

VOLUME I

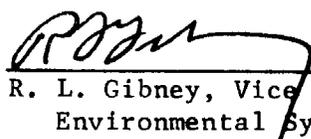
SUMMARY

MANDATORY VEHICLE EMISSION INSPECTION
AND MAINTENANCE
PART A - FEASIBILITY STUDY
FINAL REPORT

Prepared Under Contract

Contract ARB 1522
with
State of California
Air Resources Board

Approved by


R. L. Gibney, Vice President
Environmental Systems

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NORTHROP CORPORATION
Electro-Mechanical Division
500 East Orangethorpe Avenue
Anaheim, California 92801

in association with
OLSON LABORATORIES, INC.

FOREWORD

The Second Annual Report of the Air Resources Board, titled "Air Pollution Control in California," published in January 1970, documents the activities of the Board during 1969. In addition to a review of its many accomplishments, it was stressed that many problems remained to be solved. One of these was to determine the effects of various maintenance procedures on exhaust emissions and to develop a practical vehicle inspection program. In accordance with a legislative directive (AB76), the Air Resources Board issued a Request for Proposal on July 3, 1970, to conduct a Vehicle Emission Inspection and Maintenance Study that would determine the feasibility of such a program. Northrop Corporation, Electro-Mechanical Division, was selected to perform this study; Standard Agreement number ARB-1522 was consummated on November 30, 1970. Part A of the study addressed the overall feasibility and public acceptability of a program of mandatory vehicle emission inspection and maintenance. Part B of the total study which will be completed during November 1971 will obtain data on the reductions of automotive emissions that can be achieved through vehicle inspection and maintenance.

Part A of the study has been completed, documented, and is presented herewith in accordance with the requirements set forth by the Standard Agreement. This final report is presented in four volumes. Volume I is the Summary which provides a synopsis of the analytical methodology employed to determine and evaluate the feasibility of a statewide inspection program. The findings and results of the analyses are summarized, and recommendations for further effort are provided. Volume II is the Recommended Vehicle Emission Inspection and Maintenance Program. Volume III is the Technical and Economic Feasibility Analyses. It describes the conduct of the study; provides the findings, results, and conclusions of the analyses; and recommends areas for further investigation. Volume IV is the appendixes which contain data references, relevant correspondence, instrumentation survey data sheets, and other substantiating documentation.

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SECTION 1
SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The conclusions from this study are as follows:

- Mandatory Periodic Vehicle Inspection (PVI) in California is feasible in terms of emission reduction, program costs, vehicle owner costs, and public opinion.
- Inspection should be performed by the State, and repairs be performed by private enterprise.
- Of the inspection regimes studied, Key-Mode appears to be the most cost-effective when considered over the first 5 to 7 years of operations (Figures 1-1, 1-2, and 1-3).
- The present program of Certificate of Compliance, as conducted by the service industry, produces no significant benefits in terms of emission reduction.
- An inspection program will significantly reduce CO and HC emissions but may increase NO_x emissions slightly on pre-1970 vehicles.*
- There appears to be a public acceptance of a vehicle inspection program in California as a means to reduce air pollution.
- Instrumentation and equipment which can be adapted to the requirements are available for a network of inspection stations.
- Technical skill level required for immediate staffing of Key-Mode inspection facilities is not presently available. Necessary training to upgrade the required personnel can be accomplished within the construction period.

Based on these conclusions, the following recommendations are suggested:

- Immediately initiate the planning for a State-owned and operated network of Key-Mode inspection stations. The recommended area of implementation is the State's first five largest air basins - South Coast (including Los Angeles, Orange County, Riverside), San Francisco Bay Area, San Joaquin

*Vehicles tested are equipped with CO and HC control systems. For future vehicles equipped with NO_x control, deterioration and malfunction may cause NO_x emissions to increase. Inspection and maintenance will probably produce a benefit of NO_x emission reduction. The magnitude of this reduction cannot be determined with the data available at this time.

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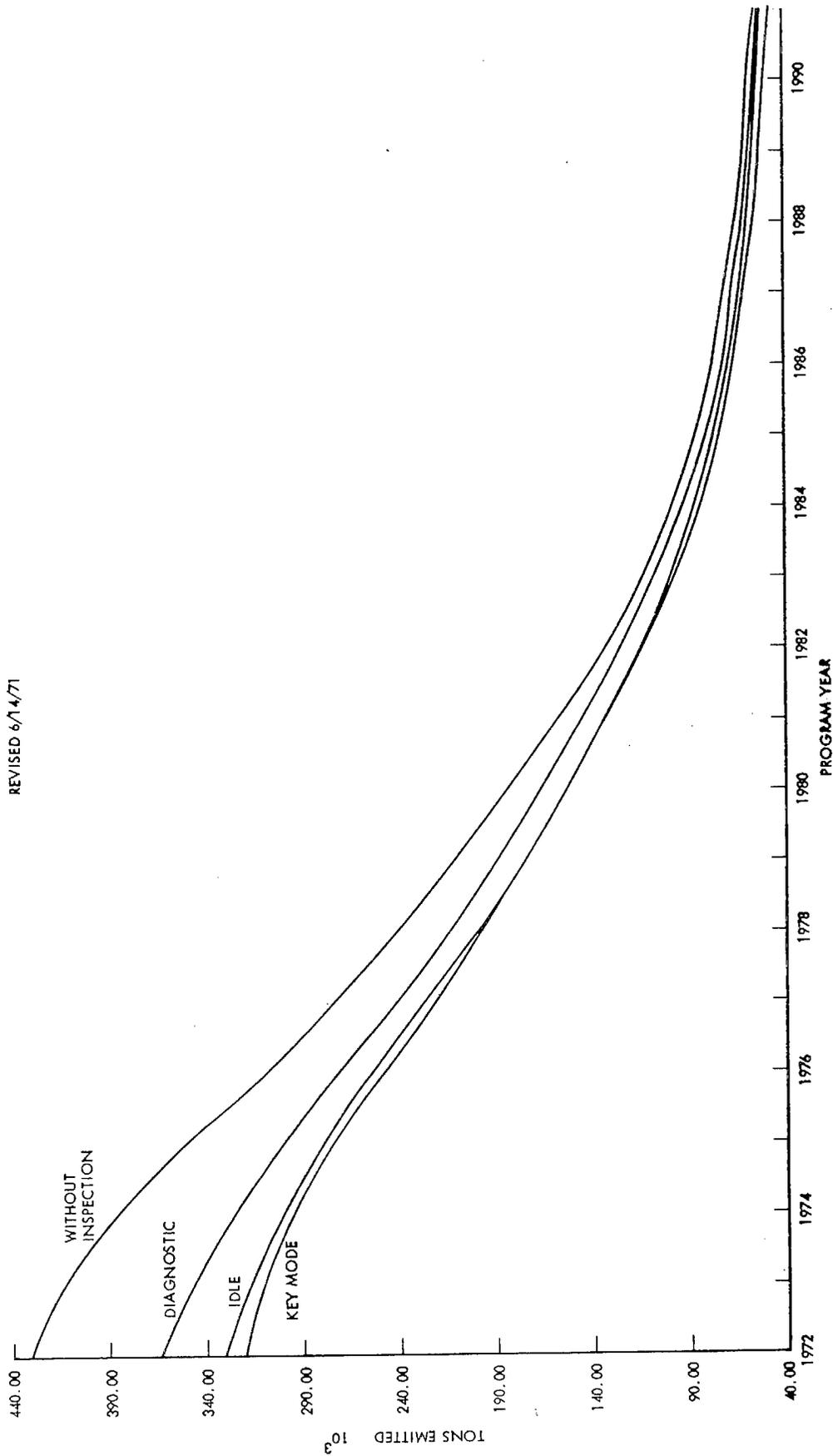


Figure 1-1. ESTIMATED HYDROCARBON EMISSION LEVELS

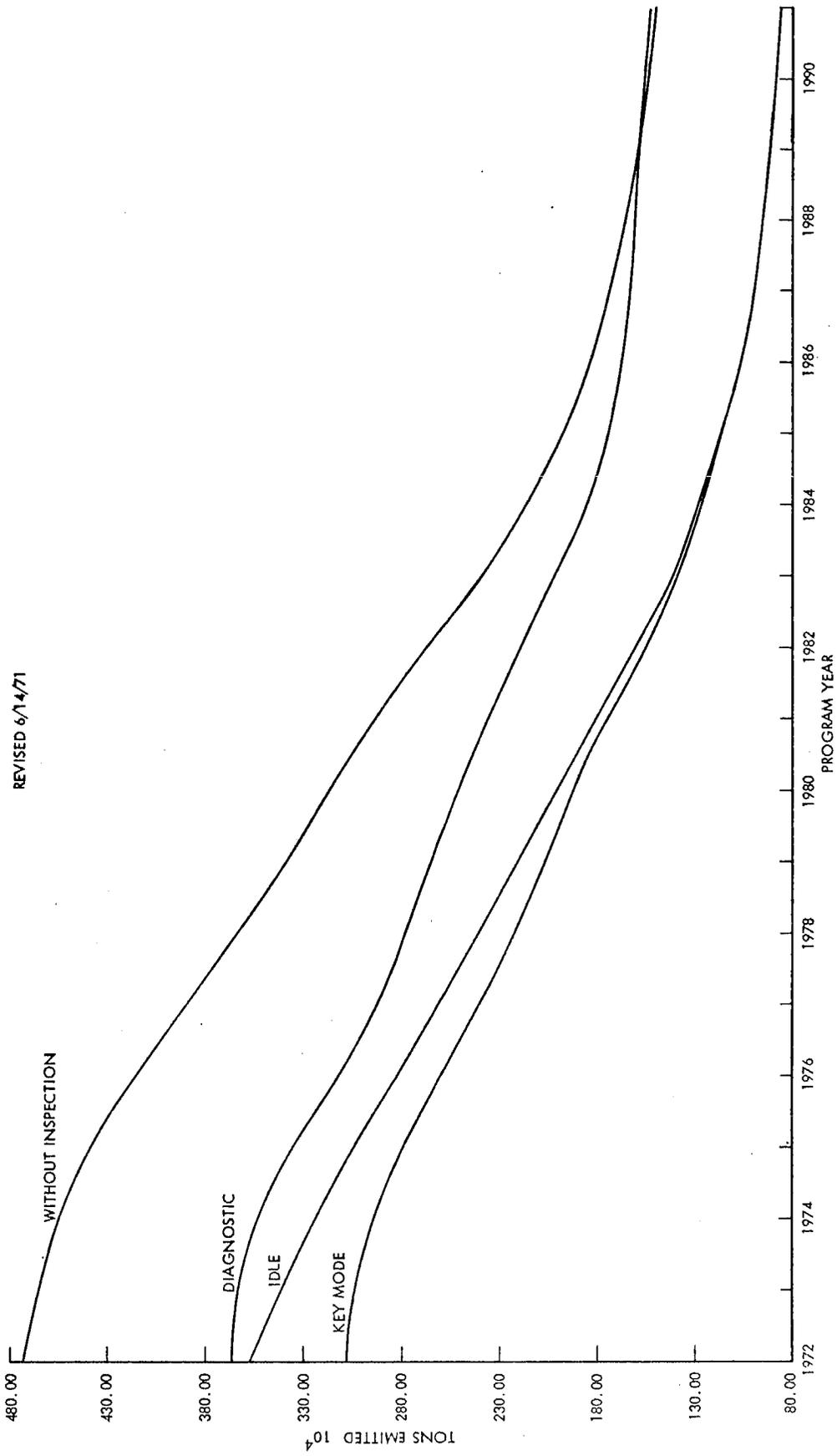


Figure 1-2. ESTIMATED CARBON MONOXIDE EMISSION LEVELS

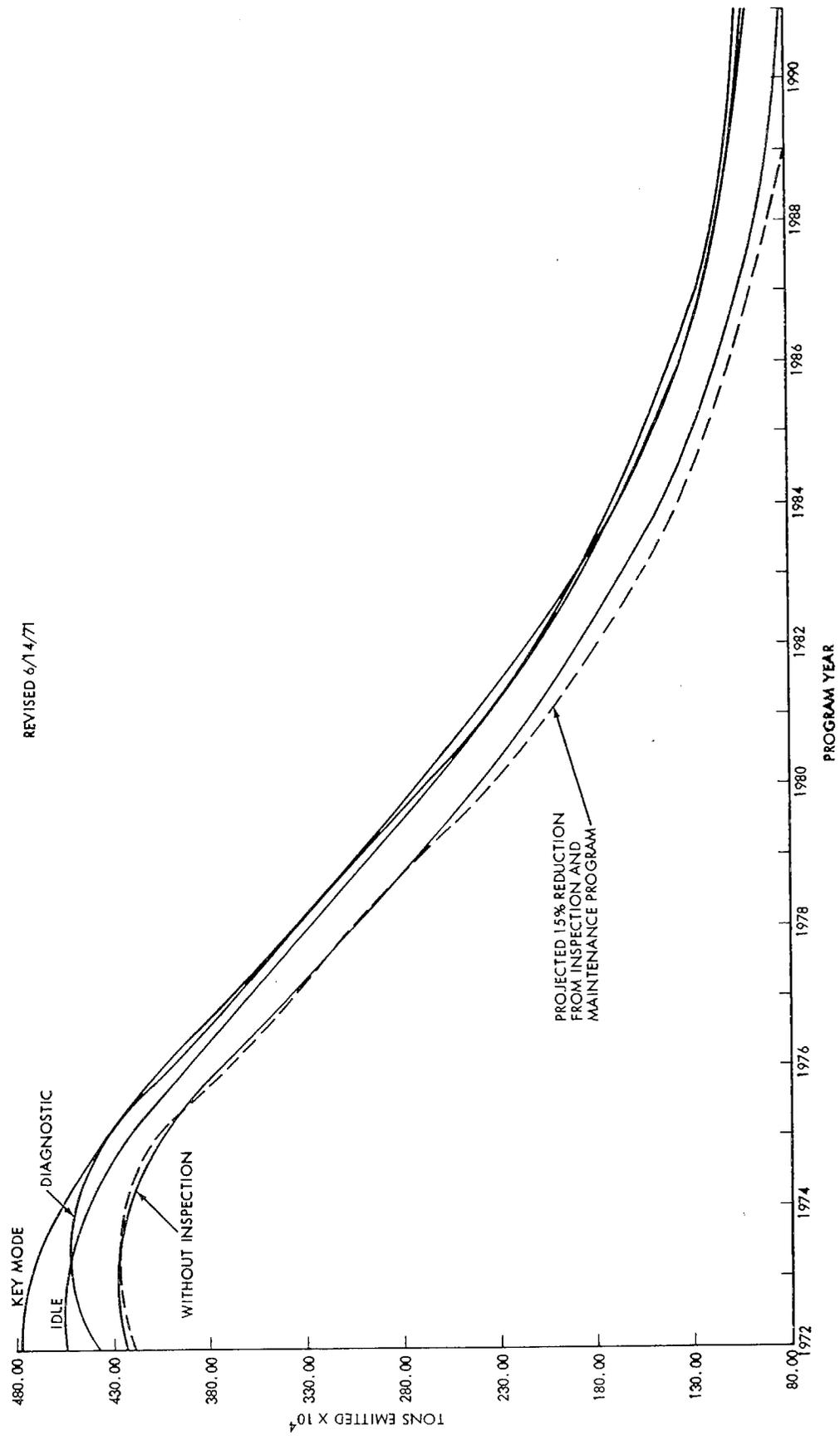


Figure 1-3. ESTIMATED OXIDES OF NITROGEN EMISSION LEVELS

Valley, Sacramento Valley, and San Diego Air Basins. These five basins contain approximately 92 percent of California's cars, all of which could be inspected annually by approximately 97 stationary and 18 mobile Key-Mode inspection facilities.

- During the planning and the subsequent period of construction, initiate a training program to develop the necessary skill levels to staff the facilities.
- Immediately upgrade present Class A stations to conduct a mandatory Modified Certificate of Compliance inspection and maintenance program which includes Idle test capability. This will occur on all vehicles at transfer of ownership.
- The Certificate of Compliance program should be phased out when the State inspection becomes operational; those stations that will have been upgraded during this period should be certified as repair facilities.
- As the State air pollution control agency, the Air Resources Board should be authorized to administer the inspection program; such a program also would be in accordance with the directives as outlined in the amendments to the Federal Clean Air Act of December 1970.
- Studies should be conducted to develop simple and effective ways of evaluating the performance of emission control systems.

SECTION 2 INTRODUCTION AND BACKGROUND FOR RECOMMENDATIONS

The automobile has long been identified as a major source of carbon monoxide (CO), hydrocarbon (HC), and oxides of nitrogen (NO_x) entering the atmosphere. In California, emission standards have been established for over 10 years and applied to automobiles over the past 8 years, first to engine crankcase emissions in 1963, then to exhaust emissions in 1966, and finally to evaporative emissions in 1970. Each set of standards has resulted in devices, methods, and/or engine design changes that reduce emissions to levels prescribed by the standards. These various emission control measures have reduced air pollution attributable to automobiles, but their full effectiveness will not be achieved over the life span of the cars if emissions increase because of deterioration, maladjustment, and malfunction after a vehicle is purchased.

This study which was requested by the California legislature has shown that a program of mandatory periodic vehicle inspection (PVI) and corrective maintenance is a feasible approach to the reduction of exhaust emissions from automobiles in the State of California. Key-Mode inspection tests and corrective maintenance performed on privately owned cars in this study have shown that CO and HC exhaust emissions for California's present vehicle population can each be reduced initially on the order of 25 percent if a program is initiated immediately and if emission criteria are established which will fail about 50 percent of the vehicle population. Some of this benefit will be lost due to deteriorations following maintenance. Reducing CO and HC to minimum levels in this program resulted in slightly increased NO emissions on the average. A properly managed PVI program will assure that California vehicles are maintained at emission levels which approach their minimum potential.

The feasibility of implementing such a program was examined technically, economically, and in terms of public opinion. The effectiveness and costs of four alternative inspection test regimes were analyzed to determine which would be optimum for a mandatory PVI program. Other alternate approaches and hybrid test regimes were reviewed and carefully considered. These included the New Jersey vehicle inspection program, cooperative programs sponsored by the Air Pollution Research Advisory Committee, and the inspection and repair of vehicles to their minimum pollution capability in existing or modified repair centers. Future requirements such as the constant volume sampling (CVS) test procedures specified by the Federal government were also considered.

The Key-Mode test and the Idle test with corrective maintenance produced maximum emission reductions and were clearly the most cost effective approaches. The full diagnostic regime is relatively less cost-effective and the existing Certificate of Compliance test as it is actually conducted in Class A stations does not significantly reduce emissions, especially on uncontrolled vehicles. However, it was apparent that application of a Modified Certificate of Compliance procedure in

exact accordance with existing and supplemental written instructions will result in significant emission reductions on the average. A rigorous and efficient management plan plus modest upgrading of present facility capability can result in the Certificate of Compliance procedures approaching the pollutant reduction effectiveness of the Idle and Key-Mode regimes.

The Key-Mode inspection test is recommended as the most cost-effective. The inspection cost per vehicle in a State-owned inspection center using the Key-Mode test is estimated to be \$1.05. The average repair cost for vehicles which fail the inspection is \$24.86. Repaired vehicles can expect an \$8.70 annual savings in fuel cost so their average, net expense is only \$16.16 plus the inspection fee. Conservatively this expense will result in eliminating at least 10 percent of the automotive emissions in California's atmosphere even if implementation is delayed (25 percent if initiated immediately). To eliminate this same amount of pollutants with any other known method is estimated to cost at least 3 to 5 times more per vehicle.

The most cost-effective approach is for State-owned and State-operated stations; this method is favored in the public opinion poll. The State, as a regulatory agency in the system, should conduct the inspection of those vehicles which transfer ownership initially to properly accomplish enforcement of emission standards. Private industry should perform the corrective maintenance function on those vehicles that State inspection finds to be noncompliant with emission standards, and should supplement this State program by early implementation of a modified properly managed inspection and maintenance program on all cars not inspected at State stations.

The details of a suggested implementation plan are provided in Section 10, Volume II, and schematically shown in Figure 10-1 of this volume. This plan recommends the initiation of a State-owned and operated inspection system, but also addresses the need for early implementation by upgrading and immediately utilizing existing Class A stations. Class A stations will function as repair centers, and with the addition of relatively low cost HC/CO instruments, will be able to use most of their present facility complement. Performance of the Class A stations must be carefully audited by an upgraded State certification and management program. The implementation plan offers a phasing schedule with new implementation decisions identified in Volume II.

SECTION 3 PUBLIC ACCEPTABILITY

A significant requirement of the feasibility study was to determine the public's acceptability of a mandatory vehicle emission inspection and corrective maintenance program. To make this determination, a public opinion survey was conducted among 1,000 owners of private automobiles registered in the State of California. Each vehicle owner was asked 142 questions designed to assess his feelings about improving air quality by a mandatory program, and how such a program should be conducted. Besides this, personal interviews were conducted with a specially selected group of 50 people considered to be opinion leaders. These people represent businesses, industries, professions, public organizations, and public office holders. The data obtained through these surveys were considered in the formulation of alternative criteria for evaluation in the feasibility analysis.

More than three-fourths of the automobile owners and four out of five of the opinion leaders interviewed name the automobile as the major contributor to air pollution in California. Three-quarters of the owners believe a mandatory vehicle emission inspection and corrective maintenance program for all vehicles in the State is necessary, while just over half of the opinion leaders agree that a mandatory program is necessary.

More than half of the owners believe the inspection program should be conducted by the State rather than private garages or service stations licensed by the State. The opposite is true of the opinion leaders. The main reason the owners give for preferring a State operated system is that they do not trust private garages and service stations. The main reason the private garage is preferred by the minority is because of the convenience factor.

The opinion leaders who believe the inspections should be conducted by the State are likewise concerned about potential abuses and dishonesty of the private garages. Those who believe that the private garage or station should do the inspection do so because they feel that the costs for the State to develop and run the inspection centers might be too high.

More than three-fourths of the automobile owners believe that the frequency of inspection should be at least once a year. Three-fifths of the opinion leaders concur with this frequency. The majority of the automobile owners think that the inspection should be limited to 30 minutes or less, with an inspection fee of \$1.00 or less, a driving distance of less than 10 miles to an inspection center, and an average repair cost of \$10.00 or less.

A significant division of opinion exists among both vehicle owners and the opinion leaders on the question of enforcement provisions for an inspection program. Forty-seven percent of the owners approve and an equal number disapprove of an enforcement

provision which would require the owner to repair his vehicle within a specified time limit or surrender his license plates and registration papers. Nineteen of the leaders approve and 23 disapprove of these provisions. The remainder are undecided. Among those who disapprove, approximately half believe there should be some fine, but there is no consensus as to the amount. Details of the public opinion survey are provided in the Appendix, Volume IV.

SECTION 4 INSTRUMENTATION ANALYSIS

An analysis of vehicle exhaust emission instrumentation was performed to evaluate the available instrumentation technology; to establish criteria for selection of the optimum inspection station configuration; to define a recommended instrumentation system; and to identify areas requiring further study or development.

4.1 TECHNOLOGICAL EVALUATION

Adequate technology presently exists to support the instrumentation requirements for a mandatory vehicle emission inspection and corrective maintenance program. Carbon monoxide can be measured in the 1 and 10 percent ranges with 1 percent accuracy by the use of nondispersive infrared (NDIR) and by ultraviolet emission techniques. Hydrocarbons can be measured by nondispersive infrared or by flame ionization detection (FID) with 1 percent accuracy in the 1,000 and 10,000 ppm (as C₆) ranges. The choice of method is partially dependent on the ability to correlate the measurements made with these two instruments with the photochemical reactivity of exhaust hydrocarbons. Oxides of nitrogen can be measured with 1 percent accuracy in the 2,000 ppm ranges with NDIR, with electrochemical sensors, and with a chemiluminescent method. The latter two methods are also capable of sufficient sensitivity to provide required accuracy in instruments of 100 or 200 ppm range. Continued development of instrumentation technology for application in ambient air quality monitoring can provide instruments of adequate sensitivity and accuracy for testing to the low level emission standards which are projected through 1980.

4.2 OPTIMUM INSTRUMENTATION CONFIGURATION

Conventional exhaust analysis equipment is not required for the Certificate of Compliance inspection. All other test regimes that were evaluated required measurement of CO, HC, and NO. Thus a basic complement of equipment, with certain additions or deletions, can meet the exhaust measurement requirements of the three inspection test regimes requiring these measurements. The principal difference to be evaluated is whether the equipment should be manually or semiautomatically controlled in operational usage.

A manual system consists of three or four analyzers and a common sampling system. The recommended analyzers are NDIR for CO, NDIR or FID for HC, and NDIR or chemiluminescent for NO. Data from the analyzers are manually recorded. These values are compared to the failure limits which are entered on the test report form prior to initiation of the test.

The semiautomated system is applicable to all three test regimes of concern. The system consists of a standard card punch machine, the instrument set, a simple input system for reference data, a digital scanner, and a small processor which incorporates the required data storage and logic functions. The basic report

document is a double size punched card. When all test and reference data have been entered, the system produces a two-part report. One part has the pass-fail result visually presented by punched information and is given to the owner. The other part contains all the data in punched card format and is used for station and program record keeping and for statistical analysis.

Cost-effectiveness evaluation of these two systems favors the semiautomatic system for State-operated inspection stations.

SECTION 5
RECOMMENDED DEVELOPMENT AND STUDY PROGRAM

To ensure an effective vehicle emission inspection and maintenance program, a number of studies are required. They cover the areas of implementation, technology and methodology, and statistical analysis.

- Implementation
 - Develop a detailed management and operational plan to implement the recommendations of this study.
 - Develop a detailed system design.
 - Assemble and evaluate a prototype system.
 - Prepare detailed design, performance, and acceptance test specifications.
- Technology and Methodology
 - Evaluate exhaust dilution using oxygen concentrations.
 - Develop new technology affecting the vehicle inspection and maintenance program such as maintenance-free engine components and external sensing for engine diagnosis.
 - Evaluate motivation of mechanics with new diagnostic procedures and instrumentation and the use of quality control methods to ensure effective repair.
 - Expand Key-Mode truth charts to include NO.
- Statistical Analysis (beyond the scope of the present contracted effort)
 - Develop failure rate analysis to determine effects of different failure rates on implementation and vehicle owner costs and effectiveness.
 - Complete cost-effectiveness analysis based on all 1200 cars.
 - Conduct analysis of additional parameters such as engine size, mileage, and type of emission control device to determine their correlation with emission levels.
 - Conduct analysis of degradation retest data.

SECTION 6
INSPECTION STATION REQUIREMENTS ANALYSIS

6.1 EQUIPMENT, PERSONNEL, AND TRAINING REQUIREMENTS

The alternative inspection station requirements were determined for each inspection test regime. The requirements for equipment, personnel, and training were determined for maximum test capability in vehicles per hour through the inspection lanes of a station. The requirements for the alternative test regimes are shown in Table 6-1.

6.1.1 Equipment

Equipment requirements and costs were based on use of the semiautomatic exhaust gas analyzing instrumentation described in Section 4. For the Key-Mode and Diagnostic dynamic test regimes, which require vehicle operation under simulated road conditions, a dynamometer is required. For the Diagnostic test, engine performance analysis instrumentation also is required. Each of these add-on requirements is included in the summary costs shown in Table 6-1.

6.1.2 Personnel Requirements

Personnel requirements for the four test regimes were determined in terms of competitive wages, skill levels required to perform tests competently, numbers of personnel required, and training level. Three personnel levels were determined for application to the four regimes; these levels are technician Grades I through III. These levels are based on 1 to 3, 3 to 10, and 10 and over years of experience, respectively. These personnel are automotive mechanics with special training in exhaust emissions; engine components, malfunctions and maladjustments which cause excess emissions, and engine exhaust instrumentation.

6.1.3 Personnel Training

All inspection station personnel will require certification. Training requirements include review of engine and vehicle components and functions, correct adjustment procedures, demonstrations, and laboratory practices. Training programs can be conducted by automotive mechanics instructors in public and/or trade schools who have had a special preliminary course. Final performance testing would permit issuance of a certificate to the student. He would still be subject to periodic performance inspection at his place of employment and required to attend special courses as new emission system devices or test methods are accepted.

6.2 INDIVIDUAL STATION SIZE AND LOCATION

Vehicle population centers were defined as a station location if they contained 6,000 automobiles within a 10-mile radius or if they represented a significant portion of the vehicle population of a given county or air basin. Vehicle populations not fulfilling these criteria were assigned to a county-wide pool. The inspection station

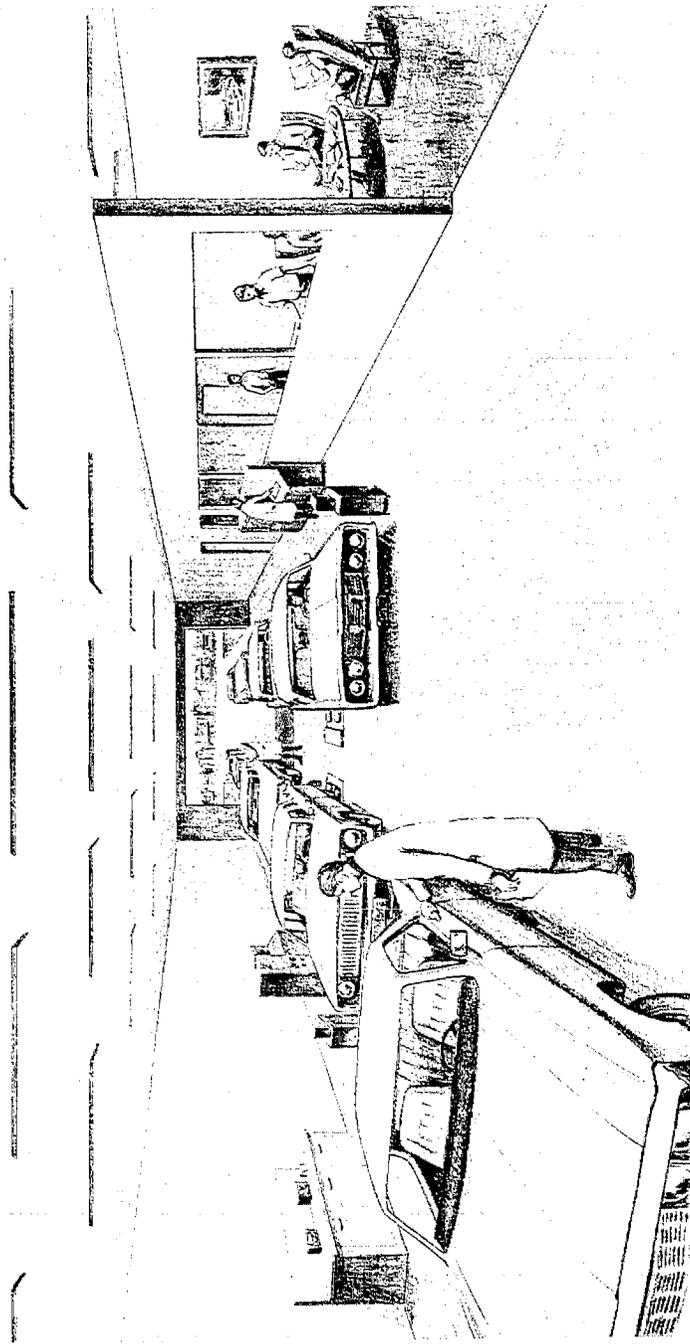


Figure 6-2. ARTIST'S CONCEPTION OF INTERIOR VIEW OF KEY-MODE INSPECTION STATION

SECTION 7
STATE VERSUS PRIVATELY OWNED AND OPERATED INSPECTION STATIONS

The issue of State versus privately owned and operated vehicle emission inspection and maintenance program was a major consideration in the type of inspection test to be recommended for implementation. Public opinion prefers that the State conduct the vehicle inspection independent of the repair centers. This approach is also the most cost-effective.

The alternative considerations for ownership and operation were encompassed by the following:

- a. Total State management, ownership and operation of the inspection facilities.
- b. State management of privately owned and licensed inspection facilities which presently exist or could be modified.
- c. Private sector ownership and operation of inspection facilities under State regulation.

The relative participation of State and private concerns was evaluated. Obviously, State regulation of the program is a minimum requirement, as far as State participation is concerned. Private ownership and operation may vary from the establishment of a separate corporation to manage and implement the program under State regulation, to State licensing and regulation of individual owners in the vehicle maintenance industry.

The cost-effectiveness of each ownership alternative varies. State ownership and operation is the most cost-effective in terms of pounds of pollutant reduced per dollar per year. The cost-effective ranking of the alternatives is shown in Figure 7-1. The cost advantage of State ownership is derived from the absence of private industry taxes and profits. In either of the private ownership options, there is the requirement for a State regulatory function, which further adds to their cost.

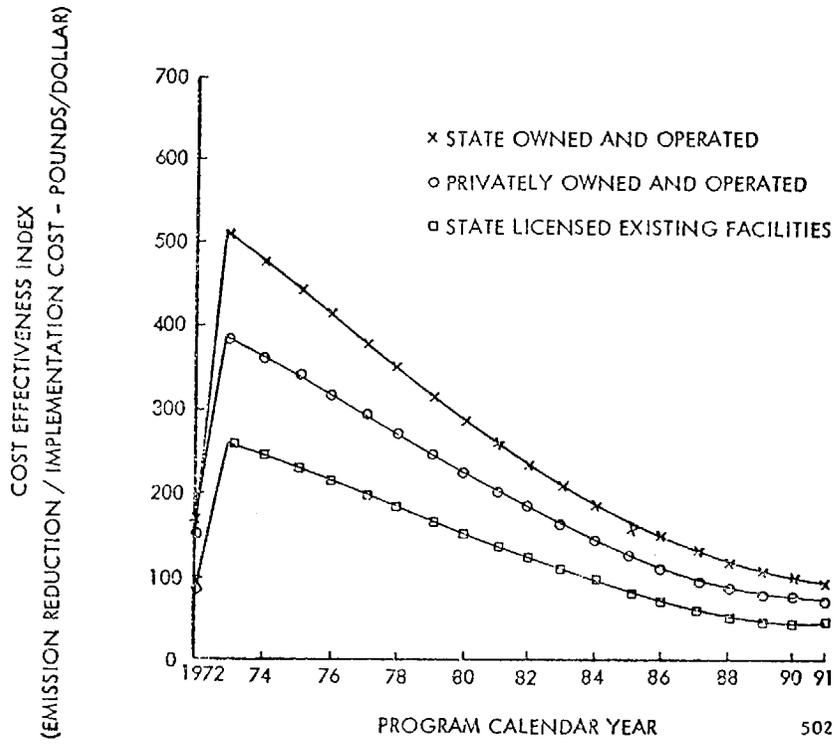


Figure 7-1. KEY-MODE OWNERSHIP AND OPERATION COMPARISON

SECTION 8
PROGRAM EVALUATION

8.1 COST ANALYSIS

Each of the test regimes was analyzed by a life-cycle cost model designed to identify all significant costs in the three major categories of (1) research and development, (2) initial investment and acquisition, and (3) operating and maintenance, into which the program concept of periodic vehicle inspection and maintenance had been divided. Three alternative configurations of each regime were considered. The first was a wholly State-owned, State-operated network of vehicle emission testing centers providing no on-site automotive service. The second configuration considered was a privately owned and operated network of facilities, with supervision by the State on a continuing basis. The third concept considered was a network of licensed inspection facilities such as automobile dealerships, service centers, independent garages, and gas stations that would perform emission inspection for an established fee. For each regime it was determined that the least costly approach would be the first option - a State-owned, State-operated network of vehicle emission test centers. Initial investment cost for each of the three regimes in this configuration was estimated to be \$12,084,000 for Idle, \$19,830,000 for Key-Mode, and \$88,776,000 for Diagnostic.

Operating costs for the inspection station the first year of operation for the three are: \$9,576,000; \$10,476,000; and \$30,688,000, respectively. Operating costs in all cases determine the vast majority of expenditures required. All the costs above represent aggregate amounts required to test all cars in the State.

The detailed cost analysis in Volume III of this report discusses costs of implementation on the basis of costs by individual air basins within the State. In all cases, 60 to 70 percent of the cost figures quoted above would be required for implementation in the two largest air basins, South Coast and San Francisco Bay. Implementation in the first four largest air basins containing approximately 85 percent of all cars in the State would require expenditures of approximately 80 percent of the figures quoted for each regime.

8.2 COST-EFFECTIVENESS ANALYSIS

Shown below is the simplified equation used for determining the quantitative measures of cost effectiveness for the alternative test regimes:

$$\text{Cost-Effectiveness (CE)} = \frac{\text{Effectiveness Measure}}{\text{Program Cost}} = \frac{\text{Pounds of Pollutants}}{\text{Dollars}}$$

Using the cost effectiveness indices thus calculated, the alternatives were ranked in the order of greatest emission reduction for money expended. The test regime

achieving the greatest reduction for the least estimated total cost would generate the largest index and thus rank the highest. This does not necessarily mean that this particular test regime would realize the greatest reduction of all alternatives, nor does it imply that it would cost the least to implement. It merely identifies that one test regime that realizes the greatest potential for a specified amount of resources and money.

8.2.1 State-Owned and Operated Inspection Facilities

In this alternative, the State of California acquires the necessary sites, constructs the inspection facilities, equips the test lanes, staffs the facilities, and manages the total program. Figure 8-1 compares the four test regimes using the calculated cost effectiveness indices.

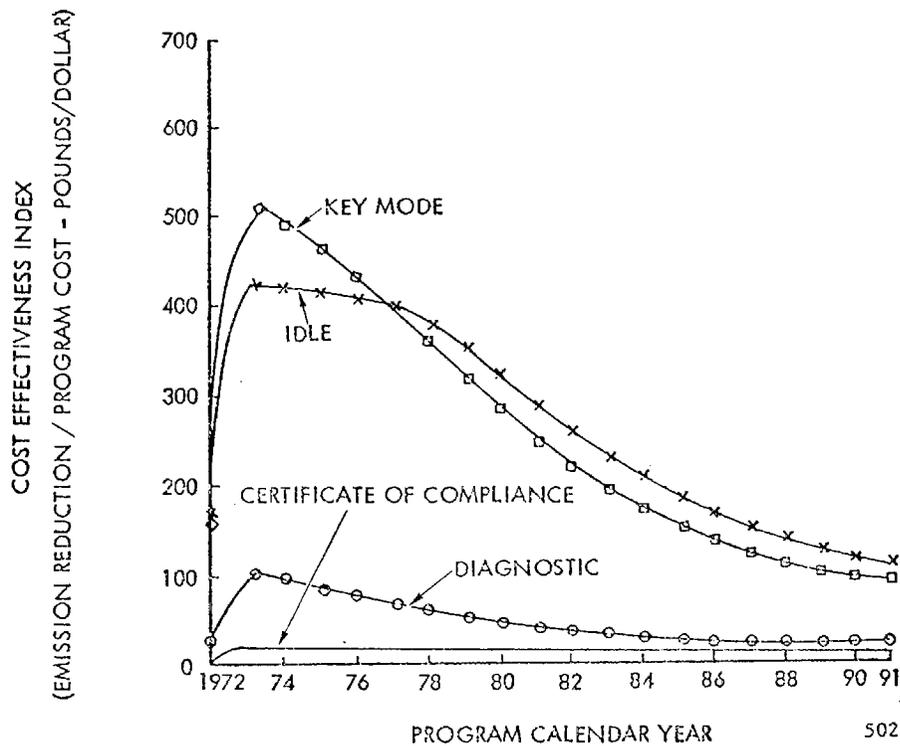


Figure 8-1. TEST REGIMES COMPARISON - STATE OWNED AND OPERATED INSPECTION FACILITIES

Key-Mode inspection exhibits the greatest emission reduction for the costs incurred during the first 5 years of operation. After 1978, it is essentially equal to the Idle test. The figure shows that Idle test is more cost effective than Key-Mode during the period 1978 through 1991. Diagnostic testing is much lower in cost-effectiveness than both Key-Mode and Idle testing. This is due to its high annual operating cost. Certificate of Compliance is relatively poor compared with the other three test regimes as it achieved relatively little emissions reduction and the annual operating costs were about twice that of Idle or Key-Mode.

8.2.2 Privately Owned and Operated Inspection Facilities

For this alternative, the State of California would select on a competitive basis, a private concern to administrate and manage the overall program. This would include site selection and construction of new inspection facilities. The actual ownership and operation of the inspection facilities would be by private industry subject to the applicable State regulations. It is assumed that a staff of State personnel would be required to review the inspection activities periodically to assure conformity to State-established policy. Cost items would be similar to State ownership and operation, plus the supplemental cost of the State regulatory agency and private industry taxes and profits.

Figure 8-2 shows the cost effectiveness indices by calendar year for each of the four test regimes. The Key-Mode test exhibits an early advantage over the other three test regimes. After 5 years of operation, the Idle test regime shows a slight advantage over Key-Mode test.

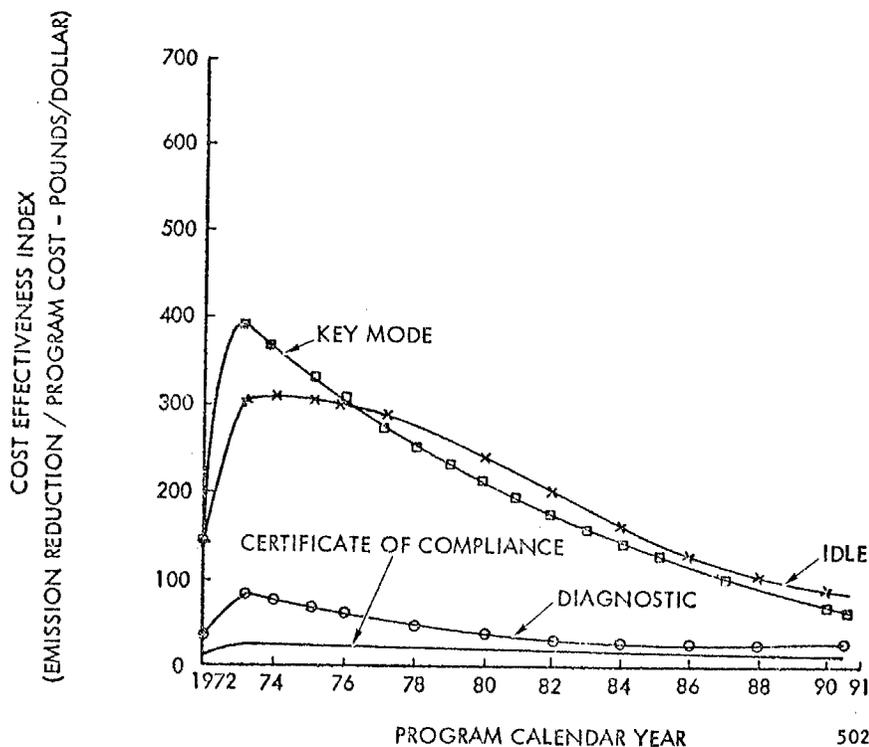


Figure 8-2. TEST REGIMES COMPARISON - PRIVATELY OWNED AND OPERATED

Both Diagnostic test and Certificate of Compliance are relatively low in cost-effectiveness when compared with the other two test regimes. Whereas Diagnostic test is fairly effective in achieving emission reductions, the high annual operating cost (approximately \$40 million) of the inspection facilities seriously reduces the ratio of emission reduction achieved for each dollar spent. In the case of Certificate of Compliance, the cost-effectiveness index is lowered considerably due to much lower effectiveness than that achieved by the Diagnostic test, coupled with an annual operating cost of about \$30 million.

8.2.3 State Licensing of Existing Privately Owned Facilities

In this alternative, the State of California would provide total program administration and management. Existing vehicle maintenance centers are qualified and certified by a State agency to perform vehicle emissions inspection. Service may or may not be performed on site. Many of the investment costs are obviated due to the existence of the facilities. Additional cost considerations included equipment depreciation and business profit. Taxes were not considered since inspection fees are based on labor charges only.

Figure 8-3 compares the four test regimes as a function of calendar year. The Key-Mode test exhibits a greater cost effectiveness index than Idle test during the first 4 to 5 years of operation, but from 1976 through 1991, the Idle test regime is more cost-effective than Key-Mode. Diagnostic test and Certificate of Compliance rank third and fourth, respectively, from 1972 and on.

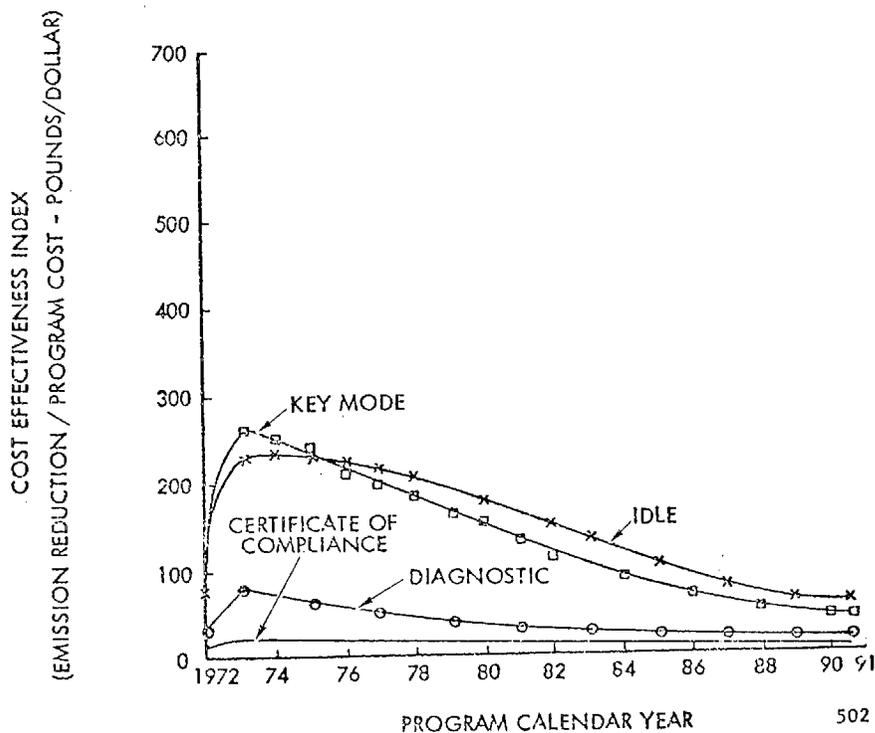


Figure 8-3. TEST REGIMES COMPARISON - STATE LICENSED, EXISTING PRIVATE FACILITIES

8.3 CONSIDERATION OF QUALITATIVE FACTORS

The preceding analysis considered the quantitative factors of emission reduction and program cost. There are other factors to be considered in determining which of the alternatives would be the most suitable to implement. The estimation and projection of emission reductions and the associated program costs are based on available information and operational data. Wherever possible, the relevant data were quantified and used. Factors such as future regulations, technological advancements, and prototype developments cannot be quantified but they have been considered qualitatively.

SECTION 9
RECOMMENDED VEHICLE EMISSION INSPECTION
AND MAINTENANCE PROGRAM

The preceding summary has described the cost-effectiveness criteria for determining the best inspection regime. The result of this analysis is that a system of State-owned Key-Mode inspection stations would be the most cost-effective in reducing vehicle exhaust emissions.

9.1 KEY-MODE INSPECTION STATIONS

The Key-Mode stations are constructed from one- and two-lane modules. Each facility contains the inspection equipment, public waiting room and restrooms, office, and storage space. Each inspection lane can accommodate three vehicles, one each undergoing (1) pretest inspection, (2) Key-Mode inspection, and (3) post-test certification or repair instructions.

9.2 KEY-MODE INSPECTION EQUIPMENT

Each inspection lane will be equipped with the Key-Mode dynamometer exhaust emission analysis system, described in Volume III, and exhaust removal system. Additional hand tools and necessary support equipment will be required.

9.3 KEY-MODE STATION SITES AND TYPES

General locations of stationary Key-Mode facilities and the number of required lanes were determined by throughput analysis and determination of vehicle population centers as summarized in Volume III. A total of 398 inspection lanes are required statewide. Each lane will process 25,000 vehicles per year with two inspectors and \$15,000 worth of equipment. Thirty-nine single-lane mobile facilities are required and will be used in sparsely populated areas.

9.4 PERSONNEL AND FUNCTIONS

The basic one-lane station requires two men for efficient operation. One man is required to have 3 years experience as a tuneup technician, while the other man is only required to have 1 year of experience. These inspectors will receive specialized training amounting to 142 hours of lecture and actual operation of the test equipment.

An initial training program for instructors will be required with the top students from subsequent classes supplementing the instructor cadre.

9.5 TEST DESCRIPTION

The Key-Mode test regime developed by the Clayton Manufacturing Co. consists of a dynamic test on a chassis dynamometer of the carburetion and ignition system in high and low cruise modes and a static test performed in the Idle mode. These "key" modes were selected to identify common problems with a high degree of accuracy. The results of the emission test are recorded on a Key-Mode "report card" with check marks for failed modes. This card is then compared to "truth charts" by the mechanic to determine the most probable cause of failure, and to conduct the necessary repair action.

9.6 CERTIFICATION RECORDS

A record of the certification of a passed or repaired vehicle will be required for statistical and enforcement records. The method used must provide for vehicle identification and recording of the emission test results. The format will be such that the Key-Mode report card and truth chart system remain intact but is in machine readable form to expedite computer processing.

The final selection of the certification record media must be deferred until the inspection station system design is undertaken to ensure total system compatibility. This includes compatibility with all State agencies that would require data from or provide information to the vehicle emission inspection program.

9.7 DESCRIPTION OF KEY-MODE FACILITY OPERATION

The following description refers to the movement of a vehicle through a typical test lane. The first function performed is a pretest inspection of the exhaust system to ensure that the exhaust sample is within a correctable limit. Also included is an inspection for major gas, oil, or water leaks and tire condition to ensure safe operation of the vehicle on the dynamometer. A courtesy inspection of lights, radiator hoses, and battery condition is accomplished concurrently with negligible additional time required. This pretest inspection is performed by the second level inspector.

The car is moved onto the dynamometer by the top level inspector and the emission inspection performed. He then moves the car forward to the post-test area with a copy of the test results.

The second level inspector provides the vehicle owner with certification if the vehicle passes, or with the appropriately checked Key-Mode report card and instructions on how to obtain certification if the vehicle failed.

SECTION 10 IMPLEMENTATION PLAN

The recommended implementation plan is described with a suggested time frame in Figure 10-1. The plan is designed to provide optimum utilization of the existing service industry by simultaneously initiating the plan for upgrading Class A stations and for establishing a State inspection and management network. The long-range action will include Key-Mode inspection in State-owned and operated centers. Elements of the Idle inspection along with upgraded Certificate of Compliance requirements must be phased into existing Class A stations at the earliest possible date.

10.1 STATE EMISSION CONTROL OBJECTIVES AND REQUIREMENTS

The State of California has urgent short-term objectives to meet in the field of vehicle exhaust emission reduction as well as existing long-term objectives. Of immediate concern is the reduction in vehicle exhaust emissions that can be obtained with the implementation of a mandatory vehicle emission inspection and maintenance program. To provide maximum benefit, this program should be implemented by 1972. The inspection test regime selected, first of all, should be implementable in this time span. Concurrently, the longer term requirements presented by the Clean Air Amendments of 1970 must be considered.

The Clean Air Amendments of 1970 present requirements which must be considered in two areas. One is the requirement that automobile manufacturers provide warranty on emission control devices once a suitable inspection is found to exist and is promulgated by the Environmental Protection Agency. In line with California's lead in the field of air pollution control, consideration in the selection of a mandatory vehicle emission inspection and maintenance program should be given to an inspection system that will provide the basis for implementing manufacturer warranties on emission control devices in California.

The second area is the requirement for exhaust emission constant volume sampling and mass measurement testing presented by the 1972 Federal Test Procedure. This requirement is related to the aforementioned warranty inspection test system requirement in that the inspection test must be compatible with the Federal Test Procedure. Both of these requirements support the need for an inspection system that has dynamic test capabilities, such as could be provided by the Key-Mode Test.

The most important single consideration in the recommended Implementation Plan is the management control required to assure successful accomplishment of the program objectives. The requirement for a Management Plan plus emission control effectiveness and cost effectiveness are three of several factors which have been carefully considered in the recommended implementation plan. Other important factors included the following.

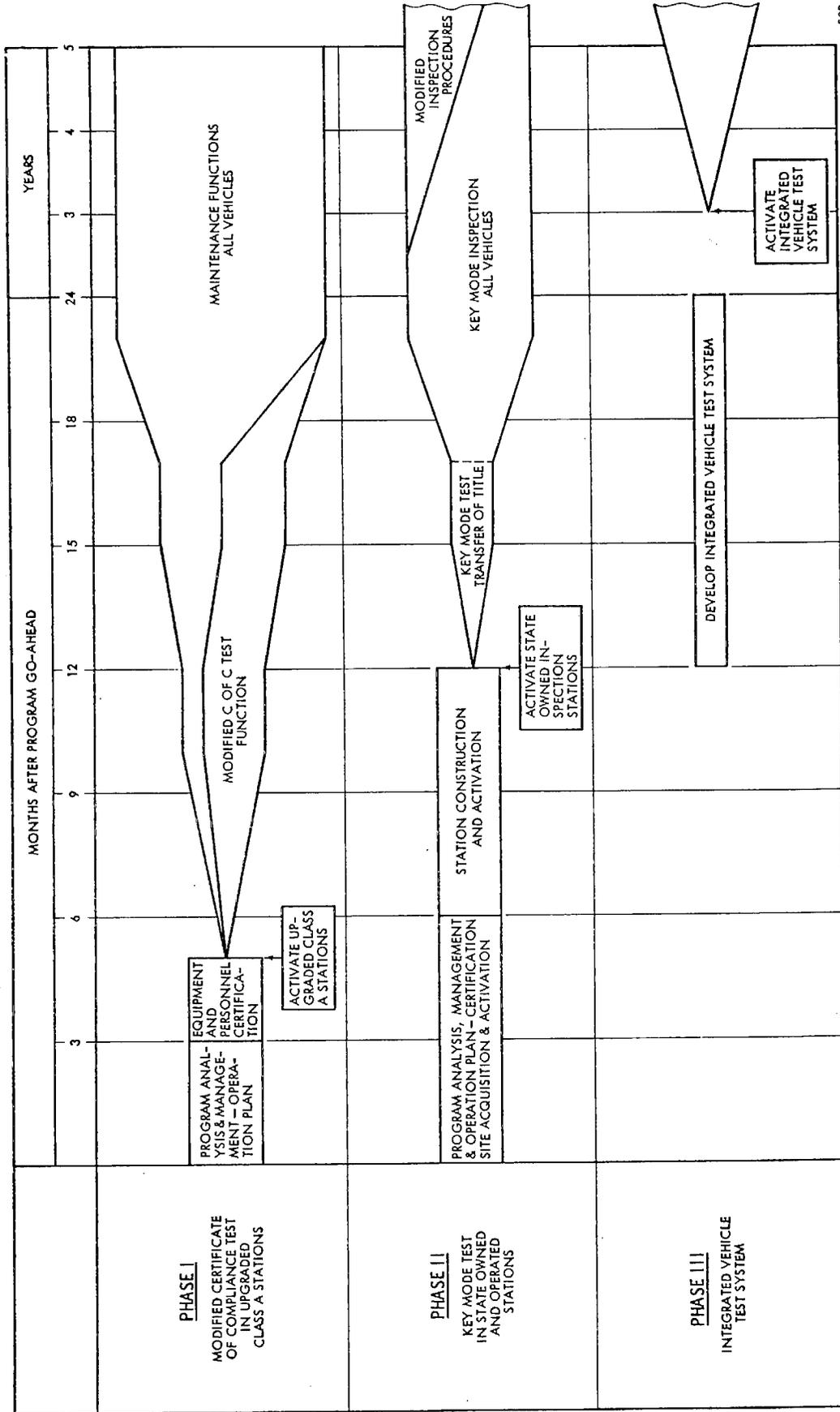


Figure 10-1. IMPLEMENTATION PLAN

- a. The need for immediate action to eliminate up to 25 percent of present vehicle emissions
- b. The difficulty of implementing a full-scale State-operated inspection program in a short time frame
- c. The requirements of the Federal Clean Air Amendments of 1970 for vehicle manufacturers to provide 5-year warranties that their vehicles will continue to meet emission standards and that emission certification testing be accomplished by the Constant Volume Sampling method
- d. The possibility that tighter standards and changing requirements for emission testing may obsolete present equipment and procedures within the next 5 years
- e. Recognizing that present Certificate of Compliance procedures are ineffective because the present management system does not provide necessary enforcement and economic incentives to assure that Class A stations follow the written procedures
- f. The ability to repair and adjust vehicles that have been inspected by a Key-Mode procedure with relatively modest capital equipment
- g. The need for incorporating features that enable automatic testing within vehicles at the time of manufacture as vehicle emission standards become very low.

10.2 RECOMMENDED IMPLEMENTATION APPROACH

A three-phase implementation program is recommended:

- Phase 1 - Upgrade Class A stations to approach effectiveness of the Idle inspection and maintenance regime which was evaluated in this study
- Phase 2 - Establish State-owned and State-operated centers initially inspecting vehicles by the Key-Mode procedure and providing "truth chart" reports as vehicle repair aids for vehicle repair facilities
- Phase 3 - Provide for modification of the overall system to accommodate lower emission standards, more intensive quality audit and management responsibility, and for different testing requirements in the future.

10.2.1 Task Definitions

The specific events which must be accomplished by the State are as follows:

- a. Define the necessary upgraded standards and procedures and notify all existing Class A stations of the time schedule and requirements
- b. Parallel with a, above, develop a detailed management and operational plan which defines functions of the State centers and the upgraded Class A stations in a specific time frame

- c. Initiate the building of State inspection centers and incorporate the new State management system
- d. Develop a plan and conduct proof-testing for systems to permit automatic testing of new automobiles.

10.2.2 State Inspection Center Functions

State inspection centers must be the heart of an effective inspection-maintenance system in California. Flexibility in the plan is paramount to permit expansion of the State inspection system as necessary and to permit modifications in the operational functions as time passes. It is suggested that the State inspection centers house operating elements for the overall management system. The State inspection centers will serve as the control points for Class A stations throughout the State.

In addition to the inspection of automobiles by the Key-Mode test, it is recommended that State centers assume the following responsibilities:

- a. Continuing quality audit of Class A repair effectiveness - This should be a management and enforcement aid for the Class A stations rather than a mechanism to force the recycle of vehicles which continue to fail the inspection test following repair in Class A stations
- b. Training centers for inspectors, technicians and mechanics in private industry as a required step in obtaining accreditation for Class A licenses
- c. Centers for surveillance of vehicle emission levels as they exist in the normal population - This information will provide a continuing quality audit of the effectiveness of vehicle manufacturers in building automobiles to meet emission standards
- d. Centers for measurement of vehicle emissions in accordance with the warranty provisions of the Federal Clean Air Amendments of 1970
- e. Centers for the evaluation of new testing procedures and development of a modified management system as requirements change over the years.

