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COMPILATION OF INSPECTION/MAINTENANCE FACTS AND FIGURES

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INTRODUCTION

Since the passage of the 1977 Amendments to the Clean Air Act, a great deal of information has been assembled about vehicle inspection and maintenance (I/M) programs. Laboratory studies, surveys, and investigations of operating I/M programs have been conducted to quantify the costs and benefits and to project the impact of these programs on air quality.

This report compiles and summarizes the latest technical information available from these studies for the use of policy makers and planners. The facts and figures in this report have been gathered from the technical reports referenced at the end of the document. Interested readers are encouraged to obtain these reports for additional information.

AIR POLLUTION

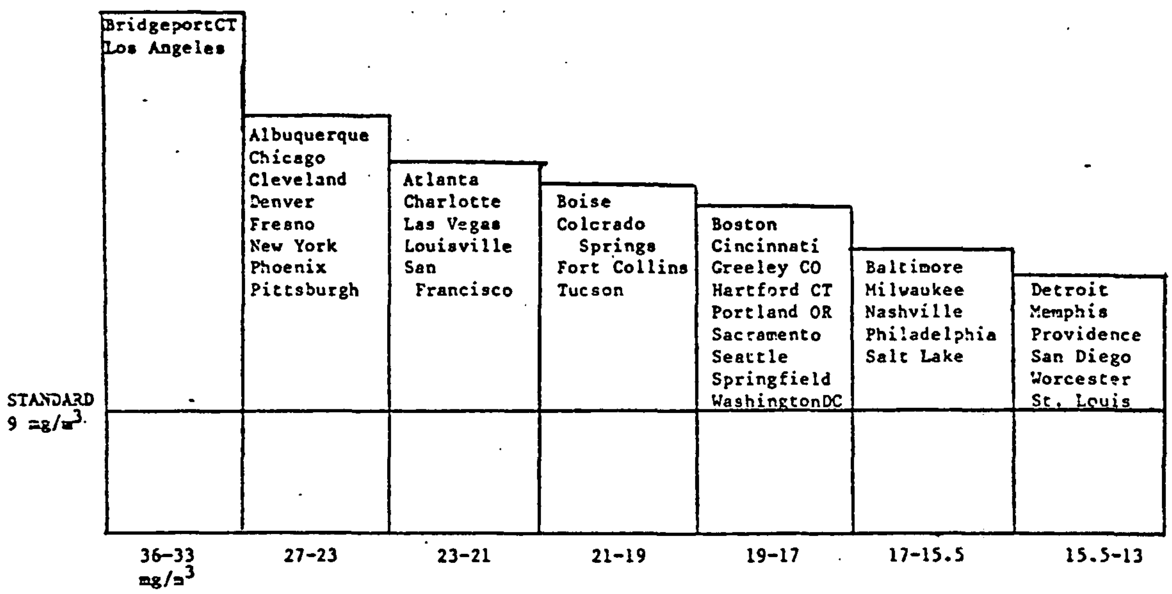
Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless, poisonous gas produced by the incomplete burning of fuels. The primary source of CO emissions is motor vehicles.

Carbon monoxide combines with hemoglobin and thereby reduces the amount of oxygen normally carried in the blood. This condition is called hypoxia. Hypoxia can cause cardiovascular diseases, fetal abnormalities, and central nervous system disorders which affect sleep, alertness, and muscle coordination.[1]

In 1977, 62 of 105 urban areas with population over 200,000 exceeded the health-related ambient air quality standard for carbon monoxide. The most recent State Implementation Plan (SIP) revisions, which were submitted to EPA in 1979, indicate that 39 major urban areas will continue to exceed the CO standard beyond 1982.

AREAS PROJECTED TO EXCEED THE AIR QUALITY STANDARD FOR CARBON MONOXIDE BEYOND 1982



DATA COLLECTED FROM AIR QUALITY MONITORING SITES during the period 1975 to 1977 were used by the States to project when air quality standards would be attained. The urban areas shown above had monitored ambient CO values ranging from one and a half to four times the standard and are projected to continue to exceed the standard beyond 1982.

AIR POLLUTION

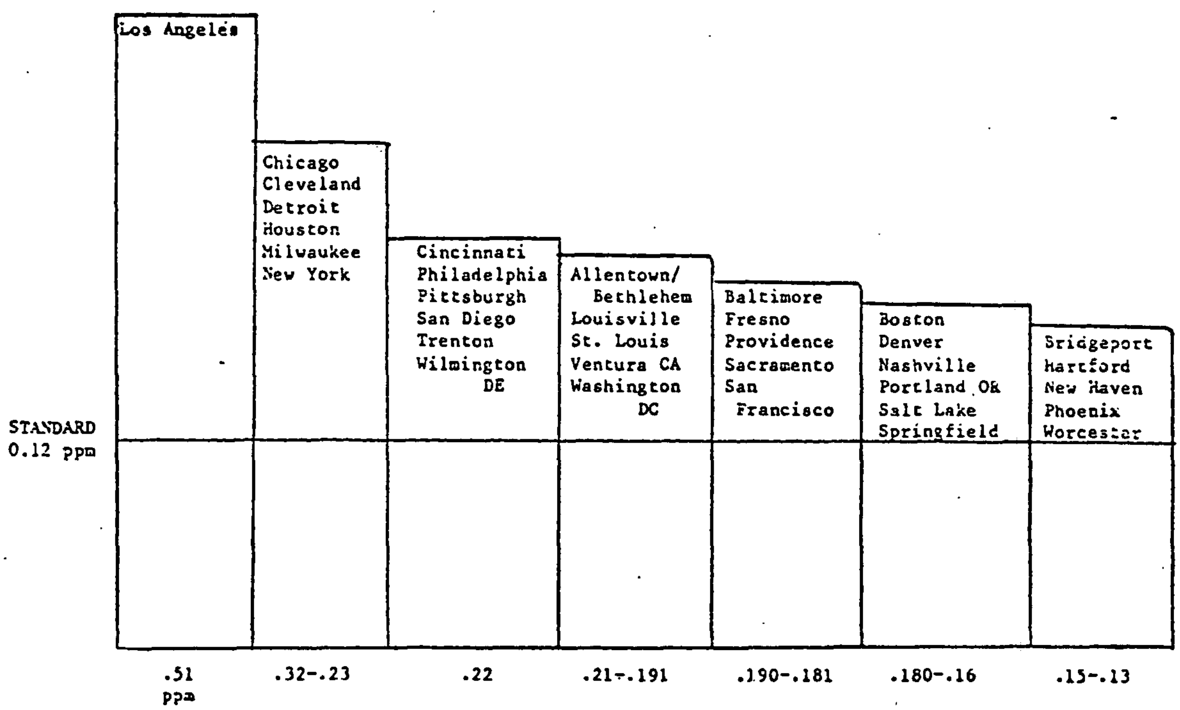
Ozone

Ozone (O_3), the main constituent of smog, is formed by the reaction of hydrocarbons and oxides of nitrogen in the presence of sunlight. Ozone precursors are emitted by both stationary and mobile sources.

Exposure to ozone can cause coughing, chest discomfort, and irritation of the nose and throat. Ozone can also damage the cells that line the lung walls and protect them from harmful bacteria. This can increase the chances of contracting an infectious lung disease.[1] These harmful effects are especially pronounced in children, the aged and those with respiratory ailments.

In 1977, 103 of 105 major urban areas exceeded the health-related air quality standard for ozone (0.08 parts per million). When the standard was relaxed to 0.12 ppm in 1979, the number of areas exceeding the standard became 93. The 1979 SIP revisions indicate that 36 urban areas with over 200,000 population will continue to exceed the ozone standard beyond 1982.

AREAS PROJECTED TO EXCEED THE AIR QUALITY STANDARD FOR OZONE BEYOND 1982



DATA COLLECTED FROM AIR QUALITY MONITORING SITES during the period 1975 to 1977 were used by the States to project when air quality standards would be attained. The urban areas shown above had monitored ambient ozone values ranging from slightly above to over four times the standard and are projected to continue to exceed the standard beyond 1982.

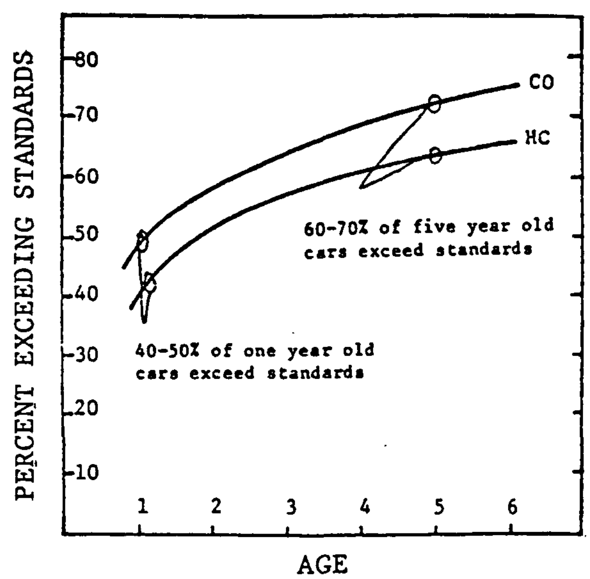
THE NEED FOR INSPECTION AND MAINTENANCE

In an urban area, motor vehicles typically contribute 90% of the carbon monoxide and 50% of the hydrocarbons; the latter combine with other pollutants to form ozone.

The Federal Motor Vehicle Control Program (FMVCP) has operated since 1968 to assure that cars are designed and built for lower emissions. Increasingly stringent emission standards for new cars have resulted in vehicles which are capable of emitting less than 10% of the emissions of an uncontrolled, mid-1960's model. But the ability of the new car strategies (prototype certification, assembly line testing, and recall of defective designs) to reduce emissions depends on proper use and maintenance by vehicle owners once the new cars are put on the road.

Tests of thousands of typical vehicles, borrowed from their owners, show that much of this emission reduction potential is being lost because of inadequate or improper maintenance.

PERCENT OF CARS ON THE ROAD WHICH FAIL
TO MEET EMISSION STANDARDS

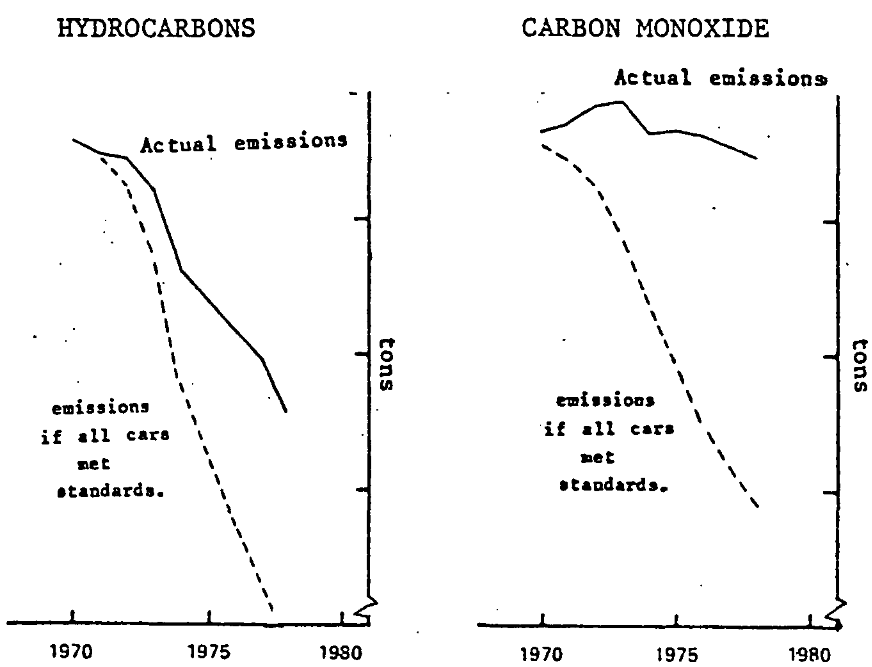


NEARLY HALF OF THE ONE YEAR OLD CARS on the road exceed federal emission standards and this increases with the car's age. Most of the cars fail to meet standards because of improper maintenance and adjustments by owners and mechanics after the cars leave the factory.[2]

THE NEED FOR INSPECTION AND MAINTENANCE
(continued)

Due to the poor emission performance of vehicles on the road, the significant downward trend in emissions from motor vehicles expected as a result of the FMVCP has not been fully realized. Inspection/Maintenance (I/M) is a strategy which attempts to solve this problem by providing the incentive for proper maintenance by car owners.

NATIONAL EMISSIONS OF CARBON MONOXIDE AND HYDROCARBONS FROM MOTOR VEHICLES



THE EMISSION REDUCTION POTENTIAL OF THE FEDERAL MOTOR VEHICLE CONTROL PROGRAM IS NOT BEING FULLY REALIZED. These graphs compare actual on the road emissions (solid lines) with the hypothetical emissions (dashed lines) which would have resulted had all cars met federal emission standards. The area between the curves represents the emission reductions not realized.[3]

THE INSPECTION AND MAINTENANCE PROCESS

Motor vehicles undergo an annual emissions inspection, normally as a prerequisite to annual registration, sometimes in conjunction with an existing safety inspection. The inspection may be performed at a licensed garage or at facilities operated by the state or local government.

EMISSIONS TEST

The car is tested by sampling the exhaust emissions while the car is idling. High levels of measured pollution indicate the need for maintenance.

PASS

70-80% of the cars pass the test.

FAIL

20 to 30 percent of the cars fail the test. Car owners are provided with test results and diagnoses which can help the mechanic perform more efficient repairs.

REPAIR

Normal, inexpensive repairs such as a simple carburetor adjustment are all that are usually necessary to achieve lower emission levels and improved fuel economy.

RETEST

The inspection is repeated to verify that the repairs have resulted in lower emission levels.

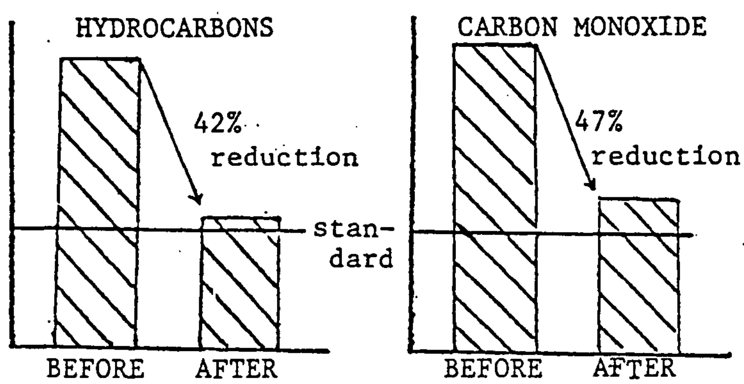
EMISSION REDUCTIONS FROM I/M

EPA has undertaken a study of the Portland, Oregon I/M program to determine the costs and benefits associated with an operating program.

The study showed that the idle test used in most I/M programs properly identifies vehicles with excessive emissions. A comparison using the complex Federal Test Procedure shows emissions from cars failing the idle test at the state operated inspection lanes are two to three times higher than from those passing the test.

In the Portland study, those cars failing the state inspection test were taken by their owners to private repair facilities where corrective maintenance was performed. The maintenance resulted in each car passing the state reinspection test and produced an emission reduction of over 40%, bringing emissions close to the federal standards to which these cars were originally certified.

EMISSION REDUCTIONS FROM CARS RECEIVING MAINTENANCE IN EPA'S PORTLAND STUDY

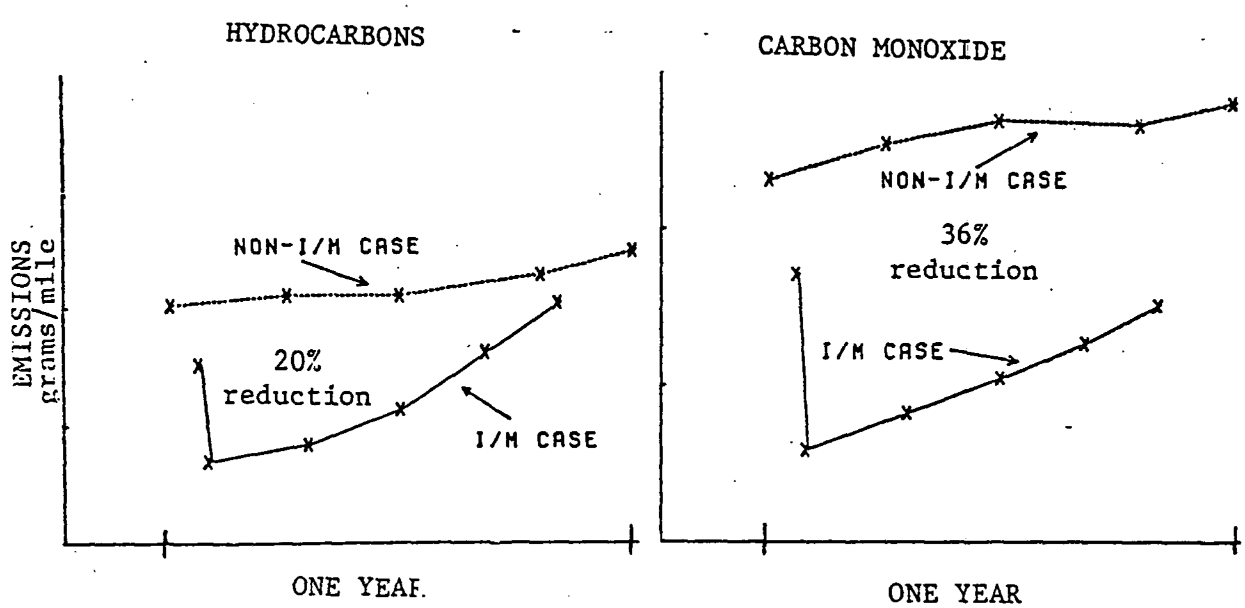


ENGINE MAINTENANCE by Portland area mechanics to vehicles failing the state inspection resulted in a 42% reduction in hydrocarbon emissions and a 47% reduction in carbon monoxide emissions .[4]

EMISSION REDUCTIONS FROM I/M
(continued)

The Portland Study also followed a sample of cars throughout a full year to determine whether the emission reductions following maintenance last. Although emissions deteriorated following maintenance, the average emissions of the Portland fleet were 20 percent lower for HC and 36 percent lower for CO when compared to a similar fleet of vehicles in a nearby city which does not have an I/M program.

AVERAGE EMISSION LEVELS OVER A YEAR PERIOD FOR SIMILAR FLEETS OF VEHICLES IN PORTLAND AND EUGENE, OREGON



EMISSION REDUCTIONS FROM I/M LAST for much of the following year. The top curve shows the emissions, in grams per mile, of a fleet of 1975 to 1977 model year vehicles in Eugene, Oregon a city which does not require I/M. The curve shows the typical trend of emissions increasing with age (in this case, one year). The bottom curve presents the emissions of a similar fleet of vehicles in Portland, Oregon, which requires I/M. The sharp drop in emissions at the beginning of the one year period reflects the maintenance received by the approximately 30% of the vehicles that failed the inspection test. The emission levels over the following year increase, but not sufficiently to reach the levels of the Eugene cars. Over the one year following inspection, Portland vehicles averaged 20% lower HC and 36% lower CO emissions. The initial "gap" between the Eugene and Portland cars is attributed to a previous inspection and repair cycle undergone a year before by some of the older Portland vehicles. Note that these curves represent the entire fleet, including the 70% of vehicles that passed the inspection and received no repair.[4]

AIR QUALITY BENEFITS OF I/M

By reducing emissions from motor vehicles, ambient levels of pollution should also be reduced. Supporting evidence comes from a variety of sources.

Carbon Monoxide

The relationship between reductions in carbon monoxide (CO) emissions from motor vehicles and improved ambient air quality for CO is well established. In 1981, a statistical analysis of CO air quality data from Portland, Oregon quantified the effect of the I/M program on ambient CO levels. The researchers found that the I/M program produced reductions in ambient CO levels which compared well with the predicted improvements based on reductions in tailpipe emissions.

AMBIENT CO AIR QUALITY IMPROVEMENT
DUE TO I/M IN PORTLAND, OREGON

IMPROVEMENT	COMMENT
8-15%	Observed ambient improvement in 1976 and 1978
10-19%	Adjusted to annual inspection frequency

AMBIENT CO LEVELS IN PORTLAND, OREGON showed an 8 to 15 percent improvement over what would have occurred had there been no inspection program. These improvements were observed in 1976 and 1978, the years when about 70% of the fleet were inspected in Portland's biennial program.[5] Adjusting these data to reflect an annual inspection program results in a 10 to 19 percent improvement in ambient CO levels due to I/M.

AIR QUALITY BENEFITS OF I/M

Ozone

Ozone is produced in the presence of sunlight through the interaction of non-methane hydrocarbons (HC), oxides of nitrogen and oxygen. Research smog chamber studies have demonstrated that HC emission reductions reduce ambient ozone levels. Air quality data from California show both hydrocarbon and ozone reductions occurring simultaneously. This link between HC reductions and lower ozone levels, along with data (such as from the Portland Study) indicating I/M's ability to reduce HC emissions from motor vehicles, provides strong evidence that I/M will be effective in improving air quality for ozone.

HYDROCARBON AND OZONE REDUCTIONS

San Francisco (1967-1976)	
HC reduced	25%
Ozone reduced	25%
Los Angeles (1967-1974)	
HC reduced	18%
Ozone reduced	19%

ANALYSES OF AIR QUALITY and emission trends in California indicate that changes in hydrocarbon emissions are consistent with changes in ambient levels of ozone.[6,7]

AN I/M PROGRAM TO SAVE FUEL

The same corrective maintenance which lowers tailpipe emissions can also result in improved fuel economy. Studies show that the repair of 1981 and later model year cars which have computer failures can result in fuel economy improvements averaging 15 percent ($135 fuel savings per year). However, the Portland study showed that the repair industry in Oregon does not achieve a net fuel economy improvement from the pre-1981 failed cars.

The key to achieving fuel economy improvements is properly performed maintenance. When Portland area mechanics were trained in proper diagnosis and repair of high emitting vehicles, they were able to improve the fuel economy of the pre-1981 failed cars.

Large fuel economy improvements can also come from proper tire inflation. The average tire is 1.8 pounds per square inch (psi) underinflated. Fleetwide fuel economy can be improved 1.1 percent if all tires are inflated to the vehicle manufacturer's "soft-ride" specification (28 psi); a 3 percent fuel economy improvement can occur if tires are inflated to the tire manufacturer's limit of 32 psi. An inspection program provides a good opportunity to achieve this potential benefit.

ANNUAL FUEL ECONOMY BENEFITS PER INSPECTED VEHICLE FROM THE OPTIMAL I/M PROGRAM

PROGRAM COMPONENTS	DOLLAR SAVINGS	GAS SAVINGS	NATIONWIDE GAS SAVINGS (million gallons)
Basic I/M Program	$2.74	0.29%	83.6
More Effective Test	$1.11	0.12%	33.8
Mechanic Training	$4.18	0.46%	130.2
Tire Pressure Checks	$14.88	1.59%	453.8
OPTIMAL PROGRAM: TOTAL	$22.91	2.46%	701.4

An optimal I/M program would incorporate the most effective exhaust test (identifying a greater number of 1981 and newer vehicles with computerized fuel system failures), mechanics training, and tire pressure checks to achieve the greatest fuel savings for the entire fleet. It is interesting to note that a $14 fuel savings (61% of the maximum possible savings) will exactly offset the total cost of the I/M program.[8]

COST TO THE AUTOMOBILE OWNER

There are two costs to the auto owner associated with I/M: the inspection fee and the repair cost. Each owner will pay an annual fee for inspection; only those failing the inspection will incur repair costs. These repair costs can be partially to completely offset by fuel economy improvements resulting from the maintenance performed.

Fees

Inspection fees in currently operating programs range from $2.50 to $17. The fee is set to make the program self-supporting by covering both the fixed and operating costs of the program including facilities, equipment and administration. Fees for I/M programs beginning in 1983 are estimated to be $8.00 to $10.

OPERATING PROGRAM INSPECTION FEES

Arizona	$5.75
California	$11.00
Nevada	$11-17*
New Jersey	$2.50
Oregon	$5.00
Rhode Island	$4.00°°

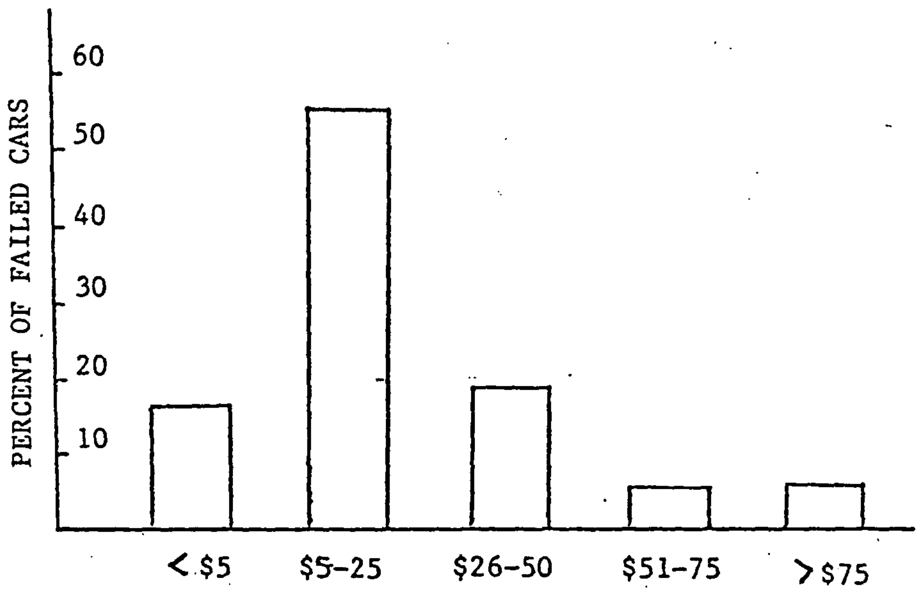
* Includes mandatory adjustment
°° Includes safety inspection

Repair Costs

Between 15% and 30% of pre-1981 vehicles will fail an inspection and require repairs. The most common maintenance includes repair, replacement or adjustment of the carburetor, spark plugs, timing, choke, dwell, idle speed or air filter. Average repair costs reported from operating I/M programs range from $17 to $30.

COST TO THE AUTOMOBILE OWNER
(continued)

DISTRIBUTION OF REPAIR COSTS FOR FAILED CARS IN EPA'S PORTLAND STUDY



THE MAJORITY OF CARS in the Portland Study required only minor tune-up work to pass the state inspection test. The distribution of costs is skewed heavily to the low end with 50% of the sampled 1972-1977 vehicles incurring costs of $14 or less. A small number of cars incurred high maintenance costs, bringing up the mean of the sample to $29, but 90% of the cars were repaired for $70 or less. Many I/M programs will limit the cost of required repairs to under $75. [4]

Some 1981 and later model year cars will also require repair of ignition problems, vacuum leaks, and tampering of some emission control components with older cars. In addition, some of the newer cars will require repairs of their computer controlled fuel metering systems. These repairs will range from simply reconnecting a wire to a sensor or actuator to replacing a sensor, an actuator, or the computer. Preliminary data from computer controlled cars participating in California's I/M program indicate that the average repair cost is likely to be approximately $30.[9]

COST-EFFECTIVENESS OF I/M

The cost-effectiveness of an air pollution control strategy is the measure of that strategy's cost relative to its ability to remove a particular pollutant from the atmosphere. Cost-effectiveness estimates allow air quality planners to evaluate and compare various strategies which might be implemented to attain air quality standards. The cost-effectiveness of I/M is estimated to be $581 per ton of hydrocarbons and $53 per ton of carbon monoxide reduced. This compares favorably with that of other stationary and mobile source strategies for reducing emissions.[9]

I/M COST-EFFECTIVENESS OVER A FIVE YEAR PERIOD (1983-1987)

POLLUTANT	ALLOCATED I/M COST (million dollars)	MASS REMOVED BY I/M (tons)	COST-EFFECTIVENESS (dollars/ton)
Hydrocarbons	27.05	46,500	581
Carbon monoxide	27.05	512,600	53

I/M COST-EFFECTIVENESS WAS MODELED by having an example fleet of one million vehicles participate for five years in a hypothetical I/M program starting in 1983. The design of the hypothetical I/M program was typical of programs now being implemented. Total costs were determined by adding together repair costs and inspection costs for the five year period, then subtracting fuel savings attributable to the program. Emission reductions were obtained using MOBILE2 (EPA's model for predicting the emission behavior of a fleet of vehicles with and without I/M). Because most areas which are implementing I/M require reductions for both hydrocarbons and carbon monoxide, the costs of the program have been allocated equally to both pollutants.[9]

Minimum fuel savings attributable to a basic I/M program are included in the cost effectiveness estimates given above. By enhancing the program to achieve the greatest fuel economy improvement from the fleet of inspected vehicles, it is possible to entirely offset the inspection and repair costs and to realize a net savings.[8,9]

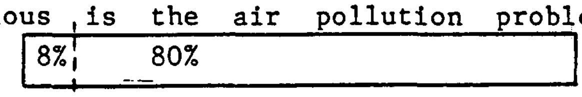
Planners must exercise caution in comparing cost-effectiveness values for different control measures. The presence of air pollution control strategies with greater or lesser cost-effectiveness estimates than other strategies does not mean that there is a cut-off cost-effectiveness above which no strategy is implemented. The size of the emission reductions available from a strategy must also be considered. Although a strategy may have a low cost-effectiveness estimate, it may not produce sufficient emission reductions to allow attainment of air quality standards. I/M produces substantial emission reductions which contribute to expeditious attainment of ambient air quality standards.

PUBLIC OPINION ON AIR POLLUTION

Prior to 1970 and Earth Day, little public polling was done on environmental issues. The number of public polls then increased until the early seventies, when they became a regular occurrence. These polls have become very sophisticated over the years, requiring individuals to make choices between environmental protection and higher prices, more taxes, lower economic growth, and higher unemployment.

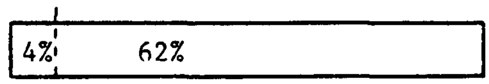
PUBLIC ATTITUDES TOWARD ENVIRONMENTAL PROTECTION

"How serious is the air pollution problem?"



Not serious   Somewhat serious or very serious

Do you consider yourself active, sympathetic, neutral or unsympathetic to the environmental movement?"



Unsympathetic   Active or sympathetic

THE LATEST NATIONAL SURVEY conducted by Resources For The Future for the President's Council on Environmental Quality demonstrates that environmental protection enjoys continued strong public backing. 1,576 adults were interviewed in person between January and April 1980. [10]

A survey conducted in New York by Social Data Analysts for Hamilton Test Systems suggests that urban area residents understand the connection between automobiles and air pollution, and are willing to participate in clean-up efforts. 500 New York City area residents were interviewed by telephone in December 1980.

RESPONSE OF NEW YORK RESIDENTS TO QUESTIONS ON POLLUTION CONTROL

"What do you think are the major causes of air pollution in the New York metropolitan area?"

Auto emissions	86%
Factories, light co.	56%
Trucks, buses, taxis	45%

"Do you think there should be laws making it illegal for both business and individual citizens to pollute the air?"

Yes	71%
No	14%
Business only	2%

PUBLIC OPINION ON I/M

Several public polls have been conducted in areas where I/M programs are either planned or operating. The results of some of these polls are presented below.

ARIZONA

(Arizona State University, Telephone survey N*=600, May 1979)

"Arizona has had an emission inspection program for cars and trucks for about three years now. Do you personally feel the program should be kept or repealed?"

Keep	58%
Repeal	42%

CALIFORNIA

(Gannet News Service, Telephone survey N=824, October 1980)

"California voters support the idea of smog and safety inspections for their cars."

For	58%
Against	42%

NEW JERSEY

(New Jersey Motor Vehicle Inspection Study Commision, N=3245, February 1978)

"In the past, for economic reasons there have been recommendations to eliminate our mandatory vehicle inspection program. Do you agree or disagree?"

Keep	83%
Eliminate	16%

NEW YORK

(Social Data Analysts, Telephone survey N=500, December 1980)

"Starting in January 1981, cars will have to be inspected to find out whether they are safe and if they are polluting the air too much. The cost of the inspection will go up from $6 to $12. Do you think that this program is a good idea?"

Yes	82%
No	17%

OHIO

(Cleveland Plain Dealer, Telephone survey N=5256, November 1980)

"Do you favor the proposal to require mandatory inspection of the exhaust systems of all cars to curb pollution?"

Yes	52%
No	31%

RHODE ISLAND

(Rhode Island Lung Association, Telephone survey N=300, April 1979)

"Do you think that exhaust emission tests on automobiles are important?"

Yes	87%
No	8%

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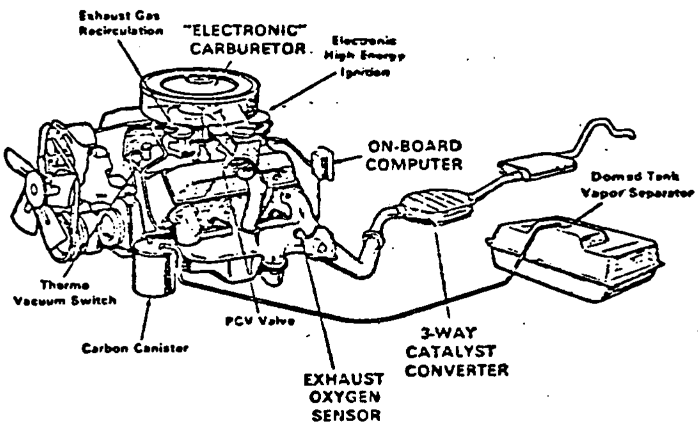
* N is the sample size

I/M AND NEW TECHNOLOGY

Stringent new car emission standards for 1981 along with the need for better fuel economy have brought about revolutionary changes in automobile engine technologies. An issue that has been the subject of much discussion is the need for and effectiveness of I/M for the 1981 and later fleet.

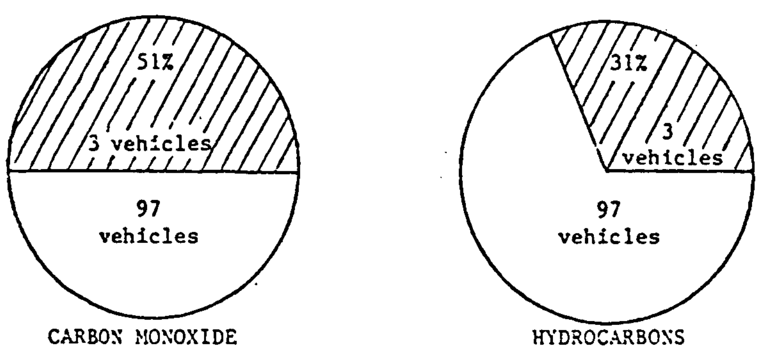
"NEW TECHNOLOGY" ENGINES AND EMISSION CONTROLS

Many new cars will employ a small computer that receives signals from a variety of sensors which monitor key engine variables such as coolant temperature, throttle position, engine speed, and air/fuel ratio. Then, the computer automatically adjusts engine functions bringing the engine into optimal working condition. The automatic adjustment also allows the new catalysts to most effectively convert all three automobile pollutants to harmless by-products.



Data from California where new technology vehicles were introduced in small numbers as early as 1977 and then introduced fleetwide beginning in 1980, reveal two important findings. First, the rate of emission control system failure is low for the vehicles tested to date. Second, failures that do occur result in emission levels up to ten times the emission standard for those cars.

FRACTION OF NEW TECHNOLOGY FLEETWIDE EMISSIONS CONTRIBUTED BY CARS WITH CONTROL SYSTEM FAILURES



BEFORE THEY ARE ONE YEAR OLD, 3 of every 100 vehicles will have a computer control failure, and these 3 vehicles will account for one half of the new technology fleetwide CO emissions and one third of the HC emissions.

I/M AND NEW TECHNOLOGY (continued)

I/M short tests are capable of identifying a significant portion of the excess emissions from computer controlled fleets. On the basis of limited data, repair of vehicles with computer problems results in large emission reductions. Substantial fuel economy improvements (15% on the average) are also associated with repair of failed computer systems.

Traditional problems such as improper maintenance, misfueling, tampering, and ignition related malfunctions will also be occurring in the 1981 and later fleet. It is estimated that from 5% to 10% of the fleet will fail an I/M test each year due to either the traditional causes or a computer failure.[11]

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