ABSTRACTS OF I/M TECHNICAL REPORTS AND POLICY

March 1991

NOTICE

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U.S. Environmental Protection Agency
Office of Air, Noise and Radiation
Office of Mobile Sources
Emission Control Technology Division
Technical Support Staff
2565 Plymouth Road
Ann Arbor, Michigan 48105
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INTRODUCTION

The purpose of this document is to provide readers with an easy to use reference to major I/M program technical reports and policy memoranda. Abstracts of technical reports are provided for most of the documents listed. Descriptions are given for technical reports that do not lend themselves to abstracting. For policy memoranda, descriptions of the policy issues discussed are provided.

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2565 Plymouth Road
Ann Arbor, Michigan 48105
(313) 668-4367
I/M EFFECTIVENESS
(see also Air Quality)

Exhaust and Evaporative Emissions of High Mileage Taxicabs
and Passenger Cars. Technical Support Staff,

The report gives the results of exhaust and evaporative
emissions tests. Southwest Research Institute performed on 27
vehicles. Test cars were selected randomly from a
registration list of all 1981 passenger cars in Bexar County,
Texas (which includes the greater San Antonio area and some
surrounding suburban and rural areas). Seven of the 27 cars
underwent restorative maintenance after baseline testing
(replaced canister or gas cap) and evaporative emissions were
measured again after maintenance. The results of the tests
are summarized in the report.

Exhaust and Evaporative Emissions of High Mileage Passenger
Cars. C.A. Harvey, and B. Michael. EPA-AA-TSS-PA-85-1,
Feb 1985.

Prepared in cooperation with Southwest Research Inst., San
Antonio, TX

This report gives the results of exhaust and evaporative
emission tests. Southwest Research Institute performed on 27
motor vehicles. Test cars were selected randomly from a
registration list of all 1981 passenger cars in Bexar County,
Texas (which includes the greater San Antonio area and some
surrounding suburban and rural areas). Seven of the 27 cars
underwent restorative maintenance after baseline testing
(replaced canister or gas cap) and evaporative emissions were
measured again after maintenance.

Emission Effects of Inspection and Maintenance at Cold
Temperatures, T. Darlington, EPA-AA-IMS-81-24, PB 83 136 556,
revised October 1982.

This report discusses the potential effectiveness of
Inspection and Maintenance (I/M) programs at reducing CO
emissions from vehicles operated at cold temperatures. EPA
has extensively studied the effectiveness of I/M for reducing
emissions at 75°F, and has shown that I/M is capable of
reducing CO emissions on failed vehicles by about 50% at
75°F. At warm temperatures maladjustment of idle mixture is
the most common cause of high CO emissions. At colder
temperatures the operation of choke systems causes high CO
emissions. However, vehicles which have maladjusted idle
mixture may emit more CO in cold temperatures than vehicles
without maladjusted idle mixture. I/M would therefore be capable of producing some CO reductions from vehicles operated in cold temperatures. The results and conclusions in this report should be viewed as preliminary until the State of Alaska presents data on in-use vehicle testing.

Four vehicles were deliberately maladjusted and tuned up to simulate the effects of an I/M program on vehicles needing emission-related repairs. The results indicated that I/M has the potential for reducing CO emission from in-use vehicles operated at temperatures below 75°F. Specifically, for all test cycles used, reductions in CO emissions occurred when vehicles with maladjusted idle mixture and disconnected choke assists were tuned-up. This relationship did not necessarily occur with the repair of the disconnected heated air intake system, possibly because colder, denser air passes through the carburetor in this case, resulting in a leaner air fuel mixture and lower CO emissions.


This report describes the two phases of the Portland Study, a contractor-operated vehicle emission test program that was conducted in Portland, Oregon, over a five-year period beginning in 1977. The report includes information on the history of the program, the objectives of the various tasks that were completed, program design, and some of the problems encountered. It does not include any test results, which are abstracted elsewhere in this document.


This report presents an analysis of emission factor (EF) data directed towards the effects of the Phoenix, Arizona I/M program. Phoenix has been a site for EF testing for several years, both before and after the advent of its I/M program. Federal Test Procedure (FTP) data recorded from EF testing in Phoenix and several non-I/M cities provide an opportunity to evaluate the effectiveness of the I/M program in reducing emission from in-use light duty vehicles. Statistical evaluation of the data indicates a significant reduction in both HC and CO emissions due to I/M in Phoenix as compared with non-I/M cities.


This study was designed to determine whether simple
carburetor adjustments, that ignore manufacturer specifications and rely on idle CO readings on an emission analyzer, are effective. Further considerations included whether a universal target idle CO level could be used, and what additional repairs are necessary to pass the I/M test. 83% (29 out of 35) of the 1976/78 cars from Vancouver, Washington, that received simple carburetor adjustments to a universal idle CO target level of 0.2%, were able to pass the Oregon emission inspection. Average FTP HC emissions of all vehicles were reduced 40% and FTP CO emissions were reduced 58%. Additional maintenance performed on the six failing vehicles increased the average reduction for the 35 vehicles to 47% for HC and 71% for CO. Average city fuel economy improved 2.5% while highway fuel economy was reduced 0.4%. Fuel economy improvements in failed vehicles alone were 3.2% city and 7.5% highway after the simple carburetor adjustment. Additional maintenance brought average fuel economy improvements up to 8.3% and 9.2%, respectively. In conclusion, the study results indicate that the average reductions in FTP HC and CO emissions from specific idle CO adjustments can be as large as idle adjustments using manufacturer specifications. Substantial emission reductions were achieved by using a simple carburetor adjustment to a universal idle CO target.


This report presents findings from a comparison of similar cars in Portland, Oregon and Vancouver, Washington. The purpose of this study was to compare the emissions from vehicles subject to the I/M program with emissions from non-I/M vehicles. A group of 100 1976-1978 model year vehicles of similar vehicle type and odometer readings were tested, using the FTP, from each of the two cities.

For the 1976 model year, Portland I/M vehicles had FTP HC emissions 27% lower and CO emissions 22% lower than the non-I/M vehicles. The results for both I/M and non I/M cities agree closely with predictions from MOBILE2. The 1978 model year vehicles in Vancouver were unexpectedly and unexplainably clean (contrary to results from other testing), having emission levels near that of the Portland vehicles.


The cost-effectiveness of an inspection and maintenance program for a typical urban area over a five-year period (1983-1987) would be $581/ton for HC and $53/ton for CO (in
1981 dollars). The cost-effectiveness of I/M compares favorably with that of stationary source control measures, traffic controls, and transit improvements.


The tables in this report were compiled from data selected from the computer data records from several testing programs. Except in the Portland Study NOx Analysis Tables, only vehicles which received at least one repair and retest sequence were selected from the testing programs for summary in this report. No effort was made to create a sample which would contain a specific mix of model years or vehicle types. Caution should be used in extrapolating any measured changes from this report to real world changes which might be observed in an in-use fleet.

Update on EPA's Study of Oregon Inspection/Maintenance Program

Analysis of Oregon's Inspection/Maintenance Program,

EPA conducted an extensive evaluation of the Portland, Oregon Inspection and Maintenance program. The Oregon inspection (idle) test identified 55% of all vehicles emitting above the federal carbon monoxide (CO) or hydrocarbon (HC) standards. This 55% accounted for 80% of the CO and HC emissions in excess of the federal standards. Maintenance performed by Portland area mechanics resulted in a 47% reduction in CO emissions and a 42% reduction in HC emissions. The average cost of maintenance was $22, with over half of the repairs costing less than $14. In a comparison with an area where inspections are not performed (Eugene, Oregon), average CO emissions for the Portland fleet were 36% lower than fleet emissions for Eugene during the year following maintenance. Hydrocarbon emissions were 20% lower.

Testing Support for Evaluation of Inspection/Maintenance Issues (Test Groups No. 9 & 10) H. Ashby 1980, PB 81 203 168; See also PB 81 123 499.

The intention of Test Group No. 9 was to evaluate exhaust emissions from vehicles in Portland, Oregon, which are subject to a state inspection and maintenance (I/M) program with those in Vancouver, Washington, which was not subject to I/M. Fifty 1976 and fifty 1978 model year vehicles were
recruited from Vancouver and tested. Matching vehicles were then recruited from Portland and tested. The intention of Test Group No. 10 was to evaluate the effect of specific maintenance tasks on emissions from vehicles which have high emission levels as determined by a state I/M program. Thirty-five vehicles from the Vancouver, Washington, area which failed the Oregon State Inspection Test as part of the testing required for Test Group No. 9 were selected for this group.
NEW TECHNOLOGY VEHICLES
(see also Emission Factors)


The report summarizes an effort to study new technology cars. The goal was to recruit and test approximately 100 late-model year cars which failed the Maryland Inspection and Maintenance (I/M) program. The goal was to determine the nature of in-use emission problems on 1981 and later vehicles which fail I/M short tests and the types of repairs needed to reduce their emission levels to near or below the new car standards.


The report presents the results of an emission testing program which was conducted for EPA in Washington, D.C., under contract. In the test program, 1980 and 1981 model year vehicles which failed the Inspection and Maintenance (I/M) test in Washington, D.C. were given two or three series of emissions tests. Each series included a Federal Test Procedure (FTP), a Highway Fuel Economy Test, and the following short tests: 50 mph cruise, four-mode idle, engine restart idle, and loaded two-mode. In June, 1984, EPA became aware of some quality control problems which were evident at the D.C. inspection stations. These problems may have caused some of the vehicles which were participating in the project to be inappropriately failed during the initial inspection or inappropriately passed during the reinspection. Analyses described in the report evaluate the decisions made by the inspection lane, and compare the effects of I/M on the whole group of cars with those of subgroups that have had suspect cases removed.

Fact Sheet: Inspection and Maintenance for "New Technology" Vehicles, FS-70, EPA-0MSAPC-45513

This fact sheet discusses issues dealing with I/M for new technology vehicles (i.e., 1981 and later model year vehicles) in a question and answer format. The report describes the differences between new technology and previous technology for emission control systems. The report also examines the emission control performance of new technology vehicles, the types of emissions-related maintenance problems common to these vehicles, and the applicability of I/M to these vehicles.

EEA's previous analysis of the Arizona I/M program (Analysis of Inspection/Maintenance Data from The Arizona Program, EEA, Inc., April 1983.) is updated with an additional 12 months (July 1982 through June 1983) of test data, and expanded to include 18 months (January 1982 through June 1983) of test data from the Seattle I/M program. The study spans five groups of late-model vehicles: 1980 GM LDV's, 1981 LDV's and LDT's, and 1982 LDV's and LDT's. The bulk of the report is devoted to extensive data tables and regression analyses of the performance of late model vehicles. The text contains a discussion of the development of the data base, and an investigation of failure rate trends at successive annual inspections and as a function of accumulated mileage. Among EEA's conclusions are, 1) that failure rates generally increase linearly with accumulated mileage, and 2) that vehicles which fail the initial test of one annual inspection have a substantially increased probability of failing subsequent inspections.


This report provides a detailed forecast of gasoline-fueled light-duty vehicle emission control systems for the years 1982-1990. The emission control technology mix is broken down in detail for each major manufacturer, as well as for the new car fleet as a whole. The report also discusses the emission control system malperformance strategies used by each manufacturer.


The purpose of this study is to better understand the performance of new emission control system designs under I/M. Data for over 16,000 1980 and 1981 cars inspected in the Arizona I/M program were analyzed to determine failure rates, repair types, and repair costs. The results show that the initial failure rate was about 1.0% for the 1980 vehicles and 2.5% for 1981 cars. The pass rate on the first retest is over 70% and moved up to 80-90% on subsequent retests. Repair cost data for these vehicles averaged around $38. The
most common repair reported was to the air fuel mixture and the idle speed. Dwell and timing adjustments were the next most prominent repair type.


This report presents the results of emission control system disablement testing of recent model year vehicles. Starting in 1981, Federal vehicles were designed to meet more stringent emission standards such that most employed computer controls utilizing exhaust emission feedback. This study was designed to test four vehicles equipped with throttle body fuel injection. The results showed that several types of disablements, such as sensor disconnections or EGR vacuum line disconnections, which might result from tampering, cause very high FTP emissions. HC emissions often were 10 times certification standards and CO emissions were 20 or more times greater. Short tests were able to identify about 95% of the excess FTP emissions.


This paper presents results from EPA testing of 1,328 randomly selected passenger cars from the 1980-1982 model years in-use in Los Angeles and other low altitude areas. The primary purpose was to examine emission characteristics of various control technologies, provide information for improvement of I/M programs, and identify potential failure areas in advanced emission control systems. Each vehicle was tested in "as received" condition using the 1975 Federal Test Procedure, the Highway Fuel Economy Test and several short cycle tests developed for use in I/M programs. In addition, underhood inspections of emission related components were conducted and certain vehicles were selected for maintenance (generally a major tune-up). These "restored" vehicles were then retested using the same sequence.

The results show that new technology vehicles are capable of maintaining very low emission levels but they may also have extremely high levels due to defects, deterioration and tampering. The results also show that the I/M short tests are effective for 1980 and later vehicles and that it is important to use I/M cutoffpoints of 220 ppm HC and 1.2% CO to achieve maximum benefit from I/M. Further, the results indicate that failure rates and error of commission rates will be lower among 1980 and later vehicles than pre-1980 vehicles. Firm conclusions regarding repair costs and I/M
cost-effectiveness are not possible. A reasonable upper limit for repair cost of 1980 and later vehicles is estimated at $105 per failed vehicle.


This report presents the derivation of the I/M emission reduction benefits for pre-1981 model year vehicles (non-California, low altitude) which were prepared for use in EPA's emission factors model, MOBILE2 (corrected version). Included is a discussion of the I/M credits for pre-1981 vehicles included in MOBILE2, a comparison of the credits used in MOBILE2 versus MOBILE1, a step-by-step analysis of the simulation model with formulate and parameters, and a listing of the Fortran IV source code for the program which produced the credits.


New technology vehicles are vulnerable to malmaintenance or parts failure and tampering, resulting in emissions grossly exceeding the design standards. Even though only a small percentage of vehicles experience failures, these few vehicles contribute the majority of the entire new technology fleet's CO emissions and a large share of the new technology fleet's HC emissions.

The fuel economy penalty for new technology vehicles operating in a full-rich mode (i.e., too much fuel being supplied to the engine in relation to the amount of air being supplied resulting from any of a variety of malfunctions) is quite large: approximately 15%. Therefore, individual failed vehicles will enjoy substantial fuel savings ($135 per year) subsequent to proper repair.


This report presents test results which were gathered to determine the suitability of existing I/M short tests on a Chevrolet car with a computer based emission control system. This car had a microprocessor based engine control system with a dual bed catalyst. After suitable baselines were established, various components were made inoperative in the emission control system. Complete FTP, HFET, and I/M tests were run for each vehicle condition. Also an on-board system
diagnostic check was performed for each configuration after the initial baselines. This report presents the measured data taken during the tests.


This report presents test results which were gathered to determine the suitability of existing I/M short tests on a Cadillac car with a computer based emission control system. This car had a microprocessor-based engine control system with throttle body fuel injection (TBI), modulated displacement and a dual bed catalyst. After suitable baselines were established, various components were made inoperative in the emission control system. Complete FTP, HFET, and I/M tests were run for each vehicle condition. Also, an on-board system diagnostic check was performed for each configuration. This report presents the measured data taken during the tests.


This report discusses the derivation of I/M benefits for the post-1980 Federal fleet as contained in EPA's emission factor model MOBILE2. As is widely recognized, the post-1980 model year fleet will be predominantly composed of vehicles which employ what has become known as three-way catalyst technology. This technology incorporates a sophisticated microprocessor-based engine control system which holds the air/fuel ratio very close to stoichiometry, thereby allowing the three-way catalyst to simultaneously convert hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) to harmless by-products. Such a significant shift in technology will have an impact on the expected in-use emissions performance of these vehicles both with and without an inspection and maintenance (I/M) program.


This report presents test results which were gathered to determine the suitability of existing I/M short tests on a Toyota car with a computer based emission control system. This car had a microprocessor based fuel injection system and a small light-off catalyst followed by a three-way catalyst.
After suitable baselines were established, various components were made inoperative in the emission control system. Complete FTP, HPET, and I/M tests were run for each vehicle condition. This report presents the measured data taken during the tests.


This report describes the methodology used in revising the emission factor equations for the post-1980 light duty vehicle fleet. It presents and discusses data on which the revisions are based, and outlines the pertinent assumptions used to make calculations. The report is only concerned with the non-I/M case for low altitude, non-California, gasoline-fueled, post-1980 model year light duty vehicles.


This paper presents the results of an exhaust emission testing program conducted by EPA in which 686 1978-1979 passenger cars of various makes and models were tested. Each vehicle tested was equipped with a three-way catalyst system and was certified to California standards. The purpose of the program was to gather information on the ability of the three-way system to meet emission standards in the future. The results indicate the these systems are capable of achieving low emission levels, although high levels are possible due to defects, deterioration, or tampering.


The majority of vehicles on the road today exceed their design emission standards. This failure to achieve design emission levels is primarily attributed to improper maintenance, tampering with emission controls, and misfueling catalyst cars with leaded gasoline. A method of reducing improper maintenance, tampering, and misfueling is periodic emission inspection and maintenance (I/M) programs.

This report discusses I/M's ability to deal with in-use emission problems and contrasts I/M to other mobile source emission control strategies. The results of EPA's Portland, Oregon, I/M program are presented. This study shows I/M to be effective in reducing emission levels.
A question remains, however, about how I/M will work as an emission control strategy for the generation of electronically controlled, 3-way catalysts vehicles that will be introduced nationwide in 1981. Data on California models and several 1981 control systems show that failures of these new systems, or failure to replace the vehicle's oxygen sensor, can result in extremely high emission levels. The potential for the high emission levels to occur in-use are discussed, and preliminary data on the various short tests' ability to detect high emitting vehicles is presented.

Questions and Answers Concerning the Technical Details of Inspection and Maintenance, IMS 002/QA-1, PB 301 215, April 1979.

This report discusses the costs and benefits, implementation issues, and policy matters related to the I/M program. It addresses, in a question and answer format, air quality benefits and emission reductions (FTP, failure rates, Appendix N, ambient effects, and other factors). It looks at fuel economy, maintenance costs, and vehicle/engine life. A discussion of loaded and idle tests, and heavy duty I/M are included. Repair costs and the factors that affect it are reviewed, as well as the cost effectiveness of the program. Various other issues are discussed including mechanic training, catalytic converters, fuel switching, new technology vehicles, and warranty regulations. Finally, a brief overview of I/M program implementation is provided.

This report presents information to help states include a tire inflation check in their existing and planned motor vehicle safety or emissions inspection programs. It has been estimated that as much as 515 million gallons of gasoline are wasted in the U.S. each year due to improper tire inflation. Tire inflation, if added to an inspection program would help motorists increase vehicle fuel economy, reduce tire wear, and improve safety. States adding tire inflation to inspection programs would thereby increase the cost-effectiveness of their programs. This report explores the options available in implementing a tire inflation check. It estimates fuel economy benefits and dollar savings from various scenarios. Dollar savings from reduced tire wear and fuel savings are estimated for vehicle owners. It estimates the cost of adding the tire inflation check to an inspection program. A step-by-step methodology is provided to aid program planners in determining the potential cost impact of the program and the fuel economy and treadwear benefits of the program.


The average annual fuel savings per inspected vehicle in the basic I/M program is 0.3% or an annual savings of $3. With optional elements added to the basic program (a more effective test - either a Two Speed Idle Test or the Loaded Test - for 1981 and later vehicles, a mechanics training program, and a tire pressure check), annual fuel savings would increase to as much as $23 per inspected vehicle per year, a 2.5% fuel savings. The savings from the optional program can completely offset the costs of I/M. The nationwide annual fuel savings from I/M would be 83.6 million gallons in the basic program and 701.4 million gallons in the optimum program.
The primary goal of inspection and maintenance (I/M) programs is to improve air quality by reducing emissions from motor vehicles. Many studies have indicated that I/M programs will achieve this goal. In addition several studies have indicated that fuel economy improvement can be expected to occur as a result of maintenance performed on vehicles failing an I/M test. Most studies which have been performed have looked at pre-1975 model year vehicles and have had expert mechanics performing the maintenance work. It is the intention of this report to consider both the results from past studies and the results from more recent studies in order to provide EPA's best estimates of fuel economy benefit which can be attributed to I/M maintenance.
AIR QUALITY
(see also I/M Effectiveness)


The report is designed to be a compilation of available information on emission levels of potentially carcinogenic substances from motor vehicles. While earlier EPA reports discuss air toxics emissions in general, their main emphasis was not mobile sources.


This study evaluated monthly, daily and hourly ambient carbon monoxide (CO) averages for the years 1970 - 1979 from four Portland, Oregon monitoring sites (where I/M is operating) and one Eugene, Oregon site (where there is no I/M). This data was statistically compared to changes in traffic volume, meteorology and the long term effects of the Federal vehicle emission standards.

The results of these analyses indicate that significant reductions in carbon monoxide (CO) air quality levels can be attributed to the biennial I/M program in Portland. In the years when most Portland vehicles received their inspections (1976 and 1978), ambient CO concentrations were 8% to 15% lower than they would have been without the I/M program. Based on this finding, EPA has calculated that the ambient CO improvement due to an annual I/M program that inspected every subject vehicle each year would have been 10% to 19%.

Natural Sources of Ozone: Their Origin and Their Effect on Air Quality, EPA-AA-IMS-AQ-80-2, March 1980.

There are two main natural sources of ozone: 1) the stratosphere, and 2) biogenic hydrocarbons (from plants) which react in sunlight with nitrogen oxides to form ozone. On the average, natural sources of ozone contribute about 0.02 to 0.05 parts per million to the ambient background level. The National Ambient Air Quality Standard for ozone is a one-hour standard of 0.12 ppm. Man-made sources contribute most of the ozone in urban areas where the standard is being exceeded.
From 1971 to 1977, carbon monoxide levels monitored at seven stations in New Jersey decreased significantly. The average reduction is approximately 28%. This reduction is attributed to the progressively stringent federal emission standards, to state programs such as the car inspection and maintenance, and to the oil and energy crisis. The above conclusions are not significantly altered when meteorological variables are factored into the model.
SHORT EMISSION TESTS AND STANDARDS  
(see also Instrument Specifications)


This report describes in detail new test procedures designed to minimize test variability, and the resulting false failures of new technology vehicles. There are currently six promulgated test procedures. The new procedures differ from the current ones in that they include controlled pre-conditioning, second chance testing, and sampling and score selecting algorithms. These are intended to minimize the variability in testing conditions and thereby reduce false failures of clean vehicles. High emitting vehicles which have been escaping detection with the current test procedures will continue to do so under the new ones. It is EPA's hope that these new procedures will improve the possibility of using more stringent cutpoints and non-idle test modes in the future to detect these high emitters by eliminating the additional false failures that would otherwise occur by instituting such measures under current procedures.


This appendix provides technical background information on the proposed Engine Restart Idle Test and the Engine Restart 2500/Idle Test. It includes an in-depth discussion of the 1980 and 1981 Ford technologies of concern. It discusses the possible failures of these vehicles as a result of excessive idling. It provides the rationale for the proposed tests.


This report is a supplement to EPA-AA-IMS-81-1, "Recommendations Regarding the Selection of Idle Emission Inspection Cutpoints for Inspection and Maintenance Programs". The original report described methods for selecting HC and CO cutpoints given an idle emission data base and recommended specific HC and CO cutpoints by model year groupings for desired program failure rates. The recommended cutpoints in the original report were intended for use in I/M programs in areas which require only HC, or both HC and CO, emission
reductions in order to attain the National Ambient Air Quality Standards. This report is intended to aid I/M programs, which require only CO emission reduction, in the selection of cutoffpoints, prediction of failure rates, and estimation of I/M emission benefits.


This report addresses idle hydrocarbon (HC) and carbon monoxide (CO) cutoffpoints and expected resulting failure rates in an I/M program. Recommended cutoffpoints are included for various failure rates both in the first year of an I/M program and in its second year. The analysis applies to both centralized and decentralized programs.


This report presents testing results which were gathered to investigate the suitability of using the INCOLL procedure as an emissions inspection and maintenance (I/M) testing procedure compared to existing I/M testing procedures. The INCOLL procedure utilizes engine and transmission inertial forces to produce pressures and temperatures in the engine that will generate significant quantities of exhaust emissions. The existing I/M test procedures utilize steady state engine operating modes to produce significant quantities of exhaust emissions. The test sequence consisted of FTP, INCOLL, LA-4 and I/M cycles. The test sequence was applied to six vehicles in various states of tune.


This action establishes emission performance warranty "short tests" as provided in Section 207(b) of the Clean Air Act, 42 U.S.C. 7541(b). These short tests and corresponding warranty regulations [proposed April 20, 1979; 44 FR 23784] will be used in conjunction with I/M programs. Under certain circumstances, a vehicle owner will be entitled to repairs at the manufacturer's expense if the vehicle exceeds short test standards. This action promulgates three test procedures: an idle test, a two speed idle test and a two-mode loaded test for 1981 and later model year light duty vehicles and light duty trucks and 1982 and later model year vehicles at high altitudes. For each test, uniform standards apply to all
vehicles: 1.0% CO and 200 ppm HC (hexane) for the two speed idle test, 1.2% CO and 220 ppm HC for the idle and loaded-mode procedures. The regulations provide manufacturers the option of requesting alternate standards and procedures if the general provisions are not appropriate because of special designs, unique technology and other similar factors.


Propane gain values have been collected from 292 Portland Element III (1975-77 model year) vehicles along with as-received FTP and idle test emission measurements. This data is used here to compare the expected failure rate, errors of commission, and the amount of FTP excess emissions identified if one of two sets of idle values or one of four propane gain values had been used as a cutoff to screen the vehicles in the sample with high emissions.


This report is an analysis of the effectiveness of I/M type "short tests" in identifying grossly emitting vehicles. This report examines the question for two vehicles equipped with the technology to be introduced nationwide in 1981. This technology incorporates a high degree of engine control through the use of sensors, actuators, and an on-board computer, and allows the simultaneous conversion of HC, CO, and NOx in a three-way catalyst. In a testing program performed in-house, a 1980 Chevrolet Citation and a 1979 Dodge Aspen were selectively disabled to simulate possible in-use vehicle conditions. A wide range of testing was performed at each condition including FTP testing and I/M short tests. In this report, the FTP results are compared to the results of two I/M tests to examine their effectiveness in identifying vehicles with gross FTP emissions. Each vehicle is first discussed separately and then an overall comparison is given. Full data sets for the two vehicles may be obtained from the reports referenced at the end of the report.
This report addresses the relationship between short test emission results and emissions measured by the Federal Test Procedure (FTP) for 1981 and later model year light duty vehicles and light duty trucks. As provided in section 207(b) of the Clean Air Act, EPA must establish an Emission Performance Warranty if a short test can be developed which is: 1) available, 2) in accordance with good engineering practice, and 3) reasonably capable of being correlated with the Federal certification test, FTP. This report recommends three short tests that meet the above criteria: idle, two speed idle and two mode loaded. The test procedures, necessary equipment and short test standards are all described in this report.
I/M Test Variability Observed in the Louisville I/M Program, Landman, EPA-AA-TSS-I/M-90-7, August 1990.

EPA conducted this test program on 271 1981-1988 model year vehicles, that had failed the Louisville, Kentucky I/M program, to determine the effect of an immediate second chance test. The second chance tests were of two types; an immediate retest and a similar test with a three minute 2500 rpm, no load pre-conditioning cycle. The results showed that the pre-conditioning cycle did very little to change the pass/fail rate compared to an immediate retest. However, the pre-conditioning cycle did have a significant effect on reducing the failure rate of vehicles that exceeded only the hydrocarbon standard.

Variability of I/M Test Scores Over Time, Southwest Research Institute, EPA-460-3-88-008, September 1988.

This report provides a description and the results of a test program conducted on 25 1981 and older model year vehicles to determine the variability in I/M short test emission results, the impact of no-load pre-conditioning on I/M emission results, and the emission differences between a fully warmed vehicle and a soaked vehicle having undergone minimum operation. Test results showed a reduction in hydrocarbon emissions following pre-conditioning and higher emissions following a three hour soak. Carbon monoxide emissions were low both before and after pre-conditioning but were noticeably higher after the three hour soak. Pre-conditioning following the three hour soak return the carbon monoxide emissions to previous levels.

I/M Test Variability, Landman, EPA-AA-TSS-I/M-87-2, April 1987.

This report summarizes the results of an EPA test program to determine the effects of various pre-conditioning cycles on vehicles that exhibit variable I/M emission results. A secondary objective was to characterize the FTP emissions of the I/M variable vehicles. In 1985, EPA tested approximately 100 1983-1985 model year vehicles, that had failed the Maryland I/M test program, at the EG&G Virginia Test Laboratory. The data suggest that I/M emissions from closed-loop fuel injected cars equipped with air injection are less affected by various pre-conditioning cycles than are closed-loop carbureted cars equipped with air injection. Forty-eight vehicles were FTP tested and the results were used to determine the percentage of excess hydrocarbon and carbon monoxide emissions that I/M tests identify.
TAMPERING AND MISFUELING

Motor Vehicle Tampering Survey - 1987, August 1988
Motor Vehicle Tampering Survey - 1986, September 1987
Motor Vehicle Tampering Survey - 1985, November 1986
Motor Vehicle Tampering Survey - 1984, September 1985
Motor Vehicle Tampering Survey - 1983, August 1984

EPA conducts surveys in 10-12 different cities each year to determine the nature and extent of tampering and misfueling. Surveys are done in areas with I/M programs as well as non-I/M areas. The reports describe the findings of the surveys and any significant trends that are evident from the data. Tampering rates are described on a city-by-city basis, by component, and in various other ways.


The report describes project involving the testing of lead-poisoned catalytic converters in the Houston, Texas, area. Five lead-poisoned catalysts were collected from motor vehicles. Various methods to evaluate the conditions of the degraded catalysts included weight and back pressure measurements, and x-ray diffraction to define substrate structure.


The report presents the results of a misfueling study done by automotive Testing Labs under EPA contract. The study was performed to evaluate the performance of Plumbtesmo brand lead sensitive paper in detecting the presence of lead on vehicle tailpipe after the vehicles were misfueled with 0.10 + 0.02 grams/gal leaded fuel (low lead fuel). The report also addresses the concern whether the test paper can still be used in vehicle Inspection and Maintenance programs to detect the presence of lead deposits resulting from the use of the reduced lead content of gasoline.
The report describes samples of in-use gasoline analyzed from a selection of gasoline outlets that were not major (national) brands. A total of 123 samples were obtained from three cities; Baltimore, Detroit, and Philadelphia. All samples were analyzed from Reid Vapor Pressure (RVP), distillation temperature curve, methanol, ethanol, tertiary butyl alcohol (TBA), water content, and lead content. In addition, the 'Evaporative Index' (EI) was calculated for each fuel.


Twenty-nine in-use automobiles with three-way catalyst emission control systems were misfueled with leaded gasoline in order to quantify the emissions effects. The vehicles used between four and twelve tanks of leaded gasoline. The leaded gasoline had an average of 1.0 grams Pb per gallon. Four different test programs were conducted with different misfueling intensities (rates) and mileage accumulation schedules. The Federal Test Procedure and several short tests were conducted at various stages. The results of the program indicate that vehicle emissions are affected mainly by the amount of lead passing through the engine and secondarily by the rate of misfueling.


This report examines the effects of tampering and misfueling on vehicle emissions and the emission reduction benefits of anti-tampering/anti-misfueling programs. From 1978 to 1982, EPA collected tampering/misfueling data from in-use surveys of over 8,000 cars and trucks. The 1982 survey of nearly 3,000 1975 and later cars is used as the data base for calculating current and projected (1988) tampering and misfueling rates. Four specific targets of tampering are analyzed: catalytic converters, evaporative control systems, air pumps and PCV. In addition, three misfueling parameters
are examined: (1) whether the lead content in the fuel tank is over the legal limit of 0.05 g/gal.; (2) whether the fuel inlet restrictor was enlarged or removed to accommodate a leaded fuel nozzle and (3) whether lead deposits are detected in the tailpipe using Plumbtesmo test paper. Several approaches to anti-tampering programs are covered, including periodic inspection, change-of-ownership inspections and random audits. Methods for calculating program benefits are detailed, along with tabulations of specific emission reductions and sample calculations.

The excess emissions due to tampering and the emission reduction benefits developed in this report are incorporated in EPA's MOBILE3 emission factor model. MOBILE3 output which reflects benefits from an anti-tampering/anti-misfueling program can be used in SIP inventory calculations in the same manner as normal MOBILE3 output.


A test program was initiated to study the effects of misfueling on late model vehicles in order to help predict the effect of misfueling on fleetwide emissions in the 1980's. Five 1981 and 1982 model year vehicles with around 25,000 and 15,000 miles accumulated, respectively, were obtained and tested in as received condition for emission levels. In all, ten tankfuls of leaded fuel were put into each vehicle and mileage was accumulated on a test track. Emission levels and fuel economy were periodically evaluated. All vehicles experienced steadily increasing emission levels of both CO and HC with more and more misfueling. Three-way catalyst vehicles also experienced increasing NOx emissions, as well. In general, HC emissions were four times base levels and CO emissions were three times base levels after ten tankfuls of leaded gas. NOx emissions in the three way catalyst vehicles were double the baseline levels. Most of the catalyst deactivation occurs within four tankfuls of leaded gasoline, although emission levels continue to increase with further misfueling.
Use of leaded fuel in catalytic converter equipped vehicles (misfueling) adversely affects the ability of the catalyst to reduce undesirable emission levels. A quick reliable method of detecting habitual misfueling would be a valuable diagnostic tool for detecting lead poisoned catalysts. PLUMBTESTMO is a lead sensitive test paper that according to its manufacturer's product literature can be used to detect metallic lead. When applied to the inside surface of a tailpipe containing lead deposits, the originally white test paper develops red spots and streaks within a few minutes. This test can be applied to cold or hot tailpipes. The reaction appears to take place in less time when the tailpipe is hot. The I/M staff has conducted an evaluation of PLUMBTESTMO on a sample of vehicles in the Ann Arbor area. This report describes that evaluation and its results.
EMISSION FACTORS: MOBILE MODELS
(see also Air Quality)


The MOBILE4 Tech IVCredit Model is used to estimate the emission factor equations, the effects of inspection and Maintenance (I/M) programs, and the bag fraction equations for 1981 and later passenger cars. The model’s results are then stored in the EPA MOBILE4 emission factor model database. The report describes the development, use and results of the Tech IVC model. It also documents the normalized bag fractions, high altitude emission factors, biennial I/M credits, and idle emission I/M credits used in MOBILE4.


The document briefly describes changes made to the standard MOBILE4 emission factors program to create a special version which facilities modeling the effect of the use of oxygenated fuel on carbon monoxide (CO) emissions from mobile sources. The document also explains the changes made to the MOBILE4 input and output formats to allow user input of oxygenated fuel use. Finally, examples of input and output files for the model are provided.


The document provides methods and assumptions for estimating the impact of use of alternative fuels and fuel blends on motor vehicle emissions including HC, CO, and NOx. The information is presented in a format which assumes it will be used by State and local air quality planning agencies in preparing current and future emissions inventories and emission reduction strategies during 1988, 1989, and 1990. Such planning efforts will be necessary in areas which receive calls from EPA for revisions to their ozone or CO State implementation Plans (SIP) following their failure to attain (or in a few cases following their failure to provide for attainment in a prospective sense) the National Ambient Air
Quality Standards (NAAQS) for these pollutants. EPA has recently proposed requirements applicable to these SIP calls (52 FR 45044, November 24, 1987), and many affected areas will need to estimate current and future year motor vehicles emissions. Use of alternative fuels and fuel blends is likely to be part of future scenarios that will be examined in many areas.


The report provides the basis for the equations used in MOBILE3 to predict the emission levels of 1981 and newer gasoline powered light-duty passenger vehicles. This was done by characterizing the performance of vehicles in the Emission Factor data base separately for several technology types, such as fuel-injected versus carbureted, and reconceiving the technologies based on projected mixed to produce estimates of emissions of future model years. The Tech IV Credit Model is the computer software developed to calculate the MOBILE3 emission factor estimates. In addition, the model was used to estimate the emission reductions due to Inspection and Maintenance (I/M) programs for these vehicles. The emission levels of vehicles in the sample identified by various test type and cutpoint combinations were reduced to reflect repairs due to the I/M program. After combining the repaired and unrepaird vehicle emission levels, the overall reduction from the non-I/M base case is expressed as a fraction of the base case. This reduction fraction is scored in MOBILE3 and used to estimate fleetwide reductions due to I/M programs.


MOBILE3, as with all of the EPA mobile source models, uses a single stringency to identify the first year failure rate of Tech I (pre-catalyst) and Tech II (oxidation catalyst) vehicles in the Inspection and Maintenance (I/M) program to be modeled. This single number most often covers a wide range of technologies and vehicle classes when applied to an I/M program which inspects many model years and all vehicle types. Unless the cutpoints used are carefully balanced, the actual failure rate may vary greatly from model year to model year and vehicle class to vehicle class. This single stringency input was meant to reduce the amount of input information necessary to model an I/M scenario. It is
possible for MOBILE3 to use a separate stringency for each model year of each vehicle class. The only barrier has been the need to modify the input stream and appropriate subroutines to accept and utilize user supplied information. Such modifications have been done and the results are described in this report.

Modifications to MOBILE2 Which Were Used by EPA to Respond to Congressional Inquiries on the Clean Air Act. EPA-AA-IMS-82-2 EB 83 137 414, May 1982.

This report provides the modifications (generally known as MOBILE2.5) used by EPA to respond to Congressional inquiries regarding the impacts of changes in motor vehicle emissions. The modifications represent EPA's revised estimates of emissions from certain vehicle classes under current statutory standards, as well as expected differences in administratively determined standards from those assumed in the original version of MOBILE2.

MOBILE2 Errata, memo from C. Gray to Air and Hazardous Materials Division Directors, Region I-X, 22 April 1982.


MOBILE2 I/M Credits for High Altitude Areas, memo from C. Gray to Air and Hazardous Materials Division Directors, Region 8-10, 4 August 1981.

Due to the differences in vehicle operation at high-altitude versus low-altitude, the standard I/M credits contained in MOBILE2 (developed for low-altitude areas) are not the most appropriate for use in evaluating the effects of I/M in high altitude areas. An alternate set of I/M credits has been developed for use in MOBILE2 for high altitude areas. This memo explains the basis for these changes and provides composite I/M benefits for high altitude areas.

MOBILE2 I/M Credits for Scheduled Failure Rates, memo from T. Cockette to Air Branch Chiefs, Regions I-X, 3 June 1981.

This memo contains information regarding special purpose MOBILE2 I/M credits. In I/M programs with permanently fixed cutpoints, MOBILE2 accurately provides the associated emission credits. In programs in which the cutpoints may be changed, a new computer program is available which estimates I/M benefits for any given schedule of failure rates. This

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memo describes this program and how it can be made available to interested states.

MOBILE2 I/M Credits for California, memo from C. Gray to L. Giersch, Region IX, 20 March 1981.

Due to the difference in new vehicle emission standards between California and the non-California fleet and the resultant differences in emission control technologies, the question arises as to whether I/M credits developed for the federal fleet, as used in MOBILE2, are directly applicable in California. This memo reviews an analysis of this question and presents I/M emission benefits for use in the 1982 SIP.


MOBILE2 is a computer program that calculates emission factors for hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) from highway motor vehicles. It estimates emission factors for any calendar year between 1970 and 2020. Compared to MOBILE1, MOBILE2 incorporates several new options, calculating methodologies, emission factor estimates, emission control regulations, and internal program designs. The program uses the calculation procedures and emission factors presented in Compilation of Air Pollutant Emission Factors: Highway Mobile Sources, March 1981 (EPA 460-3-81-005).

High quality, scientific polls require careful planning and attention to numerous details. There is considerable flexibility in the development and implementation of a poll. The decisions which are made about sample selection and size, the choice of a polling methodology, questionnaire design and wording, and the use of quality control measures will ultimately affect the cost and accuracy of polling results.

The purpose of this report is to provide state and local governments with information that could be used in the planning and implementation of public opinion polls, especially those with respect to I/M programs. The report discusses the purposes of polls and how to effectively plan one. Technical issues addressed include: survey design; sample selection and size; accuracy of data; and, data analysis, interpretation and presentation. General information on the cost of various polling options and determining who should conduct a poll is presented.


The report, "Public Awareness Guidance for Inspection and Maintenance Programs", issued by EPA in January 1981, discusses in considerable detail a step-by-step process for developing a public awareness plan. An important part of that planning process includes the development of a viable budget. The budget should be prepared to ensure that funds are spent in accordance with public awareness goals and plans; that proposed activities are supported at sufficient funding levels to achieve their objectives; and that funds are allocated to maximize their potential effectiveness.

This guidance is intended to assist state and local agencies to identify the typical items that could be included in their annual I/M PA budget. It provides explanation of these items and a typical range of costs for them based on the experience of planned or operating programs around the country, and on estimates provided by advertising agency representatives. A sample I/M public awareness budget is also included.
EPA developed this guidance to assist state and local agencies in educating the public about I/M. The guidance recommends a step-by-step planning process to inform the public about I/M and related issues. Such planning items as identification of audiences, messages, media techniques and schedules are addressed. Reference and sample materials that can be used as models for the production of new materials are included.
INSTRUMENT SPECIFICATIONS


This report is the result of a contract to review the draft analyzer specification and develop a final specification for the Massachusetts I/M program based on a detailed review of existing analyzer specifications and input from knowledgeable industry and government sources. Manufacturers comments and EPA's recommended procedures were also used to develop specifications for a quality assurance program. The report provides the technical and performance specifications that were finally developed. It also provides proposal evaluation methodology and criteria.


This report explains how calibration gases will be used in I/M programs, and identifies the problems states may have in obtaining accurate gases. A Recommended Analysis Practice for gas manufacturers to use when naming I/M calibration gases is presented. States are encouraged to procure gases named according to this Recommended Practice for their own use, and to require licensed inspection stations to procure them to ensure that they are obtaining accurate calibration gases which meet the terms of the Emission Performance Warranty [207(b)], and to improve the general quality of their I/M programs.


This report changes EPA's recommended specifications for emission inspection analyzers based on recent results of several engineering design studies by equipment manufacturers. The report gives section by section changes in concepts or specific wording and reasons for the changes. Most changes have been made to allow manufacturers more flexibility in analyzer design, to reduce design and production costs, and to clarify the intent of certain specifications.

This report includes EPA's recommended specifications for inspection analyzers in I/M programs. EPA recommends manually operated emissions analyzers for centralized I/M programs and computerized emissions analyzers for decentralized ones (for maximum quality assurance and consumer confidence). The report also discusses optional features for the inspection analyzer, evaluation procedures, and performance test procedures.


This report in this three-part series distinguishes between the "repair" and "inspection" analyzers by explaining the different roles each plays in the I/M process. It includes discussions on minimum quality analyzers, the inspection analyzer, and I/M program considerations to be weighed in choosing analyzer specifications.
I/M CALIBRATION GASES

EPA Recommended Practice for Naming I/M Calibration Gas: A Discussion for I/M Programs, EPA-AA-TSS-83-8-A, PB 84 185 222, Sept 1983.

This report discusses the use of calibration gases in I/M programs and introduces a Recommended Practice for gas manufacturers to use in naming I/M calibration gas cylinders. Details of the Recommended Practice are presented in a parallel report entitled "EPA Recommended Practice for Naming I/M Calibration Gases" (EPA-AA-TSS-83-8-B). EPA recommends that calibration gases contain HC and CO with nitrogen as the diluent. CO2, where needed, should be purchased in separate cylinders. Propane should be used as the HC component in order to avoid traceability and condensation problems associated with hexane. Gas concentrations should fall between 1-2% CO, 200-800 ppm propane and 4-6% CO2. For gas concentrations greater than 500 ppm propane and 4% CO, the sample should be analyzed using gas chromatography to avoid CO/propane interference problems.

EPA Recommended Practice for Naming I/M Calibration Gas, EPA-AA-TSS-83-8-B, PB 84 165 042, Sept 1983.

This report establishes a set of procedures for blending, analyzing and labeling I/M calibration gases. These procedures are intended to be used by manufacturers who wish to label calibration gases with the statement: "made in accordance with the EPA Recommended Practice for naming I/M calibration gas". An explanation of how calibration gases are used in I/M programs is provided in a parallel report entitled "EPA Recommended Practice for Naming I/M Calibration Gas: A Discussion for I/M Programs" (EPA-AA-TSS-83-8-A). The procedure begins with analyses of individual component gases for impurities and determination of analyzer response (linear or non-linear). Calibration curves and equations describing instrument response must be generated monthly for use with NBS or other standards. Quality control measures are specified for gas blending and cylinder charging, including checks for concentration, homogeneity and process accuracy. Also included are guidelines for cylinder labeling and documentation.
MECHANIC TRAINING


This report presents the results of a study performed to determine if a short practical training course for mechanics on emissions diagnosis and repair has a supplementary emission reduction and fuel economy benefit to an inspection and maintenance program. The study was performed in the early part of 1980 in Portland, Oregon. The results indicate that training mechanics in Portland did not produce a significantly greater emission reduction benefit than if no training were given. However, a 0.8% improvement in fuel economy was seen after training due to better repairs.

Training for Inspection and Maintenance Programs, A. Chijner, EPA-AA-IMS-81-14, PB 81 214 199, April 1981.

This report provides guidance to I/M program administrators on the development of training for inspectors, auditors, investigators and mechanics. The report reviews the experiences and problems encountered by currently operating I/M programs and provides recommendations on course content and coordination of training efforts.

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Inspection/Maintenance Program Implementation Summary, updated quarterly.

This document summarizes essential characteristics of every required I/M program in the country. These characteristics have been derived from statutes and/or rules and regulations promulgated by the state or locality. The list includes the names of states, cities and counties implementing I/M and lists the SIP-approved implementation dates. It indicates whether the program is centralized or decentralized and what type of enforcement mechanism is planned or being used. Test fees are listed along with the cutoffpoints for light duty vehicles.

Inspection/Maintenance Fact Sheet, FS-67, August 1981.

The question and answer format of this fact sheet provides a brief background on the I/M program. Key issues are covered, including what I/M is, how it works, public acceptance, costs and cost effectiveness, emission reductions, air quality impacts, fuel economy benefits, and warranties.


This report summarizes the information known about the health effects of carbon monoxide (CO) and ozone (O₃), and how that information is used by EPA to set National Ambient Air Quality Standards. In addition, this report discusses the sources most likely to contribute to high levels of CO and O₃, and how EPA control programs will reduce emissions from these sources in the future. The information in this report is presented in a question and answer format.


This report compiles and summarizes the latest technical information available from laboratory studies, surveys and field investigations of operating I/M programs for the use of policy makers and planners. Issues addressed include: air quality, the role of I/M, emission reductions, fuel economy, economic costs, cost effectiveness, public attitudes, and new technology vehicles. The facts and figures in this report have been gathered from various technical reports referenced at the end of the document.

This report provides information on currently operating I/M programs as an aid to state/local agencies which are presently planning the implementation of I/M. The report is divided into two sections. The first section is a narrative description of the programs. The second section contains tables that summarize the different technical and administrative aspects of the programs. The topics discussed in the report include a general descriptions of each operating program, cutpoints, data collection and analysis, quality assurance, training, public information, and air quality improvements.


This report describes the laboratory effort to characterize regulated and unregulated exhaust emissions from three-way catalyst-equipped gasoline automobiles operating under malfunction conditions. Three automobiles were evaluated over three driving schedules in the unmodified configuration and in four engine and/or emission control system malfunction configurations. Exhaust emission constituents measured, in addition to the current regulated emissions, include: particulate sulfates, aldehydes, sulfides, amines, metals, and several additional elements and compounds. Additional evaluations, in each of the configurations, involved the measurement of regulated emissions over four short-cycle procedures.


This paper discusses the current Federal Motor Vehicle Emission Control Program (FMVECP) which includes car certification, selective enforcement audit (assembly line testing) and recall, which are federal responsibilities, and inspection and maintenance (I/M), which is a state or local responsibility. The first three elements of the FMVECP assume that vehicles will maintain their new car emission levels. Studies have shown this not to be the case due to maladjustments and lack of maintenance. The paper concludes that I/M is needed to identify those cars with excess emissions, and to ensure necessary repairs are performed.
OTHER FUELS


The report is a supporting document to the report, 'Guidance on estimating motor vehicle emission reductions from the use of alternative fuels and fuel blends.' It presents the data and calculations which were used to estimate the effects of gasoline/oxygenate fuel blends on vehicle exhaust emissions. Data were gathered from several studies of fuel blends, and include tests of blends with methanol, ethanol, tert-butyl alcohol, and MTBE. Effects are calculated separately for vehicles with different emission control technology. The report discusses exhaust emissions of hydrocarbons, carbon monoxide, and oxides of nitrogen.


The purpose of the report was to investigate the effect on evaporative emissions of mileage accumulation with a gasoline/methanol/cosolvent splash blend versus mileage accumulation with the base gasoline. The test program was carried out under EPA contract 68-03-3192 with Southwest Research Institute. Evaporative emission tests were conducted on a 14-vehicle fleet undergoing driveability testing for the Department of Energy at Southwest Research Institute. Seven vehicles accumulated mileage on a gasoline-alcohol blend containing four percent methanol, two percent ethanol and two percent t-butyl alcohol (TBA). The results of the tests are summarized within the report. Also included are recommendations for additional research.


A test program of about 200 1976 and 1978 Portland vehicles was designed to determine the effects of the use of gasohol (10% ethanol, 90% gasoline by volume) on ability to pass an I/M test. Gasohol generally caused a change in the failure rate, depending on the idle test used. The failure rate using the first idle portion of the Two-Speed Idle Test increased with gasohol from 39% to 46%. The failure rate using the second idle portion decreased with gasohol from 27%
to 23%. The failure rate using the full Two-Speed Idle Test (testing at both idle and 2500 rpm) remained essentially unchanged at 35%. The change in failure rate was almost entirely due to CO emission changes, not HC.


This report discusses the results of a study to investigate the effects of gasohol on CO and HC emissions as detected by the idle test. Three vehicles were set up to operate on either gasoline or gasohol. CO emissions were varied on each of the three cars by adjusting the idle mixture screws, and HC emissions were varied by inducing a misfire with a misfire generator. At each CO and HC value, the fuel was switched from gasoline to gasohol to determine the effect on tailpipe emissions. As cars were maladjusted, gasohol was found to reduce idle CO about 1.1%. The reduction was relatively constant for all three cars between idle mixture settings of 1.5% and 6.0% CO, and the catalyst cars experienced a greater average reduction. Idle HC exhaust reductions attributable to gasohol were vehicle dependent. The non-catalyst car experienced almost no reduction, while catalyst vehicles had substantial reductions with gasohol.

The paper reviews the results of EPA's Inspection/Maintenance Program audits during Federal fiscal year 1986 (FY86). EPA performed eleven initial program audits and eight follow-up audits during FY86. The paper highlights design elements that have proven successful in these programs, and discusses the applicability of those design elements to other I/M programs. Also included is the progress that has been made in resolving operating problems identified in FY86 and earlier years.

EPA Audits of State and Local Inspection/Maintenance Programs
P.A. Lorang, J.A. Armstrong and J.M. Cabaniss

Many State and local agencies have implemented vehicle emissions I/M programs in the last few years. EPA began to audit these programs in federal FY1984. The audit process for I/M was developed in conjunction with STAPPA/FLAPCO; the I/M audit became part of the National Air Audit System in FY1985. Results of the I/M audits indicate that (1) enforcement is a problem in some programs with sticker based enforcement; (2) low reported failure rates are a problem in many decentralized programs, especially those that use manual analyzers, and in some centralized, government run programs; (3) high waiver rates are a problem in some programs, both centralized and decentralized; (4) analyzer quality assurance ranges from excellent in centralized, government run programs to marginal in decentralized programs with manual analyzers and in some centralized government run programs; (5) data analyses are not being effectively used in most programs to monitor and improve program performance and the performance of individual inspection stations; (6) the quality of I/M repairs is a problem, to some extent, in every program audited. EPA believes that the resolution of these problems generally rests with each State/local I/M program developing an overall I/M quality assurance program to ensure that problems are identified and resolved in a timely manner.

Two basic types of I/M systems exist: 1) inspection and retest at high volume, test-only lanes (a centralized network), and 2) inspection and retest at privately-owned, licensed facilities (a decentralized network). This report examines how I/M network choice affects program costs, convenience, and overall emission reductions. The report is based on operating results from I/M programs across the country. Significant factors include the design of test procedures, occurrence of improper testing, resources necessary for and effectiveness of quality assurance and quality control, and the incorporation of more sophisticated I/M technology, especially in light of the recent Clean Air Act Amendments. The report concludes that centralized I/M networks will usually offer greater emission reduction benefits at a lower cost than decentralized networks.

A Discussion of Possible Causes of Low Failure Rate in Decentralized I/M Programs Eugene J. Tierney, EPA-AA-TSS-I/M-87-1, January 1987.

This technical report reviews six possible explanations for low reported failure rates in manual, decentralized I/M programs. The report analyzes and discusses random roadside idle survey data, reported I/M program data and data collected during audits of I/M programs. The data indicate that five of the explanations: quality control, fleet maintenance, differences in fleet mix or emission standards, anticipatory maintenance, and pre-inspection repair, do not sufficiently explain low reported failure rates. The report concludes that the major problem contributing to low reported failure rates in decentralized, manual I/M programs is improper inspections by test station personnel.

Guidance on Quality Control for Inspection/Maintenance Programs, EPA-460/3-82-006, PB 82 254 335, Radian Corporation, June 1982.

A crucial aspect of an effective I/M program is the quality control procedures and processes incorporated into it. Accurate inspections are key to identifying gross emitters without error. Therefore, quality control of the emission analyzers, inspection procedures and audit procedures play a major role in the overall success of the program. This report discusses the planning and development of quality control procedures for each of these three elements. The report details quality control for emission analyzers
including daily and weekly quality control checks, preventative maintenance, documentation and audits. The report discusses pre-inspection, during-inspection, and post-inspection quality control procedures. Finally, quality control for inspection station auditing is discussed including checking the performance of equipment, checking procedures, taking corrective action, and documentation.


This document describes the I/M data handling system for the Automobile Inspection and Readjustment (AIR) Program operated by the State of Colorado. Machine readable forms (also called optically read or scanned forms) play a key role in that program's inspection data system. The intended purpose of this report is to provide detailed descriptive information for the consideration of other I/M programs. The report includes information on planning and implementation of the data handling system and the analysis of data.

Guidance on Data Handling and Analyses in an Inspection/Maintenance Program, EPA-460/3-82-007, PB 82 252 974, Radian Corporation, December 1981.

This report provides guidance on the establishment of a data handling and analysis system for I/M programs. The report discusses the various uses of data including: evaluating inspection facility performance, the vehicle waiver system, and sticker enforcement effectiveness; revising cutpoints; determining sticker accountability and fee accountability; quantifying idle emission reductions; and preparing reports. Details are presented on statistical analysis and sampling techniques, manual and computer assisted analysis, and ways of presenting data. The report also contains a discussion of data collection and handling techniques, including provisions for assuring quality control in the data base. Finally, the report discusses the cost of data processing, including manual, computer assisted and on-line data base management approaches.

This report addresses an I/M program in which only idle CO emissions are measured. In comparison with most common I/M programs, which also test idle hydrocarbon emissions, this approach will achieve the same amount of CO emission reduction and is only moderately less effective in reducing HC emissions. Repairs will be much simpler and cost much less in a "CO only" program since carburetor adjustments will usually be the only necessary repair for pre-1981 vehicles. This type of repair will cost between $6 and $10, compared to average repair costs of $18 to $30 in a conventional program. The "CO only" program will also improve fuel economy of repaired vehicles by 4%. The report concludes that a "CO only" I/M program offers significant reductions in total HC and CO emissions from automobiles at a lower cost than most conventional I/M programs.

Discussion of the Selection of Coverage and Frequency Alternatives in Inspection and Maintenance Programs, J. Armstrong, EPA-AA-IMS-81-17, PB 82 112 434, August 1981.

Automobile Inspection/Maintenance (I/M) program managers are faced with many decisions when designing and implementing an emissions inspection program on how to best serve the needs of their local area. All of these decisions are impacted by both technical and socio-economic considerations. This report will examine those decisions which concern the coverage of the program and the frequency of inspection.

Specifically, this report addresses the concerns surrounding the selection of the geographic area, vehicles classes, and model years included in the program. Additionally, this report discusses the impact of including change-of-ownership inspection and/or random roadside checks along with the annual cycle.


The model RFP is a guide for state and local agencies to follow in developing a contract with the organization that will administer and operate their I/M program. It contains sections on program information, contract and operating requirements, equipment specifications, administrative conditions, bidder qualifications and a cost proposal.

Centralized I/M Program Cost Calculation Worksheet, IMS-005-CW-1, August 1979.

These worksheets are designed to enable I/M program administrators to project total costs of I/M programs at early stages of planning. The factors involved in initial and annually recurring costs are systematically organized to compute an annual inspection fee which will cover all program costs for the total length of the program.

This memo provides information to assist states and EPA Regional Offices in the development and review of complete I/M SIP submittals in accordance with the 1982 SIP policy. It includes the 1982 I/M SIP Checklist which lists all elements needed for the I/M SIP submittal.

Approval of 1982 Ozone and Carbon Monoxide Plan Revisions for Areas Needing an Attainment Date Extension, final policy, (46 Federal Register 7182), 22 January 1981.

The Federal Register Notice specifies the 1982 SIP requirements for states that have received an extension of the attainment date for carbon monoxide (CO) or ozone. The I/M portion of the SIP must contain program elements including inspection test procedures; emission standards; inspection station and inspector licensing requirements; emission analyzer specification and maintenance/calibration requirements; recordkeeping and record submittal requirements; quality control, audit, and surveillance procedures; procedures to assure that non-complying vehicles are not operated on the public roads; any other official program rules, regulations, and procedures; a public awareness plan; and a mechanics training program if additional emission reduction credits are being claimed for mechanics training.


This memo answers common questions regarding the application of the elements of the 1978 I/M policy. It covers emission reductions required for I/M (RACT), inspection procedures, equipment and quality assurance, assurance of compliance by vehicle owners, data collection and reporting, and emission credits for mechanic training.

This memo discusses criteria for granting extensions beyond the July 1, 1979 deadline for obtaining state enabling legislation for I/M programs and sets a uniform implementation date of December 31, 1981 for decentralized programs and December 31, 1982 for centralized programs.


This memo indicates the elements EPA considers to be part of a minimally acceptable I/M program. It includes information on what should be included as part of an I/M SIP submittal, the I/M implementation schedule and deadlines, authority to implement I/M, geographic coverage, emission reductions needed for I/M, and minimal program requirements for centralized and decentralized programs.
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