procedures of the program. Public opposition can be unintentionally stimulated by having a very high failure rate in the voluntary phase or by having no voluntary phase at all. Voluntary phases have been used in a number of programs, including New Jersey, Portland, and Arizona.

Consumer Protection

Provisions must be made to insure that vehicle owners are protected from abuses which could appear in the system (e.g., overcharging by repair shops and unnecessary repairs) just as care must be taken to avoid hardships in terms of extremely costly repairs or the denial of vehicle registration without due cause. One facet of the consumer protection program is the exemption of certain classes of vehicles, for example, new cars and antique vehicles. In addition, some areas have considered a ceiling on the cost of repairs required for compliance. The ceiling could be either a flat rate or a percentage of the market value of the vehicle. This would eliminate the potential for certain vehicle owners experiencing undue hardships.

Finally, some kind of mechanism should be established to handle consumer complaints concerning overcharging and unnecessary repairs by garages as well as complaints about the program in general. This consumer affairs office could also be responsible for the licensing of repair facilities. If too many complaints about any one repair facility are received the consumer affairs office could investigate and revoke the license of the garage if the claims were justified.

Consumer Convenience

An I/M program will be more readily accepted by vehicle owners if their inconvenience in terms of travel and waiting times is minimized. Ideally, the average distance travelled by a vehicle owner to an inspection station is 5 miles while a 10-mile travel distance is a reasonable objective as an upper limit. Proximity to local community activity centers is desirable in locating stations.

For a central test lane configuration, providing the option to retest at a private garage can reduce consumer travel and waiting time. A vehicle owner can have his car reinspected at the same facility that performs the repairs and eliminate a second trip to the test station.

The time period between notification of required inspection and the compliance date should be designed to allow ample time for inspection, maintenance and reinspection. It was Arizona's experience that 30 days was not enough time; the legislation has subsequently been revised to permit vehicle inspection during the 90 days prior to registration renewal.

Finally, one of the major concerns of a vehicle owner will be what he will have to pay to have his car inspected. For this reason, and to avoid burdening any population group, the inspection fee should be kept as low as possible.

SECTION 6

INSPECTION/MAINTENANCE PROBLEM AREAS

This section deals with four major problems associated with inspection/maintenance programs. These are the following:

- Quality control of private garages
- Adequacy of the repair industry to perform emissions related work
- Combined safety and emissions testing
- Impact of waivering repair requirements for certain vehicles

QUALITY CONTROL OF PRIVATE GARAGES

As mentioned in a previous section, there are essentially two operational options for an I/M program. These are a centralized inspection system (government or contractor operated) and a decentralized system (private commercial garages). Among the disadvantages of a decentralized system are potential problems in the area of quality control.

The two major quality control problems associated with a decentralized system are nonuniformity of enforcement criteria and cumbersome and potentially inadequate data collection and handling. The first of these problems results in variation in the quality or stringency of the test from station to station. This problem is, of course, of the same type as the one present where safety inspections are performed by private commercial garages. Some stations are less diligent than others in both the care of the testing equipment and in the actual performance of the test.

The second problem, inadequate data collection, leads to difficulties in monitoring the success of the problem. Unless adequate before and after inspection emissions data is properly collected, necessary adjustments in the program, such as the stringency of the emissions standards, cannot be made since problems would go undetected.

These disadvantages or drawbacks to testing at private commercial garages are offset by the greater conveniences offered the motorist. Since there are typically a large number of stations performing the test (compared to the number of facilities under the centralized alternative), the probability of a testing site being nearer to a given individuals home or office is greater. In addition, waiting lines would tend to be smaller given the wide choice of testing sites. Thus, the question becomes one of determining what can be done to mitigate the drawbacks associated with this option.

EPA has addressed this issue in the revised edition of Appendix N. In addition to the minimum requirements for all I/M programs, for a state to receive the basic emission reduction benefits for a decentralized program, five additional provisions must be made.

The first of these additional provisions is the licensing of inspection facilities by the agency governing the program. While the exact requirements are determined by the governing agency, EPA has provided certain guidelines. First, the facility must have the necessary instrumentation which has been approved by the governing agency and employ someone competent in the use of such equipment. Secondly, the facility must agree to perform the specified recordkeeping and submit themselves to inspection.

The next two provisions involve recordkeeping. First, the records should include a description of each vehicle with its emission test results plus information on the calibration of the emission analyzers. Copies of these inspection records must then be submitted on a periodic basis to the governing agency for auditing.

The last two provisions concern the monitoring of the inspection facility. EPA stipulates that each facility licensed must be inspected at least once every 90 days. In addition to these periodic checks, EPA requires that the governing agency have a program of unannounced/unscheduled inspections to handle complaints and to keep the station "honest."

It should be emphasized that without at least the above provisions, a decentralized I/M could become nothing more than a sham. Unless such precautions are taken, the effectiveness of this I/M approach could be minimal.

ADEQUACY OF THE REPAIR INDUSTRY TO PERFORM EMISSIONS-RELATED WORK

The ability of the repair industry to perform emission-related repair work is crucial to the overall success of an I/M program. If inadequate or incorrect adjustments are made to vehicles requiring maintenance, then by definition the overall effectiveness of the program in terms of emission reduction is decreased. In addition, inadequate or incorrect repairs can lead to public distaste for the program. Unless repairs are performed properly the first time a vehicle comes in, an increased dissatisfaction on the part of motorists is likely to result. Thus, the repair industry is at the center of any I/M program.

The question of the adequacy of the repair industry to perform emissions-related work is compounded to some extent by an element of distrust on the part of the motoring public. Rightly or wrongly, it is often perceived that the quality of repair work in general is, upon occasion, questionable and that the price of repair work is not insignificant to a given household in many instances. In addition, automobiles in the past have been tuned more for performance than for meeting emissions standards. Having the latter as the goal may necessitate some adjustments on the part of mechanics. In short, an I/M program requires that some effort be made to change the climate in which these perceptions evolved.

There exist several options to ensure that the repair industry is versed in emission related work. The first of these options is the offering of courses in automobile emissions in vocational training schools. Colorado State University, under contract to EPA, has developed the materials for such a course. Consisting of colored slides with accompanying script, the material covers the causes of excessive emissions and presents solutions to the existing problems. Such a course is of value to both would be mechanics as part of their overall training and to experienced mechanics as a refresher course in emission related work. The information, in addition to being offered solely in vocational schools, could also be presented in the form of workshops or seminars. California, for example, has offered workshops utilizing material that have developed. Of relatively short duration, (e.g., 8-32 hours) workshops can both acquaint the repair industry with the I/M program and present basic emissions related information.

A second way of ensuring the adequacy of the repair industry is to certify repair shops performing emission related work. New Jersey has established such a system. In New Jersey, a motorist whose vehicle fails to pass the emissions test has the option of returning, after repairs, for a retest at a central inspection facility. There is no additional charge for the retest. As an option, the motorist may take his vehicle to a repair facility certified by the state to perform the retest. While there is a charge with this second option, the motorist reduces the risk of receiving inadequate repair work on his vehicle. While an individual can have his emission repair work performed anywhere he prefers, the certification of some repair facilities serves as a guide to those vehicle owners unsure of where to have the work done.

Lastly, the adequacy of emissions related repair work can be guaranteed. This simply means that inadequate repair work be rectified without any additional charge to the consumer. While this option is understandably the least popular of the three alternatives mentioned, at least one state, California, has experimented with this approach.

COMBINED SAFETY AND EMISSIONS TESTING

A total of 31 states and the District of Columbia require periodic safety inspections of registered vehicles. An additional 12 states have spot or title transfer safety inspection programs. These systems vary in terms of what is inspected, who performs the inspection, and the frequency of the inspection. The systems usually inspected include wheel assemblies. tires. suspension system, steering and braking systems. Of the states having a periodic inspection, 25 do so annually and 7 inspect vehicles on a semi-annual basis. Thirty-three states use service stations or garages, licensed by the state for inspection while five states have state operated programs. There are two states with a few state operated facilities but most of the inspections in these states are done by service stations. The remaining two states perform inspection using state facilities, but these operations are confined to only a few cities. Seven states have no safety inspection programs.

Given the widespread existence of safety inspection programs, the combination of safety and emissions testing must be considered. Two obvious alternatives for doing so exist. The first is to simply add emissions testing to the list of items to be tested. The second alternative is to create a new combined testing program of a form different from the existing safety inspection program.

In deciding which alternative to follow, several factors would appear to be important in reaching a final decision. These are the following:

- public reaction to the existing safety inspection program
- nature of the existing safety inspection program
- commercial garage interest in the existing safety inspection program

The first aspect to consider when deciding how to combine safety and emissions testing is the degree of public acceptance of the existing safety inspection program. If the public respects the safety program and perceives that it is nontrivial in scope, just in testing, and efficiently administered, it would appear to be best to simply add emission testing to the list of items to be inspected, all other things equal. On the other hand, if there is low public regard for the safety inspection program, the decision is not as clear-cut. In instances where the safety inspection is regarded as a sham, the inclusion of emission testing with its resulting higher inspection fee is likely to be perceived as, at a minimum, a further unjustified annoyance. Where this is the case, it may be wise to, in cases where the safety inspection is conducted by private commercial garages, develop a centralized combined test. If this course of action is not possible, at a minimum the combined program should be more rigidly enforced and more effort put into its administration.

The nature of the existing safety inspection program is a second consideration. If it is conducted at centralized facilities run by the state, it would appear to be easiest to have emissions testing conducted there as well. This is due to the existing capital investment made by the state in land and buildings. Although some investment in the equipment necessary to perform safety testing would have been undertaken by service stations and garages, it is not typically of a significant enough magnitude to preempt the consideration of a combined testing program in a centralized facility.

Finally, commercial garage interest in the testing of vehicles must be considered. If service stations and garages exhibit no interest in performing emission testing, then the choice of action is obvious. Where this group does have an interest in emissions testing, then the combining of safety and emission testing (in areas having safety inspection done at private establishments) must be included in the list of proposed options.

IMPACT OF WAIVING REPAIR REQUIREMENTS FOR CERTAIN VEHICLES

One of the most commonly voiced fears of I/M programs is that the cost of repairs necessary to reduce emissions may in some instances be prohibitive. As a means of alleviating this problem, some have suggested the establishment of a price ceiling on repair costs. The ceiling, expressed as an absolute amount and/or a percentage of the book value of the vehicle would exempt vehicles from having repair work done which exceeded the ceiling.

The cost of exempting certain vehicles from having emissions related repair work performed is the reduction in the overall effectiveness of the program. Given the relatively small percentage of major emissions related repair work, however, it would appear that little decrease in overall emissions reduction would result from the exemption of some vehicles. This is based upon the fact that in Oregon and Arizona only 2 percent of the tested vehicles cost more than $100 to repair. In New Jersey the figure is 5.6 percent. It would appear, therefore, that the gains in terms of public acceptance would tend to outweigh any decrease in emission reduction resulting from the waving of repair requirements for certain vehicles.

SECTION 7

FACT SHEETS ON EXISTING INSPECTION/MAINTENANCE PROGRAMS

The following pages present information on existing I/M programs. Both technical and nontechnical topics are included. The information is current as of September 1977.

Location: Arizona

Type of Program: Contractor operated, permanent and mobile facilities, with loaded mode capabilities. Vehicle emission to comply with idle standards only.

Sites: 12 permanent sites, 36 lanes (9 "metro" stations of 3 to 5 lanes and 3 one-lane stations in outlying areas.) One mobile station.

Chronology: Voluntary testing began December 1975; became mandatory January 1976, and maintenance became mandatory January 1977.

Geographic Coverage: Maricopa (Phoenix) and Pima (Tucson) Counties, approx. 1.1 million vehicles including trucks and motorcycles.

Administering Agency: Arizona Department of Health Services

Operated by: Hamilton Test Systems, Inc.

Staff Contacts: ADHS - Fred Iacobelli, (602) 271-4548
HTS - Jack Hesse (Assistant Manager, (602) 955-9670
Dan Stone (Manager), (602) 955-9670

Capital Cost: $134,000 one-time appropriation by State. $9 million to HTS, including location studies, administrative start-up, etc., as well as equipment, land acquisition, and construction.

Operating Cost: Est. $0.5 million by HTS in 1976.

Cost to Motorist: $5, includes one free retest.

Standards: HC and CO standards at low cruise, high cruise, and idle dependent on engine type (2 or 4 stroke), model year (4 stages) curb weight, and number of cylinders. Vehicles required to comply with idle emission standards only. Dynamic evaluation for diagnostic purposes. Twenty percent opacity standard for diesels. Projected 1976 stringency factor was 35 percent but approximately 45 percent of vehilces actually failed to meet standards. Revised standards for 1977 estimated to achieve a rate of 25 percent, but during the first half of the year only 16 percent of the vehicles did not meet standards at time of the first inspection. All 50 cc and larger engines are covered, including two strokes and diesels. Golf carts are exempted. New cars are not inspected until 1 year old. Thirteen year and older "moving exemption;" e.g., in 1977, model years 1964 and older are exempted.

Enforcement: Vehicles could not be registered without proof of inspection in 1976, or proof of passed inspection in 1977. Proof consists of embossed stamp on registration form by Hamilton. Under-hood check for tampering and PCV operation. Besides annual registration, vehicles must also be inspected at title change. Scrap and auction sales, and sales between private individuals are exempt.

Instrumentation: All Otto-cycle vehicles tested on Hamilton infrared (NDIR) exhaust analyzers for HC, CO, and CO_2. Wider range meter for two-stroke engines. Opacity testing. Clayton dynamometers. Computer link provides automatic printout of results (no engine hookup as in Riverside).

Data Collection: Vehicle ID information, all test results, lane location, time of day, etc. for all vehicles.

Mechanic Training: ADHS has conducted 2-day seminars for mechanics. Seminars held monthly.

Waiting Times: Some problems experienced at start of program, but these are expected to disappear due to optimizing hours of operation and better public awareness of all station locations. Ten minutes is the planned maximum wait during a typical peak hour. Problems experienced at end-of-month and peak hours. Total inspection time is 5 minutes.

Other Aspects: If the State should renege on its 5-year contract with Hamilton, a guarantee provides that Hamilton shall receive a sum, prorated over the remainder of the 5 years. After 5 years, the program will discontinue operation or Arizona may operate the program on its own, having to compensate Hamilton only for its nondepreciated capital holdings. The State may also continue to contract the I/M program, with Hamilton having exclusive contract rights for an ensuing 10-year period. Of the $5 inspection fee, 55¢ goes to the State. Part of this money is used for its own operating expenses and the remainder is deposited in a special fund to be used for future expansion, contingencies, etc. Hamilton's $4.45 share of the fee includes profit and program public relations.

Problems: Initial adverse public reaction.
Repeal proposition on November 1976 referendum ballot (did not pass).

Achievements: Nation's first contractor-operated program keeps cost to State minimal.

Location: California

Type of Program: State-operated permanent facilities in Riverside.
Phase I - Mandatory inspection with voluntary maintenance, loaded mode testing. (Phase I completed).
Phase II - Incorporation of idle mode test only.
Phase III - Test mode undecided.

Sites: Two sites, six lanes.

Chronology: Phase I (pilot program) - began inspections September 2, 1975; second station opened, February 19, 1976. Phase II scheduled to begin January 1979. Phase III needs further legislative approval. Under Phase II, program expands to 18 to 19 sites with a total of 43 to 45 lanes. I/M to be mandatory for those vehicles requiring registration changes and for those vehicles that fail California Highway Patrol random roadside checks. Inspection stations to be operated by a private contractor. Phase III requires fully mandatory I/M for all registered vehicles on a yearly basis.

Geographic Coverage: Phase I - City of Riverside only (120,000 LDV's). Phases II and III will expand program to the remainder of the South Coast Air Basin (approximately 6.6 million vehicles), including the whole or parts of Riverside, San Bernardino, Los Angeles, Orange, Ventura, and Santa Barbara Counties.

Administering Agency: California Bureau of Automotive Repair - administration. California Air Resources Board - operations.

Staff Contacts: Jack Dolan and Joe Todd (916) 322-3823.

Capital Cost: $250,000 for six lanes of equipment (analyzers, dynos, computer control). Land and building of currently operating station are leased on a monthly basis.

Operating Cost: Not available.

Cost to Motorist: Free at present. Phases II and III, $7 to $8 (estimated). Waiver System - Maximum mandatory repair cost is $50 with provisions to raise it to $75 in later years if required.

Standards: Matrix of standards for three model year groups, two engine size groups, and the presence or absence of air injection. Projected stringency factor under these standards is 35 percent. Standards will be updated as required.
Vehicles 1955 and older and vehicles of gross weight greater than 6000 lbs are exempt from program.

Enforcement: Phase I - not applicable.

Phase II - changes in registration (buying, moving into state, etc.) cannot be made without passing inspection.

Phase III - annual renewal of registration and changes in registration cannot be made without passing inspection.

Instrumentation: For Phase I, most analysis equipment, including dynamometers, was manufactured by Autoscan. System uses computer data processing.

Data Collection: Odometer readings and vehicle age along with tailpipe concentrations fo CO, HC, and NO_x. Computer hookup (to tailpipe and engine) permits instant diagnosis, with three-mode analysis of emission readings. Vehicle owner is provided with printout, indicating probable cause of malfunction and recommended service action. About 30 percent of the vehicles tested during Phase I did not meet standards. Data collection during Phase II will utilize highly automated techniques.

Accompanying Phase I was a surveillance program involving 650 vehicles. Results of this effort include program effectiveness, and "technical effectiveness" (vehicle thruput, waiting times, etc.). These results were used to help identify required elements for the proposed Phase II program.

Mechanic Training: California has a program of mechanic licensing.

Under Phase I, a "certificate of qualification" was required of mechanics to perform repairs resulting from the I/M program. These mechanics had to attend an orientation seminar and either:

(a) possess a California "Class A" mechanic's license, or

(b) pass a written examination.

Currently developing master plan to qualify mechanics in the S.C.A.B. prior to Phase II.

Waiting Time: No problems during Phase I where demand was kept uniform by mailing out notices to 450 to 500 vehicle owners daily (chosen at random by computer). The owner then had 2 weeks from date of postmark to bring in his vehicle.

Total inspection time is about 7 minutes.

Waiting time objective for Phase II is less than 10 minutes for most vehicles and an absolute maximum of 20 minutes during peak periods.

Problems: No action at this time on I/M in remainder of State.

Achievements: Public reaction has been excellent. Unique combination of exhaust analysis, engine monitoring, and computer technology. Diagnosis helps insure satisfied consumer.

Location: Chicago

Type of Program: City-operated vans, idle mode. Mandatory inspection with no enforcement = voluntary inspection. Voluntary maintenance.

Sites: Five permanent sites with two lanes each; plus six mobile sites with two lanes each. Permanent sites have varied in past years with a high of 9.

Chronology: Began inspection in June 1973. EPA Region V issued enforcement (s 113) order to city to meet inspection rate of 3000 vehicles/day by December 1975. If failing to comply with this requirement the city was to implement full mandatory inspection/maintenance in March 1976; all Cook County vehicles entering the loop would also have been required to undergo full I/M. One year later, Chicago has not met established rate and EPA has not initiated action.

Geographic Coverage: City of Chicago only (1.0 million LDV's), but any vehicle coming in will be inspected. Remainder of Cook County is far behind in implementation.

Administering Agency: City of Chicago, Department of Environmental Control.

Staff Contact: John Winkler - (312) 744-7152; Joe Seliber (312) 744-5958.

Capital Cost: $2 million, including $350,000 design and start-up.

Operating Cost: 1977 Budget: $1.448 million.

Cost to Motorist: No fee collected at time of inspection. Portion of annual city vehicle registration fee allocated to cover program costs.

Standards: CO and HC standards for four model-year groups - estimated 30 to 35 percent stringency factor.

Enforcement: None, although Vehicle Emission Testing Ordinance adopted by City of Chicago during 1973.

Instrumentation: 18 Sun #910 I Analyzers, modified to include CO_2 testing and computer control. Eleven backups w/o CO_2 modification.

Data Collection: Record kept on emissions by Make and by Model year, especially late model years 1975 to 1977's which are failing at above 25 percent. Study done during 1975 to 1976 in conjunction with EPA's Emission Factor Program showed 1975's failing at 28 percent (on Chicago test).

Mechanic Training: Definite need, but none to date.

Waiting Times: No problems.

Problems: Recent figures show less than 20 percent of city's registered vehicles are being inspected.

City position favors mandatory I/M programs with three conditions:

1. Federal Government and auto manufacturers concurrence on a warrantee program. (See 207(b) of Clean Air Act).
2. Auto Manufacturers compliance with statutory emissions standards.
3. I/M to be implemented regionally because of the large percentage of travel on city streets by non-Chicago vehicles.

Achievements: Communication channels established with Auto Manufacturers regarding high emission levels of late model vehicles.

Location: Cincinnati and Hamilton County, Ohio

Type of Program: Municipally-operated permanent facilities, idle mode, mandatory inspection and maintenance.

Sites: Cincinnati - One site, four lanes, includes safety inspection.

Norwood - One site, one lane, includes safety inspection.

Hamilton County - Two sites (Newtown and Glenway), three lanes total, no safety inspection.

Chronology: Fully mandatory I/M began in Cincinnati and Norwood on January 1, 1975, with no voluntary phase-in periods. Newtown began operation 8-75 and Glenway 9-75. Operations ceased at Newtown and Glenway, February 1, 1976.

Geographic Coverage: Eventually the whole of Hamilton County, about 500,000 LDV's.

Administering Agency: Individual local governments.

Area Contact: Marion Smith, (513) 352-4880 (Cincinnati APCD)
None (513) 632-8222 (Hamilton County Commissioners)
Rick Hogan, (502) 564-6798 (Kentucky DAP)

Capital Cost: (Cincinnati) $12,600 for 9 analyzers - inspection facilities already in operation for safety.

Operating Cost: (Cincinnati) $130,000 for 11 additional positions.

Cost to Motorist: $3.75, including safety,

Standards: Same as Chicago, four-stage standards dependent on model year stringency factor 25 percent in 1975 and 18 percent in 1976 and first quarter of 1977.

Enforcement: (Cincinnati) Vehicle cannot be registered by city (sticker issued) unless inspection is passed. City Division of Air Pollution Control has four vehicles issuing tickets on a limited basis. Enforcement was initially inadequate due to lack of Police Department backing and difficult due to the inability to distinguish between Cincinnati vehicles and Hamilton County commuter vehicles. However, during 1976 enforcement was stepped up with nearly 80,000 citations issued by Cincinnati and Norwood police.

(Hamilton County) No enforcement program. Recently cited by Federal Government with court action pending.

Instrumentation: Sun #910 I analyzers modified with color-coded scales and pass/fail lights. Cincinnati has 9 of these, Norwood 2, and Hamilton County 4.

Data Collection: Records kept on volumes passing and failing only. Percent of vehicles not meeting standards are as follows:

	1975 %	1976 %	1977* %
Cincinnati	21.5	16.9	17.6
Norwood	31.8	19.7	

*First quarter.

Mechanic Training: No formal program, but Colorado State University conducted a course for Cincinnati metropolitan area vocational education instruction in June 1976.

Waiting Time: No major problems.

Problems: Woefully low throughput caused by no enforcement and lack of "tradition of inspection," caused Hamilton County to cease operations February 1, 1976.

Lack of phase-in period and adequate PR caught public by surprise. Complaints that Kentucky commuters should be tested. (Kentucky established a voluntary program in the three northern Kentucky counties of Boone, Campbell, and Kenton on December 1, 1977. One state owned van visits shopping centers in order to stimulate car owners' participation.)

Achievements: Demonstrated short lead time adding I/M to existing safety program.

With improved enforcement, approximately 90 percent of registered LDV's in Cincinnati compiled with I/M requirements during 1976.

Location: New Jersey

Type of Program: State-operated permanent facilities, idle mode, mandatory inspection and maintenance. Includes safety inspection. Failed vehicles may be retested at certified private garages, for $1.00 certificate fee plus labor charges.

Sites: 38 sites, 68 lanes, one mobile van (rotates among sites).

Chronology: Inspections began July 1972, with voluntary maintenance phase. Fully mandatory program commenced February 1, 1974 with Phase I standards. On November 1, 1975, Phase II standards became effective, and private garage reinspection began a 2-year trial period. Also beginning on this date new cars were withheld from inspection for their first 2 yearly re-registrations. Phase III standards, originally scheduled to become effective on February 1, 1976, were postponed until at least January 1978. Phase III now subject to public hearings and final review.

Geographic Coverage: Entire State of New Jersey (3.9 million LDV's).

Administering Agency: New Jersey Department of Environmental Protection (establishes standards and technical procedures), Department of Motor Vehicles (administers testing and enforces standards).

Staff Contact: John Elston, NJDEP, (609) 292-6714.

Capital Cost: $250,000 for analyzers and related equipment-inspection facilities already in operation for safety.

Operating Cost: DEP, $330,000/yr
DMV, $1,000,000/yr
Total $1,330,000/yr

Cost to Motorist: $2.50, taken out of yearly registration fee, includes safety.
$1, additional fee at reinspection garages for certificate, garage labor charges extra.

Standards: Phase I - approx. 12 percent stringency factor.
Phase II - approx. 16 percent stringency factor.
Proposed Phase III - approx. 23 percent stringency factor.
All phases are four-stage, dependent on model year.

Enforcement: Vehicle cannot be registered unless inspection is passed. Enforced by sticker system. Proposed HDV standards to be enforced on the road (pullover spot check) and at operators facilities.

Instrumentation: 125 specially modified Sun "EET 910" analyzers w/color-coded scales and pass/fail lights.

Replacement equipment purchase budgeted for FY78.

Data Collection: Records kept for initial emissions test. Initial refailure rate of 40 percent had dropped to 18 percent during Phase I. Phase II refailure rate has stabilized at 25 percent. NJDEP also conducts periodic surveillance on groups of 1000 vehicles.

Mechanic Training: Training program to be conducted at vocational schools starting fall 1977. Program instructors trained during spring 1977.

Plans to certify mechanics thorugh NIASE. Exxon has already conducted mechanic training for emissions, affecting about 15 percent of all service stations in state.

Waiting Times: Major delays predated the advent of emission inspection and continued into both emission Phases I and II. Delays cause many vehicles to needlessly fail the CO emissions test because of the "hot idle" effect. These vehicles return to be retested for CO, making waiting lines even longer.

Problems (other): Two year exemption for new cars means approx. 30,000 miles pass before cars are first inspected. Lack of capital - capacity improvements cannot be made.

DMV resistance to the incorporation of Phase III standards. Refailure rate has stabilized at 25 percent · considered unsatisfactory.

Achievements: Nation's longest ongoing I/M program. Thirteen percent improvement in ambient CO readings since program began. This reduction is holding. Four thousand, two-hundred garages have installed exhaust analyzers (as of January 1977). This number has risen with the inception of the private garage reinspection program.

Location: Nevada

Type of Program: Idle test by licensed service stations, garages and auto dealers, includes check and adjustment of primary vehicle specifications.

Sites: Approximately 120 to 125 licensed private stations located in Clark County, Nevada.

Chronology: Pilot testing and inspection program initiated July 1974 for change of ownership vehicles in Clark County. Annual inspection program scheduled for July 1, 1975, postponed. State Environmental Commission directed to conduct a thorough study of a compulsory annual I/M program. Nevada Assembly Bill 464 effective July 1, 1977. Mandatory I/M in all counties with population greater than 100,000 to be phased in by July 1, 1979.

Geographic Coverage: Presently Clark County only, light-duty vehicle population about 200,000. Annual Inspection and Maintenance to be established in both Clark and Washoe Counties by July 1979.

Adminstering Agencies: Department of Motor Vehicles
Department of Human Resources

Staff Contacts: E. J. Silva, Vehicle Compliance and Enforcement Section, D. M. V. (702) 885-5396.

Capital Costs: Not reported. D. M. V. outfitted with exhaust analyzer, calibration gases and pick-up truck.

Operating Costs: Recovered from fees - \$2 - Certificate of Compliance fee
\$25 - Annual station license fee.

Cost to Motorists: Inspection fee equal to sum of \$2 certificate fee plus labor charges. Total fee ranges from \$8.50 to 17.00 due to variations in prevailing shop labor rates. Stations permitted to set own fee with D.M.V. approval.

Standards: CO and HC standards for three model-year groups.

Enforcement: Vehicles cannot be registered without Certificate of Compliance.

Instrumentation: Nevada list of approved exhaust gas analyzers.

Data Collection: Vehicle description, motor vehicle specification settings, and CO and HC tailpipe concentrations.

Mechanic Training: No formal program as such but for mechanics to be licensed as "Approved Inspector", they must provide documentation of automotive schooling and experience, must be qualified to operate emissions analyzing equipment, and pass written examination.

Station Licensing: To become an "Authorized Station" to perform emission test, a station must employ an "Approved Inspector," own proper tools and equipment for performing test and present a $1000 surety bond.

Waiting and Test Time: No problems. During change of ownership phase most vehicles are conveyed by dealers who perform inspection and required adjustments as routine task of vehicle preparation. Nevada inspection requires about 15 to 20 minutes.

Problems: Minimal.

Achievements: Consumer complaints have been minimal. Unique combination of inspection testing and check and adjustment of primary manufacturer's specification settings. Most vehicles attain at least some improvement in terms of performance, emission reductions, and fuel savings.

D.M.V. control of licensings of stations and inspectors including regular visits to check station performance, tools and emission analyzing equipment.

Location: Portland, Oregon

Type of Program: Combination of permanent and mobile facilities, idle mode, mandatory inspection and maintenance. Inspection is biennial at present.

Sites: Five permanent sites, 10 lanes; four mobile vans, five lanes Nine sites, 15 lanes total. Plans call for expansion to 17 lanes.

Chronology: Voluntary inspection and maintenance commenced January 1974. In 18 months, 105,000 vehicles were tested. No transitional mandatory/voluntary phase. Fully mandatory I/M began July 1, 1975.

Geographic Coverage: Portland Metropolitan Service District - urbanized portions of Washington, Multnomah, and Clackamas Counties (580,000 LDV's $\leq$ 8400 lbs).

Administering Agency: Oregon Department of Environmental Quality (DEQ).

Staff Contact: Ron Householder, (503) 229-6200.

Capital Costs: Total cost of analyzers (29) was about $200,000. Only one station was actually built for the program, construction costing $77,000. Located on State right-of-way, land costs are not included. This station has loaded-mode and safety testing capabilities. The four remaining permanent facilities are leased. A complete mobile van setup, including new vehicle, three analyzers, and secondary equipment, cost $40,000 in 1975.

Operating Costs: Approx. $1.45 million for "on" year, $0.8 million for "off" year.

Cost to Motorist: $5 for issuance of Certificate of Compliance. Unlimited retests.

Standards: Multiple standards, based on manufacturer's specifications, involving model year groups, manufacturer groups, and engine modifications. Testing involves preconditioning to offset hot idle effect. Vehicles can also be rejected for exhaust dilution, visible smoke, and excessive idle speed. Stringency factor is about 35 percent.

Enforcement: Vehicles cannot be registered without Certificate of Compliance.

Instrumentation: 29 Sun "OEA 75" analyzers with digital readout of HC, CO, and CO_2, and with remote viewing gauges. Systems are fully computer compatible, but are not computer controlled at this time. For supplementary data generation, two Clayton and two Autoscan dynomometers are used. Oregon State University has CVS testing capabilities.

Data Collection: Actual stringency factor, July 1975 to March 1977, was 36 percent. Survey of 3570 vehicles during February to March 1977 found refailure rate of 22 percent, up from 16 percent reported earlier.

Record kept of all emission readings. Readings are taken at idle speed, 2500 rpm (intended mainly as preconditioning), and then again at idle, with the lower of the idle readings governing.

Mechanic Training: Emission-related tune-up course at Clackamas Community College, in response to Oregon I/M. EPA Region X assisted with funding through DEQ. Several hundred enrollees in the past 2 years.

An increase in training by major service station parent organization has been noted. Other community colleges and vocational school have established self-initiated training programs. DEQ is proposing to conduct mechanic training seminars.

Waiting Time: Systemwide average waiting time approximately 15 minutes during 1976 ("on" year). Total inspection time averages 3 minutes.

Other Aspects: Inspections tied into biennial motor vehicle registration system. Even numbered years are "on" years with approximately 80 percent of LDV registrations due for renewal, and odd numbered years are "off" years with remaining 20 percent due for renewal. Inspection stations were opened 7 days/week during 1976 with 75 emission inspectors on payroll. During 1977, stations opened 5 days/week, Tuesday through Saturday. Only 23 emission inspectors required to inspect "off" year (1977) demand. Licensed private fleets (more than 100 vehicles) may inspect themselves. Inspection of HDV's proposed for 1978.

Problems: The 2-year inspection interval hurts program effectiveness. cash flow, and creates personnel problems. It will be at least July 1977 before interval can be shortened legislatively. (No action expected at this time). Public criticism of "lack of uniformity" - Portland area residents feel that commuters from Washington State should be tested, as well as vehicles in the remainder of Oregon. Some evidence of vehicles being re-adjusted following the passing of inspection due to drive-ability problems.

Achievements: Estimated reduction in CO and HC emissions of 14 percent and 7 percent, respectively, have been achieved during first inspection cycle.

Many garages are buying analyzers, indicating increased acceptance. Of all I/M programs, has the most extensive, and therefore the most equitable standards. Difficulties in identifying vehicles and their standards have been minimal.

Location: Rhode Island

Type of Program: Idle test by certified private garages. Performed in conjunction with safety inspection.

Sites: Approximately 600 private garages statewide.

Chronology: Inspection began November 1, 1977 with voluntary maintenance. Fully Mandatory I/M program commences January 1, 1979.

Geographic Coverage: Entire State of Rhode Island (0.5 million LDV's)

Administering Agency: Rhode Island Department of Transportation.

Staff Contact: Alfred Masserone, Chief Safety and Emissions (401) 277-2983
Thomas Getz, Rhode Island Department of Health (401) 277-2808

Capital Costs: $1,000,000 (includes first year operating costs) for construction of State-Run Challenge Lane Facility. Capital to be repaid from inspection fee.

Operating Costs: First year included in Capital Cost appropriation.

Cost to Motorists: $4.00 inspection fee - $1.00 to state, $3.00 to private garage.

Standards: Adopted New Jersey Phase I standards as interim guideline during first year of program. As of December 18, 1977, 69.6 percent passed, 28.9 percent failed (1.4 percent unclassified). Of the failed vehicles, 28.7 percent were voluntarily repaired.

Enforcement: Windshield stickers, staggered basis.

Instrumentation: Approved list of exhaust analyzers based on California list.

Data Collection: Data to be collected include initial emission concentration of HC and CO, type, make, year, and mileage of vehicle, repairs and cost, emission concentrations after voluntary maintenance.

Mechanic Training: First year - Mechanic orientation seminars required for "approval to inspect vehicles." Existing programs at Vocational School System based on EPA-approved program developed at Colorado State University.

Waiting Time: Inspection takes approximately 30 to 40 minutes, most garages use an appointment system.

Other Aspects: State-run central inspection facilty is used as a referee station for individuals who challenge the findings of a private garage. This facility also inspects taxicabs, buses, jitneys, and other vehicles used for the transportation of passengers for hire.

Problems: Originally intended to use centralized test lane approach operated by a private contractor.

Achievements: Program initiated and supported by Governor and RIDOT with backing from Executive and Legislature Branches.

APPENDIX A

COMPILATION OF EMISSION STANDARDS FOR I/M PROGRAMS

1. Chicago and Cincinnati--Idle

	Model year	HC	CO
(nonfleet vehicles)	pre-68	1000 ppm	6.0%
	68-69	600	5.0
	70-74	500	4.0
	75+	250	1.5

2. New Jersey--Idle

	Model year	HC	CO
Phase I, effective Feb. 1, 1974	pre-68	1600 ppm	10.0%
	68-69	800	8.0
	70-74	600	6.0
Phase II, effective November 1, 1975	pre-68	1400 ppm	8.5%
	68-69	700	7.0
	70-74	500	5.0
	75+	300	3.0
Phase III, not effective until at least January, 1978	pre-68	1200 ppm	7.5%
	68-69	600	6.0
	70-74	400	4.0
	75+	200	2.0

3. Washington, D.C.--Idle (volunteer program partially sponsored by U.S. DOT NHTSA Diagnostic Demonstration Project)

Model year	HC	CO
pre-68	700 ppm	6.0%
68-70	400	5.0
71+	300	4.0

4. Rhode Island--Idle

Model year	HC	CO
pre-68	1600 ppm	10%
68-69	800	8.0%
70-74	600	6.0%
75+	300	3.0%

5. Nevada--Idle

Model year	HC	CO
pre-69	1200 ppm	7.5%
68-69	600	5.0
70	400	4.0
71+*	400	4.0

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*In Nevada 1971 and later vehicles must also be tuned to manufacturer's emission control specifications.

6. Arizona--Loaded(1976)

Engine type	Model year	Curb weight	No. of cycles	Hi-cruise HC	Hi-cruise CO	Lo-cruise HC	Lo-cruise CO	Idle HC	Idle CO
4-stroke	All	2000	All	700 ppm	8.6%	-	-	1,050 ppm	7.5%
4-stroke	pre-68	> 2000	4 or less	1,000	5.0	1,000 ppm	6.0%	1,300	9.5
4-stroke	pre-68	> 2000	5 or more	700	4.25	700	5.25	950	7.75
4-stroke	68-71	> 2000	4 or less	450	3.75	450	4.25	500	6.0
4-stroke	68-71	> 2000	5 or more	380	3.0	380	3.5	450	5.5
4-stroke	72-74	> 2000	4 or less	380	3.0	380	3.5	450	5.5
4-stroke	72-74	> 2000	5 or more	300	2.5	300	3.0	350	4.0
4-stroke	75+	> 2000	All	100	0.9	120	1.0	150	1.5
2-stroke	All	All	All	23,000	8.0			23,000	6.0
Diesel	All	All	All	(-- 20% opacity --)					

Arizona--Idle(1977) (diagnostic evaluation conducted at 1976 loaded mode standards compliance required at 1977 idle standards only.)

Engine type	Model year	Curb weight	No. of cycles	Idle HC	Idle CO
4-stroke	All	MC	All	2000 ppm	9.0%
4-stroke	pre-1968	> 2000	4 or less	2000	9.5
4-stroke	pre-1968	> 2000	5 or more	1500	9.5
4-stroke	68-71	> 2000	4 or less	850	8.0
4-stroke	68-71	> 2000	5 or more	750	8.0
4-stroke	72-74	> 2000	4 or less	450	7.2
4-stroke	72-74	> 2000	5 or more	400	7.0
4-stroke	75+	< 6000	All	250	3.3
4-stroke	75+	> 6000	All	400	7.0
2-stroke	All	All	All	18,000	6.0

7. Riverside--Loaded

Model year	No. of cylinders	Hi-cruise HC	Hi-cruise CO	Lo-cruise HC	Lo-cruise CO	Lo-cruise NO_x	Idle HC	Idle CO
55-65	4 or less	1200 ppm	6.5%	1200 ppm	7.0%	2500 ppm	1900 ppm	8.0%
55-65	5 or more	1000	5.5	1000	6.0	2500	1200	8.0
66-67	4 or less	1200	6.5	1200	7.0	2500	1900	8.0
66-67	5 or more	500	4.0	500	4.5	2500	500	7.0
66-67	5 or more w/AI	500	4.0	500	4.5	2500	400	5.5
68-70	4 or less	600	4.5	600	5.0	2500	650	7.0
68-70	4 or less w/AI	600	4.5	600	5.0	2500	500	5.5
68-70	5 or more	500	4.0	500	4.5	2500	500	7.0
68-70	5 or more w/AI	500	4.0	500	4.5	2500	400	5.5
71+	4 or less	500	3.5	500	4.0	2500	600	5.0
71+	4 or less w/AI	500	3.5	500	4.0	2500	450	3.5
71+	5 or more	400	2.5	400	3.0	2500	350	4.0
71+	5 or more w/AI	400	2.5	400	3.0	2500	250	3.0

AI = Air Injection

8. Oregon Light Duty Motor Vehicle Emission Control Idle Emission Standards.

This section is in three parts. The first section specifies idle carbon monoxide limits, the second specifies idle hydrocarbon limits, and the third specifies maximum smoke levels.

(1) Carbon Monoxide idle emission values not to be exceeded:

	Base standard %	Enforcement tolerance % through June, 1977
ALFA ROMEO		
1975 and 1976	1.5	1.0
1971 through 1974	3.0	1.0
1968 through 1970	4.0	1.5
pre-1968	6.0	0.5
AMERICAN MOTORS CORPORATION		
1975 and 1976 noncatalyst	1.5	0.5
1975 and 1976 catalyst equipped	0.5	0.5
1972 through 1974	2.0	1.0
1970 through 1971	3.5	1.0
1968 through 1969	5.0	0.5
pre-1968	6.0	0.5
Above 6000 GVW, 1974 through 1976	2.0	1.0
ARROW, Plymouth - see COLT, Dodge		
AUDI		
1975 and 1976	1.5	0.5
1971 through 1974	2.5	1.0
1968 through 1970	4.0	1.0
pre-1968	6.0	0.5

	Base standard %	Enforcement tolerance, % through June, 1977
AUSTIN - see BRITISH LEYLAND		
BMW		
1975 and 1976	1.5	0.5
1974, 6 cyl.	2.5	1.0
1974, 4 cyl.	2.0	1.0
1971 through 1973	3.0	1.0
1968 through 1970	4.0	1.0
pre-1968	6.0	0.5
BRITISH LEYLAND		
Austin, Austin Healey, Morris, America, and Marina		
1975	2.0	0.5
1973 through 1974	2.5	1.0
1971 through 1972	4.0	1.0
1968 through 1970	5.0	1.0
pre-1968	6.5	0.5
Jaguar		
1975 and 1976	0.5	0.5
1972 through 1974	3.0	1.0
1968 through 1971	4.0	1.0
pre-1968	6.0	0.5

	Base standard %	Enforcement tolerance, % through June, 1977
MG		
1976 MG	0.5	0.5
1975 MG, MG Midget and 1976 MG Midget	2.0	0.5
1973 through 1974 MGB, MGBGT, MGC	3.0	1.0
1971 through 1974 Midget	3.0	1.0
1972 MGB, MGC	4.0	1.0
1968 through 1971, except 1971 Midget	5.0	1.0
pre-1968	6.5	0.5
Rover		
1971 through 1974	4.0	1.0
1968 through 1970	5.0	0.5
pre-1968	6.0	0.5
Triumph		
1975 and 1976	2.0	0.5
1971 through 1974	3.5	1.0
1968 through 1970	4.0	1.0
pre-1968	6.5	0.5

<u>BUICK</u> - see GENERAL MOTORS

<u>CADILLAC</u> - see GENERAL MOTORS

<u>CAPRI</u> - see FORD MOTOR COMPANY, 4 cyl.

<u>CHECKER</u>

1975 and 1976 catalyst equipped	0.5	0.5
1973 through 1974	1.0	1.0
1970 through 1972	2.5	1.0
1968 through 1969	3.5	1.0
pre-1968	6.0	0.5

<u>CHEVROLET</u> - see GENERAL MOTORS

<u>CHEVROLET L.U.V.</u> - see L.U.V., Chevrolet

<u>CHRYSLER</u> - see CHRYSLER CORPORATION

<u>CHRYSLER CORPORATION</u> (Plymouth, Dodge, Chrysler)

1975 and 1976 noncatalyst	1.0	0.5
1975 and 1976 catalyst equipped	0.5	0.5
1972 through 1974	1.0	1.0
1969 through 1971	1.5	1.0
1968	2.0	1.5

	Base standard %	Enforcement tolerance, % through June, 1977
CHRYSLER CORPORATION (Plymouth, Dodge, Chrysler) (continued)		
pre-1968	6.0	0.5
Above 6000 GVW, 1968 through 1971	4.0	1.0
Above 6000 GVW, 1972 through 1976	2.0	1.0
<u>CITROEN</u>		
1971 through 1974	3.0	1.0
1968 through 1970	4.0	1.0
pre-1968	6.0	0.5
<u>COLT, Dodge</u>		
1975 and 1976	3.0	0.5
1971 through 1974	5.0	1.0
pre-1971	6.0	0.5
<u>COURIER</u>		
1975 and 1976	1.5	0.5
1973 through 1974	2.0	1.0
pre-1973	4.0	1.0
<u>CRICKET, Plymouth</u>		
1973 through 1974 (twin carb. only)	3.0	1.0
1972 (twin carb. only)	4.5	1.0
pre-1972 (and 1972 through 1973 single carb. only)	7.5	0.5
<u>DATSUN</u>		
1975 and 1976	2.0	0.5
1968 through 1974	2.5	1.0
pre-1968	6.0	0.5

<u>DE TOMASO</u> - see FORD MOTOR COMPANY

<u>DODGE</u> - see CHRYSLER CORPORATION

<u>DODGE COLT</u> - see COLT, Dodge

	Base standard %	Enforcement tolerance, % through June, 1977
<u>FERRARI</u>		
1975 and 1976	0.5	0.5
1971 through 1974	2.5	1.5
1968 through 1970	4.0	1.5
pre-1968	6.0	0.5
<u>FIAT</u>		
1975 and 1976 noncatalyst	1.5	0.5
1975 and 1976 catalyst equipped	0.5	0.5
1974	2.5	1.0
1972 through 1973 124 spec. sedan and wagon	4.0	1.0
1972 through 1973 124 sport coupe and spider	3.0	1.0
1972 through 1973 850	3.0	1.0
1971 850 sport coupe and spider	3.0	1.0
1971 850 sedan	6.0	0.5
1968 through 1970, except 850	5.0	0.5
1968 through 1970 850	6.0	0.5
pre-1968	6.0	0.5
<u>FORD</u> - see FORD MOTOR COMPANY		
<u>FORD MOTOR COMPANY</u> (Ford, Lincoln, Mercury, Capri, except Courier)		
1975 and 1976 noncatalyst	1.0	0.5
1975 and 1976 catalyst equipped	0.5	0.5
1972 through 1974, except 4 cyl.	1.0	1.0
1972 through 1974, 4 cyl., except 1971 through 1973 Capri	2.0	1.0
1971 through 1973 Capri only	2.5	1.0
1970 through 1971	2.0	1.0
1968 through 1969	3.5	1.0
pre-1968	6.0	0.5
Above 6000 GVW, 1968 through 1971	4.0	1.0
Above 6000 GVW, 1972 through 1973	3.0	1.0
Above 6000 GVW, 1974 through 1976	2.0	1.0
<u>GENERAL MOTORS</u> (Buick, Cadillac, Chevrolet, GMC, Oldsmobile, Pontiac)		
1975 and 1976 noncatalyst	1.0	0.5
1975 and 1976-catalyst equipped	0.5	0.5
1972 through 1974	1.0	1.0
1970 through 1971, except 4 cyl.	1.5	1.0
1970 through 1971, 4 cyl.	2.5	1.0
1968 through 1969	3.5	1.0

	Base standard %	Enforcement tolerance, % through June, 1977
GENERAL MOTORS (continued)		
pre-1968	6.0	0.5
Above 6000 GVW, 1968 through 1971	4.0	1.0
Above 6000 GVW, 1972 through 1973	3.0	1.0
Above 6000 GVW, 1974 through 1976	2.0	1.0
GMC - see GENERAL MOTORS		
HONDA AUTOMOBILE		
1975 and 1976 CVCC	1.0	0.5
1975 and 1976, except CVCC engine	1.5	0.5
1973 through 1974	3.0	1.0
pre-1973	5.0	1.0
INTERNATIONAL-HARVESTER		
1975 and 1976	2.5	0.5
1972 through 1974	3.0	1.0
1970 through 1971	4.0	1.0
1968 through 1969	5.0	1.0
pre-1968	6.0	0.5
JAGUAR - see BRITISH LEYLAND		
JEEP - see AMERICAN MOTORS		
JENSEN-HEALEY		
1973 and 1974	4.5	1.0
JENSEN INTERCEPTOR & CONVERTIBLE - see CHRYSLER CORPORATION		
LAND ROVER - see BRITISH LEYLAND, Rover		
LINCOLN - see FORD MOTOR COMPANY		
L.U.V., Chevrolet		
1974 through 1976	1.5	1.0
pre-1974	3.0	1.0
MAZDA		
1975 and 1976	1.5	0.5
1968 through 1974, Piston Engines	4.0	1.0
1974, Rotary Engines	2.0	0.5
1970 through 1973, Rotary Engines	3.0	0.5

	Base standard %	Enforcement tolerance, % through June, 1977
MERCURY - see FORD MOTOR COMPANY		
MERCEDES-BENZ		
1975 and 1976 noncatalyst, 4 cyl	1.0	0.5
1975 and 1976, all other	0.5	0.5
1973 through 1974	2.0	1.0
1972	4.0	1.0
1968 through 1971	5.0	1.0
pre-1968	6.0	0.5
Diesel Engines (all years)	1.0	0.5
MG - see BRITISH LEYLAND		
OLDSMOBILE - see GENERAL MOTORS		
OPEL		
1975 and 1976	1.5	0.5
1973 through 1974	2.5	1.0
1970 through 1972	3.0	1.0
1968 through 1969	3.0	1.0
pre-1968	6.0	0.5
PANTERA - see FORD MOTOR COMPANY		
PEUGEOT		
1975 and 1976	1.5	0.5
1971 through 1974	3.0	1.0
1968 through 1970	4.0	1.0
pre-1968	6.0	0.5
Diesel Engines (all years)	1.0	0.5
PLYMOUTH - see CHRYSLER CORPORATION		
PLYMOUTH CRICKET - see CRICKET, Plymouth		
PONTIAC - see GENERAL MOTORS		
PORSCHE		
1975 and 1976	2.5	0.5
1972 through 1974	3.0	1.0
1974 Fuel Injection 1.8 liter (914)	5.0	1.0
1968 through 1971	5.0	1.0
pre-1968	6.5	0.5

	Base standard %	Enforcement tolerance, % through June, 1977
RENAULT		
1976 Carbureted	1.5	0.5
1975 and 1976 fuel injection	1.5	0.5
1975 carbureted	0.5	0.5
1971 through 1974	3.0	1.0
1968 through 1970	5.0	1.0
pre-1968	6.0	0.5
ROLLS-ROYCE and BENTLEY		
1975 and 1976	0.5	0.5
1971 through 1974	3.0	1.0
1968 through 1970	4.0	1.0
pre-1968	6.0	0.5
ROVER - see BRITISH LEYLAND		
SAAB		
1975 and 1976	1.5	0.5
1968 through 1974, except 1972 99 1.85 liter	3.0	1.0
1972 99 1.85 liter	4.0	1.0
pre-1968 (two-stroke cycle)	3.0	3.5
SUBARU		
1975 and 1976	1.5	0.5
1972 through 1974	3.0	1.0
1968 through 1971, except 360's	4.0	1.0
pre-1968 and all 360's	6.0	0.5
TOYOTA		
1975 and 1976 Catalyst equipped	0.5	0.5
1975 and 1976 4 cyl.	2.0	0.5
1975 and 1976 6 cyl.	1.0	0.5
1968 through 1974, 6 cyl.	3.0	1.0
1968 through 1974 4 cyl.	4.0	1.0
pre-1968	6.0	0.5
TRIUMPH - see BRITISH LEYLAND		

	Base standard %	Enforcement tolerance, % through June, 1977
<u>VOLKSWAGEN</u>		
1976 Rabbit and Scirocco	0.5	0.5
1976 All Others	2.5	0.5
1975 Rabbit, Scirocco, and Dasher	0.5	0.5
1975 All Others	2.5	0.5
1974 Dasher	2.5	1.0
1974 Type 4 Fuel Injection 1.8 liter	5.0	0.5
1972 through 1974, except Dasher	3.0	1.0
1972 through 1974 Dasher	2.5	1.0
1968 through 1971	3.5	1.0
pre-1968	6.0	0.5
<u>VOLVO</u>		
1975 and 1976 6 cyl.	1.0	0.5
1975 and 1976 4 cyl.	2.0	0.5
1972 through 1974	3.0	1.0
1968 through 1971	4.0	1.0
pre-1968	6.5	0.5
<u>NONCOMPLYING IMPORTED VEHICLES</u>		
All	6.5	0.5
<u>DIESEL POWERED VEHICLES</u>		
All	1.0	0.5
<u>ALL VEHICLES NOT LISTED AND VEHICLES FOR WHICH NO VALUES ENTERED</u>		
1975 and 1976 noncatalyst, 4 cyl.	2.0	0.5
1975 and 1976 noncatalyst, all except 4 cyl.	1.0	0.5
1975 and 1976 catalyst equipped	0.5	0.5
1972 through 1974	3.0	1.0
1970 through 1971	4.0	1.0
1968 through 1969	5.0	1.0
pre-1968 and those engines less than 50 cu. in. (820 cc) displacement	6.5	0.5

(2) Hydrocarbon idle emission values not to be exceeded:

Base standard	Enforcement tolerance through June, 1977	
No HC check	-	All two-stroke cycle engines & diesel ignition.
1600 ppm	250	Pre-1968 4 or less cyclinder engines, 4 or less cylindered noncomplying imports, and those engines less than 50 cu. in. (820 cc) displacement.
1300 ppm	250	Pre-1968 with more than 4 cylinder engines, and noncomplying imports with more than 4 cylinder engines.
800 ppm	200	1968 through 1969, 4 cylinder.
600 ppm	200	All other 1968 through 1969.
500 ppm	200	All 1970 through 1971.
400 ppm	200	All 1972 through 1974, 4 cylinder.
300 ppm	200	All other 1972 through 1974.
200 ppm	100	1975 and 1976 without catalyst.
125 ppm	100	1975 and 1976 with catalyst.

(3) There shall be no visible emission during the steady-state unloaded engine idle portion of the emission test from either the vehicle's exhaust system or the engine crankcase. In the case of diesel engines and two-stroke cycle engines, the allowable visible emission shall be no greater than 20 percent opacity.

(4) The Director may establish specific separate standards, differing from those listed in subsections (1), (2), and (3), for vehicle classes which are determined to present prohibitive inspection problems using the listed standards.

APPENDIX B

BIBLIOGRAPHY

The bibliography is broken down by major topics. An asterisk (*) denotes a recommended source. It is recommended that these reports be read first when seeking information on inspection/maintenance.

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APPENDIX C

GLOSSARY

GLOSSARY

accuracy: The degree by which an instrument is able to determine the true concentration of a pollutant in the exhaust gas sampled.

air contaminants: Any fumes, smoke, particulate matter, vapor gas, or any combination, but excluding water vapor or stream condensate.

air-fuel ratio: The expression of the proportional mixture of air and gasoline created by the carburetor. Usually expressed as a numerical relationship such as 14:1, 13:1, etc.

ambient air: The surrounding or outside air.

calibration gases: A blend of HC and CO gases using nitrogen as a carrier gas.

carbon monoxide: A nonirritating, colorless, odorless gas at standard conditions which has the molecular form of CO.

catalytic emission control system: Device to reduce automobile emissions by converting CO and HC emissions to harmless carbon dioxide and water.

certificate of compliance: A document which is issued upon completion of the inspection which records the results of the inspection and serves as proof of said inspection for vehicle owner.

certified mechanic: An individual licensed to install, repair and adjust motor vehicle engine emissions related components and pollution control devices in order that the motor vehicle meet applicable emissions standards.

certified station: A private facility licensed to install, repair and adjust motor vehicle engine emissions related components and pollution control devices in order that the motor vehicle meet applicable emissions standards.

chassis dynamometer: A machine equipped with two parallel rollers which support the rear wheels of a motor vehicle. When positioned on the dynamometer the vehicle may be "driven" to simulate the loadings the engine would experience when the vehicle is operated on the road. A power absorption unit is connected to the rollers to simulate the loading from the various sources of fluid and mechanical friction present during road operation. Weights can also be coupled to the rollers to simulate the inertial effects of vehicle mass during acceleration and decelleration.

Crankcase emissions: The products of combustion emitted into the ambient air from portions of the engine crankcase ventilation or lubrication system.

degradation: The decreased effect of I/M on emission reduction due to normal wear of engine system.

deterioration: A synonym for degradation indicating an increase in emission levels due to wear.

drift: The amount of meter reading change over a period of time. Zero drift refers to change of zero reading. Span drift refers to a change in reading of a calibration point on the upper half of the scale. The calibration point is established by reading a calibration gas of known concentration.

emission inspection program: An inspection and maintenance program in which each vehicle is subjected at specified intervals to a test of its emissions under specified conditions. The emission levels are compared with a standard established for the vehicle class. If the emissions are higher than the standard, the vehicle is failed and must be adjusted or repaired to bring its emissions into compliance with the standards.

exhaust gas analyzer: An instrument for sensing the amount of air contaminants in the exhaust emissions of a motor vehicle.

exhaust emissions: The products of combustion emitted into the ambient air from any opening downstream of the exhaust ports of a motor vehicle engine.

fleet owner authorized stations: A permit issued to a qualified fleet owner to perform vehicle emissions inspection limited to his fleet only.

fleet operator: The owner of a fleet of a designated number of vehicles.

hang-up: HC which clings to the surface of the sampling and analyzer system in contact with the gas sample stream which causes an erroneous indication of HC in the measured value.

heavy-duty vehicle: Any motor vehicle designed for highway use which has a gross vehicle weight of more than 8,500 pounds.

hydrocarbons: A compound whose molecular composition consists of atoms of hydrogen and carbon only.

idle test: An emission inspection program which measures the exhaust emission from a motor vehicle operating at idle. (No motion of the rear wheels.) A vehicle with an automatic transmission may be in drive gear with brakes applied or in neutral gear.

independent contractor: Any person, business firm, partnership or corporation with whom the state may enter into an agreement providing for the construction, equipment, maintenance, personnel, management and operation of official inspection stations.

inspection and maintenance program: A program to reduce emissions from in-use vehicles through identifying vehicles that need emissions control related maintenance and requiring that maintenance be performed.

inspection station: A centralized facility for inspecting motor vehicles and pollution control devices for compliance with applicable regulations.

inspector: An individual who inspects motor vehicles and pollution control devices for compliance with applicable regulations.

instrument: The system which samples and determines the concentration of the pollutant gas.

key mode test: A loaded mode test in which exhaust emissions are measured at high and low cruise speeds and at idle. The cruise speeds and dynamometer power absorption settings vary with the weight class of the vehicle. The dynamometer loading in the high cruise range is higher than normal load in order to more effectively expose malfunctions leading to high emissions.

light-duty vehicle: A motor vehicle designed for highway use of less than 8,501 pounds gross vehicle weight. Further distinctions are sometimes mad made between light-duty automobiles and light-duty trucks such as pickup trucks.

loaded mode test: An emission inspection program which measures the exhaust emissions from a motor vehicle operating under simulated road load on a chassis dynamometer.

model year of vehicle: The production period of new vehicle or new vehicle engines designated by the calendar year in which such period ends.

motorcycle: A motor vehicle having a seat or saddle for use of the rider and designed to travel on not more than three wheels in contact with the ground, but excluding a tractor.

motor vehicle: Any self-propelled vehicle which is designed primarily for travel on public right of ways and which is used to transport persons and property.

positive crankcase ventilation: A system designed to return blowby gases from the crankcase of the engine to the intake manifold so that the gases are burned in the engine. Blowby gas is unburned fuel/air mixture which leaks past the piston rings into the crankcase during the compression and ignition cycles of the engine. Without positive crankcase ventilation these gases, which are rich in hydrocarbons, escape to the atmosphere.

prescribed inspection procedure: Approved procedure for identifying vehicles that need emissions control related maintenance.

registered owner: An individual, firm, corporation or association whose name appears in the files of the motor vehicle registration division of the department of motor vehicles as the person to whom the vehicle is registered.

repeatability: The instrument's capability to provide the same value for successive measures of the same sample.

response time: The period of time required by an instrument to provide meaningful results after a step change in gas concentration level initiated at the tailpipe sample probe.

smoke: small gasborne and airborne particles, exclusive of water vapor, arising from a process of combustion in sufficient number to be observable.

stringency factor: The percentage of total vehicles tested in an inspection/maintenance program in a given time period that fail inspection and are required to have maintenance performed.

tampering: The illegal alteration, modification, or disconnection of emission control device or adjustments or manufacturer tuning specifications on motor vehicles for the purpose of controlling vehicle emissions.

vehicle dealer: An individual, firm, corporation or association who is licensed to sell motor vehicles.

vehicle emissions standard: A specific emission limit allowed for a class of vehicles. The standard is normally expressed in terms of maximum allowable concentrations of pollutants (e.g., parts per million). However, a standard could also be expressed in terms of mass emissions per unit of time or distance traveled (e.g., grams per mile).

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16. ABSTRACT

This document is prepared pursuant to Section 108(f)(1)(A)(i) of the Clean Air Act which requires that information be published on the processes, procedures, and methods to reduce or control motor vehicle emissions through inspection and maintenance programs. Included are basic information for those who are unfamiliar with inspection/maintenance and references for those who wish to go into specific topics in greater detail. Subjects treated include:

a. benefits and costs;
b. alternative methods for implementing programs;
c. legal and administrative considerations of inspection/maintenance;
d. inspection/maintenance problem areas; and
e. summaries of existing programs.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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