IMS-002/QA-1

Questions and Answers Concerning the Technical Details of Inspection and Maintenance

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Office of Air, Noise, and Radiation
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1. BENEFITS

a) Air Quality - One question often asked is, will I/M programs really help to solve the CO and oxidant problems? New Jersey has concluded that an annual reduction in average statewide CO concentrations of 3 percent is due to I/M. Is other information available on measurable air quality benefits? Will there be any observable oxidant benefits from I/M in the near future?

Air quality data now available strongly suggest inspection and maintenance programs will result in improved air quality.

A recent study of seven years of carbon monoxide (CO) data in New Jersey has led researchers to conclude that the I/M program, which began in 1974, and the increasingly stringent new car emission standards are together responsible for a 28 percent decrease in ambient carbon monoxide levels. I/M was shown to increase the rate of improvement of ambient CO levels. The University of Wisconsin statisticians found that the improvement in air quality occurred independent of year-to-year weather patterns and at a time when traffic volume was increasing.

There is strong evidence that the general strategy of controlling automotive emissions is effective in reducing ozone levels. Officials from the South Coast Air Quality Management District attribute most of the credit for a decreasing trend in ozone levels in the Los Angeles Air Basin to controls on auto emissions. The area's mean ozone concentration has fallen steadily from a high of 0.228 ppm in 1956 to 0.125 in 1975. In addition, the area has not experienced a Stage III ozone alert (0.50 ppm) since 1973.

At this time, there are not studies which specifically relate the effects of tailpipe emission reductions resulting from I/M to reductions in ozone levels. This is due to the complication of factors affecting oxidant levels such as meteorology, pollutant transport, and the impact of stationary hydrocarbon sources. Several more years of ozone data in I/M areas will be required before this analysis can be made.

b) Emission Reductions: (FTP) - Arizona, New Jersey and Oregon have reported substantial reductions in idle emissions. Arizona has also found reductions in the two cruise modes for which it tests. How do these results compare to reductions over the entire driving cycle?

It is reasonable to expect HC and CO emission reductions at idle to carry over to a typical urban driving cycle since urban driving contains a significant portion of idle mode operation. Data from the Portland Study substantiate this expected carry over in emission reductions from the idle test to the Federal Test Procedure. As the table below indicates, the vehicles which failed the Oregon state inspection test (an idle test plus a brief physical inspection) realize significant emission reductions over the entire Federal Test Procedure (FTP) driving cycle as well as at idle.

Initial Emission Reductions -
Vehicles Failing Portland Short Test

	1975-77 Models			1972-74 Models		
	Initial	After Maint.	% Change	Initial	After Maint.	% Change
Idle HC (ppm)	325	80	-75.4	328	189	-42.4
Idle CO (%)	3.09	0.17	-94.5	3.20	0.72	-77.5
FTP HC (gpm)	2.87	1.60	-44.3	4.04	3.02	-25.2
FTP CO (gpm)	40.87	19.36	-52.6	55.30	34.41	-37.8

Data on loaded test FTP reductions occurring as a result of I/M maintenance are not available from an operating I/M program, since no I/M program currently uses a loaded test to pass or fail cars. (Arizona performs the loaded test, but a vehicle is passed or failed only on the basis of the idle portion of the test.) EPA's surveillance programs show a relationship between high loaded mode emission values and high FTP emissions. Thus, one would expect to see emission reductions over the full FTP as a result of performing maintenance which reduces emissions over the loaded test.

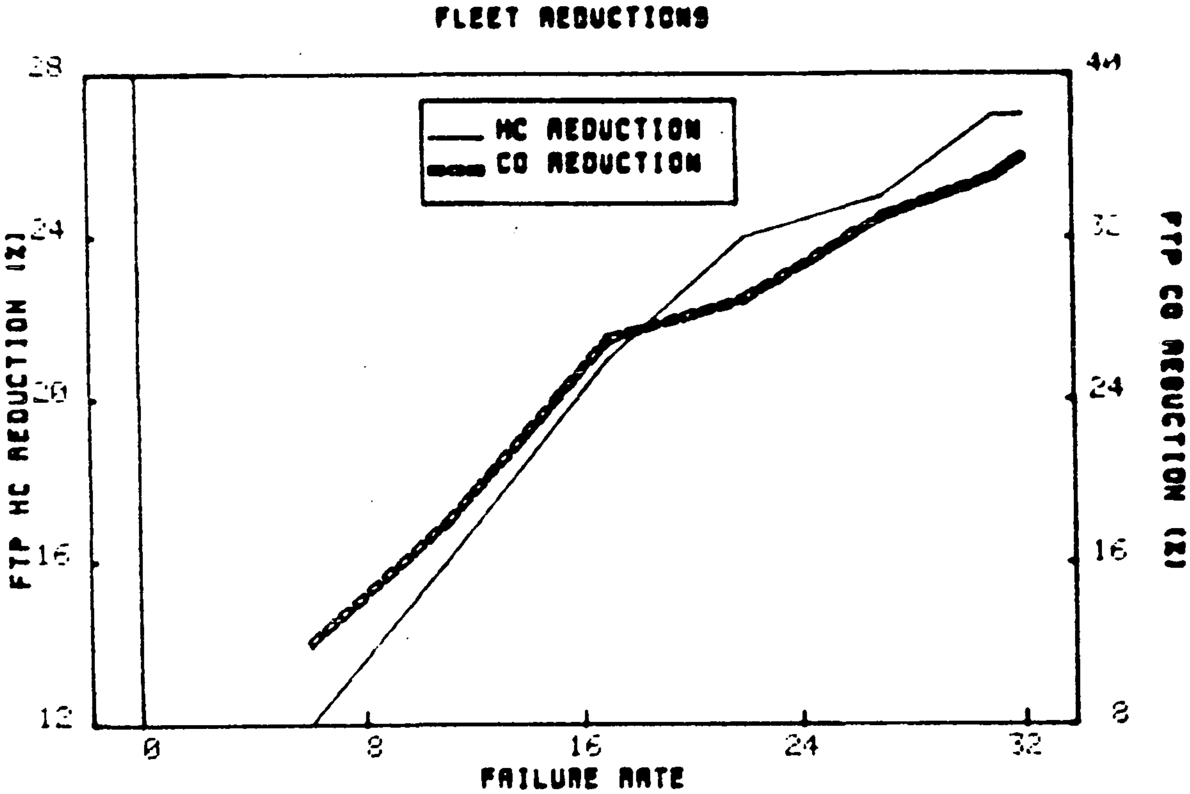
c) Emission Reductions: (Failure Rate) - Is there a relationship between the failure rate in existing programs and the emission reductions they achieve?

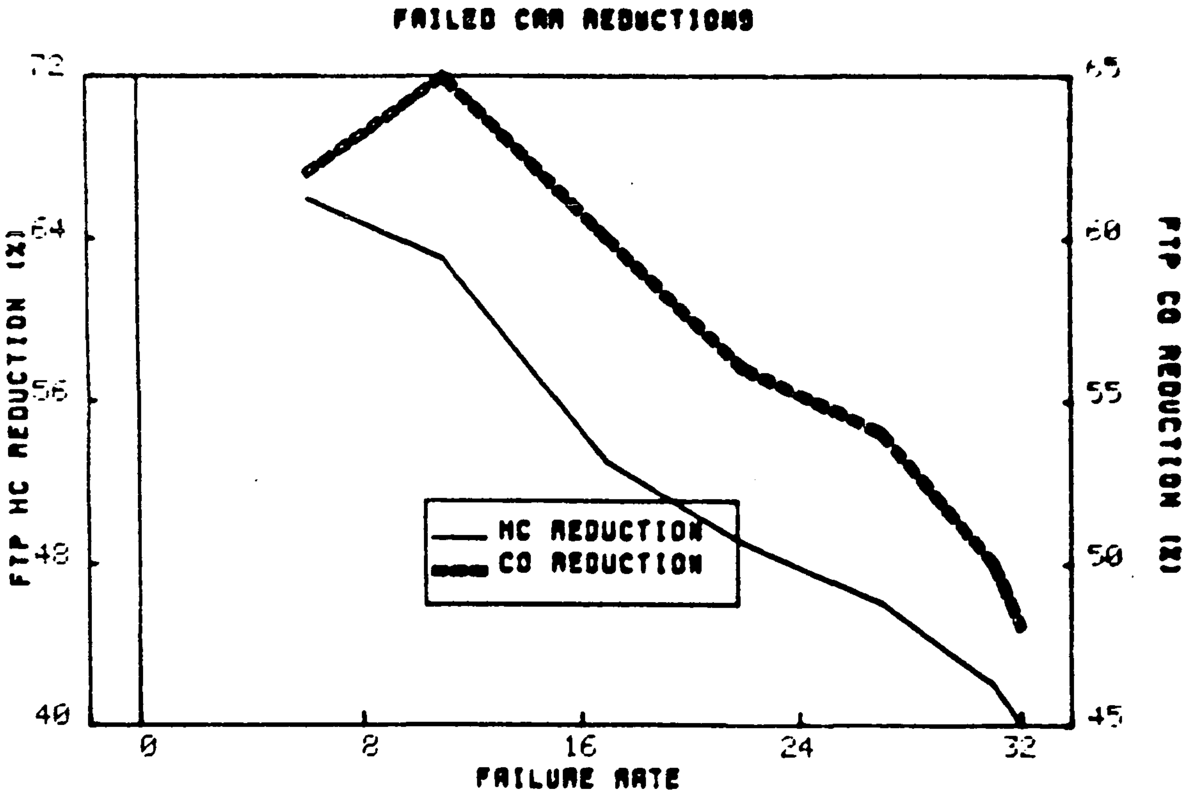
The Portland study data for 1975-1977 model year cars have been analyzed to help determine the effect of failure rate on I/M program effectiveness and average cost of maintenance. The results of the analysis are summarized in the table below. The 31% failure rate case is based upon an application of the idle HC and idle CO cutpoints used by the Oregon State inspection test. The other five cases (27% to 6% failure rate) were derived by moving cutpoints for idle HC and CO progressively higher in a systematic manner, thus simulating less stringent programs.

I/M Reductions and Costs

	Fleet % Reductions		Failed Cars				
			FTP HC		FTP CO		
Failure Rate	FTP HC	FTP CO	Before Maint. Level	% Reduct. due to Maint.	Before Maint. Level	% Reduct. due to Maint.	Average Maint. Cost
31%	27%	35%	2.67	42%	38.57	50%	$22
27%	25%	33%	2.85	46%	40.71	54%	$22
22%	24%	29%	3.10	49%	43.36	56%	$23
17%	21%	27%	3.26	53%	47.73	60%	$25
11%	16%	18%	3.73	63%	50.75	65%	$27
6%	12%	12%	4.66	66%	61.39	62%	$34

I/M Reductions due to Maintenance for Various Failure Rates*





*Based on EPA's Portland Study data, 1975 to 1977 models.

Emission reductions for each failure rate have also been plotted in the following figures. The top figure gives fleetwide reductions while the bottom figure gives reductions for the failed fleet. As would be expected, fleetwide emission reductions increase with increasing failure rate while emission reductions per failed car decrease with increasing failure rate. This phenomenon supports the argument that as fewer cars are failed, those failing are the highest emitters. The data also show that repair cost is mildly affected by failure rate.

d) Emission Reductions: (Appendix N) - Are the Appendix N reductions proven in the field?

EPA's Portland Study is the first complete evaluation of an operating mandatory inspection and maintenance program. Based on the data now available (emissions measured over nine months following inspection and repair, then extrapolated to one year as shown in the attached graphs), the emission reductions being experienced in Portland are greater than those predicted by Appendix N. (This comparison is based on a fleet of 1975-77 models undergoing I/M in which the 1975 models had one inspection and the 1976-77 models no inspections prior to entering the study.) The results are shown below.

Preliminary Comparison of Portland I/M Effectiveness to Appendix N Estimates

	Fleet Reductions	
	HC	CO
Portland Study	16%	35%
Appendix N	13%	25%

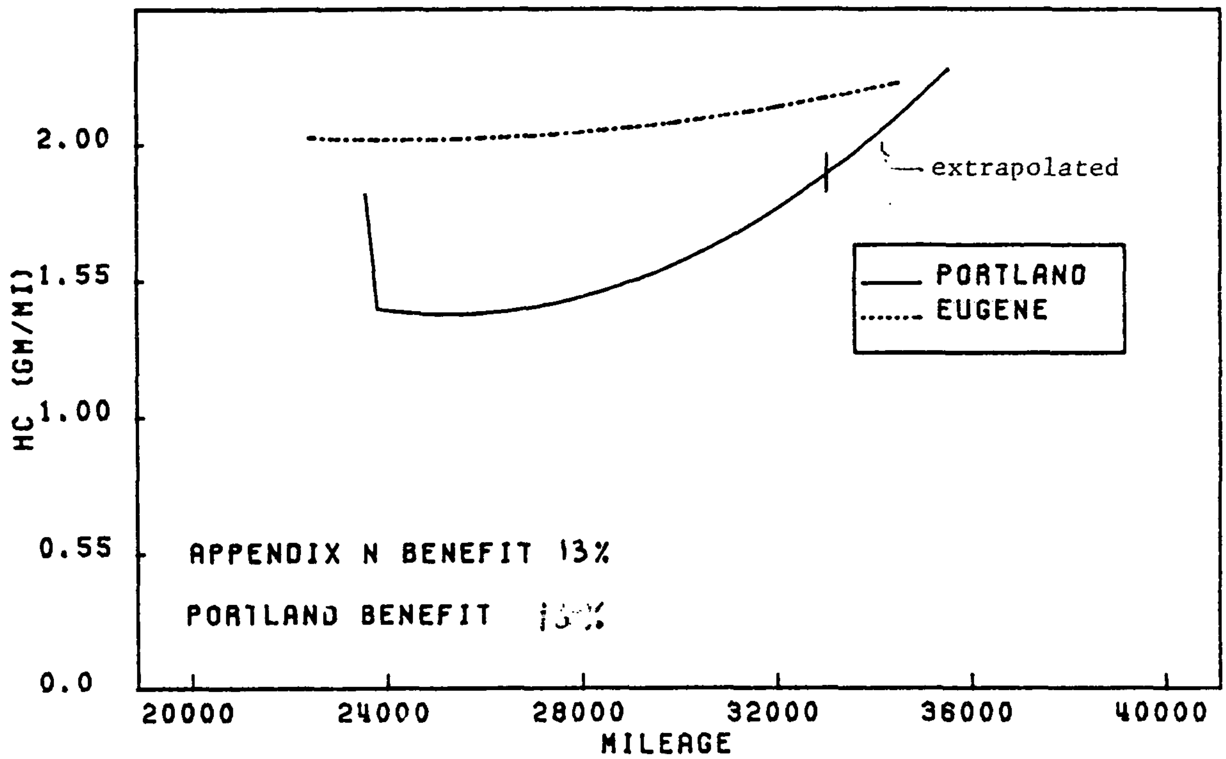
The above values for Portland may change slightly as the fourth quarter deterioration data become available, thus the comparison has been labeled preliminary.

e) Emission Reductions: (Waivers) - Is program effectiveness compromised by such factors as waivers?

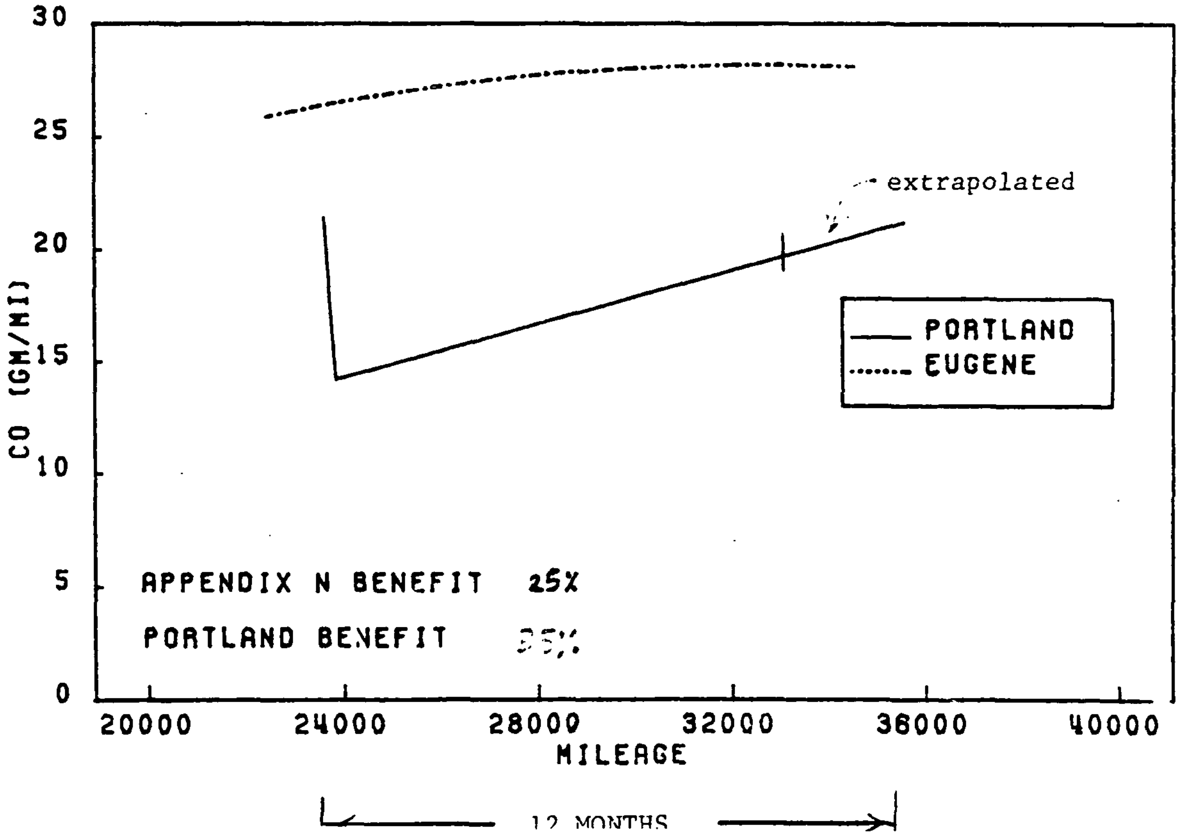
This question will be answered in two parts: 1) waivers based on the age of vehicle; 2) waivers based on the cost of repair of failed vehicles.

AGE WAIVERS: Given a typical I/M program with 30% stringency, no mechanic training, implemented in 1982 and evaluated in 1987, the reduction in HC and CO due to I/M is estimated to be 28% and 30% respectively. The effect of exempting any group of vehicles from the I/M process is shown in the following figure and summarized below.

HC EMISSION LEVEL ESTIMATES FOR PORTLAND AND EUGENE (75-77)



CO EMISSION LEVEL ESTIMATES FOR PORTLAND AND EUGENE (7



Effect of Age Exemptions

Exempted Model Years	Emission Reduction, % HC	CO	% Fleet VMT Exempted (1987)
None	28	30	0
pre '68	28	30	.4
pre '75	24	25	4.8
pre '80	15	9	25.0

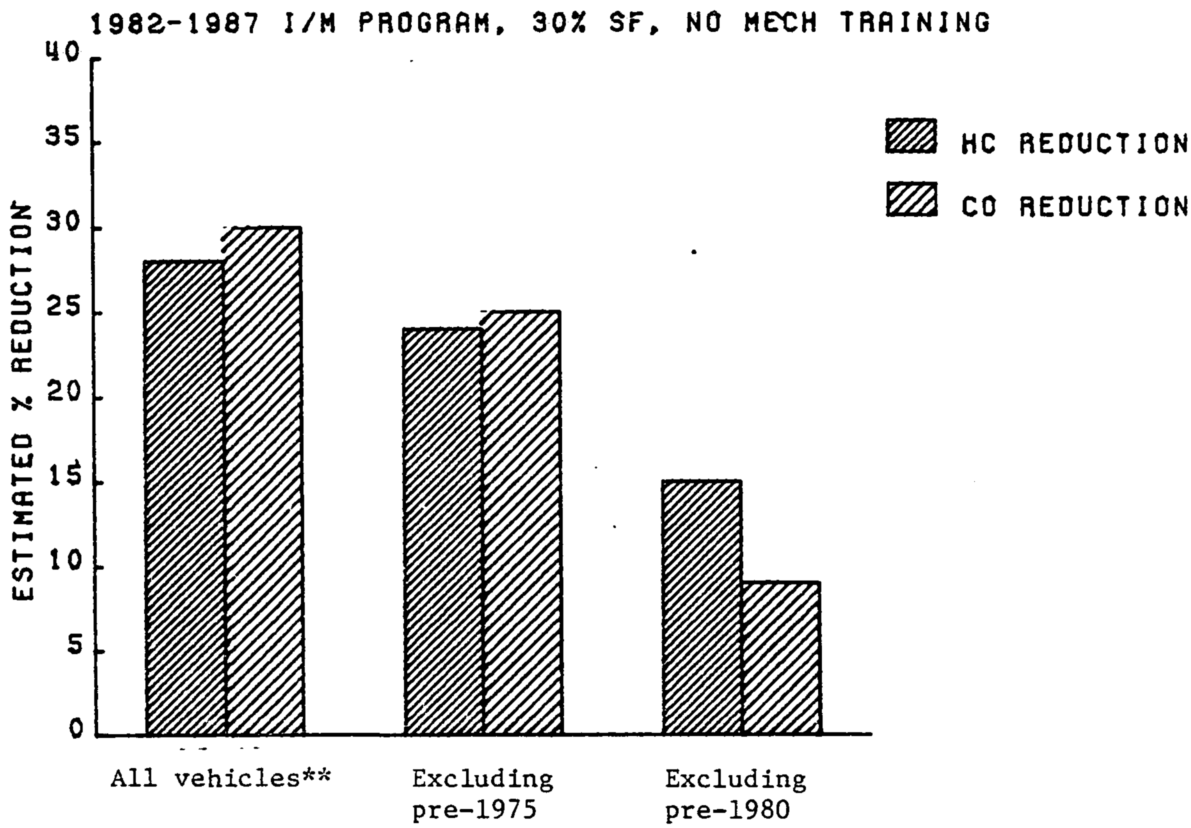
These data show a negligible effect on I/M effectiveness of exempting pre-1968 vehicles while program effectiveness is reduced significantly for the other exemptions shown. For the pre-1980 exemption in this scenario, the 25% emission reduction by 1987 (minimal program requirement) is not achievable.

COST CEILINGS: Portland data have been analyzed to help determine the effect of cost ceilings on I/M program effectiveness. The results of the analysis are summarized in the table below. For maintenance cost ceilings from $25 to $150, failed vehicles with repair costs above that ceiling were identified. For example, 4% of the 94 1972-74 model year vehicles in the sample requiring maintenance had reported maintenance costs greater than $150 and 32% of these 94 vehicles had reported maintenance costs greater than $25. HC and CO emission reductions were calculated for each cost ceiling. It was assumed that vehicles above the cost ceiling received no maintenance and their emission levels thus remained unchanged. If an I/M program requires that maintenance expenditures up to the cost ceiling be performed, the impact on program effectiveness presented below would be less.

	1972-74 Model Year Failed Cars			1975-77 Model Year Failed Cars		
		% Reduction			% Reduction	
Cost Ceiling	% within Cost Limit	FTP HC	FTP CO	% within Cost Limit	FTP HC	FTP CO
No Limit	100%	25	37	100%	40	48
150	96	24	36	100	40	48
100	91	14	35	96	36	46
75	89	9	30	94	36	46
50	83	9	28	88	31	40
25	68	6	22	74	20	31

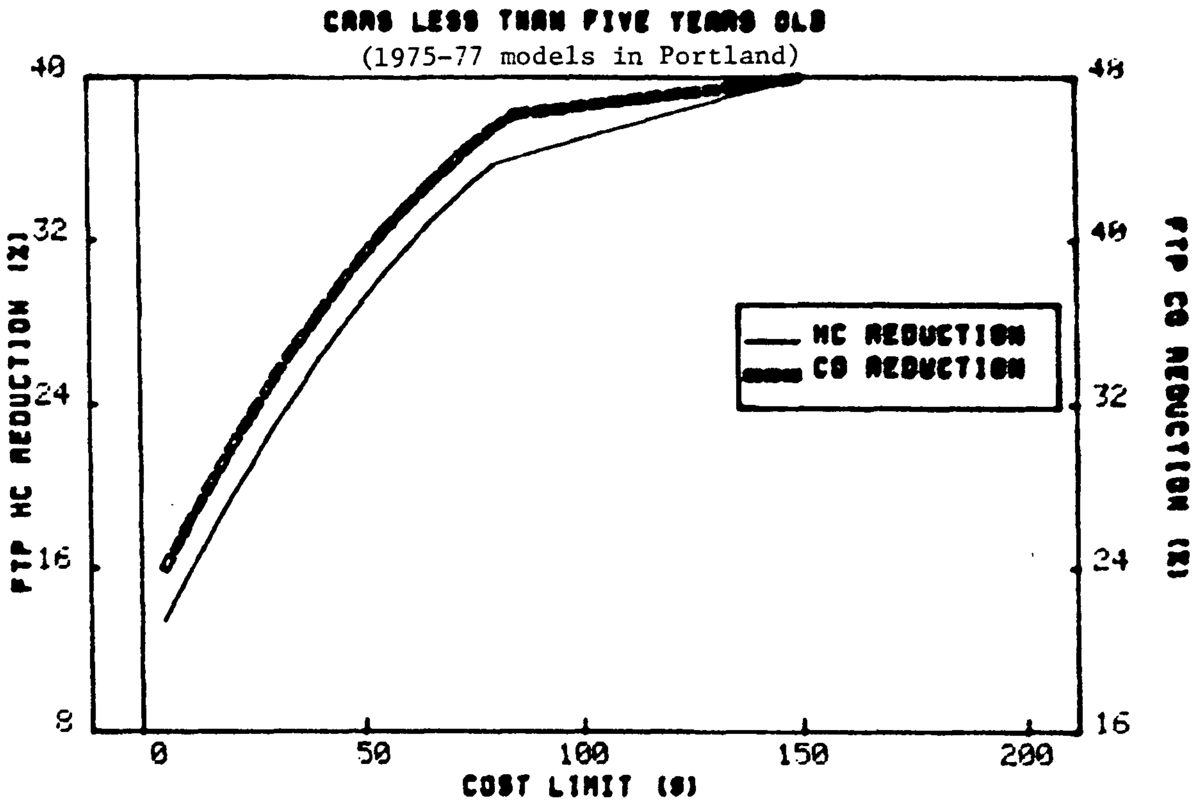
The data have been smoothed and plotted in the following figures. For newer cars, cost ceilings above $75 have only a minimal effect on fleetwide emission reductions. For older cars, the ceiling must be in the $100 - $150 range or greater or avoid a reduction in program effectiveness.

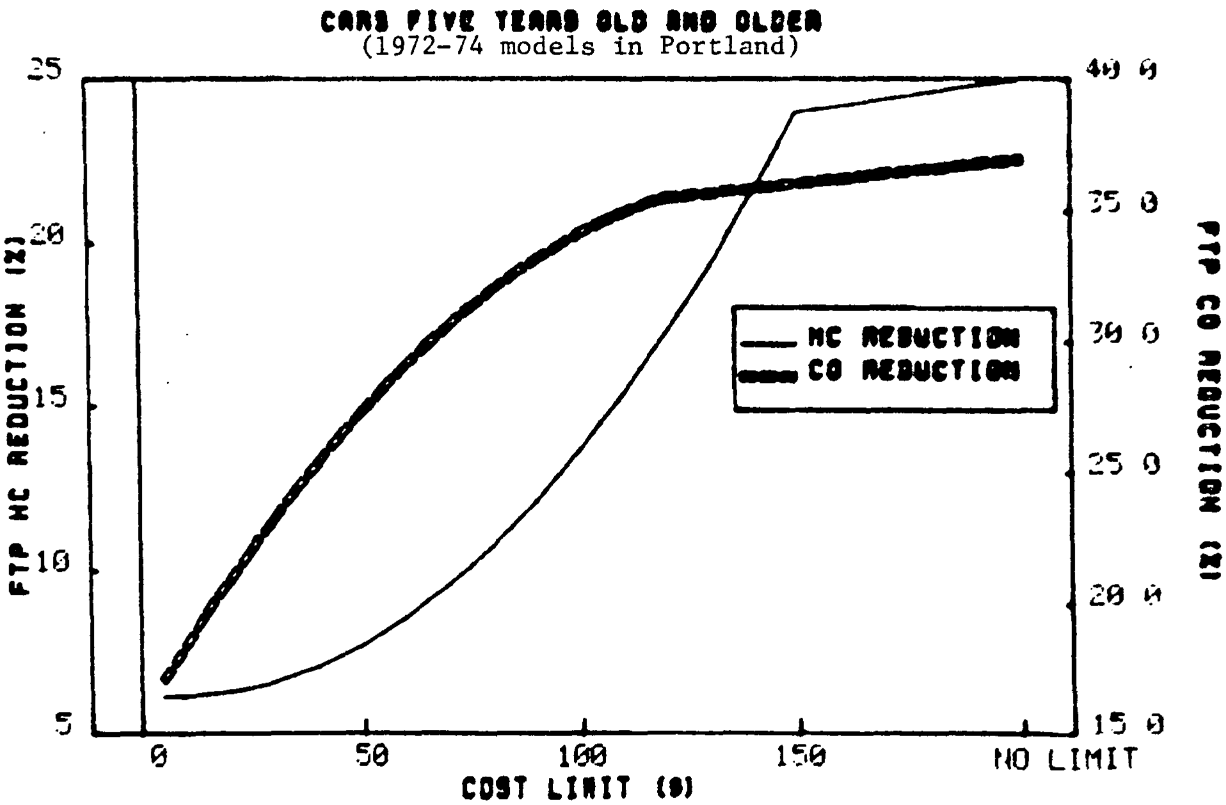
I/M FLEET EMISSION REDUCTION WITH AGE WAIVERS*



*1982-1987 I/M program, 30% stringency factor, no mechanic training.
**Benefit when excluding pre-1968s is the same as benefit for all vehicles.

I/M Reductions with Cost Ceilings





f) Emission Reductions - Is program effectiveness compromised by such factors as private garage reinspection?

Centralized, garage based, and centralized with garage retest authority programs have the same potential for emission reductions. Where private repair facilities become involved with testing or retesting for compliance, the potential for more variable test results or fraud exist. To overcome this, the state must establish a strong quality control and enforcement program. Periodic inspections of repair facility equipment and personnel skills, independent testing of vehicles recently repaired, and a good data collection system in which repair facility test results can be compared and matched to other data surveys can assure that program effectiveness is not reduced.

g) Emission Reductions: (Ambient Effects) - Is program effectiveness compromised by such factors as high or low ambient temperatures?

The I/M benefits as set forth in MOBILE1 are based on emission levels and reductions as measured by the Federal Test Procedure. This test is run at ambient temperature ranging from 20 to 30°C (68 to 86°F). The test is divided into portions which represent cold start, hot start, and stabilized, warmed-up operation. In areas with high or low ambient temperatures, the percentages of cold start, hot start, and stabilized operation will be different than assumed under FTP conditions (21% VMT cold start, 52% VMT stabilized, and 27% VMT hot start operation). For areas with higher than FTP temperatures, more stabilized and hot start operation and less cold start operation will exist. Since high temperature (up to about 100°F) does not significantly affect emissions during any mode of operation, the reductions due to I/M at high temperatures should be greater than reductions seen at 75°F. The reductions at 75°F (absolute and percentagewise) are given below.

Reductions due to I/M During Stabilized/Hot Start Operation (1975-77 Model Year Failed Cars in Portland) 75°

	Absolute Reduction (gm/mi)		% Reduction	
	HC	CO	HC	CO
Cold Start	0.80	10.44	23%	23%
Stabilized	1.39	26.89	55%	67%
Hot Start	0.80	10.35	41%	46%
Overall	1.27	21.51	44%	53%

For areas with cold temperatures, there will be more cold start operation, less hot start, and perhaps less stabilized. Since cold temperature has been shown to affect emissions during cold start operation, I/M's effect at cold temperatures (particularly with respect to CO, since HC is not a problem below about 50°F) is not adequately indicated by Portland data alone. Although data at cold temperatures are limited, all available data have been collected on 1975-77 model year cars: cars have been classified as "as-received" and as "tune-up." The as-received cars have been used to reflect CO emission levels of failed vehicles. Since these cars were in various states of tune, they likely underestimate the emissions of those vehicles which would have failed an I/M test. The results of comparing cold start emissions for the "as-received" and "tuned-up" fleets are presented below, and indicate, based on these limited data, that I/M will have a substantial effect on CO emissions at least to temperatures as low as 20°F.

Estimated CO Reductions Due to I/M
During Cold Start Operation
(1975-77 Model Year Cars)

	Absolute Reduction (gm/mi)	% Reduction
20°	23	13%
30°	37	26%
60°	27	35%
75° (Portland)	10	23%

h) Emission Reductions - Is program effectiveness compromised by such factors as a high volume of transient, non-inspected vehicles in a region?

I/M's effectiveness is based on the population of inspected vehicles. Therefore, if 10% of the vehicles in a region are transient and non-inspected, the corresponding fraction of miles traveled by these vehicles should be included in the 'without I/M' emission inventory calculation, and should be represented in the 'with I/M' emission inventory calculation with unchanged emission levels. The resulting calculation will determine any reduction in air quality benefit from I/M. As I/M programs become more widespread (over 50 programs are expected to be in operation by 1983), more of the transient vehicles will have been inspected in the home state, thus the impact of transient vehicles will be reduced.

i) Fuel Economy - Can any fuel economy benefits be expected from I/M, and if so, how much? Earlier studies have shown savings would average 3 to 5 percent for serviced vehicles. Now it appears that the average mechanic will not adjust a failed car to achieve any fuel benefit. What happened to the previous assertion?

The fuel economy benefit associated with the typical repairs performed as a result of an I/M program depends on the skill of the mechanic and the type of vehicle. Numerous studies have shown that maintenance performed to manufacturer's specifications can result in a 3 to 4 percent fuel economy improvement for current technology vehicles. EPA's study of the Portland I/M program, however, has indicated that a fuel economy benefit is not being realized. It is believed that the lack of training specific to proper emission control maintenance is a factor. Thus for an area which does not have widespread mechanic training specific to emission control maintenance, no fuel economy benefit is expected for current technology cars. For areas with trained mechanics, a fuel economy improvement of 3 to 4 percent for repaired cars can be expected.

For future technology cars, the situation is expected to be somewhat different. Beginning with model year 1981 (1980 in California), passenger cars will commonly utilize mini-computer controlled fuel and ignition systems. Failures associated with these systems are likely to cause significant fuel economy penalties. While the frequency of failures is not currently known, the per-vehicle fuel economy improvement due to repair, based on tests of several prototype vehicles, is expected to be 10 to 20 percent.

j) Maintenance Costs - Will overall maintenance costs be reduced with I/M?

We do not have data available upon which to incorporate emission oriented maintenance performed in the absence of I/M into a net I/M cost estimate. Some emission maintenance now occurs; an example is replacement of spark plugs. We can not, however, conclude overall vehicle maintenance will be reduced as a result of I/M.

Two qualitative arguments shed light on this question. First, I/M has the objective of increasing the maintenance performed on the fleet, thus it can be argued I/M will increase maintenance costs. From the opposite point of view, the idle test acts as an indicator of the need for maintenance and provides diagnostics. Thus it can also be argued that with properly trained service personnel, unnecessary maintenance will be reduced and the quality of maintenance performed will increase. Since these are only qualitative arguments, we have chosen to consider the cost of inspection and repair as additional costs of maintenance.

Put into perspective, the average cost to the motorist for I/M is between $10 to $15 per year. This compares to a Motor and Equipment Manufacturers Association estimate of $215 of general maintenance and repairs performed each year per vehicle. Thus the increase in maintenance cost, in the extreme, is less than 10 percent.

k) Vehicle/Engine Life - Will the useful life of the engine or entire vehicle be enhanced by I/M?

There are no hard data to quantify whether vehicle/engine life increases due to I/M related maintenance. It is highly unlikely that proper maintenance will decrease engine life. In some areas experience and technical judgment indicate that engine or component life may be extended due to proper maintenance. Examples are carburetor adjustments reducing carbon buildup, valve adjustments extending valve life, and ignition maintenance preventing misfires which may damage the catalyst.

1) Loaded/Idle Tests - What actual benefits can be derived from loaded testing? Are they worth the extra time and cost? Do you recommend loaded or idle testing?

An evaluation of the idle vs. loaded test involves two aspects: 1) the ability of each test to identify the worst polluting vehicles, and 2) the emission reduction achieved when failed cars are repaired to meet the short test standards. Although EPA is still evaluating the loaded vs. idle test, it is clear from the Portland study that the idle test does an excellent job of screening the worst emitters of HC and CO. Maintenance performed by the mechanics in the Portland area appears to be effective in reducing FTP as well as idle emissions. High emitters of NOx are not successfully identified by the idle test.

The benefit of the loaded test for areas with only HC and/or CO air quality problems centers around the more complete diagnostics available from this test. Although the idle test detects most failures associated with current technology cars, some carburetor and high speed ignition failures can only be detected with the loaded mode test. (Loaded mode testing is expected to be more valuable for the electronic controlled advanced technology vehicles of the early 1980's. It is also expected, however, that non-loaded diagnostic methods will be available as an alternative.) Repair of these defects will result in an increased HC and CO emission reduction. The CARB Riverside program indicated that mechanics were not able to translate the diagnostics into larger emission reductions or more efficient repairs. Thus to realize additional HC and CO benefits, proper mechanic training appears to be necessary. Another potential consumer benefit may be a reduction in unnecessary repairs resulting from the better diagnostics.

For areas which have NOx problems, there are two possible alternatives for using I/M as a control strategy. One is to add a physical inspection of the EGR system to an idle test regime. The other is to perform a loaded mode test. The idea behind the physical inspection of the EGR system is to identify only the cars which have obviously malperforming EGR systems and require maintenance just on this group. The other approach is to measure the NOx exhaust emissions at a high speed/load condition and establish pass/fail criteria based on these measurements.

A comparison of these two approaches from the standpoint of effectiveness and cost is currently underway. Some preliminary information on the loaded test, based on the Portland study, is available. These results indicate that at least the high speed mode of the Federal Three-Mode test is capable of identifying the worst NOx emitters. The following table presents the FTP NOx levels of Portland area vehicles passing and failing the high speed test for NOx. These data show the failed cars had emission levels 60% higher than those passing the loaded test. (The high speed cutpoints used were 2430 ppm for 1975-76 models and 2165 ppm for 1977 models.)

Effectiveness of the Loaded Test in
Detecting High NOx Emitters
(High Speed Mode of Federal 3-Mode Test)

	Loaded Short Test Failure Rate		
	10%	20%	30%
FTP emissions, passed cars	2.40 gpm	2.28 gpm	2.05 gpm
FTP emissions, failed cars	3.96	3.67	3.47

No I/M program currently requires maintenance to be performed in response to loaded test standards. Therefore, no appropriate after maintenance data on failed vehicles exist. However, data from EPA's Restorative Maintenance program indicates that FTP NOx emissions on 1975-76 model year cars with EGR system or related failures are reduced to approximately 2.6 gpm as a result of maintenance. This after maintenance level was applied to the Portland area 1975-76 models which were failed by the loaded test. For 1977 models where the federal exhaust emission standard for NOx is more stringent, it was assumed that failed vehicles could be maintained to levels which are below their standard by the same percentage as 1975-76s are below theirs; thus to 1.68 gpm. The following table provides the estimates of NOx emission reductions which would be achieved using the assumed post-maintenance levels for each failure rate, and shows that fleet NOx reductions of 6 to 13% are possible.

The incremental cost of a loaded mode inspection over an idle inspection includes a higher inspection fee (estimated to be a maximum of $1.35 extra) and the NOx related repair cost, estimated at $7.50.* The average additional per vehicle cost of the NOx inspection and repair is shown in the following table. (All cost has been attributed to the NOx reduction; the repair cost has been averaged over the entire fleet.) In addition, the NOx cost-effectivness is calculated (10,000 miles per year assumed). The cost-effectiveness is in the range of other NOx control strategies.

*This estimate comes from the Restorative Maintenance Program and represents primarily the average cost of repairing malperforming EGR systems.

Estimated FTP NOX Emission Reductions due to Maintenance
(Loaded Test, 1975-77 Models)

	Loaded Short Test Failure Rate 10%	20%	30%
FTP NOx Emissions of Passed Cars	2.40	2.28	2.16
FTP NOx Emissions of Failed Cars Before Maintenance	3.96	3.67	3.44
Assumed Post-Maintenance FTP Emission Levels for Failed Cars	2.38	2.36	2.34
Fleet FTP Emissions Before Maintenance (N = 230)	2.55	2.55	2.55
Fleet FTP Emissions After Maintenance	2.40	2.29	2.22
% Reduction in NOx	5.9%	10.2%	12.9%

Estimated Cost and Cost-Effectiveness
for NOx Emission Reduction
(Loaded Mode Test, 1975-77 Models)

	Loaded Short Test Failure Rate 10%	20%	30%
Cost per inspected vehicle	$2.20	$2.85	$3.60
Cost-effectiveness, $/ton	$1270	$994	$990

The effectiveness and cost of an EGR inspection for NOx is presented below for comparison. The results show that the reductions achieved and cost-effectiveness are similar to the 10% stringency loaded mode test. Actual EGR inspection effectivness may be somewhat less because of the difficulty of observing the EGR on some vehicles (e.g., it is sometimes located behind the air cleaner).

Estimated Cost and Cost-Effectiveness
for NOx Emission Reduction
(EGR Inspection, 1975-77 Models)

% vehicles failing inspection	13%
FTP NOx Emissions: Passed cars	2.38 gpm
FTP NOx Emissions: Failed cars	3.46 gpm
Assumed Post-maintenance level	2.32 gpm
% NOx reduction: Failed cars	33%
% NOx reduction: Fleet	6%
Cost of inspection repair: Fleet avg.	$2.00
Cost-effectiveness	$1210/ton NOx

To summarize, further analysis is being performed to evaluate the loaded vs. idle I/M test. Preliminary analysis indicates that an idle test is an adequate I/M test for areas which require control only of HC and CO. NOx problems cannot be addressed by an idle I/M test. Both a loaded test and the physical inspection of the EGR system are considered to be viable alternatives for controlling NOx through I/M. We are not yet ready to recommend one procedure for NOx over the other, but further information will be forthcoming.

m) Appendix N - Are the credits in Appendix N valid? What reasons are there for the delay in the revised version? Is there sufficient technical documentation now or will there be in the future to justify the credits?

Appendix N reflects EPA's best judgment of the benefits associated with an inspection and maintenance program. Appendix N, as contained in the computer program MOBILE1, is based on a careful review of available I/M data and on engineering judgment. EPA sees no need for revision now.

Later this year, as the Portland study is completed, and test results from prototype advanced technology vehicles become available, EPA will revisit Appendix N and make any needed adjustments. The adequacy of 1979 SIP revisions with respect to the 25% emission reduction requirements in EPA's I/M policy (July 17, 1978) will be judged according to MOBILE1 credits.

n) Heavy Duty I/M - What emission reductions can be expected for I/M of heavy duty vehicles at various stringency levels?

There are no appropriate data to evaluate this question quantitatively at the present time. Based on engineering arguments, one could expect that emission oriented tune-ups would result in similar emission reductions on heavy duty trucks as occur on lighter duty vehicles.

Although no quantitative estimates of heavy duty vehicle I/M's effectiveness are available, several states either are considering implementing or already have implemented a heavy duty vehicle I/M program. New Jersey is now conducting a voluntary I/M program for heavy duty vehicles and expects to set idle emission, smoke and noise standards and require compliance in the very near future. Arizona presently requires inspection of approximately 130,000 heavy duty vehicles. The failure rate for HDVs is slightly higher than the 16% failure rate for LDVs. Oregon is presently inspecting approximately 1,000 heavy duty vehicles per month with a failure rate of about 50%. All three of these programs are based upon the idle test procedure. None has yet reported any estimate of effectiveness. As data become available, it will be disseminated.

In the 1977 Clean Air Act amendments, Congress established new vehicle emission standards for trucks which reflect the same emission reductions from uncontrolled levels as passenger cars. EPA has been developing an improved test procedure to complement these standards, which will go into effect in 1983. Included in this procedure is an idle test and emission standard which will facilitate establishing warranty provisions and cutpoints for heavy duty vehicles. Since the technology that will be used on these vehicles will be similar to that used on current passenger cars, I/M will be necessary to assure appropriate maintenance is performed and tampering and misfueling are discouraged.

2. COSTS

a) Repairs - How do repair costs vary with stringency and test mode? Will the loaded test reduce repair costs? If so, why are the average repair costs lower in New Jersey than in Arizona?

As briefly discussed in the response to question "Emission Reductions: (Failure Rate)," costs appear to vary with stringency factor. For the Portland sample of failed cars, average repair costs tend to increase with lower stringency programs. Average costs of repairs for failed vehicles range from approximately $20 to $35 for stringencies of 30% to 6% respectively. This suggests that the worst emitters (those identified by low stringency programs) tend also to have the highest repair costs.

The only available data on loaded test repair costs come from the California Air Resources Board's Riverside Pilot I/M Program.* CARB selected two samples of pre-75 model year vehicles; one sample was subjected to an idle test, the other to a loaded test. The intent was to determine the costs and effectiveness for the two tests. The average repair costs were slightly higher for the loaded test than for the idle test ($23 vs. $21), with emission reductions on HC, CO, and NOx insignificantly different for the two tests. The mechanics who were performing maintenance on the loaded test failures had not been specifically trained in loaded test diagnostics. Therefore, although the potential for additional benefit and lower repair costs may exist for the loaded test, CARB's study suggests that mechanic training is essential for its realization.

Our latest information indicates that both New Jersey's and Arizona's average costs of repair are low: $16 and $23, respectively. It does not seem unreasonable that repair costs should be higher in areas where a loaded test regime is used simply because more problems can potentially be diagnosed and fixed. Typically, the necessary repairs performed in response to failing the idle test (both N.J. and Arizona pass or fail cars on the basis of an idle test) involve simple adjustments or replacement of relatively inexpensive parts such as spark plugs or wires. Thus, the additional diagnostic information provided by the loaded test would not be expected to affect repair costs one way or the other for these typical cars. For cars which have atypical problems, the use of the loaded test diagnostics may result in more appropriate and perhaps more costly repairs than would be performed in the absence of the diagnostic information. This may imply a higher average cost of repair for the loaded test regime.

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*Vehicle Inspection and Maintenance - The California Program, G. Rubenstein, R. Ingels, R. Weis, and A. Wong, SAE Paper 760557, June 1976.

b) Costs: (Mechanic Training) - Does mechanic training have a positive effect on repair costs?

The primary purpose of automotive exhaust emission oriented mechanic training programs is to improve the skills of mechanics in performing emission related repairs. Successful training programs provide mechanics with the ability to more rapidly and effectively diagnose and repair defects which cause high emission levels. This results in lower costs. However, the knowledge acquired during emission related training may cause mechanics to do more repairs than they might otherwise do in an attempt to achieve even greater emission reductions. Since the costs of these two effects tend to offset each other, the net result may be little or no change in average repair costs. Of course, both effects would have a tendency to increase emission reductions and thus program benefits.

c) Costs - What are the average repair - not inspection - costs for private garage test systems?

The only garage based I/M programs in operation are in Nevada and Rhode Island. Rhode Island just began mandatory repair, thus no repair cost data are now available. Nevada's program includes setting certain parameters to manufacturer specification on all inspected vehicles, thus data from this program are not applicable to the typical garage I/M program. However, the repairs required to pass an exhaust emission test are the same whether the test is performed in a private garage or in a centralized inspection lane. Therefore, one would expect the average cost of repairs in a garage based program to be about the same as that of a lane program, somewhere between $16 and $32 per failed vehicle.

d) Costs - Will repair costs decrease after programs have been in operation for several years?

The key to emission reductions and therefore overall I/M program effectiveness is the ability of the automotive service industry to provide proper emission related repairs. It is reasonable to expect that once mechanics have gained some experience with I/M programs they should be able to repair the failed vehicles more efficiently and with reduced costs. Very little data exist to quantify this effect however. Survey data from New Jersey and Arizona indicate that the I/M programs in those states have experienced little or no change in repair costs over the past several years. These surveys are not conclusive, however, and the true answer to this question will have to wait until more quantitative data are available.

e) Cost Analysis: (Cost Effectiveness) - What are the results of the various cost-benefit analyses performed on I/M? How are the results affected by varying the assumption of test mode, stringency and other factors?

Several cost-benefit analyses on I/M have been performed by EPA to date. Analyses have been based on 1) Portland data, 2) MOBILE1-Appendix N estimates, and 3) a combination of Portland data and MOBILE1-Appendix N estimates. The best currently available estimate of I/M's cost-effectiveness in Portland is based on the 1977 model year vehicle fleet. These vehicles were on the average one year old when first inspected and maintained. They had received no inspections prior to entering EPA's Portland Study. Thus, I/M's effectiveness on these vehicles is relatively easy to track compared with earlier model year cars, some of which had been inspected prior to entering the EPA study.

A complete year's worth of emission deterioration data is not available yet, so the observations on nine months of emission testing have been smoothed and extrapolated to the full year. 1977 model year vehicles in Portland and Eugene were taken as the I/M and non-I/M fleets respectively. Both fleets were weighted to better represent the Portland area fleet of 1977 models. (Plots of deterioration for 1975-77 vehicles were provided in response to a previous question.) It should be noted that the initial emission levels (prior to maintenance) in Portland and Eugene were approximately the same for both HC and CO, suggesting that Eugene vehicles provide a good estimate of Portland area vehicles' emissions in the absence of I/M. By calculating the areas under the Portland and Eugene curves respectively, estimates of grams (tons) of HC and CO eliminated per vehicle over the year following I/M were obtained. (It was assumed that each fleet traveled 15,000 miles in the year following the initial test.) The average per vehicle cost of I/M was estimated by applying Portland's $5 inspection fee to all cars, and an average $20 repair cost to the 30% failed cars. This cost ($5 x .7 + $25 x .3) averages $11 per inspected vehicle. The effectiveness and cost per vehicle, and the combined cost-effectiveness estimates are tabulated below.

I/M's Effectiveness and Costs
1977 Model Year Cars Based on Portland Sudy Data

	Effectiveness HC	Effectiveness CO
Tons per vehicle without I/M	.03291	.44973
Tons per vehicle with I/M	.02366	.29612
Tons eliminated per vehicle	.00925	.15361

Costs

Inspection fee = $5/vehicle

Repair Cost = $20 /failed vehicle

Average Cost of I/M per vehicle (30% failure rate) = $11 /vehicle

Cost-Effectiveness
(attributing one half of cost to each pollutant)

HC: $11 /2/0.00925 tons = $595/ton
CO: $11 /2/0.15361 tons = $36/ton

The comparable calculations (for catalyst-equipped vehicles following their first inspection based on MOBILEI-Appendix N estimates are provided below. Appendix N is understating the benefit seen in Portland for 1977 models. Since costs are assumed to be the same as in the Portland scenario, the resulting cost-effectiveness estimate is numerically higher than that of the Portland fleet.

I/M's Effectiveness and Costs
1977 Model Year Cars in the Year Following First Inspection
MOBILE1 - Appendix N Estimates

	Effectiveness HC	CO
Tons per vehicle without I/M	.02728	.41584
Tons per vehicle with I/M	.02373	.30208
Tons eliminated per vehicle	.00355	.11376

Costs

Inspection fee = $5/vehicle

Repair Cost = $20/failed vehicle

Average Cost of IM per vehicle (30% failure rate) = $11 /vehicle

Cost-Effectiveness
(attributing one half of cost to each pollutant)

HC: $11/2/0.00355 tons = $1549/ton
CO: $11/2/0.11376 tons = $48/ton

EPA's best estimate of the range of I/M cost-effectiveness for the first year is $600 - $1500 per ton HC and $30 - $50 per ton CO for the split costs case.

The calculation of cost-effectiveness estimates relies on two inputs: cost and effectiveness. Thus, any factor which affects cost or effectiveness could potentially affect the cost-effectiveness ratio. Such factors include test mode, stringency of program, cost or age waivers, emission deterioration with and without I/M, mechanic training programs, and type of program (centralized or decentralized). Although, as alluded to in previous responses, the effects of some of these factors on costs and effectiveness have been investigated, no comprehensive quantitative summary of the sensitivity of cost-effectiveness to these various factors is available now.

f) Cost Analysis: (Indirect Costs) - Why are indirect consumer costs, such as time and travel for inspection and repairs, usually neglected in these analyses?

The indirect consumer costs listed in the question have historically not been included in cost-effectiveness analyses. One reason is it is difficult to reach agreement as to their quantification. Also, no attempt to remove the costs of emission related repairs which may have been done in the absence of I/M has been made, and possible indirect benefits such as lower long term maintenance costs or longer engine life have not been included. These cost reducing considerations tend to offset the inconvenience factors described in the question. Thus, to keep the cost and cost-effectiveness analyses as quantitative and straightforward as possible, only the direct I/M cost and benefits have been used.

g) Comparing Systems - Too often EPA reports fail to point out the fact that New Jersey's system is an old, well-established program. The $2.50 test fee does not include a retest nor does it pay for initial capital costs as other programs must. Negating these factors, how do the various systems' costs compare? How do capital and manpower costs differ between the three types of systems?

Table A presents an example which compares typical per vehicle program costs for an idle emissions inspection with an initial auto population of 400,000. The following assumptions are made:

program length	5 years
annual interest on borrowed capital	12%
annual inflation	7.5%
annual population growth	5%
contractor's net return on investment	8%
depreciation periods:	
land	no depreciation
construction	20 years
other capital investments	5 years (length of program)

For the centralized programs, each of the eight required facilities in this example includes three lanes, each lane performing 26,000 four- to five-minute inspections annually (including retests). For the decentralized program, each of 640 private garage stations performs approximately 700 ten-minute inspections annually. One challenge lane, similar in nature to the lanes used for the centralized programs, is assumed to be sufficient to provide referee facilities for 5% of the vehicles in the decentralized program.

Table A shows that the fee for the various program types is in the range of 7 to 9 dollars, with the decentralized program the most expensive. Assumptions other than those shown, such as adding a program to an existing safety inspection, may affect these results. Also of interest is the greater percentage of fee attributed to initial costs of a centralized program. This suggests that after the initial costs have been paid for, the fee difference between the centralized and decentralized program will increase.

Table B compares state personnel requirements for the same three programs. Program design, engineering and evaluation, and public information functions are not included among these requirements. Noteworthy is the larger number of state employees required to monitor a decentralized program compared to the contractor centralized program.

h) Economic and Social Impact - What effect does I/M have on the underprivileged? Have waiver systems or free repairs ever been considered? What effect does I/M have on the repair industry?

Based upon census data, people in the low income groups tend to drive cars that are on the average five to seven years old. Depreciation, gasoline, repairs, insurance, etc. on a car in this age range average from $1200 to $1500 per year. Typical costs for a vehicle of this age failing an I/M test would be about $20. Some of that maintenance cost would be incurred without an I/M program. The net cost of an I/M program would therefore be about $12 to $15 or approximately 1% of the cost of owning and operating a vehicle of that age.

Several states have considered methods of reducing this financial burden on the underprivileged. Arizona, for example, has placed a limit of $75 on the cost of repairs resulting from failing an inspection test. (See question dealing with the effect of such waivers on the program's effectivness.) The limit in California is $50, with a provision to extend it to $75. New Jersey and Oregon, on the other hand, consider the cost of repairs as a necessary cost associated with the privilege of driving on the state roads and place no limits on repair costs.

Those agencies presently conducting I/M programs report no noticeable change in the service industry as a result of implementing their programs. As I/M programs have started up, there have been no reports of shortages of mechanics, or facilities to perform the necessary maintenance. The number of vehicles on the road per mechanic has steadily risen over the past two decades to about 235 cars per mechanic currently. While the situation has been called critical by at least one industry official, it appears that the current repair force can handle extra I/M related repairs. One recent survey indicates that over 80% of repair facilities which perform tune-ups could handle at least an extra 10% workload in this area, and about one-half of these shops could handle a 30% or higher increase in tune-up work. New Jersey estimates the extra work is, on the average, less than 5% of the repair facilities' workload and that there is no trouble absorbing the work.

TABLE A
Inspection Fee Breakdown
(Costs to state for contractor and decentralized programs indicated in parentheses)

	State	Contractor	Decentralized
INITIAL COSTS (annualized)			
Facility Investment Costs			
Land	.30	.30	---- (.02)
Construction	.61	.61	---- (.04)
Other Investment (training, equipment, site prep, etc.)	.62	.62	.89 (.03)
Administrative Startup Costs	.25	.21 (.10)	---- (.22)
TOTAL Annualized Initial Costs	1.78	1.74 (.10)	.89 (.31)
ANNUAL COSTS (with inflation)			
Facility Operating Costs			
Personnel (inspector's time and overhead)	3.11	2.42	4.65* (.19)
Other Operating Costs (equip. maint., support services, etc.)	.88	1.44	.88 (.05)
Administrative Operating Costs	1.10	.70 (.46)	----- (1.57)
TOTAL Annual Operating Costs	5.09	4.56 (.46)	5.53 (1.81)
ANNUAL INSPECTION FEE			
TOTAL Program Cost			
to Operators	-----	6.30	6.42
to State	6.87	(.56)	2.12
Contractor's net return	----	.50	----
TOTAL Inspection Fee	6.87	7.36	8.54

*Assumes the mechanic performs inspection.

TABLE B

State Personnel Utilization*

Person-years. For training and hiring categories, these figures represent total person-years of training time for personnel not considered full time staff until program is in actual operation.

Personnel Area	State	Contractor	Decentralized
Start-Up Personnel			
Program Administrators (including contract monitor)	(3)	(3)	(2)
Technical Officers (e.g., mechanic training, building, quality control, etc.)	(3)	(1)	(2)
Data Analysis/Statistical Staff	(1)	(1)	(2)
Secretarial/Clerical Staff	(3)	(1)	(3)
Training and Hiring of Field Facility Staff (including challenge lane)	(1.6)	-	(0.1)
Training and Hiring of Field Facility Monitors (or station examiners)	-	(0.03)	(0.2)
	(11)	(6)	(9.3)
Annual Operating Personnel (present dollars)			
Program Administration (including contract monitor)	(3)	(3)	(2)
Technical Officers (mechanical training, qual. cntl., etc)	(7)	(1)	(2)
Data Analysis/Statistical Staff	(2)	(1)	(2)
Secretarial/Clerical Staff	(3)	(1)	(3)
Field Facility Staff (incl. challenge facilities)	(91)	-	(5)
Field Facility Monitors (or station examiner)	-	(1)	(10)
TOTAL	(106)	(7)	(24)

*These estimates are provided for illustrative purposes only. The actual number of state personnel will vary depending on the intensity of efforts in each area. Public information and program design, engineering and evaluation efforts are not shown.

i) COWPS Report - What is EPA's response to the Council on Wage and Price Stability's assessments of the ozone standard and the cost-effectiveness of I/M? From whence did EPA's cost vs. stringency calculations come? Was this based on restorative maintenance data or I/M data? What cost-effectiveness can now be claimed considering the questionable fuel savings and all indirect and direct consumer costs? Will EPA revise its cost estimates?

The Council on Wage and Price Stability's assessment of I/M's cost-effectiveness for ozone was in error due to the fact that repair costs were attributed to all vehicles, not just those which failed the I/M test. EPA has pointed this out to COWPS and has provided them with our cost-effectiveness analysis. EPA's best estimate for first year cost-effectiveness is \$600 to \$1500 per ton HC. This range reflects the higher than expected benefits occurring in the Portland study. The details of this calculation are presented in response to the "Cost Analyses: (Cost-Effectiveness)" question. No fuel economy benefit is assumed. As discussed in a previous question, neither indirect costs or health and welfare benefits are included in these calculations.

3. IMPLEMENTATION

a) Funding - Will funds be available for any of the following: mechanics' training, public information programs, construction of I/M facilities, preliminary or continuing studies, pilot programs or introductory full-scale mandatory inspection/maintenance programs, or the administrative costs associated with I/M?

Funds are available through the EPA regional offices to help support the implementation tasks listed above. Once mandatory inspection begins, the program should be self-supporting from the inspection fees collected.

Funds were made available in FY78 to support I/M studies in many states. In FY79 over $5 million has been allocated to support state I/M activities. In the FY80 budget EPA has proposed additional funds be made available for the states implementing I/M. Other grant funds may also be available from the Regional offices. Priority in distributing funds will be given to those states with or making progress towards obtaining enabling legislation.

b) Delays - How many states plan to request extension beyond June 1979 to obtain legislation? On what basis will EPA make decisions on the requests?

At this time two states have requested an extension in obtaining legislation to beyond July 1, 1979. These requests have been denied. The Clean Air Act, as amended in 1977, requires proof of legal authority to implement the elements of the non-attainment plans (Section 172(b)(10)), including inspection maintenance. In the absence of such proof, a SIP cannot be fully approved. To facilitate submittal and review of the SIPs, and in recognition of the fact that most legislatures will not meet until after the January 1, 1979 SIP submittal deadline, EPA will accept, in lieu of certification of legislative authority, a commitment by the governor to a schedule for implementing I/M. A required date in that schedule is certification of adequate legal authority by July 1, 1979; at that time evidence of legal authority must be submitted to EPA.

The Costle and Hawkins policy memos of February 24, 1978, July 17, 1978, and February 21, 1979 detail limited exceptional cases in which an extension from EPA in certifying legal authority is possible. These are:

a) There was insufficient opportunity to conduct necessary technical analyses and/or

b) The legislature has had no opportunity to consider any necessary enabling legislation for inspection/maintenance between enactment of the 1977 Amendments to the Act and June 30, 1979.

Regarding the first point, the large amount of information available from contractor studies, EPA, and operating I/M programs coupled with the 18 months which have passed since the Clean Air Act Amendments indicate that extensions on this basis will not be needed. On the second point, the state must show there has been insufficient opportunity to consider legislation since passage of the 1977 amendments to the Clean Air Act. EPA will grant no extension if the legislature has had an opportunity to consider enabling legislation but has not given such legislation serious consideration. In any case, an extension will not be considered by EPA until after June 1, 1979.

c) Delays - What will be EPA's response to delays in implementation? Can the definition of "as expeditiously as practicable" be widened to accept an implementation schedule that would initiate a mandatory inspection/voluntary maintenance program two and one-half years after legislation? This would run for one year to fine-tune the entire I/M program - including standards, mechanics training, and administrative processes. After that year, mandatory maintenance would be required.

The Act requires I/M to be implemented as expeditiously as practicable. EPA policy has recently extended the date for mandatory inspection and repair to beginning no later than 1981 for decentralized programs and no later than 1982 for centralized programs. In general, SIP schedules should reflect realistic intermediate milestones which can accomodate unanticipated delays while achieving the deadline for mandatory repair.

d) Public Information - What assistance is available for public information programs? Arizona's experience is known, but how have other states handled the public education problem?

An understanding by the public and other affected groups of the need for and operation of I/M is essential to the success of the program. For this reason a public information program is a required element of the SIP I/M implementation schedule. Assistance for States pursuing I/M public information programs is available in the form of grants from U.S. EPA Regional Offices and a multi-media package on I/M developed by EPA and the American Lung Association. I/M information materials which are available include:

Film - "On the Road to Clean Air" - this 17-minute color film covers the purpose and need for I/M programs, the benefits and costs and how a program operates. Available from your local ALA chapter or from EPA Regional Offices on a free-loan basis.

Publications - "Information Document on Automobile Emissions Inspection and Maintenance Programs" - EPA-400/2-78-001 (February 1978), a report produced pursuant to Section 108 of the Clean Air Act which presents substantial information on all aspects of inspection/maintenance programs. Available from EPA, (I/M Staff, 2565 Plymouth Road, Ann Arbor, MI 48105).

"Motor Vehicle Emissions; Inspection/Maintenance Kit," - EPA-460/3-78-013 (September, 1978). A loose-leaf binder containing information on benefits, legislation, public awareness, and an extensive section on cost estimation.

"Tuning Down Auto Air Pollution" - a 16-page booklet which discusses the need for I/M programs, the benefits and costs and how a program works. Available from EPA.

"Get a Check-up for your Car?" - a leaflet on the need for keeping cars well maintained to cut pollution along with pointers on what can go wrong with your engine and what to do about it. Available in English and Spanish from your local ALA chapter or EPA regional office.

"Do Your Own Car" - a leaflet which explains pollution control systems and gives the reasons why motorists should not tamper with those devices. Available from EPA.

"The Health Effects of Air Pollution" - a 16-page pamphlet which discusses the various air pollutants and the effects they have on health. Available from EPA.

"I/M Update" - a bi-monthly information service for the exchange of news and ideas on I/M implementation. Available from EPA.

Materials for the Mass Media - American Lung Association (ALA) TV spot - a 60-second television presentation which emphasizes the need for regular car maintenance to minimize auto-related air pollution. Produced in cooperation with the ALA and Car Care Council. Available from ALA and EPA.

ALA radio spots - four 30-second presentations, including one in Spanish, which stress the connection between air pollution and the automobile. Available from ALA and EPA.

In California, Hamilton Test Systems is obligated by contract to design and operate a public information and education campaign, under the direction and review of the California Air Resources Board. Funds have been budgeted throughout the five-year lifespan of the contract. Initially these funds will be used to produce material for many communications media, including brochures, fact sheets, newsletters, slide and film presentations, pamphlets, billboards and announcements for radio and television.

Portland, Oregon has utilized mobile vans with emission analyzers for demonstrations at major shopping centers and other key activity centers. Oregon found that bumper stickers were one of the most successful public information tactics.

In New Jersey, posters were circulated in large volume around the state. Each new car dealer and garage that purchased an emission analyzer was contacted and the state compiled lists of approved analyzers and garages which owned them. The dealers and garages displayed signs indicating they had the analyzers.

Two program elements stand out as being widely used as I/M public information techniques. One is the use of radio and television spot announcements and newspaper advertisements. A second technique that is key to reaching the individual motorist is preparing an informational pamphlet and mailing it to all vehicle owners, usually along with motor vehicle registration forms. Both California and Arizona have indicated costs for these elements to be approximately $0.12 per vehicle.

States with existing I/M programs have indicated that as the public becomes used to the program there may be somewhat less need for an intensive public information effort. There would still be a need to inform motorists of any significant changes in program operations or other modifications of program elements such as waivers, exemptions, repair cost ceiling, inspection fees, or registration procedures. This could entail periodic mailing or possibly some media announcements. The public should also be made aware of the status of the program in terms of emissions reductions achieved.

e) Emission Control Devices (Catalysts) - Cars with fouled catalysts can pass current I/M standards. They pollute more than they should, but is there any reasonable test that can spot this?

There are a number of possible causes for catalyst failures among in-use vehicles. Poisoning by lead deposits as a result of improper use of leaded fuel is thought to be the most common, but plugging or fouling with other substances, deliberate removal or tampering, and thermal damage as a result of other neglected engine malperformances are also possible. Whatever the cause of the failure, a vehicle with a failed catalyst will pollute more than it should and will fail to meet the Federal HC and CO emission standards, as measured by the lengthy Federal Test Procedure. The vehicle will also emit more than a similar vehicle in good condition when tested using any of the I/M-type short tests. This includes the idle test, the short test currently used to pass and fail vehicles in all of the I/M programs now in operation. Despite that fact that emissions increase at idle, it is possible for a vehicle with an inoperative or failed catalyst to pass current I/M idle standards.

There are a number of contributing factors that make this possible. Current I/M idle standards have been set fairly loosely relative to what vehicles in good condition are capable of achieving. This keeps the number of failing vehicles manageable in terms of the capacity of the repair industry to fix them and the capacity of the I/M program to reinspect them, while achieving significant air quality benefit. It tends to result in vehicles being failed only if their problems are easily and inexpensively repaired, as observed in the Portland study. It also helps ensure that very few vehicles which would actually be found to have low emissions on the Federal Test Procedure are mistakenly failed and maintained unnecessarily. Such mistakes are inevitable when using the idle test or any other short test to pass and fail vehicles, since these tests repeat only a portion of the Federal Test Procedure; the number of such mistakes becomes very small when the idle standards are set relatively loosely.

On the other hand, relatively loose idle standards allow some vehicles which actually have problems which make them pollute more than they ideally should to pass the idle test. Vehicles with catalyst failures may be among these, in part because the catalyst failure does not cause idle emissions to exceed the relatively loose idle standards and in part because it is sometimes possible to counteract the idle emissions increase due to catalyst failure by adjusting certain engine parameters to nonrecommended settings. Such maladjustments do not reduce emissions on the Federal Test Procedure enough to compensate for the catalyst failure, and therefore only camouflage the catalyst failure.

Catalyst failures are only one of several types of problems which cause cars to pollute more than they should but without causing them to fail current idle test I/M standards. Mild forms of carburetor maladjustment, choke maladjustment, and EGR problems are the most common of the other problems with similar effects. Taken together and compared to the problems which currently account for most idle test failures, catalyst failures and problems with similar effects are important but not the major item of concern. The problems which currently account for most idle test failures are more common and more severe, taken together. As a result the vehicles which do fail idle standards are responsible for most of the "excess" HC and CO emissions of the in-use fleet of catalyst-equipped cars.

Even though an I/M program using an idle test and standards like those used in current programs will not spot all vehicles with failed catalysts, it can over time reduce the number of such vehicles on the road, relative to what this number would be without I/M. Drivers can be expected to be more reticent about deliberately destroying or removing their vehicles' catalysts, for fear of decreasing their chances of passing the I/M test. (EPA is investigating tampering rates in New Jersey which does not actually inspect for tampering in its I/M program, to compare them with tampering rates in non-I/M areas to see if this expectation is borne out.) Drivers may also be more reluctant about improperly using leaded fuel. And any I/M program raises the public's consciousness of motor vehicle emissions and their relationship to air pollution; this alone may reduce the frequency of tampering and misfueling.

As stated above and as implied by the question, the problem of identifying failed catalysts is an important one, even though not a critical one from the standpoint of I/M's effectiveness, and one which EPA is currently pursuing. It is possible that loaded-mode I/M tests would be more successful in spotting failed catalysts. It is also possible that a simple idle test conducted at a higher engine speed (as in the Two-Speed Idle Test) would be better. A visual inspection certainly would be able to detect vehicles whose owners have removed the catalyst (about one-half of one percent of all 1975 and later model year cars), and this can give some improvement to air quality. Finally, EPA is investigating other simple tests to detect failed catalysts which could be adapted to an I/M program.

f) Emission Control Devices (Fuel Switching) - Is there any way for EPA, perhaps in concert with the Department of Energy, to initiate a change in the gasoline pricing policy to make leaded gas equal, if not greater, in cost than unleaded gasoline?

EPA shares the questioner's concern about the incentive for misfueling catalyst vehicles created by gasoline price differentials, particularly in light of the potential impact of price deregulation on those differentials. EPA itself does not have any statutory authority which would allow it to change gasoline pricing policy. EPA has been discussing this issue with the Department of Energy (DOE), which does have this authority, and with other executive branch offices. An agreement has been reached. Under the agreement, DOE will propose a rulemaking which would limit the retail price differential between leaded and unleaded gasoline. The Notice of Proposed Rulemaking is expected at about the end of March, 1979. DOE will propose limiting the price differential to approximately its current level, a move which would prevent misfueling from becoming more prevalent after gasoline prices are deregulated. DOE will invite public comments on whether some other maximum limit on the differential should be adopted instead, and on the regulatory mechanism for enforcing the limit (i.e., on whether a "trigger level" should be established which would have to be exceeded before regulations took effect or whether they should be in effect continuously). EPA hopes that State air agencies will participate in this rulemaking by submitting comments to the public docket.

Vehicle drivers and service station operators are the ones who choose to misfuel. Their choices are capable of being influenced by factors other than price differential. EPA is conducting a public awareness campaign to inform these persons of the harm resulting from misfueling, in an effort to dissuade them. State agencies can contribute by running similar campaigns. It should also be noted that the existence of an I/M program can be a deterrent to misfueling because it raises people's awareness of motor vehicle pollution and also causes them to think ahead about their vehicles' ability to pass the next inspection. In addition, a State can check for tampering to the fuel filler neck restrictor as part of the I/M inspection. This would provide a strong incentive not to tamper with the restrictor and thus would reduce the incidence of misfueling.

g) <u>Emission Control Devices (Physical Inspection)</u> - Is a test for tampering by checking the functioning of emission control devices worthwhile from both a cost and an emission benefit standpoint?

A recent survey performed in conjunction with six state safety inspection programs has shown approximately 20% of all 49-state cars now on the road have been grossly tampered. The EGR system, which primarily affects NOx emissions, is the most common target for tampering, with a tampering rate of about 18%. Other forms of tampering have rates of at most a few percent. (These rates include cases where a malfunction may have occurred naturally but is equivalent to one caused deliberately.) The survey data show that tampered vehicles tend to have higher than average idle emissions and thus tend to fail an idle test more frequently. For example, 45% of the tampered vehicles in the survey failed a set of idle standards (the New Jersey Phase III standards), while only 35% of all the vehicles in the survey failed. (A smaller sample of California cars also showed about 20% gross tampering, but for presently unexplained reasons the portion of the tampered cars which would fail I/M standards is lower, about 10%.) The higher idle emissions of tampered vehicles are due in part to the effect of the tampering itself and in part to the fact that tampered vehicles tend to be misadjusted as well. The net effect is that a sizable fraction of tampered vehicles will be sent to get repairs even in an I/M program that does not inspect for tampering. Some of these will have the tampering corrected; a state can increase the number through mechanics' training and/or regulations governing repair practices.

EPA has not yet analyzed the available survey data to see whether a loaded mode test would identify a larger fraction of the tampered vehicles than does the idle test. Engineering considerations alone suggest that it would, at least for emission control system elements which affect exhaust emissions. (Positive crankcase ventillation (PCV) and evaporative emission controls do not always have an effect on exhaust emissions.)

For a state to be certain of identifying cases of tampering and getting them repaired, there is no substitute for a tampering inspection. The Portland, Oregon I/M program has found the inclusion of a tampering inspection to be workable.

Any I/M program can be expected to be a deterrent to tampering. An I/M program that includes a tampering inspection presents a particularly strong deterrent. The survey mentioned above showed that tampering sharply increases with vehicle age. If an I/M program prevents this increase it will achieve additional emission reductions at low cost.

The table shown below represents a very preliminary estimate of how much the fleet-average emissions of 1975 and later cars would be reduced if vehicles with the listed types of tampering were repaired. A more definitive analysis and quantification is now underway.

Preliminary Estimate of Fleet Emission Reductions
(1975 and Newer Cars) Resulting from Tampering Inspections
(Base Emissions: 1.7 gpm HC, 25 gpm CO)

Component or System	Approximate Tampering Rate*	Approximate Fleet Emission Reductions HC	CO	NOx
PCV	2.5%	1.4%	0	0
Air Pump	1.3%	0.8%	1.5%	0
Catalyst Removed	0.8%	0.7%	0.5%	0
Evaporative Emissions Canister	1.3%	0.6%	0	0
Fuel Tank Cap and Seal	0.7%	0.2%	0	0
EGR	13%	0	uncertain	5-18%

*The "tampering" rates listed here include some malfunctions, such as those due to inadequate maintenance, which are not due to tampering but which may be detectable in a tampering inspection. Tampering rates are based on all in-use passenger cars of 1975 and newer model years (as measured in the Mobile Source Enforcement Division 1978 Tampering Study), not just those actually equipped with the particular emission control component or system.

EPA's preliminary appraisal is that inspecting the listed components would have a cost-effectivness for HC and CO that is competitive with the idle inspection itself. The same is true for a NOx/EGR inspection, as is described in question 11: "Load/Idle Test."

h) Mechanics Training - What success has been achieved with mechanics training programs? Why were the Colorado State workbooks aimed principally at emission control devices while most repairs do not consider these? Will EPA structure programs to consider this problem and the changes envisioned in future emission controls and engines?

Reports from I/M programs in which mechanic training has been implemented indicate considerable success. In Phoenix a 2-hour training program conducted at automobile dealerships and independent garages was aimed at improving mechanics' ability to perform common emission related repairs such as setting the idle air/fuel ratio. The Arizona motor vehicle inspection program staff has reported noticeable improvement in idle emission reductions resulting from this training. They found fewer cases of vehicles continuing to fail the emission standards after maintenance and a generally better acceptance of the program by the service industry.

The Colorado State University (C.S.U.) training materials were aimed principally at emission control devices in order to fill a void in the existing training programs. These materials were prepared to supplement the training in basic automotive repair being conducted in vocational training schools. At the time they were developed by C.S.U., basic training materials were available to cover most common engine repairs, but none were available to cover the newly introduced emission controls. Incorporation of the new materials into existing training programs for new mechanics was part of a long range program to upgrade emission related maintenance.

In order to improve the emission repair skills of practicing mechanics and produce a more immediate benefit, C.S.U. is now working on a new short course which will cover the detection, causes and corrections of HC and CO failures, infrared gas analyzer operation, diagnostic procedures, and EGR operational checks. This course will be pilot tested in Denver starting March, 1979. EPA will have these materials updated and/or modified as necessary for future emission control systems and repair procedures.

i) <u>New Car Testing and Cars of the Future</u> - Some states are considering testing new cars after their sale. Would EPA consider testing all vehicles at the assembly plant with a short test as in I/M? States could then decide on the necessity of post-sale tests. What will be the effect on I/M - both its operation and effectiveness - of EPA's proposal that new cars meet emission standards over the entire range of timing and carburetion adjustments? Will an engine parameter check be necessary with these vehicles?

Data needed to respond to the first part of this question have not been received in time to be included in this letter. A response will follow later.

On January 12, 1979, EPA promulgated regulations which will require that automobiles are capable of meeting federal emission standards anywhere within the range of adjustments available on certain components. The devices which limit the adjustability of a component must be tamperproof. Components affected by these regulations, and the model year to which the regulation applies, are: idle mixture adjustment (1981); choke (1981); idle speed (1982); initial spark timing (1982). The inclusion of these components in the regulations was in direct response to the results of the restorative maintenance testing performed by EPA, in which these parameters were most frequently found to be maladjusted.

For cars using current technology emission controls in 1981 and later model years, failures of an I/M test are expected to decrease due to these regulations. In 1981, however, emission control technology for most cars is expected to change significantly. This new technology is expected to have different maintenance requirements which will minimize the need to periodically adjust common tune-up parameters. Maintenance for this new technology is expected to involve periodic replacement of oxygen sensors and repair of input sensors to the electronic control system, items not commonly found on current technology systems. I/M will help assure these new maintenance and repair requirements are met, for it is expected in many cases that the driver will not perceive a need to take corrective actions (e.g., driveability may remain good). In addition, the emissions in the failed modes are expected to be at least as high as those seen on today's maladjusted vehicles. Thus while it is hoped the failure rate will decrease, it is expected that the amount of excess emissions per failed vehicle will increase relative to the lower federal emission standards.

These factors, combined with the widespread occurrence of tampering and misfueling, establish a need for I/M programs for new technology vehicles into the 1980's. And of course, the current fleet of cars, for which maladjustments are widespread, will remain in the fleet for 10 years or more, and I/M is the only strategy to control their excess emissions.

An engine parameter check may also be a valuable tool in assessing the operation of the new electronic control systems. On some vehicles this may be as simple as checking a diagnostic light on the instrument panel. An emission check, however, is expected to continue as the primary indicator of the total vehicle's emission performance.

j) Warranty - When will final warranty rules be promulgated? Will the New Jersey type of idle test be sufficient to invoke the warranty provision of the Clean Air Act? Would a private garage inspection system be acceptable under warranty rules? How will enforcement be carried out?

Final emission performance warranty regulations and idle test standards will be promulgated this year, effective beginning with 1980 or 1981 model year vehicles. This warranty will be available to owners whose vehicles fail the Federal warranty idle test standard. Further, by law the warranty will be available only if some penalty or sanction is imposed; a non-mandatory program will not be sufficient. Either a centralized (inspection lane) or decentralized (private garage) program will be acceptable. EPA will not normally be involved in the day-to-day operation of these regulations. However, failure of a manufacturer to comply will be a "prohibited act" as specified in Section 203 of the Clean Air Act; civil penalties up to $10,000 are possible. If problems arise, EPA will take appropriate enforcement.

k) EPA Reports and Rules - What is the cause of the delay in the publication of the Oregon study, Appendix N, and the warranty rules?

The Oregon I/M study will not be complete until early 1980. To deal with the need for information on the preliminary results of the study, a series of interim reports have been planned. The first preliminary report, dealing with the initial effects of maintenance was published in May 1978. The second preliminary report, which analyzes the deterioration over the first six months after maintenance, is now available. Additional reports are planned as the study progresses; all reports are available through the EPA regional offices.

Modifications based on comments to the proposed Appendix N (FR2422177) have been incorporated into the computer program MOBILE1, which is being widely used to calculate emission inventories and I/M credits for the January, 1979 SIP submittals. This computer program contains EPA's best estimate of the benefits of I/M. Appendix N has not been finalized in order to allow for modeling changes which will best reflect the incoming data from the Portland study and testing of advanced prototype vehicles. A final Appendix N will be promulgated late this year.

Warranty coverage under section 207(b) will be promulgated prior to the widespread initiation of I/M programs, a prerequisite for its application. The enforcement provisions are being reproposed in response to the change in warranty provisions in the 1977 Clean Air Act Amendments. The enforcement and short test regulations will be promulgated for the 1981 model year with a good chance of them being applicable to model year 1980 as well.

l) EPA Reports and Rules - Why is inconsistent information regarding fuel economy benefits of I/M being given out?

Every attempt is made to inform the EPA Regions and the States of the latest information on I/M benefits. In the case of fuel economy benefits, the Portland study presented preliminary data which conflicted with the other fuel economy studies. In the interim while this apparent discrepancy was under investigation, some inconsistency in interpreting the various studies was sure to occur. As set forth in a previous question, the fuel economy benefit of I/M is now better understood and quantified, and a report detailing the fuel economy analysis will be distributed to the Regions and States in April.

m) EPA Reports and Rules - Can't reports such as the EPA information document be updated periodically to reflect new information and correct erroneous data?

As new information on I/M becomes available, it will be distributed to EPA Regions and to the states. The form this information may take will vary from updates of existing reports (such as the Portland Study) to new technical support reports. The recently distributed information kit, in looseleaf format, will be used to update information whenever possible. To obtain the latest information available on any I/M-related topic, a request may also be addressed to the Ann Arbor I/M Staff.

It is impossible to update each document each time a piece of data changes. The approach EPA is taking is to publish changing data whenever it may impact on conclusions concerning I/M. In the example given in the question, the New Jersey cost estimate did decrease based on a newer study, however the range of repair costs quoted by EPA ($16 to $32 per failed vehicle) was still valid.

n) Information Center - Would EPA consider funding or lending assistance to establishment of a better I/M information network among the states. All affected states should be kept up-to-date on recent reports, legislation, and other information. Some states have expressed interest in obtaining copies of current enabling legislation and study efforts by other states. If your office could compile this information and provide it for distribution through the regions, it would be of much help. EPA should be sure to make its reports and summaries sufficiently detailed to withstand the numerous challenges faced on the state level.

It is our view that a satisfactory system for distributing reports to the states exists. As information and reports such as the Portland Study become available, they will be distributed to the EPA regions, who will send the information to the states. Likewise, questions concerning I/M should be addressed by the state to the Regions, who will assure the appropriate answer or information is obtained.

A newsletter, entitled I/M Update will be issued bi-monthly and will be used to disseminate information on recent developments in I/M. A list of older studies on I/M is included in the I/M information document. Specific to the question, copies of enabling legislation and a list of study reports on I/M options will be available from the regional offices.

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