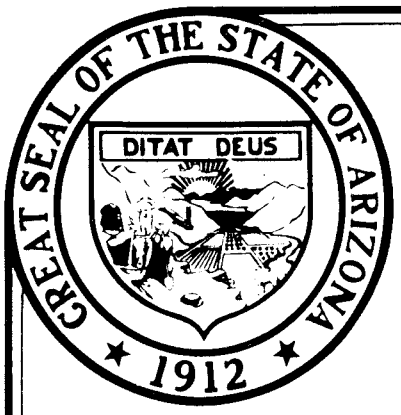

PERFORMANCE AUDIT

DEPARTMENT OF ENVIRONMENTAL QUALITY VEHICLE EMISSIONS INSPECTION AND MAINTENANCE PROGRAM

Report to the Arizona Legislature
By the Auditor General
December 1988
88-11

DOUGLAS R. NORTON, CPA
AUDITOR GENERAL

STATE OF ARIZONA
OFFICE OF THE
AUDITOR GENERAL

LINDA J. BLESSING, CPA
DEPUTY AUDITOR GENERAL

December 13, 1988

Members of the Arizona Legislature
The Honorable Rose Mofford, Governor
Ronald L. Miller, Ph.D.
Acting Director
Arizona Department of Environmental Quality

Transmitted herewith is a report of the Auditor General, A Performance Audit of the Department of Environmental Quality, Vehicle Emissions Inspection and Maintenance Program. This report is in response to Chapter 266, Section 13 of the 1985 Session Laws.

We found that the benefits of the Vehicle Emissions Inspection and Maintenance Program have been overestimated. As we predicted in our 1983 report, the State's heavy reliance on this Program has failed to bring the State into compliance with national ambient air quality standards. As a result, additional clean air measures are needed if Arizona is to achieve compliance with air quality standards.

My staff and I will be pleased to discuss or clarify items in the report.

Sincerely,

Douglas R. Norton
Auditor General

DRN:lmn

STAFF: William Thomson
Peter N. Francis
Barbara Nienstedt
Nancy Lovell Moore
Anthony J. Guarino
Cynthia A. Kappler
Thomas F. Komaniecki

SUMMARY

The Office of the Auditor General has conducted a performance audit of the Department of Environmental Quality, Vehicle Emissions Inspection and Maintenance Program. This performance audit was conducted in response to Chapter 266, Section 13 of the 1985 Session Laws.

The Benefits of the Vehicle Emissions Inspection and Maintenance Program Have Been Overestimated (see pages 9 through 19)

The impact of the Vehicle Emissions Inspection and Maintenance Program (VEIP) on air quality has been overestimated. Results of a time series analysis, and an analysis of the Environmental Protection Agency (EPA) computer simulation model (MOBILE3) used to project program benefits, both indicated VEIP benefits have been overestimated. As a result, Arizona will need to adopt additional measures to meet clean air standards. Further, this finding is not new. In 1983, we reported that the VEI program had not been effective in reducing carbon monoxide levels. At that time we stated " . . . Arizona needs to develop alternatives to the VEI Program for reducing automobile pollutants."

Several studies, including a time series analysis performed by our Office, could not substantiate the large benefits attributed to the program by the Environmental Protection Agency. The time series analysis, covering the fourteen-year period between 1974 through 1987, found that VEIP did not have an overall effect on ambient carbon monoxide (CO) levels in Phoenix and Tucson.

We believe the computer simulation model used by the EPA to project the effects of VEIP overestimates the program's benefits. Using MOBILE3, EPA has consistently credited VEIP with a 25 percent reduction in CO and hydrocarbons. However, an analysis of MOBILE3 uncovered several problems with the emission reductions calculated for Arizona. For example:

- MOBILE3 relies upon a limited database which appears to underestimate fleet emissions and overestimate VEIP benefits.

- MOBILE3 overestimates the benefits of repairs. The model assumes vehicles failing the VEIP test will receive appropriate repairs that significantly decrease emission levels. This assumption may be incorrect. First, proper repair and maintenance is not as effective as MOBILE3 assumes. Second, several studies indicate that many mechanics are not able to properly diagnose and repair emission-related problems. Third, circumvention of the program may still be a significant problem.

- MOBILE3 may be overestimating the number of high emitting, post 1980 vehicles identified by the VEIP test and subsequently repaired.

Federal law requires Arizona to operate an emissions inspection program. However, the State needs to recognize that the effectiveness of VEIP has been overestimated and take steps to ensure that additional measures are implemented to achieve compliance with Federal air quality standards.

Additional Clean Air Measures Are Needed To Assure That Arizona Achieves Air Quality Standards (see pages 21 through 27)

Since VEIP is not having the predicted impact, additional clean air measures will be needed if Arizona is to achieve Federal air quality standards. The State continues to assume full benefits for VEIP. Consequently, Arizona's State Implementation Plan underestimated the emission reductions needed to achieve compliance with Federal standards. It is unlikely, therefore, that the State will achieve compliance by 1991.

In addition, evidence suggests that projections regarding the impact of oxygenated fuels on air quality may be optimistic. Although Colorado officials have judged the Denver area's oxygenated fuels program to be a success, this success is based on EPA projections and MOBILE3 estimates, not the program's actual impact on air quality.

Moreover, benefits from present and future emission control strategies will likely be offset by continued increases in traffic growth. High growth rates in Phoenix and Tucson continually impede emission control strategies from achieving their desired effect. Traffic growth in Phoenix is expected to increase by approximately 57 percent between 1987 and 1995.

Similarly, vehicle miles traveled in Tucson is projected to increase by about 48 percent for the same period.

Our analysis shows that traffic control measures, primarily those which reduce vehicle miles driven, will need to be promoted more aggressively to attain clean air standards. Public commitment must increase, however, if these types of strategies are to work. Traffic control strategies also must be well coordinated to be implemented effectively.

Administrative Control Problems Cited During Our Last Review Have Been Corrected (see pages 29 through 30)

Administrative control problems cited during a 1983 performance review of VEIP have been corrected. Periodic field audits are necessary to assure that equipment used for emissions testing is accurate and reliable. During the last review, we found that neither the Bureau of Vehicle Emissions Inspections, now the Vehicle Emissions Section, nor Hamilton Test Systems conducted the number of field audits required during fiscal year 1981-82. These deficiencies have since been addressed. A review of inspection files showed both the Vehicle Emissions Section and Hamilton Test Systems are now meeting audit requirements.

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND

The Office of the Auditor General has conducted a performance audit of the Department of Environmental Quality, Vehicle Emissions Inspection and Maintenance Program. This performance audit was conducted in response to Chapter 266, Section 13 of the 1985 Session Laws.

History of the Vehicle Emissions Inspection and Maintenance Program

The Vehicle Emissions Inspection and Maintenance Program (VEIP) was developed as a strategy to identify vehicles emitting excess amounts of hydrocarbons (HC) and carbon monoxide (CO) and to provide incentive for proper maintenance by vehicle owners. New car emission standards resulted in a 90 percent reduction in emissions by 1981. However, according to the Arizona Department of Environmental Quality (ADEQ), " . . . inadequate maintenance of engine and exhaust control systems significantly reduce the effectiveness of manufacturer installed pollution control devices."[1]

Arizona established a voluntary VEI program in 1976, one year before the Federal government mandated it do so. In 1977 vehicles less than 14 years old and located within the nonattainment areas[2] were required to be inspected as a part of vehicle registration. Since the program's inception, it has undergone several changes making it a more comprehensive and stringent program.

Originally, VEIP was under the jurisdiction of the Department of Health Services. But with its creation in 1987, the Arizona Department of Environmental Quality became responsible for the program. ADEQ contracts with Hamilton Test Systems (HTS) to perform the inspections. HTS has operated VEIP from its inception in Arizona and presently is in its third year of a five-year contract. HTS operates 11 facilities (eight in Maricopa County and three in Pima County) and conducted approximately 1.9 million tests in 1987.

---

(1) The Arizona Department of Environmental Quality, "The Arizona Vehicular Inspection & Maintenance Program: An Air Quality Strategy," January 1988.

(2) A nonattainment area is an area which does not meet air quality standards for a given pollutant. (See also Arizona Revised Statutes §49-541.14.)

EPA considers Arizona's VEI program as one of the best in the nation. The program consists of both an emissions test and a tampering check. All 1967 and later-model-year vehicles registered in nonattainment areas or vehicles commuting into a nonattainment area must be tested annually. The test measures the CO and HC concentrations emitted from a vehicle while in the idle mode. Allowable emissions vary depending on the age of the vehicle.

The visual tampering test ensures that individuals have not removed or tampered with emission control devices. It is a four point test that includes a visual check of the catalytic converter and the air pump to ensure they are in place, a visual inspection of the fuel inlet to ensure that it has not been tampered with and a tailpipe test to check for lead which indicates misfueling.

The program allows waivers for owners who are unsuccessful in achieving appropriate emission reductions if repair costs exceed the following limits:

1967 through 1974	$ 50
1975 through 1979	$200
1980 and newer	$300
all heavy duty diesels	$300

However, the waivers cannot be given for tampering violations and resulting repair costs. Three percent of the vehicles tested are never able to pass the test and eventually receive a waiver.

Also as part of VEIP, ADEQ trains and certifies fleet inspectors and mechanics. These individuals are able to conduct emission inspections on vehicle fleets. ADEQ reports that in 1987 120,000 inspections were performed by licensed automobile dealers and 30,000 by commercial and governmental fleet operators.[1]

---

(1) Arizona statutes allow governmental entities with fleets of 100 or more vehicles and owners of fleets with at least 25 vehicles to establish their own emission inspection programs. A fleet emissions inspection permit requires the facility to have approved equipment and employ licensed personnel.

Vehicle Emissions and Inspection's Role in the State Implementation Plan

The Clean Air Act amendments of 1970 required EPA to establish standards to protect public health from air pollution. Amendments passed in 1977 called for states to attain national air quality standards for carbon monoxide and ozone - two pollutants caused primarily by automobile emissions - no later than December 31, 1982. States were required to develop and implement State Implementation Plans (SIPs) which detailed how the national standards would be attained.

Because the Phoenix and Tucson areas could not meet the Federal standards by December 1982, the SIP had to contain plans for a VEI program. It also had to demonstrate attainment by the end of 1987. The SIP relied heavily on VEIP and Federal emission requirements for new motor vehicles. ADEQ reports " . . . 99 percent of the current level of control comes from these programs."(1)

However, even with implementing the SIPs, Arizona did not meet the national air quality standards by December 31, 1987. The U.S. Congress granted an extension until August 1988 and then EPA administratively granted a third extension to December 31, 1991. ADEQ reports that Tucson is close to attainment, but for Phoenix the air quality outlook is bleak. "Violations of CO, ozone and particulates continue at [an] unsettling rate . . . The [current] nonattainment area plans fail to ensure attainment of Federal standards in the foreseeable future."(2)

The current SIP continues to focus on minimizing per-mile emissions rather than vehicle miles traveled (VMTs). To reach attainment by 1991, EPA estimates a 24 percent reduction in CO emissions is needed. The approved SIP credits four percent of the reduction to changing the inspection from an idle mode test to a loaded mode test.(3) The remaining reductions are attributed to the oxygenated fuels program (16

---

(1) The Arizona Department of Environmental Quality, "The Arizona Vehicular Inspection & Maintenance Program: An Air Quality Strategy," January 1988.

(2) Ibid.

(3) An idle test measures a vehicle's emissions while at idle. A loaded test simulates highway conditions. The vehicle's wheels are placed on rollers which allows the car to "drive" at 30 miles per hour. The emissions are tested while in this mode.

percent) and a travel reduction program and other measures such as short range transit improvements, increased bicycle use, and alternative work hours (four percent).

Program Budget

The VEI program is principally funded by inspection fees and General Fund monies. Inspection fees pay for the HTS contract to operate the inspection stations. According to ADEQ budget staff, HTS received $9.2 million in fiscal year 1986-87. In fiscal year 1987-88 HTS received $11.6 million.[1]

General Fund monies are appropriated to ADEQ to fund and staff its Vehicle Emissions Section. The Section also uses revolving fund monies from waiver, certificate and exemption fees. The Vehicle Emissions Section performs quality assurance tests of equipment at the State inspection stations, fleet facilities and registered analyzer facilities. They also train and certify mechanics in order for fleet and mechanic shops to have registered analyzers. In addition, the Section operates the waiver lane, resolves complaints and processes waivers, exemptions and certificates. During fiscal year 1987-88 the Section was appropriated $537,776 from General Fund monies. It had 15 FTE positions funded from the General Fund and another 12 FTE positions funded by the revolving fund.

Advisory Panel

An advisory panel was selected to assist the Auditor General's staff in developing an appropriate methodology and reviewing results and conclusions based on audit work. The panel consisted of four members:

Dr. Lee Sechrest, University of Arizona

Dr. Sechrest is head of the Psychology Department at the University of Arizona and has had extensive experience in evaluation research projects in this country and overseas. He has written fourteen books and

---

(1) Beginning January 1988, HTS began collecting inspection fees directly. (See Other Pertinent Information, page 31.)

monographs and over 150 scientific articles. Dr. Sechrest is currently consulting with the National Center for Health Services Research, National Heart, Lung and Blood Institute, American Psychological Association, Veterans Administration, New York Board of Regents, U. S. General Accounting Office, National Futures Association and the Human Services Research Institute. Dr. Sechrest has been awarded the Myrdal Prize for Excellence in Evaluation Practice by the American Evaluation Association.

Dr. Carol Weiss, Harvard University

Dr. Weiss is an international expert on evaluation research and has published seven books in that area. Among her many activities and honors, Dr. Weiss has also been a senior fellow for the U. S. Department of Education, visiting scholar for the U. S. General Accounting Office, guest scholar at the Brookings Institution, a Goldwater Visiting Professor of American Institutions at Arizona State University, President of the Policy Studies Organization, Fellow of the American Association for the Advancement of Science and an international consultant on evaluation research. Dr. Weiss has been awarded the Myrdal Prize for Excellence in Science by the American Evaluation Association.

Margaret K. Singh, Argonne National Laboratory

Ms. Singh is the Transportation Systems Planner in the Energy and Environmental Systems Division of Argonne National Laboratory. Ms. Singh is responsible for a variety of studies assessing environmental concerns related to transportation. One of her specialty areas is alternative fuels. She has worked on several transportation research studies in fuels. She has also worked on several transportation research studies in Chicago, including public transportation analyses. Ms. Singh was awarded the Richard King Mellon Fellowship in Urban Planning from the University of Illinois. In addition, she has published articles and reports in numerous technical and professional journals on the subjects of emission controls, environmental concerns, alternative fuels, mass transit and future transportation outlooks.

John C. Elston, New Jersey Department of Environmental Protection

Mr. Elston directs the Bureau of Air Quality Planning and Evaluation, the Bureau of Air Monitoring and the Bureau of Transportation Control of the New Jersey Department of Environmental Protection. He has served as a consultant to the U.S. Environmental Protection Agency and the World Health Organization in Korea and China. He has had numerous papers published by the Society of Automotive Engineers, the Air Pollution Control Association, the Instrument Society of America and the North American Motor Vehicle Emission Conference. Mr. Elston has also published a seminal work on vehicle emission inspection programs in the United States.

The panel and Auditor General staff convened in June 1988 to develop a methodology. The panel recommended a time series analysis be done as follow-up to the analysis done for the 1983 Auditor General Vehicle Emissions and Inspection Program report. They also recommended we perform surveys of the public and mechanics to address questions regarding public behavior related to the VEI program, appropriateness and adequacy of repairs, and circumvention. (See Appendices for a description of the time series methodology and the public and mechanic surveys.) In addition, they suggested pertinent areas for audit work such as review of EPA's predictive tool for VEIP's effectiveness and additional strategies needed to improve air quality.

The panel and staff reconvened in October 1988 to discuss conclusions of the audit work. Upon completion of drafting audit findings, panel members reviewed the drafts and provided comments. The final audit report reflects their suggestions and recommendations to the extent we were able to incorporate them.

Audit Scope

This audit was conducted to evaluate the Vehicle Emissions Inspection and Maintenance Program including the duties performed by Hamilton Test Systems and county assessors and focused on the following areas:

- The effectiveness of the Vehicle Emissions Inspection and Maintenance Program in attaining national air quality standards.

- The need for additional measures to attain national air quality standards.

- The frequency of Hamilton Test Systems and ADEQ equipment audits at vehicle emissions test stations.

This report also contains Other Pertinent Information regarding the role of the county assessors' offices in the Vehicle Emissions Inspection and Maintenance Program and ADEQ's evaluation efforts.

This audit was conducted in accordance with generally accepted government auditing standards.

The Auditor General and staff express appreciation to the Director and staff of the Department of Environmental Quality and to Hamilton Test Systems for their cooperation and assistance during the audit.

FINDING I

THE BENEFITS OF THE VEHICLE EMISSIONS INSPECTION AND MAINTENANCE PROGRAM HAVE BEEN OVERESTIMATED

The benefits of the Vehicle Emissions Inspection and Maintenance Program (VEIP) have been overestimated. As a result, the State of Arizona must adopt additional measures if it is to come into compliance with the National Ambient Air Quality Standards (NAAQS). Several studies, including a recent time series analysis performed by the Office of the Auditor General, did not substantiate the large benefits attributed to VEIP by the United States Environmental Protection Agency (EPA). These studies vary significantly from EPA's projections of program effects, but it appears that the computer model (MOBILE3) used by EPA to project the effects of VEIP overestimates the program's benefits. The model appears to both underestimate total vehicle emissions and overestimate the benefits achieved by VEIP. Because VEIP is a major strategy for achieving clean air, adopting more realistic assumptions about the program's impact will require the State to use additional measures to meet the NAAQS.

VEIP was one of three Federally mandated programs included in all State Implementation Plans (SIP) for states requesting an extension of the 1982 deadline for compliance with the NAAQS. To assist in evaluating the effects of the program, EPA developed MOBILE3. EPA requires states to use MOBILE3 to predict future emission levels under varied conditions. Using the model and assumptions of the effects of VEIP,[1] EPA estimated that a VEI program implemented by December 1982 could reduce carbon monoxide (CO) and hydrocarbon (HC) emissions by 25 percent [2] by December 1987. With this goal in mind, EPA established a new date for

---

(1) Assumptions were based on the performance of the New Jersey VEIP which was in operation.

(2) Based on updated computer modeling, EPA later changed its estimate of VEIP benefits to a 25 percent reduction for HC and 35 percent reduction for CO.

compliance of December 31, 1987. However, the Auditor General's 1983 VEIP report concluded that reliance on VEIP would not bring Arizona into compliance by that date.

Although EPA estimated that many areas would achieve a 25 percent reduction in emissions due to VEIP, as of December 31, 1987, none of the areas that implemented VEIP have submitted official documentation demonstrating compliance with NAAQS.

Two Approaches for Assessing VEIP's Effects

Two approaches for assessing the effects of VEIP are time series analysis and computer simulation modeling. Time series methods assume that the appropriate indicator of the effectiveness of VEIP is the actual air quality. Conversely, computer simulation modeling methods do not directly consider ambient air concentrations, but rather use vehicle tailpipe emissions as the primary indicator of VEIP effectiveness. Both approaches have their merits and their drawbacks.

Time series analysis has been used to model the effects of VEIP on ambient air quality. Traditional statistical methods are not suited for use with VEIP data [1] because they are not able to deal with some of the inherent characteristics of those data. For example, environmental data are highly seasonal. In the case of CO, concentrations tend to peak with regularity during winter months. Additionally, any analysis of data over time can be confounded by trends such as increasing population. These trends can give the appearance of growth (or decay) in the data that may then be falsely attributed to the intervention (i.e., VEIP). Time series analysis enables the user to account for seasonality and for trends. A study of New Jersey CO data concluded, ". . . time series models represent useful tools for short term prediction of air quality data."[2]

---

(1) G.E.P. Box and G.C. Tiao, "Intervention Analysis with Applications to Economic and Environmental Problems." 1975.

(2) Ledolter et al., "Statistical Analysis of Multiple Time Series Associated With Air Quality Data: New Jersey CO. Data." June 1978.

Computer simulation models have been used to predict the effects of VEIP on tailpipe emissions. EPA is currently using the fourth version of its computer modeling system, MOBILE3. MOBILE3 predicts emission levels under various conditions. In particular, the model has been used extensively to determine the reduction in emissions due to VEIP. Additionally, the outputs of the model are used to predict future fleet emissions which are then used as a baseline for determining the amount of reduction needed to meet the NAAQS. MOBILE3 analyses are also used to predict the benefits of various clean air strategies including the oxygenated fuels program.

Although these two methods are commonly used to evaluate VEIP, both have weaknesses and neither is able to analyze the full range of variables and their interactions which impact air quality. A time series analysis requires a relatively long data series and specialized software and training, which are not always available. Time series methodology analyzes the inputs and outputs of a system but is unable to answer the question why a system does or does not work. (See Appendix A for a more complete description of time series analysis.) Like time series analysis, computer modeling has weaknesses. First, it does not directly address actual air quality. It assumes that test results showing lowered tailpipe emissions will also signify cleaner air. However, it does not account for other factors such as waivers that may weaken or lessen the relationship between test results and actual air quality. Second, a computer model must rely upon the assumptions of the methodology to predict future behavior. If the data used in the model are outdated, the assumptions based on the data will consequently be violated and the model's predictions will be incorrect.

Several Studies, Including a Recent Time Series Analysis Conducted by the Office of the Auditor General, Did Not Substantiate the Large Benefits Attributed to VEIP by EPA

Several studies, including a recent time series analysis conducted by the Office of the Auditor General, did not substantiate the large benefits attributed to VEIP by the EPA. The Auditor General's Office contracted for a time series analysis that was completed in 1983. The 1983 study analyzed four different measures of carbon monoxide over an eight-year period. The study concluded that VEIP had not had a statistically significant impact on ambient CO levels.

The time series analysis was updated in 1988. Due to changes in data monitoring techniques, only two different CO measures were analyzed. However, the observation period was increased to fourteen years from 1974 to 1987. As in the 1983 study, some of the contributing factors such as traffic growth and changes in meteorological conditions were accounted for within the time series models. Again, the time series found no overall effect of VEIP on ambient CO levels. MOBILE3, however, credited the program with a 30 percent reduction of CO and a 15 percent reduction of HC.

These updated findings are consistent with the results of other air quality studies that show a much smaller reduction than predicted by EPA. Tiao et al. conducted an analysis in Arizona in 1984.[1] Tiao's models, like the Auditor General's, accounted for the effects of traffic volume and meteorological changes. The largest decrease he found was 3.6 percent per year at one monitor. Tiao then incorporated estimates of the Federal emission standards and EPA's model estimates of the effects of VEIP into his results and compared these models for the impact of VEIP. Based on this comparison, he concluded, "Provided that the emission factors are accurate, there is then some evidence . . . to support the hypothesis that VEIP has had a positive impact on ambient CO levels." However, further study in 1988 by the Auditor General indicates that the emission factors given by MOBILE3 and used by Tiao may not be accurate. (See pages 13 through 18.)

Similarly, several additional studies of VEIP do not appear to have shown the large benefits attributed to the program by EPA. A time series analysis of the Oregon VEIP concluded that the average benefit from the program was only between 6 and 12 percent. [2] In addition, a study conducted by the Society of Automotive Engineers [3] used two different statistical techniques, one of which was time series, to

---

(1) George Tiao, "Final Report on Statistical Analysis of Aerometric Data to Assess the Effect of the Arizona I/M Program on Ambient CO Air Quality in Phoenix, Arizona." September 1984.

(2) George Tiao, "Final Report on Statistical Analysis of the Effect of Inspection and Maintenance on Carbon Monoxide Air Quality in Portland, Oregon." May 1981.

(3) Kay H. Jones and James F. Walsh, "The Past and Future Benefits of Automobile Inspection and Maintenance Programs." August 1983.

evaluate the effectiveness of several VEIP programs, including Phoenix. The paper reported that, aside from the New Jersey program,[1] there was little air quality related evidence to support the contention that VEIP was contributing to improving air quality CO levels. Additionally, the report stated that future ambient air trend data are even more unlikely to show any significant CO reduction trends due to VEIP being implemented.

The Computer Model Used by EPA to Project the Effects of VEIP Appears to Overestimate the Program's Benefits

The computer model, MOBILE3, used by EPA to project the effects of VEIP appears to overestimate the benefits of the program. Although several studies have been unable to attribute a large improvement in ambient air quality to VEIP, MOBILE3 has consistently credited the program with a 25 percent reduction in CO and HC. Based on a detailed analysis of the model, it appears that MOBILE3 underestimates total vehicle emissions. In addition, the model appears to overestimate the benefits of VEIP. This is due to several factors including: use of a small, outdated data base; overcrediting repair benefits due to VEIP; and overcrediting VEIP for emission reduction of post-1980 vehicles.

How MOBILE3 works - MOBILE3 is a computer program that is used as a planning tool to estimate total fleet emissions and reductions based on various clean air strategies. One purpose of the model is to predict the effect of VEI programs. MOBILE3 incorporates data from EPA vehicle samples into various equations to predict the average emission level of a vehicle fleet at a given point in time. MOBILE3 assumes that as a

---

(1) The New Jersey program was evaluated using population exposure trends and MOBILE2.5 predictions of future emission rates. A second study in New Jersey found a 28 percent reduction in CO due to the Federal new car standards, the effects of the oil and energy crisis, and VEIP. However, the effects of VEIP could not be isolated from the other variables. Ledolter et al., "Statistical Analysis of Multiple Time Series Associated With Air Quality Data: New Jersey CO Data." June 1978.

vehicle accumulates mileage its emission level will increase. In addition, the model assumes that the emission level of some vehicles will increase at a much faster rate than normal. These vehicles, referred to as "high emitters," are the ones that should be identified by the VEIP test. MOBILE3's final output is the predicted average emission level of a vehicle fleet for a specified calendar year. The average vehicle emission, multiplied by estimated vehicle miles traveled, is the total estimated emissions of a fleet.

In a VEIP area, MOBILE3 assumes that some of the high emitters will be identified. It then assumes that the high emitters will receive maintenance and repair that will reduce their emission levels. Thus, the predicted fleet emission level in a VEIP area will be lower than in a non-VEIP area. The percent difference between the predicted emission level in each area is the reduction in emissions due to VEIP. In Arizona, MOBILE3 currently predicts a CO reduction of 30 percent and a HC reduction of 15 percent.

MOBILE3 appears to underestimate actual fleet emissions - It appears that MOBILE3 underestimates future emission levels. According to an EPA official, the data that are incorporated into MOBILE3 to calculate future emission levels are obtained under highly controlled circumstances that attempt to simulate real-life driving conditions. Actual in-use emissions under a variety of conditions can vary significantly. Likewise, the sample data used in MOBILE3 are derived from low mileage vehicles. Thus, MOBILE3 predictions for emission levels of high mileage vehicles are nothing more than assumptions of how emission controls will deteriorate over time. A study in Texas[1] using mass balance technique[2] concluded that actual CO emission levels obtained from

---

(1) Michael Hlavinka and Jerry Bullin, "Validation of Mobile Source Emission Estimates Using Mass Balance Techniques." August 1988.

(2) The mass balance technique is designed as a tool for predicting emission factors from an experimental data base. It is based on the principle that the difference in the amount of a particular pollutant flowing past a downward vertical plane and an upward vertical plane is due to the traffic on the roadway.

in-use vehicles were 1.5 to 2.2 times greater than those predicted by MOBILE3. If these data are correct, MOBILE3 is greatly underestimating actual vehicle emissions.

Another factor that may cause MOBILE3 to underestimate actual emission levels is that the model does not account for high emitting vehicles that are issued a waiver. The model assumes that all pre-1981 vehicles and a percentage of high emitting, post-1980 vehicles that are identified by the VEIP test obtain significant emission reductions due to repair. In actuality, 15 percent of the vehicles that fail the VEIP test in Arizona are never able to pass the test and eventually receive a waiver.

MOBILE3's limited data base appears to result in underestimates of fleet emissions and overestimates of VEIP benefits - MOBILE3's limited database appears to underestimate fleet emissions and overestimate VEIP benefits. MOBILE3 uses two data bases, one for pre-1981 vehicles and one for post-1980 vehicles, to predict average emission levels. Both samples are based on a small number of vehicles and may not accurately reflect the effects of a VEI program. For example, the sample of pre-1981 vehicles was based on low-mileage cars requiring the model to use assumptions as to how vehicles will deteriorate over time. In addition, the samples used to predict post-1980 factors may not be representative of the actual population because participants were selected through direct mail and telephone solicitation and offered incentives to participate. According to one researcher, "If there is any relationship between response to those incentives and owner maintenance or driving habits then a major source of error exists."[1] For example, people who maintain their vehicles on a regular basis may be more likely to agree to participate than those who do not perform regular maintenance. Thus, EPA may have tested vehicles that tend to be better maintained and running cleaner than the average vehicle.

---

(1) John Elston, "Motor Vehicle Inspection/Maintenance Program: A Critical Review." 1981.

MOBILE3 overestimates the effectiveness of repairs - MOBILE3 overestimates the benefits of repairs. MOBILE3 assumes that once a high emitting vehicle has been identified (i.e., it fails the VEIP test), it will receive appropriate repair and maintenance that will significantly decrease its emission level. This assumption may be incorrect for three major reasons.

First, proper repair and maintenance for post-1980 vehicles is not as effective as MOBILE3 assumes. EPA originally believed that correct repair of these vehicles resulted in a significant emission reduction. However, further study indicates that even the appropriate repair is not nearly as beneficial as EPA thought.(1) Thus, MOBILE3 is overestimating the effectiveness of proper repair.

Second, several studies indicate that many commercial mechanics are not able to diagnose properly and repair emission related problems:

- A 1980 EPA report concluded, in part, ". . . the commercial repair industry does not currently adjust idle mixture and speed properly. . . A lack of training and proper equipment (tachometers and exhaust analyzers) is apparent in the performance of this type of maintenance." (2)

- A 1987 California study concluded that only 46 percent of the 1980 and later vehicles with obvious defects were effectively repaired.(3)

- An Auditor General survey of Arizona mechanics(4) found that of those surveyed, 40 percent did not follow the proper procedures for repairing a vehicle with high HC emissions and 92 percent did not follow the proper procedures for repairing a vehicle with high CO emissions.

- An earlier study in Phoenix reported, "The average effectiveness of repairs for each group of facilities was much less than that judged satisfactory. Only 15 percent of all repairs were satisfactory or better." (5)

---

(1) EPA Handout at MOBILE4 Workshop, received September 1988.

(2) John C. Shelton, "Effectiveness of Idle Adjustment on Light Duty Trucks of Commercial Repair Facilities." June 1980.

(3) The California I/M Review Committee, "Evaluation of the California Smog Check Program." April 1987.

(4) The Office of the Auditor General contracted with Behavior Research to conduct a survey of 201 mechanics. (See Appendix B.)

(5) R. Bruce Michael, "Analysis of Idle Adjustments by Commercial Repair Facilities in Phoenix."

Third, some people circumvent the VEIP test. Ninety-four percent of the mechanics surveyed said they have been asked to readjust a vehicle after it has passed the VEIP test. Seventy-eight percent of them said this is somewhat or very common. Additionally, eight percent of the people surveyed in the public survey admit that they had their vehicle readjusted after passing the VEIP test. This means that MOBILE3 may be giving some vehicles credit for long term repair benefits when in reality the benefits may be extremely short term.

Similarly, 93 percent of the mechanics said they have been asked to adjust a vehicle to "pass the emission test" rather than conduct the appropriate and needed emission related maintenance and repair. Eighty-eight percent of them said this is somewhat or very common. According to an EPA official, it is possible to adjust a vehicle so that it will pass the test but full emission reduction benefits, as credited by MOBILE3, are not achieved.

MOBILE3 may give too much credit for identification of high emitting, post-1980 vehicles - MOBILE3 may be overestimating the number of high emitting, post-1980 vehicles that are identified by the VEIP test and later receive emission reductions due to repair. MOBILE3 assumes that a percentage of the post-1980 failures will be high emitters that will receive appropriate repairs. An Auditor General review of MOBILE3's equations for VEIP credit and the actual vehicle failure rates within the Arizona program indicates that MOBILE3 may be overestimating the number of high emitters that are identified and repaired. Thus, MOBILE3 may be overestimating the effects of VEIP.[1]

---

(1) The only way for an area to determine if the MOBILE3 credit and the vehicle failures are comparable is to test vehicles using the Federal Test Procedure (FTP). The FTP involves collection of a diluted exhaust gas sample in a small plastic bag by means of a constant volume sampler. The test can take up to 48 hours and can cost up to $3,000 per vehicle. Arizona has recently set up an FTP laboratory and intends to test for the actual number of high emitters that fail the VEIP test. (See Other Pertinent Information, pages 28 and 29 for further discussion of FTP research.)

Benefits of VEIP are overstated - MOBILE3 appears to overestimate the benefits of VEIP.[1] Exactly how much it overestimates the program's benefits is not known. However, a recent study conducted for California[2] suggests that VEIP benefits are considerably overestimated. The study used the Federal Test Procedure to test vehicles that were likely to fail the California VEIP test. The study monitored the number of vehicles that actually failed, and then retested failed vehicles after they received emission reducing repairs. Thus, the researchers were able to determine actual emission reductions due to repair. The study concluded that the California VEIP resulted in a 9.8 percent reduction in CO and an 11 percent reduction in HC. In contrast, EPA estimates that VEIP will result in an emission reduction of 25 percent, more than twice the reduction found in the California study.

More Realistic Assumptions about the Impact of VEIP Will Require Arizona to Use Additional Measures to Meet the National Ambient Air Quality Standards

VEIP is a major strategy for achieving clean air in Arizona. Both the time series analysis and the analysis of MOBILE3's operations indicate the benefits of the program have been overestimated. Consistent with our 1983 report, Arizona will need to implement additional measures to meet NAAQS by using more realistic assumptions about the impact of VEIP. If, indeed, the model is underestimating the actual emissions of a fleet, then the base that EPA uses to determine how much emission reduction must occur to meet the NAAQS is faulty. This problem, compounded with the possibility that MOBILE3 overestimates the benefits of VEIP and other programs, places states in a precarious situation. Not only are they underestimating the problem that exists, but also they are overestimating the benefits they are achieving in trying to solve the problem.

---

(1) EPA is currently creating an updated version of MOBILE3 that will be called MOBILE4. However, it is possible that MOBILE4 will have many of the same problems as MOBILE3. No changes have been made to the pre-1981 data base and EPA testing of post-1980 vehicles is declining.

(2) California I/M Review Committee, "Evaluation of the California Smog Check Program." April 1987.

The State Implementation Plan is based upon the estimated reductions that must occur in future years and the estimated benefit of each program. These estimates are based on MOBILE3 predictions. The Arizona Department of Environmental Quality (ADEQ) recognized that MOBILE3's predictions may not be accurate. Thus, ADEQ attempted to adjust MOBILE3's figures to more accurately represent real world occurrences. Based on this adjustment, ADEQ determined that Arizona would need an additional 18.5 percent reduction in emissions to comply with the NAAQS by 1995. However, EPA would not accept the Arizona adjustments and, relying on MOBILE3 outputs, concluded that Arizona would only need a 7.8 percent reduction to comply by 1995. To meet the 1995 standards, EPA will require Arizona to commit to clean air programs predicted to result in an emission reduction of only 7.8 percent rather than 18.5 percent. If Arizona is going to achieve clean air, additional measures beyond those adopted in the SIP will be needed.

Recommendations

1. The Legislature and the Department of Environmental Quality should recognize that the effectiveness of VEIP has been overestimated and take steps to ensure that additional measures are implemented to bring the State into compliance with the NAAQS.

2. The Department of Environmental Quality should proceed with its plan to conduct its own evaluation, using FTP equipment, of the accuracy of predicted VEIP emission reductions.

FINDING II

ADDITIONAL CLEAN AIR MEASURES ARE NEEDED TO ASSURE THAT ARIZONA ACHIEVES AIR QUALITY STANDARDS

As noted in Finding I, the Vehicle Emissions Inspection and Maintenance Program (VEIP) is not having the predicted impact. As a result, additional measures are needed if Arizona is to achieve Federal air quality standards. Emission control strategies, such as VEIP and oxygenated fuels, cannot be relied upon to bring about compliance. Consequently, increased emphasis on traffic control measures, primarily those that reduce vehicles miles traveled, are needed to assure compliance with air quality standards.

Arizona's federally approved State Implementation Plan (SIP) projects that a 24 percent reduction in air pollution will be needed for the State to achieve compliance with ambient air quality standards by 1991. The plan relies heavily on VEIP improvements and oxygenated fuels to meet this goal. These two emission control programs account for approximately 92 percent of the anticipated reductions. The remaining 8 percent reduction comes from traffic control measures, primarily those designed to reduce vehicle miles traveled. Moreover, the needed 24 percent reduction was calculated based on the assumption that VEIP has already reduced emissions by 25 percent.

Emission Control Strategies Cannot Be Relied Upon To Bring About Compliance

Emission control strategies cannot be relied upon to achieve air quality standards. VEIP benefits are overestimated and the actual impact of Arizona's oxygenated fuels program is not yet certain. Moreover, benefits from these, and future emission control strategies will likely be offset by continued increases in traffic growth.

VEIP - As noted in Finding I, VEIP's impact on air pollution is less than was expected. When the program was first implemented it was widely believed that it would lead to compliance with the air quality standards.

However, this has not been the case. Despite being credited by the EPA with having one of the best VEI programs in the nation, Arizona is still unable to comply with Federal standards.

Moreover, by continuing to assume full benefits for VEIP, Arizona's current State Implementation Plan underestimates the emission reductions needed to achieve compliance with air quality standards. As a result, it is unlikely that the State will achieve compliance by 1991.

Oxygenated fuels - While enactment of an oxygenated fuels program is a positive step, projections regarding the impact of Arizona's program on air quality may be overestimated as well. To confirm reductions projected for Arizona, ADEQ plans to test the actual effects of oxygenated fuels on air quality.

There are two reasons why the impact of Arizona's oxygenated fuels program may be too optimistic. First, the methodology used in calculating emission reductions resulting from oxygenated fuels may be flawed. The estimated reductions used by EPA for oxygenated fuels come from a relatively small sample of 346 cars. Further, the cars in this sample were not all tested with the same fuel, but rather with different fuels grouped together by oxygen content. The EPA used the results of this limited study to make nationwide predictions. Second, emission reductions calculated for oxygenated fuels depend on adjustments made to MOBILE3. Since MOBILE3 data are invalid (see Finding I), anticipated reductions from the program may not be enough to bring about compliance.

There are no data available nationwide to evaluate the actual effect an oxygenated fuels program will have on air quality. Denver is the only area other than Arizona that has implemented an oxygenated fuels program. The actual impact of Denver's oxygenated fuels program on air quality is still not fully certain. Colorado officials have stated they are pleased with their program's results. Officials there state Denver's oxygenated fuels program reduced CO levels by 8 to 11 percent in certain areas of the state. However, these reductions are estimates based on projections and MOBILE3 estimates and are not direct measures. As noted above, these projections may not be valid.

ADEQ claims it may be possible to increase the oxygen content if program benefits are overestimated. However, some authorities have stated that the oxygen content of Arizona's program cannot be increased much beyond its present maximum level. Further increases in oxygen content could decrease a vehicle's drivability and increase the emissions of other harmful pollutants.

ADEQ plans to test the effects of oxygenated fuels to confirm projected reductions in emissions. ADEQ recently purchased test equipment needed to calculate actual, as opposed to estimated, benefits. The department has reported it will use its new test equipment for this purpose. An ADEQ official stated the agency will use the results of these and other outside studies to determine if increasing oxygen content is beneficial and/or feasible.

If anticipated gains from the oxygenated fuels program are not fully realized, attainment of air quality standards by 1991 will be further impeded. Emission reductions from oxygenated fuels account for 74 percent of the reductions needed to reach attainment.

Emission control strategies and the impact of traffic growth - Other options for lowering emissions may become available. New emission reduction strategies would help compensate for the problems with current emission programs. However, benefits from these as well the benefits from the programs discussed earlier will likely be offset by continued traffic growth.

A committee of environmental experts, consisting of officials from eleven environmental protection agencies, recently reported on the status of the Federal Motor Vehicle Control Program. This group, called the Northeast States for Coordinated Air Use Management (NESCAUM) Mobile Source Committee, published its report in July 1988. Two of our panel members recommended this report because of its thorough review of clean air issues. According to the July 1988 reports, numerous proposals have been suggested to further lower emissions. In addition to tighter emission standards, the NESCAUM report cites other emission reduction proposals which would:

- Require fleet operators to make increasing use of low polluting, alternative fueled vehicles;

- Ban lead in gasoline beginning in 1990;

- Prohibit the manufacture and sale of emission control defeat devices;

- Extend the useful life for the auto standards to apply for the full vehicle life [10 years or 100,000 miles] rather than the current half life [5 years or 50,000 miles].

In addition, ADEQ has noted that reducing fuel volatility "may result in dramatic CO emissions reductions."[1] Fuel volatility refers to the extent which fuel evaporates into the atmosphere. Energy and Environmental Analysis, Inc., a consultant to ADEQ reported current research indicates that reducing fuel volatility may reduce CO, but cautioned, "The scope of individual research is often limited and show a wide range of results. In fact, in some cases carbon monoxide actually increased . . . ." One of our panel members, a planner for the Energy and Environmental Systems Division of Argonne National Laboratory, concurs with this assessment.

Ultimately, benefits from emission control strategies will likely be offset by continued increases in vehicle miles traveled by motorists. The NESCAUM July 1988 report concluded:

> "Whatever success is achieved in reducing per mile emissions from vehicles can eventually be eroded by continued high growth rates in the number and use of vehicles. . . .
>
> It is now clear that technological solutions to the motor vehicle pollution problem are increasingly offset by growth in the vehicle population. Therefore, long term solution of the nonattainment problem is dependent on coming to grips with the overall growth issue."

---

(1) Arizona Department of Environmental Quality, Memorandum to the Office of the Auditor General's Office, November 30, 1988.

The high growth rates in Phoenix and Tucson, therefore, continually impede emission control strategies from achieving their desired effect. Between 1980 and 1987, Phoenix had a vehicle miles traveled increase of approximately 25 percent, while Tucson had an increase of approximately 18 percent. These high growth rates are expected to continue. Traffic growth in Phoenix is expected to increase by approximately 57 percent between 1987 and 1995. Similarly, vehicle miles traveled in Tucson is projected to increase by about 48 percent for the same period.

Increased Emphasis on Traffic Control Measures Are Needed to Insure that Arizona Attains Air Quality Standards

Our analysis shows that traffic control measures, primarily those which reduce the vehicle miles driven by motorists, will need to be promoted more aggressively to attain current clean air standards. The level of public commitment to reducing the number of miles driven, however, must increase if these types of strategies are to work. Traffic control strategies also must be well coordinated to be implemented effectively.

Level of commitment must increase - The level of commitment to traffic control strategies, specifically those designed to reduce vehicle miles driven, must increase to insure attainment with air quality standards.

Arizona's current State Implementation Plan contains a variety of traffic control strategies. The Plan includes short range transit improvements, a travel reduction program, provisions for high-occupancy-vehicle lanes, and an expanded regional ridesharing program. Some parts of the Plan have already been acted upon. For example, recent legislation enacted a mandatory employer-based trip reduction program. However, these traffic control strategies, designed primarily to reduce the vehicle miles driven by motorists, represent less than 10 percent of the State's Plan to reduce emissions and improve air quality.

The commitment to implement these types of programs is still relatively weak. For example, the Arizona Center For Law in the Public Interest (ACLPI) criticized the State's current clean air plans for failing to "commit actual implementation of needed control measures." According to

the ACLPI, the language in current plans lacks clear commitment either in resource allocations or enforcement provisions. Current proposals do in fact use ambiguous language such as:

- Encourage alternative workdays such as a four-day work week.

- Encourage the use of park and ride lots and provide additional park and ride capacity where appropriate, especially along new freeways. [Emphasis added]

As a result, past measures designed to reduce vehicle miles traveled have not proven successful. Although Phoenix has implemented public transit improvements, the City's bus system is rated last among comparable cities in miles of transit per capita.

A survey conducted for our Office by the Behavior Research Center [BRC] indicates that the public may be ready to reduce miles driven. In a 1986 public opinion survey conducted by BRC for the City of Phoenix, motorists did not strongly support clean air strategies designed to keep them from driving. However, a survey performed by BRC for our Office showed greater support for programs designed to reduce vehicle miles traveled. For example, 66 percent of the respondents stated that a first rate transit system was an important clean air strategy.

A coordinated effort is necessary - If strategies for reducing vehicle miles traveled are to be effective, they must be coordinated and implemented in concert with each other. According to a 1986 report prepared by Cambridge Systematics, Inc., it is widely accepted that implementing several transportation measures at the same time significantly enhances each's individual effectiveness.[1] A trip reduction ordinance, for example, will be more effective if it features a mixture of incentives and disincentives. The following case examples illustrate how programs have been successfully implemented in other communities:

---

(1) Cambridge Systematics, Inc., "Improved Air Quality In Maricopa and Pima Counties - The Applicability of Transportation Measures," Cambridge, Massachusetts, November 1986.

- A company in Los Angeles instituted a carpooling program where the number of single occupant vehicles dropped from 42 percent to 8 percent. This program worked because parking fees of over $50 per month were phased in for solo drivers while they remained free for carpoolers.

- A high occupancy vehicle lane on the North Freeway in Houston was successful because it was implemented in conjunction with improved, more frequent express bus services, a vanpool promotion and matching program, new park and ride lots, and marketing promotion.

RECOMMENDATION

1. The Legislature and the Department of Environmental Quality should take the lead role in emphasizing strategies that control traffic and reduce vehicle miles traveled. These strategies should:

    - Be coordinated to increase effectiveness,
    - Require stronger commitment of resources for implementation and enforcement, and
    - Be evaluated for their impact.

FINDING III

ADMINISTRATIVE CONTROL PROBLEMS CITED DURING OUR LAST REVIEW HAVE BEEN CORRECTED

Administrative control problems cited during a 1983 performance review of the Vehicle Emissions Inspection Program have been corrected. In contrast to our last review, the Arizona Department of Environmental Quality (ADEQ) and Hamilton Test Systems (HTS) now take adequate steps to insure accurate and reliable emissions testing.

Administrative control problems corrected - Periodic field audits are necessary to assure that equipment used for emissions testing is accurate and reliable. A field audit is an inspection which uses a blend of gases of known proportions to test the ability of equipment to sample and analyze emissions accurately. The intent of the audit is to approximate actual emissions test conditions. Audits are performed by both the Department and HTS.

During the last review, we found that the Bureau of Vehicle Emissions Inspection, now called the Vehicle Emissions Section, did not conduct the number of field audits required during fiscal year 1981-82. The Bureau conducted only 56 percent of the required field audits of HTS stations that year. In addition, the Bureau did not conduct timely inspections of fleet and registered equipment used by private facilities.

These deficiencies have since been addressed by the Department. A review of inspection files from January 1988 through the first week of May 1988 showed all audits of HTS stations were completed during the specified timeframe. Moreover, a file review of the inspection timeliness of 78 randomly selected registered analyzers revealed that ADEQ conducts 93 percent of these audits within the specified ninety days. Allowing for a five-day grace period, ADEQ conducts 99 percent of these audits within the specified timeframe.

HTS, like ADEQ, has corrected control problems cited during the last audit. HTS conducted only 53 percent of the field audits required by its

internal company policies in fiscal year 1981-82. A review of HTS inspection files from July 1987 through September 1988 showed the company now meets and exceeds its current policy of performing semi-monthly inspections.

In addition, a file review showed continued good performance by HTS in other quality control areas as well. For example, test equipment used by HTS is periodically calibrated to ensure accurate recordings of gas concentrations. During the last audit, a file review showed the contractor in compliance with calibration requirements. During the current audit, a three-month review of calibration checks showed continued compliance. In addition, we found evidence that preventive maintenance activities important to a well-run operation are routinely performed by HTS.

OTHER PERTINENT INFORMATION

During the audit we developed other pertinent information regarding the County Assessor's role in the Vehicle Emissions Inspection and Maintenance Program and the need for ongoing evaluation of the program and other clean air strategies.

The County Assessor's Role

In Session Laws 1985, Chapter 266, Section 13 the Legislature directed the Auditor General's Office to review the county assessor's duties related to the Vehicle Emissions Inspection and Maintenance Program.

The Maricopa County Assessor's Office and the Arizona Department of Transportation, Motor Vehicle Division (MVD) in Pima County are no longer responsible for collecting emission inspection fees for tests conducted after January 1, 1988. To improve cost-effectiveness the contract was amended to allow the contractor to collect fees at the time of inspection. However, the County Assessor's Office and MVD in Pima County still collect monies for tests conducted before January 1988.

Before January 1, 1988, the Maricopa County Assessor's Office and MVD in Pima County collected the monies due for vehicle emissions tests. An individual would have his/her vehicle tested as a requirement of registering it. At the time of registration the motorist would pay the testing fee along with the registration fee. The County forwarded these monies to the State. The State then paid Hamilton Test Systems (HTS) for conducting the inspection.

In an attempt to improve cost-effectiveness, the Arizona Department of Environmental Quality (ADEQ) initiated changing the method of collecting inspection fees. Collecting and transferring inspection monies created additional tasks for the Assessor's Office, MVD and ADEQ. In addition, HTS was dissatisfied with the lag time between the time of inspection and the time it received payment. HTS also felt it may not have been

receiving payment for some tests it conducted.[1] Furthermore, ADEQ was concerned the inspection fee would have to be increased to compensate for the unpaid tests.

Because of these problems, ADEQ and HTS agreed to amend the contract to change the payment procedure.[2] Beginning January 1, 1988, the vehicle owner is required to pay HTS directly at the time of inspection. HTS must report monthly to ADEQ the number of inspections performed and the amount of fees collected. In addition, HTS must reimburse ADEQ $8,100 quarterly for ". . . earned interest on the funds not available to the Department resulting from the Contractor collecting and retaining such fees."

The Assessor's Office and MVD feel that the change has been advantageous for their offices. It has reduced their workload. However, the County Assessor's Office and MVD continue to collect any emission fees that were due and payable to Hamilton Test Systems before 1988. For example, a vehicle tested and due to be registered in November 1987 but not registered until February 1988 would still be required to pay the inspection fee at the time of registration. Again, the County and MVD forward this money to the State. From January through September 1988, the Maricopa County Assessor has collected $283,942 and MVD has collected $51,352 for tests done before 1988. The amount collected each month is steadily declining. Maricopa collected $210,154 in January but in September it collected only $602.

Need for Ongoing Evaluation

In response to a Legislative request, our Office reviewed and was critical of the ADEQ's January 1988 in-house evaluation of the Vehicle Emissions and Inspection and Maintenance Program (VEIP). The Department's evaluation, required by the Omnibus Air Quality Bill of 1987, concluded that VEIP is responsible for a 30 percent improvement

---

(1) No payment would be made when a vehicle failed the emissions test and the owner chose not to register the vehicle. Because collection was at the time of registration, no money would be collected. Consequently, HTS would not be paid for a test performed.

(2) A.R.S. §49-543.C allows for the contractor to collect the fee at the time of inspection or the County Assessor's Office to collect it at the time of registration. The statutes were amended in 1985 to allow the contractor to collect fees.

in ambient air quality. Our Office questioned ADEQ's reliance on computer simulation models to assess the program's success, as well as the Department's assumption that emission reductions have a one-to-one relationship with carbon monoxide concentration. These concerns were affirmed by the work conducted for this report and presented in Findings I and II.

Actions taken by the Department since that evaluation, however, indicate a commitment to more rigorous research activities. The Air Quality Fund, for example, was established in 1987 to allow the Department to conduct air quality research and begin programs needed to improve air quality in the State. Monies for the Fund are generated from a fee collected when motor vehicles are registered. ADEQ used monies from the Fund to purchase test equipment needed to calculate the actual as opposed to estimated emission benefits realized through VEIP and the alternative fuels program.

ADEQ's response to new legislation and agency comments attest that it will attempt to evaluate the actual benefits of emission control strategies. House Bill 2206, an Act mandating numerous clean air strategies, requires the Department to report on a variety of air quality issues, including the effectiveness of VEIP and the alternative fuels program in reducing carbon monoxide and other forms of pollution. In an October 1988 report to the Legislature, ADEQ outlined, in response to House Bill 2206, it will use its new test equipment to assess the impact of alternative fuels under conditions representative of the Arizona environment. In addition, once this project is complete, the agency plans to use the equipment to calculate actual VEIP benefits as well.

These, as well as other air quality issues addressed by ADEQ in its response to House Bill 2206, indicate the Department recognizes and is acting on the need for ongoing evaluation of clean air strategies.

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Rose Mofford, Governor
Ronald Miller, Acting Director

December 14, 1988

Douglas R. Norton
Auditor General
2700 North Central Avenue
Phoenix, Az. 85004

Dear Mr. Norton:

This letter documents comments of the Department of Environmental Quality on the Revised Performance Audit Report on the Vehicle Emission Inspection Program (VEIP). Those comments are enclosed.

In reviewing these comments, please note that the Department does not disagree with the Findings and Recommendations contained in the Revised Report. These comments reflect concerns over methodology and the context in which statements are made. They also raise questions on matters of interpretation as well as fact.

We appreciate the opportunity to review the Revised Report. Please contact Nancy Wrona at 257-2308 if you have questions on these comments.

Sincerely,

Ronald L. Miller, Ph.D.
Acting Director

RLM:NCW:la

Enclosure

Comments of the Department of Environmental Quality

Revised Performance Audit Report
Vehicle Emissions Inspection Program

December 14, 1988

Summary

For the cursory reader, the Summary should state that, like all other states, Arizona is required by the U.S. Environmental Protection Agency (U.S. EPA) to utilize the MOBILE 3 computer simulation model in developing revisions to the State Implementation Plan (SIP) . Likewise, the Department's past acknowledgments of the limitations of MOBILE 3 results and adjustments to MOBILE 3 to improve accuracy should be acknowledged in this section.

Introduction and Background

Approximately 1.5, not 1.9, million tests were conducted by the program contractor in 1987 (page 1).

The discussion of the waiver component of the program fails to note that in order to qualify for a waiver, a vehicle must undergo a low emissions tune up. While the Report is correct in assuming that waived vehicles do not receive all necessary repairs, the low emissions tune up does reduce tailpipe emissions. We point out again that during the first nine months of 1988, 41% of all vehicles receiving waivers did pass at the time that the waiver was granted, although the Department did not change their status from "fail" to "pass" at the time of waiver issuance. Based on these data it may be more accurate to state that 3% of vehicles tested receive a waiver and 1.8% of vehicles tested are never able to pass the test. The Department adjusted MOBILE 3 to reflect the waiver provision of the Program: this correction has been accepted by U.S. EPA (page 2).

In light of the measures enacted in HB 2206 this year, we do not concur that ". . . for Phoenix, the air quality outlook is bleak", particularly as related to carbon monoxide pollution. In fact, the air quality trend for carbon monoxide in the Phoenix metropolitan area has improved greatly in recent years. The Department and U.S. EPA project significant further improvement as a result of measures included in HB 2206. Statements by the Department cited to support this conclusion reached by your office were made prior to the enactment of HB 2206 (page 3).

Projected emission reduction targets and benefits of each component of the SIP are not reported correctly. With passage of SB 1360 in 1987 and incorporation of these measures and local plans into the SIP, the U.S. EPA estimated that an additional 22% reduction in emissions was necessary for the Phoenix area to demonstrate attainment of the carbon monoxide standard. The projected 24% reduction discussed in the Report was not identified by U.S. EPA or the Department as an emission reduction goal. The U.S. EPA credited HB 2206 with achieving a 24% reduction in carbon monoxide emissions, which was 2% greater than the target identified by U.S. EPA. The travel reduction program instituted under HB 2206 was attributed by U.S. EPA with an approximate 2% emissions reduction (pages 3 & 4).

It is more precise to state that in Fiscal Year 1987 - 88, the Program contractor received/collected $11.6 million (page 4)

During FY 1987-88, the Vehicle Emissions Section had fourteen, not fifteen, positions funded from the General Fund (page 4).

Finding I

The introduction to this Chapter is not contemporary, as it fails to acknowledge that Arizona has adopted measures beyond VEIP, and is evaluating other potential measures (page 9).

The Clean Air Act, as amended in 1977, set out a deadline of December 31, 1982, for all areas to meet federal clean air standards. In that same Act, Congress, not the U. S. EPA, provided an ultimate compliance deadline of December 31, 1987, for areas which could qualify for an extension from the earlier date (pages 9-10).

While it is correct to state that MOBILE 3 does not consider ambient air concentrations in assessing the effects of VEIP, this discussion does not acknowledge that projected ambient air quality is considered through the use of the Urban Airshed Model (UAM). MOBILE 3 results are used as input to the UAM in order to project ambient conditions on the design day and through time (page 10).

The body of the Report should explicitly acknowledge that all computer models, simulation or statistical, must rely on assumptions of the methodology to predict future behavior. In the case of MOBILE 3, assumptions are made regarding in-use emissions and other factors. Time series analysis also relies on assumptions, such as the reliability of indicator variables and theoretical constructs which underlie the use of these indicators (page 11).

The Report should cite the communication in which a U.S. EPA official stated that because emission levels used in MOBILE 3 are developed under highly controlled conditions, actual in-use emissions can vary significantly (page 14).

While MOBILE 3 itself does not account for vehicles which receive a waiver, Arizona does adjust MOBILE 3 results to reflect the waiver provisions. These adjustments have been accepted by U.S. EPA and should be acknowledged (page 15). The discussion in this section of waiver rates and the pass/fail status of waived vehicles should reflect the Department's comments on these issues, as discussed in the previous section.

The mechanics survey performed for the Office of the Auditor General revealed that mechanics frequently failed to follow proper procedures for repairing vehicles with high carbon monoxide and hydrocarbon emissions; however, failure to follow proper procedures does not equate to a failure to make proper repairs (page 16).

Similarly, the discussion of mechanics who have been asked to adjust a vehicle to pass rather than to perform all appropriate repairs may be misleading. The survey did not attempt to quantify the number of mechanics who, when asked to adjust a vehicle to pass, explained that this was not possible without making all necessary repairs (page 16).

The discussion on page 19 of the role of MOBILE 3 in SIP development is confusing, as there are no citations pointing out when these projections were developed. If these estimates are being represented as contemporary, they are incorrect. The U.S. EPA currently projects that the Phoenix area will meet the ambient carbon monoxide standard in 1991, without the adoption of additional measures. Because the State recognizes the optimism of the MOBILE 3 estimates, the Department has been directed by the Legislature to study a variety of additional measures to reduce carbon monoxide pollution. These inconsistencies should be addressed (page 19).

Finding II

With enactment of SB 1360 in 1987 and adoption of the Nonattainment Area Plan prepared by the Maricopa Association of Governments, the U.S. EPA projected before enactment of HB 2206, that a 22% reduction in carbon monoxide emissions was needed to attain the standard in 1991 (page 21).

The report does not acknowledge that while emission control strategies alone may not bring about attainment, they are extremely reliable in reducing emissions every time a vehicle is operated. While measures to reduce traffic flow can have significant long-term benefits, they are inherently less reliable than emission controls in that they rest on personal choice and often require changes in behavior (page 21).

Again the Department points out that the SIP, as approved by U.S. EPA, does not take full credit for VEIP benefits. As noted elsewhere, the Department modifies MOBILE 3 outputs to account for certain identifiable optimisms in MOBILE 3. This fact should be acknowledged (page 22).

Statements by authorities that the oxygen content of Arizona's fuels program cannot be increased much beyond the current maximum should be cited (page 23). Similarly, statements by Department officials on this issue should also be cited (page 23).

The sources of projections of vehicle miles traveled should be noted (page 25).

The Revised Report does not discuss how traffic control measures were selected as having greatest potential air quality benefits, to the exclusion of other methods such as traffic flow improvements (page 25).

Statements by the Arizona Center for Law in the Public Interest and the public opinion survey conducted for the City of Phoenix should be cited (pages 25-26).

Appendix A

The Department does not concur with the conclusions that the time series models developed by the Auditor General indicated that VEIP has no impact on ambient carbon monoxide levels, or that the effectiveness of the program is highly overrated. Given the information presented in pages 9 through 13, and Appendix A of the Report, it may be more reasonably deduced that

the results of the time series analyses are inconclusive. The authors admit that "the effects of VEIP could not be isolated from other variables" in one study that was used as a model by the Auditor General (footnote 1 on page 13), and the Department agrees that this is a more appropriate conclusion. First, the indicator variables used in the time series models were surrogate measures. Though the correlation between these surrogates and the more preferred measures may be strong, the surrogate measures are not precise. Gasoline sales only explain 53% of the variability in vehicle miles traveled (VMT), and the precision of relative humidity as a surrogate for temperature inversions may not be much better. Thus, it is likely, not merely possible, that the results of the models could be inconclusive because of measurement error (see the last paragraph on page A-4).

Finally, how the federal new-automobile emissions standards could be isolated from VEIP was not explained. Both programs were: 1) being implemented simultaneously; 2) expected to have gradual rather than immediate impacts; and 3) modified several times during their implementation. Without having a control city where no VEIP was implemented, isolating one from the other could only be accomplished by proposing and testing explicit hypotheses as to what impact each program would have on ambient carbon monoxide concentrations. These weaknesses in the time series analyses performed by the Auditor General render verification of the conclusions that either the impact of VEIP is grossly overstated, or it has no measurable effect on ambient carbon monoxide concentrations, impossible.

NCW:la

TIME SERIES ANALYSIS OF THE VEHICLE EMISSIONS INSPECTION PROGRAM

The 1983 Auditor General study of the effectiveness of VEIP on clean air stated that no statistically significant improvements in clean air could be attributed to the VEI program. The study came to that conclusion by using a methodology that was considered especially appropriate for use with environmental data and testing for impacts over the course of the year that VEIP was implemented in 1977 and also for impacts due to tightening of emissions standards in Arizona in 1979. A reanalysis of the effect of the program by Tiao et al., in 1984 took the time series methodology a step further and incorporated information about the magnitude of the expected effects of Federal emission standards. He also categorized the time periods into winter and summer components. Despite the addition of those changes, Tiao did not find substantially different results in terms of reductions in carbon monoxide (CO) due to the VEIP than did the 1983 Auditor General study and neither study detected the large benefits of a 25 percent reduction claimed by EPA.

The time series methodology used by both Tiao and the Auditor General is the AutoRegressive Integrated Moving Average (ARIMA) stochastic process modeling developed by Box and Jenkins (1976).[1] These models analyze inputs into a system and outputs from it. ARIMA models are built from relatively long data series which are discrete observations of a process. In this case, the data are CO measurements taken from ambient air in Phoenix and Tucson. In 1983, the Auditor General study used four distinct conceptual indicators of those measurements. In 1988, due to changes in reporting and missing data, all four series were not used. The series which were able to be used are the highest monthly eight-hour readings and the monthly average of the highest daily eight-hour readings.

Empirical models are built around the three ARIMA process components (the autoregressive, integrated and moving average). The first component to be considered is the integrated component which is closely related to the

---

(1) G.E.P. Box and G. M. Jenkins, Time Series Analysis: Forecasting and Control, 2nd Revised Edition. San Francisco: Holden-Day 1976.

concept of trend. Trend is defined as any systematic change in the level of a time series. Trend must be removed from the data series before assessing whether an intervention can be credited with a significant effect, either positive or negative. Failure to do so would give an intervention program false credit or blame for a trend which was apparent well before the program's inception. In this situation, for example, there is a downward trend in CO concentrations due to stricter federal emission standards well before the VEIP was implemented. The effects of this downward trend must be removed before assessing the impact of VEIP. This is done by incorporating an integrated component into the time series model.

The autoregression and moving average components which are modeled next exhibit different characteristics to be factored into the process and are identified by patterns exhibited in their autocorrelation functions (ACFs). To further complicate matters, seasonality is especially evident in environmental data and must be accounted for by incorporating seasonal components in the univariate ARIMA model.

Each ARIMA model is custom-built to fit a particular time series. In our study, we built models for monthly measurements of CO in the air from 1974 through 1987. This is our dependent time series. We also built models for two independent time series which have been found to have major impacts on CO in the air. These are relative humidity (as a surrogate for temperature inversion) and gas sales which are representative of vehicle miles traveled. Relative humidity has been used by Tiao in past studies (1981, 1984) since data are not available for temperature inversions and its use has been commonly accepted. Although gas sales has been used as representing vehicle miles traveled, it does have some weaknesses. For example, better fuel economy means more miles driven per gallon of gas. While this indicator is not a perfect construct, it nevertheless has been used in other types of research both in this State and internationally, and has been considered an acceptable surrogate for vehicle miles traveled.[1] Moreover, gas

---

(1) See research done by the Statistical Analysis Center of Arizona Department of Public Safety and H. L. Ross' work Deterring the Drunk Driver: Legal Policy and Social Control. Lexington, Massachusetts: D.C. Heath: 1982

sales showed a strong correlation (.73) with estimates of vehicle miles traveled in Phoenix. Other factors such as seasonality and trends which may impact ambient CO are accounted for through mathematical patterns exhibited by the data. It would obviously be better to have actual data to represent these factors, but such data are not available in comparable time series, if at all.

The model-building strategy follows a standard procedure as outlined by McCleary and Hay[1] which involves:

- Identification of the ACF to its expected pattern;
- Estimation of the parameters and incorporation of them into the model if they are statistically significant and lie within the bounds of stationarity/invertibility;
- Diagnosis of the model's residuals as white noise. This is judged by two criteria: no significant spikes at key lags and an insignificant Q-statistic;
- Metadiagnosis which prescribes a model may be used for impact assessment, for forecasting and/or for causal analysis.

Impact assessment logic follows that of theories of causality in that the temporal ordering of causation relies on the assumption that if there is a change in a process at the same time (or a theoretically plausible time after) a program begins, one can test for that change and (with controls for rival hypotheses and within certain confidence limits) attribute the results to that program.

To conduct our impact assessment, separate models were built for data from the Phoenix Central monitor and the Tucson monitor at 22nd Street and Alvernon, using the two CO indicators mentioned above. Two interventions were tested - one for the 1977 inception of the VEIP

---

(1) Richard McCleary and Richard Hay, Applied Time Series Analysis for the Social Sciences: Beverly Hills and London: Sage 1980.

mandatory inspection and maintenance and one for 1979, the year when failures were dramatically increased. Univariate models for CO, relative humidity and gas sales were built first. Next, impact components for the interventions in 1977 and 1979 were added to these univariate models. Finally, the univariate models were combined into a multivariate model and impact components were then added. The result is a process model of ambient CO which mathematically incorporates and accounts for changes in CO due to certain factors in each city and for each indicator of CO. These factors include stricter Federal standards for emissions from new cars, traffic growth, meteorology, seasonal effects, the inception of the VEIP and the policy change in VEIP which resulted in higher emission standards for automobiles.

All univariate, impact and multivariate models met the diagnostic criteria necessary for acceptance. That is, parameter estimates were statistically significant and lay within the bounds of stationarity or invertibility; there were no significant spikes at key lags; residuals were diagnosed as white noise as evidenced by the autocorrelation functions and the Q-statistic. As shown in Table 1, results of the analyses indicate that, taken as a group, the models could not attribute any overall significant decrease in CO due to the 1977 implementation of VEIP or the 1979 increase in failure rates. While there were two of eight multivariate models which showed statistically significant results, one was an increase in CO readings (Phoenix highest eight-hour CO for the 1977 intervention) and one was a decrease (Tucson highest eight-hour CO for the 1979 intervention). Given the lack of a clear pattern, the conclusion the time series models presents is that there is no effect due to the program.

As in all research, there are limitations and caveats to this analysis as well. It may be possible that the imprecision of the indicators is potentially limiting our ability to find an effect. We were not able to factor in actual temperature inversions but had to use relative humidity instead. Although this has been used in past research by other analysts, it is not as precise as inversion data. Further, we had no site-specific traffic data. Estimates of gas sales were used since they represented actual not estimated data and because they were available in comparable

TABLE 1

PARAMETER ESTIMATES AND T-VALUES
FOR
1977 AND 1979 INTERVENTIONS

	1977 Intervention		1979 Intervention	
	Parameter Value	T-Value	Parameter Value	T-Value
PHOENIX				
8-Hour Highest Mo. Average	.234	.82	.445	1.10
8-Hour Highest Mo. Reading	.129	2.00	-.020	-.25
TUCSON				
8-Hour Highest Mo. Average	.068	.26	-.264	-1.51
8-Hour Highest Mo. Reading	.130	.24	-1.404	-2.97

time series. Additionally, the lack of a control city limits the research in that quasi-experimental logic could present a stronger argument for the results if, for instance, the control city experienced similar results despite having no VEIP or if it experienced decreases in CO without such a program.

Notwithstanding these caveats, we have no hesitation in stating that the VEIP, by itself, is not enough to bring Phoenix and Tucson into compliance with EPA standards for clean air. Alternatives must be considered; moreover, attention must be paid to the collection of appropriate indicators and to future evaluations of these alternatives. Researchers representing different perspectives need to collaborate in advance on the design and methods necessary to perform definitive evaluations of future alternatives.

VEHICLE EMISSIONS INSPECTION PROGRAM STUDY

Volume I - Summary Analysis

prepared for

Office of the Auditor General
State of Arizona

prepared by

Behavior Research Center, Inc.
1117 North Third Street
Phoenix, Arizona
(602) 258-4554

TABLE OF CONTENTS

LISTING OF TABLES

(CONT.)

(CONT.) LISTING OF TABLES

1.0 INTRODUCTION

This study was commissioned by the Office of the Auditor General as one component of the Auditor General's performance audit of the Arizona Vehicle Emissions Inspection (I/M) Program. The overall objective of this study was to gather input from the general public (automobile owners) and automotive mechanics regarding: (A) the impact the Vehicle Emission Inspection Program has on vehicle repair and maintenance; (B) the quality of emissions-related maintenance and repair work performed by auto mechanics and motorists; and (C) the perception of the Program held by the public and the automobile service industry. The specific purposes of this study were to determine the following:

General Public Survey

- If the I/M Program has impacted the maintenance and repair behavior of vehicle owners whose vehicles must be tested annually.
- If there are differences between the frequency, type and cost of maintenance/repair work performed by residents participating in the I/M Program and residents not participating in the I/M Program.
- If residents participating in the I/M Program tune their vehicles especially in preparation for taking the emissions test.
- How many vehicle owners repair their own vehicles when they fail the vehicle emissions test and what is the quality of the maintenance/repair work then performed.
- If residents participating in the I/M Program attempt to circumvent the test process by adjusting their engines to pass the emissions test and then re-adjusting them after successfully completing the test.

- If the presence of an I/M Program has affected auto purchase decision made by vehicle owners.
- If residents participating in the I/M Program believe tuning vehicles to pass the emissions test negatively affects vehicle performance.
- If residents participating in the I/M Program perceive the Program to be a worthwhile method for improving air quality.
- If residents favor other air quality alternatives, (i.e., car pools, mass transit, etc.) in addition to or instead of the I/M Program.

Auto Mechanic Survey

- If mechanics know how to properly diagnose specific emission problems.
- If mechanics know how to correct specific emission problems.
- If mechanics know how to perform repair work on vehicles engineered with computer technology.
- If mechanics aid their customers in circumventing the I/M Program.
- If demographic differences among service shops impact the kinds of vehicle emission maintenance performed.
- If differences in the level of training among mechanics impact the type of work performed for vehicle emission repairs.
- If auto mechanics believe tuning vehicles to pass the emissions test negatively affects vehicle performance.
- If auto mechanics perceive the Program to be a worthwhile means for improving air quality.

The information contained in this report is based on 899 interviews conducted with automobile owners residing in the metropolitan areas of Phoenix, Tucson and Yuma, and 201 interviews with automotive mechanics in metropolitan Phoenix and Tucson.

All of the interviewing on this project was conducted via telephone by professional interviewers of the Behavior Research Center during October, 1988. For a detailed explanation of the procedures followed during this project, please refer to the METHODOLOGY section of this report.

The purpose of this report is to present a broad overview of the information collected and to address the primary study objectives. This report is not designed to present a thorough analysis of every study variable. Such analysis is left to ADEQ analysts with specific informational needs utilizing the detailed tables and data tapes generated by this project.

The information generated from this study is presented in two volumes. Volume - Analysis presents a written analysis of the findings and is divided into three general sections. The first section, OVERVIEW, presents the primary findings of the surveys in a brief summary format. The second section, SUMMARY OF THE FINDINGS, reviews each survey in detail. The final section, APPENDIX, details the study methdology and contains copies of the survey questionnaire.

Volume II - Detailed Tables presents computer-generated tables which analyze all study questions by a variety of socio-demographic variables.

The Behavior Research Center has presented all of the data germane to the basic research objectives of this project. However, if the Office of the Auditor General requires additional data retrieval or interpretation, we stand ready to provide such input.

BEHAVIOR RESEARCH CENTER

2.0 OVERVIEW

2.1 General Public Survey

- Nearly six out of ten non-attainment area residents (58%) believe air pollution is a major problem in their area. This figure is 19 percent higher than a similar reading taken in 1982 (39%) and more than three times higher than the reading recorded in the in the attainment area (17%).

- Seventy-one percent of metropolitan area residents believe that the automobile is the "major" source of air pollution in their area, up from a 57 percent reading in 1982. Windblown dust is viewed as the major source of air pollution among attainment area residents (55%).

- Nearly eight out of ten metropolitan area residents believe the vehicle emissions testing program has helped keep the air clean in the Tucson and Phoenix areas. Twenty-two percent believe the program has helped "a lot" and 56 percent think it has helped "a little."

- Building a first-rate public transit system is viewed as the most effective alternative air pollution reduction measure by Phoenix and Tucson area residents.

- Non-attainment area residents tend to take better care of their vehicles from a maintenance standpoint than do attainment area residents. For example, they tune up their vehicles more often per year (1.6 times vs. 1.4), perform more specific adjustments per year (8.9 out of 11 procedures vs. 8.6) and spend more money per year on maintenance ($107 per vehicle vs. $104) than do attainment area residents.

- Discontinuation of the emissions program in the non-attainment area would have a minimal, albeit negative, impact on vehicle maintenance patterns. However, introduction of the program into the attainment area would possibly result in a significant increase in vehicle maintenance.

- Nine percent of non-attainment area residents indicate the emissions program has influenced a vehicle purchase decision they have made.

- Only about four out of ten non-attainment area residents (39%) did anything to their vehicle prior to taking their last emissions test. This figure is a significant ten percent below the percentage recorded

in 1982. The most common steps residents took prior to testing were having their vehicle tuned (30%) and checking to make sure the air pollution devices of the engine were hooked up and working (25%).

- o Very few residents who fail the emissions test actually perform the needed repairs themselves. Of the 297 study respondents who failed the test, only 31 or 10.4 percent personally performed any repairs or maintenance themselves. The bulk of residents who fail the test (70.4%) take their vehicle to a professional auto repair shop.

- o Based on a case-by-case evaluation conducted by ADEQ, residents who flunk the test and perform their own repairs generally do an inadequate job. In fact, in only three cases (among the 25 where an evalution was possible) did the person performing the repairs do what was deemed an adequate job. The main reasons residents do not do an adequate job are two-fold:

  - First, instead of performing each of the tasks called for on the Vehicle Emissions Report, most residents simply perform one or two tasks such as adjusting the air fuel mixture or replacing the air cleaner.

  - Second, very few residents have the necessary equipment and tools to conduct the necessary repairs.

- o Fifteen percent of metropolitan area residents indicate that even though their engine can be adjusted to pass the emissions test, it does not run as well as it should when so adjusted. Further, eight percent of all the residents surveyed say they re-adjusted their vehicle's engine after their last emissions test so that it would run the way they like it to. Each of these figures is lower than the comparable figures which were recorded in 1982.

2.2 Auto Mechanics Survey

- o A majority of mechanics score fairly well in terms of the manner in which they address high HC emissions problems. Thus, we find roughly seven out of ten mechanics receiving passing evaluations when it comes to diagnosis (67%), corrective action (71%) and equipment utilization (69%). From an overall perspective, 60 percent of all mechanics receive passing grades from ADEQ in their handling of high HC emissions problems.

- Specialized tune-up shops such as Tune-Up Masters and Econo Lube N' Tune, receive the highest overall evaluation (75%) among the four types of automotive facilities tested. Gas stations receive the poorest grades with an overall evaluation of only 49 percent.

- While mechanics do a fairly good job of handling high HC emissions problems they fail miserably in their handling of high CO problems. The reason for this is very clear -- improper equipment utilization. Thus, we find that while mechanics know for the most part how to diagnose high CO problems (74% correct) and what corrective actions to follow (63%), only about eight percent utilize the proper equipment when dealing with such problems.

- Once again we find mechanics from specialized tune-up shops scoring well above other types of mechanics. Nonetheless, only 29 percent of mechanics for specialized tune-up shops appear able to properly handle high CO emissions problems.

- Mechanics score quite well when asked to indicate the type of equipment they use to check the oxygen sensors on computerized vehicles with 87 percent responding correctly to the inquiry.

- According to auto mechanics, circumvention of the emissions testing program is very commonplace among vehicle owners in the non-attainment areas. Consider for a moment the following:

  - Ninety-three percent of all mechanics indicate they have been asked by customers to simply adjust their vehicle to pass the emission test, rather than conduct the appropriate and needed emissions-related maintenance and repairs. Eighty-eight percent say such requests by customers are either very or somewhat commonplace in the industry.

  - Ninety-four percent of all mechanics also indicate that they have been asked by customers to re-adjust their vehicles after it has passed the emissions test so that it will run better. Seventy-eight percent say such requests by customers are either very or somewhat commonplace in the industry.

- A majority of auto mechanics (52%) believe that if a vehicle is adjusted to pass the emissions test such adjustments will have a positive effect on the performance of the vehicle. In comparison, only 18 percent believe it would have a negative effect on performance while 12 percent believe it would not have any effect.

- Better than eight out of ten auto mechanics (83%) feel the vehicle emissions testing program has helped keep the air clean in the Phoenix and Tucson areas. Forty-nine percent feel the program has helped "a lot" and 38 percent believe it has helped "a little." This 49 percent "a lot" reading is more than double the 22 percent "a lot" reading recorded in the general public segment of this study.

3.0 SUMMARY OF THE FINDINGS - GENERAL PUBLIC SURVEY

3.1 Attitudes About Air Quality

Nearly six out of ten non-attainment area residents (58%) believe air pollution is a major problem in their area. This figure is 19 percent higher than a similar reading taken in 1982 (39%) and more than three times higher than the reading recorded in the attainment area (17%). It is clear from these readings that metropolitan area residents have serious concerns about the quality of the air they breathe.

TABLE 1: PERCEIVED SERIOUSNESS OF AIR POLLUTION PROBLEM

"Would you say that air pollution is a major problem, a minor problem, or not a problem in your area?"

	Non-Attainment				
	Total				
	1982	1988	Phoenix	Tucson	Attainment
Major problem	39%	58%	61%	52%	17%
Minor problem	44	32	29	39	44
Not a problem	15	8	9	6	37
Not sure	2	2	1	3	2

Within no demographic sub-group of residents in the metropolitan areas of the state does the belief that air pollution is a major problem dip below 50 percent.

TABLE 2: PERCEIVED SERIOUSNESS OF AIR POLLUTION PROBLEM (DETAIL - NON-ATTAINMENT)

	Major Problem	Minor Problem	Not A Problem	Not Sure
Total - 1988	58%	32%	8%	2%
Gender				
Male	57	30	11	2
Female	60	33	5	2
Age				
Under 35	58	37	4	1
35 to 54	63	28	7	2
55 or over	55	28	15	2
Residency				
5 years or less	54	35	9	2
6 to 10 years	61	32	4	3
11 years or more	60	30	9	1
Initial Test				
Passed	58	33	8	1
Failed	62	26	7	4

Seventy-one percent of metropolitan area residents believe that the automobile is the "major" source of air pollution in their area, up from a 57 percent reading in 1982. Windblow dust is viewed as the major source of air pollution among attainment area residents (55%).

TABLE 3: PERCEIVED SOURCES OF AIR POLLUTION

"Would you say that each of the following is a major source, a minor source, or not a source of air pollution in your area?"

	Non-Attainment			
	Major Source	Minor Source	Not A Source	Not Sure
Automobiles	71%	23%	5%	1%
Commercial vehicles (busses and trucks)	57	30	11	2
Windblown dust	55	36	8	1
Businesses and industry	24	43	31	2
Mine smelters	16	29	49	6

	Attainment			
	Major Source	Minor Source	Not A Source	Not Sure
Windblown dust	55%	36%	8%	1%
Automobiles	28	53	16	3
Commercial vehicles	23	46	29	2
Businesses and industry	15	37	45	3
Mine smelters	6	16	67	11

(% Rating Each As "Major" Source)

	Non-Attainment			
	1982	1983	Difference	Attainment
Automobiles	57%	71%	+14	28%
Commercial vehicles	44	57	+13	23
Windblown dust	55	55	0	55
Businesses and industry	20	24	+ 4	15
Mine smelters	22	16	- 6	6

3.2 Reaction To Emissions Inspection and Other Air Quality Improvement Alternatives

Nearly eight out of ten metropolitan area residents believe the vehicle emissions testing program has helped keep the air clean in the Tucson and Phoenix areas. Twenty-two percent believe the program has helped "a lot" and 56 percent think it has helped "a little." The percentage of people who feel the testing program has done "a lot" is down ten percent from 1982 while the percentage who feel the program has done "a little" has increased by ten percent. This leads one to believe people have become a bit more skeptical about the impact of the emissions testing program, but in general feel that it will help reduce air pollution at least "a little."

TABLE 4: IMPACT OF EMISSIONS INSPECTION ON AIR QUALITY IN METROPOLITAN ARIZONA

"As part of its air pollution control program, Arizona requires that 1967 and newer vehicles in the Phoenix and Tucson areas pass an emissions test before they can be licensed in the state. From what you have read or heard, do you think the vehicle emissions testing program has done a lot, a little, or nothing at all to reduce air pollution in your area?"

	Non-Attainment	
	1982	1988
A lot	32%	22%
A little	47	57
Nothing	17	16
Not sure	4	5

Belief that the program has been effective or done "a lot" is fairly uniform in most demographic sub-groups and reaches its highest levels among older residents, Tucson residents, and females.

TABLE 5: IMPACT OF EMISSIONS INSPECTION (DETAIL)

	A Lot	A Little	Nothing	Not Sure
Total - 1988	22%	57%	16%	5%
City				
Phoenix	21	57	17	5
Tucson	25	55	13	7
Gender				
Male	21	61	15	3
Female	24	52	16	8
Age				
Under 35	22	61	12	5
35 to 54	20	58	18	4
55 or over	26	49	17	8
Residency				
5 years or less	24	58	13	5
6 to 10 years	20	60	14	6
11 years or more	22	56	17	5
Initial Test				
Passed	22	57	15	6
Failed	21	55	18	6

After metropolitan residents indicated how successful they feel the I/M Program has been, they were asked to indicate how successful they feel each of eight alternative air pollution reduction measures would be. Without a doubt, residents believe the most effective air pollution reduction measure would be the building of a first-rate public transit system. Sixty-six percent of residents believe this measure

would do "a lot" to reduce air pollution in their area. Other measures which receive significant "a lot" readings from residents are: (1) staggered work hours (45%), and; (2) mandatory carpooling (39%).

TABLE 6: IMPACT OF OTHER AIR QUALITY IMPROVEMENT ALTERNATIVES ON AIR QUALITY IN METROPOLITAN ARIZONA

"A variety of proposals have been made on how to reduce the amount of air pollution in the Phoenix and Tucson areas. I'd like to read you some of them and then have you tell me whether you think each would do a lot, a little, or nothing at all to reduce air pollution in your area."

	A Lot	A Little	Nothing	Not Sure
Build a first-rate public transit system to encourage use of mass transit.	66%	22%	10%	2%
Institute staggered work hours to improve traffic flow during rush hours.	45	37	15	3
Require drivers to use clean-burning alternative fuels such as methanol or gasohol in their cars.	41	34	14	12
Require employers to begin van and car pool programs for their employees.	39	43	15	3
Require employers to reward employees who carpool or use the bus to get to and from work.	39	42	16	3
Make the state's vehicle emissions testing program tougher to pass.	36	34	25	5
Institute voluntary no-drive days where residents agree not to drive one day a week.	21	42	34	3
Increase the fuel tax significantly to discourage vehicle travel.	11	30	57	2

3.3 Impact of Emissions Inspection Program on Vehicle Maintenance and Repair

Non-attainment and attainment area residents were asked a series of questions to determine if there are differences between the frequency, type and cost of maintenance work performed by residents participating in the I/M Program and those not participating.

Looking first at the frequency of engine tune-ups, we find that non-attainment area residents generally tune up their vehicles more frequently than their attainment area counterparts. Thus, we find that typical non-attainment area residents tune up their vehicles an average of 1.6 times per year compared to a frequency of 1.4 times among attainment area residents. Further, nearly one-third of attainment area residents (32%) tune up their vehicles less than yearly while only 22 percent of non-attainment area residents follow a similar pattern.

TABLE 7: FREQUENCY OF TUNE-UPS

"About how often, if at all, do you have the engine on this vehicle tuned up or adjusted?"

	Non-Attainment			Attainment			Difference
Never	7%	--	22%	14%	--	32%	- 7
Less than yearly	15			18			- 3
1 time a year	35			31			+ 4
2 times a year	27	--	43	22	--	36	+ 5
3 times or more a year	16			14			
Average Number Of Tune-ups Per Year	1.6			1.4			

In addition to tuning up their vehicles more frequently, non-attainment area residents also tend to perform more specific adjustments on their vehicles than do attainment area residents. Overall, the typical "backyard" mechanic in the non-attainment area performed 8.9 out of 11 maintenance procedures tested compared to a figure of 8.6 for attainment area residents.

TABLE 8: MAINTENANCE PERFORMED OVER PAST YEAR

"During the past year, have you done any of the following things to this vehicle?" (Among Persons Performing Work Themselves)

	Non-Attainment	Attainment	Difference
Checked the air cleaner and replaced if dirty.	98%	95%	+ 3
Checked the spark plugs and replaced if necessary.	96	93	+ 3
Checked the spark plug wires and replaced if necessary.	93	88	+ 5
Checked the vacuum hoses for leaks and repaired if necessary.	87	85	+ 2
Checked the distributor components and replaced if necessary.	86	78	+ 8
Checked the PCV valve and replaced if faulty.	79	83	- 4
Adjusted the idle speed to manufacturer's specifications.	78	71	+ 7
Set the dwell and timing to manufacturer's specifications.	77	66	+11
Checked the choke for proper operation and replaced if necessary.	76	81	- 5
Set the air fuel mixture to manufacturer's specifications.	72	56	+16
Checked the carburetor float setting, power valve, needles, seat and jets and repaired or replaced as required.	53	61	- 8
Average Number of Adjustments Performed	8.9	8.6	+.3

In the final question, aimed at measuring maintenance patterns among non-attainment and attainment area residents, we find that on average, non-attainment residents spend more per year on vehicle maintenance than do attainment area residents ($107 vs. $104 per vehicle). While this variation is minimal, and not statistically significant, when it is taken in conjunction with the data in the previous two tables, a distinct pattern is revealed. Namely, that non-attainment area residents tend to take better care of their vehicles from a maintenance standpoint than do attainment area residents. Whether this pattern is directly related to the presence of the I/M Program in the non-attainment area can not be unequivocally proven with the data. However, the indication is that the program is having an impact on maintenance behavior in the non-attainment area.

TABLE 9: DOLLAR AMOUNTS SPENT ON MAINTENANCE

"How much do you estimate you spend in an average year on engine tune-ups or adjustments on this vehicle? That is, for parts and supplies if you do the work yourself or to auto repair shops if you have it done professionally?"

	Attainment	Non-Attainment	Difference
Over $250	15%	16%	- 1
$150 to $249	18	18	0
$100 to $149	19	17	+ 2
$50 to $ 99	23	22	+ 1
Under $50	25	27	- 2
	100%	100%	
Median	$107	$104	+$3

Two additional questions were asked of residents to further determine the impact of the I/M Program on maintenance behavior. First, non-attainment area residents were asked to indicate if their vehicle maintenance patterns would change if the I/M Program did not exist and attainment area residents were asked how their patterns would change if the program were required in their area. As the following table reveals, discontinuation of the program in the non-attainment area would have a minimal, ablbeit negative, impact on maintenance patterns. However, introduction of the program into the attainment area would possibly result in a significant increase in vehicle maintenance.

TABLE 10: I/M PROGRAM'S IMPACT ON TUNE-UP FREQUENCY

Asked in Non-Attainment Area

"If emissions tests were not required, would you have your engine tuned up or adjusted more often, about as often, or less often than you do now?"

Asked in Attainment Area

"If annual vehicle emissions tests were required in your area like they are in the Phoenix and Tucson areas, would you have your engine tuned up or adjusted more often, about as often, or less often than you do now?"

	Non-Attainment	Attainment
More often	4%	16%
About as often	89	72
Less often	6	5
Not sure	1	7
	100%	100%
Net more/Less	- 2	+11

The final question in this series asked non-attainment area residents if the I/M Program had ever influenced any vehicle purchase decision they had made. As may be seen, nearly one out of ten residents (9%) indicate the program has influenced a purchasing decision.

TABLE 11: I/M PROGRAM'S IMPACT ON VEHICLE PURCHASING BEHAVIOR

"And has the fact that the vehicle emissions testing program exists ever influenced any vehicle purchase decision you've made?"

Yes	9%
No	90
Not sure	1
	100%

3.4 The Public's Most Recent Experience With the Emissions Inspection Program

Non-attainment area residents were asked a series of questions to determine the following:

- What steps they took to prepare for their most recent emissions test.
- The quality of the work performed by residents who repair their own vehicles when they fail the test.

Looking first at pre-test preparation we find that only about four out of ten residents (39%) did anything to their vehicle prior to taking the emissions test. This figure is a significant ten percent below the percentage recorded in 1982. The most common steps residents took prior to testing were having their vehicle tuned (30%) and checking to make sure the air pollution devices of the engine were hooked up and working (25%).

TABLE 12: STEPS TAKEN PRIOR TO LAST EMISSION TEST

"Before you took this vehicle in to get its last emissions inspection, I mean before you went to the station and before you knew whether it would pass or fail, did you do any of the following things?"

(% Indicating Each Was Done)

	1988	1982	Difference
Check to make sure the air pollution devices on the engine were hooked up and working?	25%	34%	- 9
Pay someone to have it tuned up?	16	18	- 2
Tune it up yourself or have someone in your family or a friend do it?	14	24	-10
Make any other adjustments to the vehicle so as to improve its chances of passing?	8	17	- 9
% Doing Something	39	49	-10

"What other adjustments were made to the vehicle to improve its chances of passing the test? (Asked Of Those Persons Responding "Yes" To Last Category Above)

	As % Of Total Sample
Adjusted carburetor	2.0%
Checked/Changed air cleaner	1.4
Changed oil	1.1
Checked/Changed spark plugs	1.0
Adjusted idle speed	0.6
Set dwell/timing	0.4
All other responses	3.4

We next take a look at those individuals who performed their own repair work after they failed the initial emission test.

Overall, very few residents who fail the emissions test actually perform the needed repairs themselves. In fact, of the 297 study respondents who failed the test, only 31 or 10.4 percent, personally performed any repairs or maintenance themselves. The bulk of residents who fail the test (70.4%) take their vehicle to a professional auto repair shop. The majority of those residents who perform their own repair work are males under 35 years old.

Based on a case-by-case evaluation conducted by ADEQ, residents who flunk the test and perform their own repairs generally do an inadequate job. In fact, in only three cases (among the 25 where an evaluation was possible) did the person performing the repairs do what was deemed an adequate job. The main reasons residents do not do an adequate job are two-fold:

- First, instead of performing each of the tasks called for on the Vehicle Emissions Report, most residents simply perform one or two tasks such as adjusting the air fuel mixture or replacing the air cleaner.
- Second, very few residents have the necessary equipment and tools to conduct the necessary repairs.

TABLE 13: TEST FAILURE EXPERIENCE

	N	%
Failed Initial Test	297	100.0
Performed Tune-up, Etc. Prior To Re-test	270	90.9
Repair Work Performed By		
Auto repair shop	209	70.4
Self	31	10.4
Family member/Friend	30	10.1
Demographics Of Persons Who Performed Repair Work Themselves		
Male	26	8.7
Female	5	1.7
Under 35	22	7.4
35 to 54	8	2.7
55 or over	1	.3
Reasons For Failure		
High HC only	8	2.7
High CO only	8	2.7
High HC & CO	6	2.0
Unknown	9	3.0
Evaluation Of Work Performed		
Correct	3	1.0
Incorrect	22	7.4
Insufficient information	6	2.0

3.5 Program Circumvention

Fifteen percent of metropolitan area residents indicate that even though their engine can be adjusted to pass the emissions test, it does not run as well as it should when so adjusted. Further, eight percent of all the residents surveyed say they re-adjusted their vehicle's engine after their last emissions test so that it would run the way they like it to. Each of these figures is lower than the comparable figures which were recorded in 1982.

Those residents most likely to re-adjust their vehicle's engine after it passes the test are those who own 1975-1980 vehicles, middle-aged drivers, Phoenix residents, and individuals who flunked the emissions test on the first go-around.

TABLE 14: CIRCUMVENTION PATTERNS

A

"Some people have told us that although their vehicle engine can be adjusted so that it will pass the emissions test, it really doesn't run as well as it should. Was this true in the case of your vehicle?"

B

"Did you have to re-adjust the engine on this vehicle after the test so that it would run the way you like it to run?" (Asked of Persons Who Answered "Yes" to Previous Question)

		A	B
Total:	1988	15%	8%
	1982	22	11
Model Year			
1967 - 1974		16	12
1975 - 1980		27	16
1981 - 1988		8	4
Initial Test			
Passed		9	4
Failed		38	26
Age			
Under 35		18	8
35 to 54		20	13
55 or over		5	3
Area			
Phoenix		16	10
Tucson		12	5

Residents who had post-test adjustments made on their vehicles were next asked to indicate who performed the work. As may be seen on the next table, such work was generally performed by a repair shop (67%) with only 22 percent of residents performing the work themselves. The current reading

for self-adjustment is 22 percent below the comparable reading in 1982 -- presumably due to the technical nature of today's engines.

TABLE 15: CIRCUMVENTION WORK PERFORMED

"Who performed this work, an auto repair shop, you personally, someone else in your household, or a friend?" (Asked of Persons Who Answered "Yes" to Previous Question)

	Repair Shop	Self	Family Member/ Friend
Total: 1988	67%	22%	11%
1982	46	42	10
Model Year			
1967 - 1974	50	39	11
1975 - 1980	74	9	17
1981 - 1988	68	32	0
Initial Test			
Passed	75	25	0
Failed	62	20	18
Age			
Under 35	46	41	13
35 to 54	77	12	11
55 or over	92	0	8
Area			
Phoenix	69	20	11
Tucson	56	31	13
As % of Total Sample	5	2	1

Finally, the most common post-test engine adjustments made by residents who perform the work themselves are carburetor and timing adjustments.

TABLE 16: CIRCUMVENTION STEPS TAKEN

"What repairs or adjustments did you perform on the vehicle to make it run the way you like it to run?" (Asked of Persons Who Did Work Themselves)

	Total	1967-1974	1975-1980	1981-1988
Adjusted/Cleaner carburetor (NFI)	63%	60%	84%	60%
Adjusted idle speed	11	10	16	0
Set air fuel mixture	7	20	0	0
Checked/Replaced choke	4	10	0	0
Set dwell/timing	26	20	16	40
Checked/Replaced air cleaner	4	10	0	0
Adjusted/Replaced spark plugs	4	0	0	10
Replaced fuel filter	4	0	0	10
Tuned up vehicle (NFI)	4	10	0	0

4.0 SUMMARY OF THE FINDINGS - AUTO MECHANICS SURVEY

4.1 Quality of Work Performed

Auto mechanics were asked a series of questions to determine their ability to diagnose and correct vehicles that flunked the emissions test because of high HC and high CO readings. The specific questions asked were as follows:

High HC

"Okay, now I'd like to ask you a few questions about how you would go about diagnosing a vehicle that flunked the state's vehicle emissions test. For the purpose of this question, let's assume that the vehicle in question is an eight cylinder, 1978 Chevrolet Camaro. Let's further assume that this vehicle flunked the test because it registered high HC values at all speeds."

"First, what do you believe is the single most likely cause for this vehicle registering high HC values at all speeds?"

"What is the single most likely procedure you would perform to correct this problem so that the vehicle would pass the emissions test?" **(IF PERSON SAYS SCOPE/ OSCILLOSCOPE, ASK IF THEY WOULD USE ONLY THE SCOPE OR THE ENTIRE PIECE OF EQUIPMENT WHICH IT IS PART OF. IF PERSON SAYS ANALYSER, ASK THEM WHAT TYPE.)**

"And what is the single most important piece of automotive test equipment you would use in performing this work? That is, other than your normal screwdrivers and wrenches?" **(IF PERSON SAYS SCOPE/ OSCILLOSCOPE, ASK IF THEY WOULD USE ONLY THE SCOPE OR THE ENTIRE PIECE OF EQUIPMENT WHICH IT IS PART OF. IF PERSON SAYS ANALYSER, ASK THEM WHAT TYPE.)**

High CO

"Okay, now let's assume that this same eight cylinder, 1978 Chevrolet Camaro flunked the test because it registered high CO values at idle only. What do you believe is the single most likely cause for this vehicle registering high CO values at idle only?"

"What is the single most likely procedure you would perform to correct this problem so that the vehicle would pass the emissions test?" **(IF PERSON SAYS SCOPE/ OSCILLOSCOPE, ASK IF THEY WOULD USE ONLY THE SCOPE OR THE ENTIRE PIECE OF EQUIPMENT WHICH IT IS PART OF. IF PERSON SAYS ANALYSER, ASK THEM WHAT TYPE.)**

"And what is the single most important piece of automotive test equipment you would use in performing this work? That is, other than your normal screwdrivers and wrenches?" **(IF PERSON SAYS SCOPE/ OSCILLOSCOPE, ASK IF THEY WOULD USE ONLY THE SCOPE OR THE ENTIRE PIECE OF EQUIPMENT WHICH IT IS PART OF. IF PERSON SAYS ANALYSER, ASK THEM WHAT TYPE.)**

Tables 17 through 20 present the results of the above line of questionning. The following patterns are evident in the tables:

- A majority of mechanics score fairly well in terms of the manner in which they address high HC emissions problems. Thus, we find roughly seven out of ten mechanics receiving passing evaluations when it comes to diagnosis (67%), corrective action (71%) and equipment utilization (69%). From an overall perspective, 60 percent of all mechanics receive passing grades from ADEQ in their handling of high HC emissions problems.
- Specialized tune-up shops such as Tune-Up Masters and Econo Lube N' Tune, receive the highest overall evaluation (75%) among the four types of automotive facilities tested. Gas stations receive the poorest grades with an overall evaluation of only 49 percent.
- While mechanics do a fairly good job of handling high HC emissions problems they fail miserably in their handling of high CO problems. The reason for this is very clear -- improper equipment utilization. Thus, we find that while mechanics know for the most part how to

diagnose high CO problems (74% correct) and what corrective actions to follow (63%), only about eight percent utilize the proper equipment when dealing with such problems.

- Once again we find mechanics from specialized tune-up shops scoring well above other types of mechanics. Nonetheless, only 29 percent of mechanics for specialized tune-up shops appear able to properly handle high CO emissions problems.

TABLE 17: HC EVALUATION

	Diagnosis	Corrective Action	Equipment Utilization	Overall Evaluation
Definitely correct	35%	48%	51%	31%
Generally correct	32	23	18	29
Generally wrong	17	13	17	23
Definitely wrong	16	16	14	17
	100%	100%	100%	100%
% Insufficient information to evaluate	5%	7%	3%	5%

TABLE 18: HC EVALUATION - DETAIL

(% Answering Correctly)

	Diagnosis	Corrective Action	Equipment Utilization	Overall Evaluation
Total	67%	71%	69%	60%
Facility Type				
Special tune-up	78	83	76	75
Franchised maintenance	56	67	86	61
Independent maintenance	74	75	62	64
Gas station	58	63	63	49
Respondent Type				
Mechanic only	59	69	68	61
Manager only	47	47	75	50
Both	71	75	68	62
Years in Industry				
5 or less	66	62	67	59
6 to 15	70	72	76	66
Over 15	64	74	62	55
State Emissions Training				
Yes	71	72	69	63
No	61	70	69	57

TABLE 19: CO EVALUATION

	Diagnosis	Corrective Action	Equipment Utilization	Overall Evaluation
Definitely correct	60%	48%	6%	5%
Generally correct	14	15	2	3
Generally wrong	11	11	8	9
Definitely wrong	15	26	84	83
	100%	100%	100%	100%
% Insufficient information to evaluate	9%	3%	6%	4%

TABLE 20: CO EVALUATION - DETAIL

(% Answering Correctly)

	Diagnosis	Corrective Action	Equipment Utilization	Overall Evaluation
Total	74%	63%	8%	8%
Facility Type				
Special tune-up	86	81	30	29
Franchised maintenance	70	52	3	3
Independent maintenance	76	65	5	6
Gas station	70	57	3	2
Respondent Type				
Mechanic only	78	54	3	0
Manager only	55	50	6	5
Both	77	67	10	10
Years in Industry				
5 or less	77	76	21	21
6 to 15	70	61	6	5
Over 15	79	60	2	6
State Emissions Training				
Yes	78	67	12	9
No	69	56	3	2

Mechanics were also asked one question to try and get some feel for their knowledge regarding the new generation of computerized vehicles. A complete analysis of mechanics' knowledge on the subject was not attempted in the study due to the extreme number of variables faced when addressing the issue.

Mechanics score quite well when asked to indicate the type of equipment they use to check the oxygen sensors on computerized vehicles with 87 percent responding correctly

to the inquiry. Again, mechanics at specialized tune-up facilities receive the highest evaluations.

TABLE 21: COMPUTERIZED VEHICLE EVALUATION

"Now I'd like to ask you a question about the new generation of computerized vehicles which have been on the market since the early eighties. What equipment do you use to check the oxygen sensors for proper operation on these types of vehicles? (PROBE) What else?"

Definitely correct	81%
Generally correct	6
Generally wrong	3
Definitely wrong	10
% Insufficient information to evaluate/Not applicable	25%

TABLE 22: COMPUTERIZED VEHICLE EVALUATION - DETAIL

(% Answering Correctly)

Total	87%
Facility Type	
Special tune-up	97
Franchised maintenance	75
Independent maintenance	83
Gas station	88
Respondent Type	
Mechanic only	86
Manager only	83
Both	87
Years in Industry	
5 or less	96
6 to 15	89
Over 15	81
State Emissions Training	
Yes	88
No	85

4.2 Program Circumvention

According to auto mechanics, circumvention of the emissions testing program is very commonplace among vehicle owners in the non-attainment areas. Consider for a moment the following:

- Ninety-three percent of all mechanics indicate they have been asked by customers to simply adjust their vehicle to pass the emission test, rather than conduct the appropriate and needed emissions-related maintenance and repairs. (TABLE 23)

  Eight-eight percent say such requests by customers are either very or somewhat commonplace in the industry. (TABLE 24)

- Ninety-four percent of all mechanics also indicate that they have been asked by customers to re-adjust their vehicles after it has passed the emissions test so that it will run better. (TABLE 25)

  Seventy-eight percent say such requests by customers are either very or somewhat commonplace in the industry. (TABLE 26)

It is clear from this data that a significant segment of the driving public attempts to circumvent the emissions testing program.

TABLE 23: PRE-TEST CIRCUMVENTION

"Next, as we have been talking to auto maintenance professionals they have mentioned that sometimes customers ask them to simply adjust their vehicles to pass the emissions test, rather than conduct the appropriate and needed emissions-related maintenance and repairs. Has this ever happened to you?"

	% Answering "Yes"
Total	93%
Facility Type	
Specialized tune-up	94
Franchised maintenance	94
Independent maintenance	91
Gas station	94

TABLE 24: PRE-TEST CIRCUMVENTION FREQUENCY

"Would you say it is very common, somewhat common, somewhat uncommon or very uncommon for customers to ask mechanics to do this?"

	Very Common	Somewhat Common	Somewhat Uncommon	Very Uncommon	Not Sure
Total	59%	29%	4%	6%	2%
Facility Type					
Specialized tune-up	67	24	6	3	0
Franchised maintenance	54	40	3	3	0
Independent maintenance	60	29	2	7	2
Gas station	57	26	6	6	5

TABLE 25: POST-TEST CIRCUMVENTION

"Some auto maintenance professionals have also told us that customers sometimes ask them to re-adjust their vehicle after it has passed the emissions test so that it will run better. Has this ever happened to you?"

	% Answering "Yes"
Total	94%
Facility Type	
Specialized tune-up	97
Franchised maintenance	89
Independent maintenance	96
Gas station	92

TABLE 26: POST-TEST CIRCUMVENTION FREQUENCY

"Would you say it is very common, somewhat common, somewhat uncommon or very uncommon for customers to ask mechanics to do this?"

	Very Common	Some-what Common	Some-what Uncommon	Very Un-common	Not Sure
Total	47%	31%	14%	6%	2%
Facility Type					
Specialized tune-up	46	48	6	0	0
Franchised maintenance	54	17	17	12	0
Independent maintenance	56	30	10	4	0
Gas station	35	32	20	8	5

4.3 The Impact of Proper Emissions Tuning on Vehicle Performance

A majority of auto mechanics (52%) believe that if a vehicle is adjusted to pass the emissions test that such adjustments will have a positive effect on the performance of the vehicle. In comparison, only 18 percent believe it would have a negative effect on performance while 12 percent believe it would not have any effect.

TABLE 27: IMPACT OF PROPER EMISSIONS TUNING ON VEHICLE PERFORMANCE

"As far as you're concerned, if a vehicle is adjusted to pass the emissions test, what effect will this have on the performance of the vehicle -- a positive effect, a negative effect or no effect at all?"

	Positive	Negative	None	Not Sure
Total	52%	18%	12%	18%
Facility Type				
Specialized tune-up	52	15	21	12
Franchised maintenance	51	26	6	17
Independent maintenance	53	19	6	22
Gas station	52	14	17	17
State Emissions Training				
Yes	57	17	13	13
No	46	19	11	24

4.4 Impact Of Emission Program On Air Quality In Arizona

Better than eight out of ten auto mechanics (83%) feel the vehicle emissions testing program has helped keep the air clean in the Phoenix and Tucson areas. Forty-nine percent feel the program has helped "a lot" and 38 percent believe it has helped "a little." This 49 percent "a lot" reading is more than double the 22 percent "a lot" reading recorded in the general public segment of this study.

TABLE 28: IMPACT OF EMISSION PROGRAM ON AIR QUALITY IN ARIZONA

"To begin, do you think the vehicle emissions testing program has done a lot, a little, or nothing at all to reduce air pollution in your area?"

	A Lot	A Little	Noth-ing	Not Sure
Total	45%	38%	13%	4%
Facility Type				
Specialized tune-up	49	39	6	6
Franchised maintenance	40	51	9	0
Independent maintenance	37	41	19	3
Gas station	54	28	14	4

5.0 APPENDIX

5.1 Methodology - General Public Survey

The information contained in the General Public segment of this study is based on 899 in-depth telephone interviews conducted with 707 non-attainment area residents (metro Phoenix and Tucson) and 192 attainment area residents (Yuma). The non-attainment area sample was designed so that individuals who failed the emissions test were greatly over-sampled. This was undertaken in order to increase the accuracy of the data collected on residents who fail the test.

SAMPLE PROFILE

Total Sample	899
Non-Attainment area	707
Passed test	402
* Flunked test	297
No test	8
Attainment area	192

* In a normal sample of 700 non-attainment area residents, approximately 140 drivers whose vehicle flunked the test (20%) would have fallen into the sample -- a figure deemed too small for meaningful analysis.

The questionnaires used in this study were designed by BRC in conjunction with the AG's Office and ADEQ (see appended questionnaires). After approval of the preliminary draft questionnaires they were pre-tested with a randomly

selected cross-section of 15 residents. The pre-test focused on the value and understandability of the questions, adequacy of response categories, questions for which probes were necessary, and the like. Several minor changes were made following the pre-test, and the final form received management team approval.

Household selection on this project was accomplished via a computer-generated random digit dial telephone sample which selects households on the basis of telephone prefix. This method was used because it ensures a randomly selected sample of area households proportionately allocated throughout the sample universe. This method also insures that all unlisted and newly listed telephone households are included in the sample.

During the course of this study, only the household member with the primary responsibility for vehicle maintenance was interviewed. This selection process was imposed because prior studies of this nature have shown that these are the individuals within each household that have the knowledge and background to respond to the topics under consideration.

All of the interviewing on this project was conducted during October, 1988, at BRC's central location telephone facility in Phoenix where each interviewer worked under the

direct supervision of BRC staff personnel. All of the interviewers who worked on this project are professional interviewers and received a thorough briefing on the particulars of the study. During the briefing, the interviewers were trained on (a) the purpose of the study, (b) sampling procedures, (c) administration of the questionnaire, and (d) other project-related items. In addition, each interviewer completed a set of practice interviews to assure that all procedures were understood and followed.

During the interviewing segment of this study, up to three separate attempts were made, on different days and during different times of day, to contact each selected respondent. Only after three unsuccessful attempts was a selected household substituted in the sample. Using this methodology, the full sample was completed, and partially completed interviews were not accepted nor counted toward fulfillment of the total sample quotas.

One hundred percent of the completed interviews were edited, and any containing administration errors were pulled, the respondent recalled and the errors corrected. In addition, 15 percent of each interviewer's work was randomly selected for validation to ensure its authenticity and correctness. No problems were encountered during this phase of interviewing quality control.

As the data collection segment of this study was being undertaken, completed and validated interviews were turned over to BRC's in-house coding department. The coding department edited, validated and coded the interviews. Each interview that received final coding department approval was then transferred to keypunching where each was 100 percent key verified. Following completion of keypunching, a series of validity and logic checks were run on the data to insure it was "clean" and representative of the sample universe. In addition to the above coding procedures, 31 of the interviews conducted with residents who failed the test and completed the repairs themselves were sent to ADEQ where they were evaluated in terms of the quality of work performed.

When analyzing the results of this survey, it should be kept in mind that all surveys are subject to sampling error. Sampling error, stated simply, is the difference between results obtained from a sample, and those which would be obtained by surveying the entire population under consideration. The size of sampling error varies, to some extent, with the number of interviews completed and with the division of opinion on a particular question.

An estimate of the sampling error range for this study is provided in the following table. The sample error presented in the table has been calculated at the confidence level most frequently used by social scientists, the 95 per-

cent level. The sampling error figures shown in the table are average figures that represent the maximum error for the sample bases shown (i.e., for the survey findings where the division of opinion is approximately 50%/50%). Survey findings that show a more one-sided distribution of opinion, such as 70%/30% or 90%/10%, are usually subject to slightly lower sampling tolerances than those shown in the table.

As may be seen in the table, the overall sampling error for this study is approximately +/- 3.3 percent, when the sample is studied in total (i.e., all 899 cases). However, when sub-sets of the total sample are studied, the amount of sampling error increases based on the sample size within the sub-set.

Sample Size	Approximate Sampling Error At A 95% Confidence Level (Plus/Minus Percentage Of Sampling Tolerance)
900	3.3%
800	3.5
600	4.1
400	5.0
200	7.1

5.2 Methodology - Auto Mechanic Survey

The information contained in the Auto Mechanics segment of this study is based on 201 in-depth telephone interviews conducted with 151 metropolitan Phoenix and 50 metropolitan Tucson auto mechanics and repair shop managers.

The sample used in this study was judgemental in nature and designed to represent the various types of facilities providing maintenance to older motor vehicles.

Facility Type	Number of Interviews
o Specialized tune-up facilities (Tune-up Masters, Econo Lube N' Tune, etc.)	33
o Franchised maintenance and repair centers (Firestone, Goodyear, etc.)	35
o Independent maintenance and repair shops	68
o Gas stations	65

The sample was developed using the latest edition of Data Source, a business cross-reference directory.

The questionnaire used in this study was designed by BRC in conjunction with the AG's Office and ADEQ (see appended questionnaire). After approval of the preliminary draft questionnaire it was pre-tested with a randomly selected cross-section of 12 auto mechanics and repair shop managers. The pre-test focused on the value and understand-

ability of the questions, adequacy of response categories, questions for which probes were necessary, and the like. Several minor changes were made following the pre-test, and the final form received management team approval.

All of the interviewing on this project was conducted during late October, 1988, at BRC's central location telephone facility in Phoenix where each interviewer worked under direct supervision of BRC staff personnel.

After the interviewing was completed on the project, the questionnaires were turned over to the ADEQ where each mechanic was evaluated in terms of their ability to address emissions-related problems (Questions 2 through 4).