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PERIODIC MOTOR VEHICLE INSPECTION AS A SMOG ABATEMENT MEASURE IN THE SOUTH COAST AIR BASIN

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Preface

The Environmental Quality Laboratory has disseminated the results of its work in a series of detailed formal reports that are widely circulated. In many cases, however, it is more important that the information be disseminated quickly but to a smaller group. To facilitate the circulation of this second kind of information a different form of report, which we will term an EQL Memorandum, has been established. The recipients for each note will be selected on an ad hoc basis but the notes will be available to anyone on request.

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ABOUT THE AUTHOR

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Periodic Motor Vehicle Inspection
As a Smog Abatement Measure
In the South Coast Air Basin

The Problem and Need for Inspection

It is well known that emissions from motor vehicles are the major cause of smog in the South Coast Air Basin. In an attempt to reduce the smog a strategy has been adopted by the State of California based on the idea of reducing emissions from each vehicle per mile driven rather than restricting the number of vehicles or the amount any vehicle is operated. The principal elements of this strategy are three. The one is a set of emission standards for new vehicles which becomes more severe with each model year until 1975 when the federal emission standards become effective. The second is a program whereby existing vehicles are retrofitted with one or more emission control devices whenever the Air Resources Board determines that appropriate devices are both effective and available. The third is a system of tax exemptions designed to encourage the conversion of existing vehicles to burn gaseous fuels. This paper discusses periodic motor vehicle inspection and maintenance as a fourth element which could be incorporated into the strategy to complement the existing measures.

There is abundant experimental evidence to show that each of the three measures in the present strategy is capable of materially reducing emissions. Unfortunately there is a growing body of data that shows that the measures are often not as effective as they might be. Usually the reason that a measure is ineffective on a particular vehicle is that the

vehicle is malfunctioning or misadjusted. It is a truism that any vehicle will emit more if it is malfunctioning or misadjusted than if it is operating properly. Depending on the nature of the malfunction or misadjustment the excess in emissions may be anywhere from a few percent to several hundred percent. For the very low emission vehicles to be produced in the latter half of this decade it is expected that certain not too uncommon kinds of malfunction would increase their emissions by several thousand percent. The periodic inspection and mandatory maintenance measure discussed below is intended to return improperly operating vehicles to proper operation and thus cause each vehicle to achieve its normal level of emissions rather than some higher level.

The Function and Nature of Inspection

The specific function of the kind of periodic motor vehicle inspection under discussion is to be the first step in a process of returning malfunctioning or misadjusted vehicles to proper operating condition. (The second step, to be discussed below, is the performance of the necessary maintenance or repair required to actually return such vehicles to proper operating condition.) This function determines the minimal characteristics that a satisfactory inspection process should have.

The first such characteristic is a capability to determine whether or not a vehicle is operating properly. The second is a capability to indicate the nature of the malfunction or misadjustment in those cases where a vehicle is not operating properly. Finally the process should

be simple, cheap, and rapid.

To see how it is best to determine whether or not a vehicle is operating properly it is necessary to discuss the structure of an internal combustion engine. When we use the term "proper operation of a motor vehicle" in the present context we really mean proper operation of the engine. While proper operation of, say headlights and windshield wiper are obviously important, their operation has little to do with air pollution.

For our purposes the engine may be considered to consist of four parts, the engine proper (cylinders, pistons, valves, etc.), the fuel metering system, the ignition system, and the emission control system. The engine proper is the basic part of the engine that draws in a charge of air and fuel, compresses it, then converts the pressure of the burning mixture to mechanical motion. The several components are tied together mechanically and in each cycle always go through the same motions relative to each other. Even so, under different speeds and loads the amount of air and fuel per charge varies and the duration of burning occupies different portions of the cycle. As a result the pressure and temperature, which have a great effect on emissions, vary with speed and load.

The basic control of engine speed and power is by means of the fuel metering system whose major part is the carburetor. The throttle controls the amount of air drawn into the cylinders depending on the power required and the carburetor adds the appropriate amount of fuel. Most carburetors have at least two semi-independent metering systems,

one for idle and one for higher speeds and power, while some have three or more. In addition there may be special features that come into operation while accelerating or decelerating. The key point is that the fuel metering system operates in quite different ways under different conditions of engine speed and load. *

The ignition system produces a spark which ignites the charge of air and fuel in the cylinder at the proper time in the cycle. The proper time in the cycle varies with speed and load and the ignition system adjusts the time of ignition accordingly. There are a number of different approaches to accomplishing this: One common scheme has a basic time of firing determined by speed but an additional adjustment determined by intake manifold vacuum which is related to load. In any case, the intent is to produce the ignition at the proper time as determined by both speed and load. Again, it is key that the ignition system operates in different ways under different conditions of speed and load.

The emission control system is still evolving in response to the yearly increase in stringency of emission standards and its final form is not yet well defined. For our purposes though, it may be considered to be that collection of devices and modifications added to the engine to control emissions. While the initial devices such as the positive crankcase ventilation system were essentially passive, the

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* The discussion here pertains to the usual kind of engine but a similar set of comments pertains to engines using fuel injection.

newer devices tend to change the way they act with changes in speed and load. Indications are that they will do this more and more in the future as they become more and more complex in an effort to meet the increasingly stringent standards.

With this brief discussion as background we may consider how to achieve the desired characteristics of an inspection process. A major point to be derived from the above discussion is that, since an engine operates differently under different conditions of speed and load, it must be inspected under different conditions of speed and load to determine whether or not it is in proper operating condition. Another point to be noted is that since proper operation is defined in terms of emissions, the correct measure of proper operation is the level of emissions. Presumably the proper operation of the several parts could be determined separately and the assumption made that they would then operate correctly together. However, it seems both better and simpler to check the overall operation. Thus the first necessary characteristic of an inspection process is achieved by a process that measures the emissions from a vehicle under different conditions of speed and load. Fortunately it has been shown that, for light duty vehicles (under 6000 pounds gross weight), measurements taken under at most four different conditions of speed and load are adequate to determine whether or not a vehicle is operating properly. The Clayton Manufacturing Company, which has done much work in this area, terms these modes of operation KEY MODES. [1] * In

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* The numbers in brackets refer to references listed at the end of the paper.

developing their simple KEY MODE test cycle, which is applicable to light duty vehicles up through the 1972 model year, they have found that the measurement of carbon monoxide and hydrocarbons at idle and at two different speeds when the vehicle is operating under load on a dynamometer is adequate to determine whether or not the vehicle is operating properly. While newer vehicles or heavy duty vehicles may prove to require measurements under more modes of operation, and will certainly also require the measurement of oxides of nitrogen, the KEY MODE cycle is certainly indicative of what will be required.

The need for the second characteristic, that the inspection process should indicate the nature of any malfunctions or misadjustments, is not immediately obvious. It might seem that if a vehicle is not operating properly it should merely be necessary to take it to a mechanic to be fixed. However, the mechanic needs to know what to fix; he needs a diagnosis. In theory at least he should be able to diagnose malfunctions, but most garages do not have dynamometers for testing under load. Moreover, most vehicles are very forgiving of some quite major malfunctions, particularly in the ignition and fuel metering systems. They continue to drive quite well in spite of them. For example, a complete failure of the ignition on one cylinder of an eight cylinder car is often not noticeable by the average person when driving on city streets. This makes diagnosing by road testing very uncertain, even for experienced persons. Thus, if the inspection process also yields diagnostic information, maintenance and repair are greatly facilitated. In fact, since the inspection process under discussion does require operating the vehicle at enough different speeds and loads to check for proper operation and since any

increase in the level of one or more of the emissions above the proper level at a given speed and load is indicative of a certain kind of malfunction or misadjustment, the inspection process does provide diagnostic information. The Clayton Manufacturing Company has systematized the presentation of the test data so that by noting which levels of emissions are excessive and in which mode of operation, the mechanic may use a simple chart to tell him where the trouble is likely to be. Then if the indicated trouble spot (sometimes more than one) is repaired (if necessary) or adjusted using standard procedures, the vehicle is very likely to operate properly. Of course the mechanic would make use of the standard tools and instruments normally available in any properly equipped garage. These tools and instruments are usually designed to check some specific part of an engine though, rather than the entire engine. Hence the need for diagnosis. Also, in some cases their use may require dismounting or disassembling parts of the engine. There is also a tacit assumption in the above that any malfunction that interfered with the use of the vehicle or was otherwise noticeable to the driver would be repaired. Hence the concern with improper operation which is not necessarily evident but which does cause an increase in emissions.

The need for the third desired characteristic, that the inspection process be simple, cheap, and rapid, is fairly obvious when one considers that there are more than twelve million motor vehicles in California with more than half of them in the South Coast Air Basin alone. The kind of inspection being discussed here requires that the inspecting technician drive the car on to the dynamometer, insert a sampling probe into the tail pipe, record (which may be done automatically) the emission levels

from the instruments at idle (zero speed) and at two (or three) constant speeds. The sampling probe is then removed and the car driven off the dynamometer. The technician notes whether or not the emission levels indicate proper operation. If not he gives the card with the levels to the vehicle operator. The levels constitute the diagnostic information needed to effect repairs. The capital costs for the inspection facility, assuming yearly inspection, are about two dollars per vehicle to be inspected and the operating cost about one dollar and five cents per inspection. The time required to perform an inspection is less than five minutes. [2] The procedure, cost, and time figures are for 1971 and earlier light duty vehicles.

As the emission control system on new vehicles becomes more complex to meet the increasingly stringent emission standards, the inspection process for those vehicles will also become more complex. Specifically, it will probably be necessary to provide a port for sampling the exhaust upstream of any catalytic or thermal reactor as well as at the tail pipe. It will also be necessary to add an instrument to read the level of oxides of nitrogen emitted. For most existing vehicles only hydrocarbons and carbon monoxide are measured. Finally, it might be necessary to add a third speed at which measurements would be taken. The additional capital cost per inspection lane would be less than twice as much assuming that additional instruments were added so that measurements would be made simultaneously at the sampling port ahead of any reactor and at the tail pipe. An additional speed, if required, would increase the time per test and the operating cost by no more than 25%. The increase in time would also reduce, somewhat, the number of cars per year that

could be handled by an inspection lane and further increase the capital costs. However, it should be noted that not all inspection lanes would have to be so equipped or operated. Only enough lanes to cope with the newer cars would have to be upgraded. Since about 11% new cars are added to the population each year it would be four years after the start of any upgrade program before half of the inspection lanes would have to be upgraded.

Heavy duty vehicles present still a different problem. No inspection procedure seems to have been worked out and verified for them. Yet they make up 13% [3] of the vehicles, burn a disproportionate share of fuel, and emit much more per mile than a light duty vehicle even when operating properly. Certainly if we are to have clean air we must be sure that this class of vehicle is not over emitting. Because of the larger size, greater complexity, and greater range of variation among heavy duty vehicles, it is likely that the procedure will be more complex and perhaps several different procedures would be required for different sizes of engines. However, initial experiments show that the model approach to inspection is applicable. Such an inspection would be therefore relatively simple, cheap and rapid.

The kind of inspection process that is being proposed then is one which would apply to essentially all vehicles and would be done periodically to ascertain whether the vehicles were operating properly from an emissions standpoint. It would measure emissions directly under enough different loads and speeds to test the vehicle adequately. In cases where the vehicle was over emitting it would provide diagnostic information to

aid a mechanic in making necessary repairs. It would be simple and cheap and require little time.

The Integration of Inspection and Maintenance

Of course merely inspecting an over-emitting vehicle will not reduce its emissions. That can only be accomplished by appropriate repair or adjustment. Perhaps some persons would voluntarily have such maintenance performed but it seems likely that it will be necessary to provide some compulsion to assure that the maintenance is done. An easy to implement and very effective form of compulsion is to require that the inspection be passed as a condition of continuing operation of the vehicle. This can be accomplished by requiring that the vehicle pass the inspection before it can be registered. Mr. Post, the Legislative Analyst, has suggested this and pointed out that it could be combined with year round registration which would smooth out both the inspection and the registration processes. [2]

Under this scheme of conditioning registration on passing inspection the owner of the vehicle would take his vehicle to be inspected any time during, say, a two week period prior to his registration date. If the vehicle passed he could then register it. If not, he would be required to return for a second inspection before the vehicle could be registered. If the vehicle still did not pass it would have to be brought back repeatedly until it did pass. If it did not pass by the registration date the vehicle could no longer be driven although it could be registered at any time it did pass inspection and then, of course, it could be driven. A similar scheme involving a windshield sticker instead of registration but with the

same requirements for passing inspection has been used by the State of New Jersey for many years as part of their safety inspection program.

Issues Raised by Mandatory Inspection and Maintenance

The careful reader of the discussion of a system of mandatory motor vehicle inspection and maintenance presented above will no doubt have thought of many questions that were not answered. The discussion to this point was intended to give an overview of the entire system. In this section we discuss and attempt to resolve a number of important issues that are raised by the proposed system of inspection.

Issue 1. Who would do the inspection?

There are usually considered to be two choices as to who would do the inspection. The one would be for the state to set up inspection stations and operate them with state employees. The other is for the state to license private organizations (probably garages) to perform the inspections. The proponents of the first approach usually cite as their major reason that it is undesirable to have a garage with an interest in performing repairs make the inspection. There is a widespread feeling that such a system would lead to abuses and much expensive and unnecessary maintenance. The proponents of a system of licensed private inspectors point out that state inspection would require a huge public investment and a large addition to an already large staff of state employees.

Both points of view have elements of validity but public confidence in an inspection scheme dealing with emissions, especially since they cannot be directly perceived, seems to be the overriding factor. A strong

secondary factor is that the cost of operation would probably be covered by a fee in either case so that additional employees would not be a drain on the state treasury. In consideration of these factors many have concluded that the inspection should be done by the state. This is in agreement with both the findings of the Northrup Corporation [1] and the conclusions of Mr. A. Alan Post [3]. It should also be noted that the original capital required to set up the system could be done by means of a one time additional assessment levied against vehicle owners and collected along with the registration fee. The two dollars per light duty vehicle or the somewhat higher amount for a heavy duty vehicle would not seem to be overly burdensome.

There also appears to be a third possibility that lies between the two opposing points of view discussed above. That is to assign the job of inspecting to a not-for-profit organization. This approach has been used often in the past, notably by the federal government, to resolve just such conflicts as arise here. When used properly it permits tight governmental control without the need for a large bureaucracy. On the other hand, since the activities of the organization are both limited in scope (usually to government sponsored activities) and are not-for-profit, there can be no conflict of interest involved. Although this approach has been little discussed it appears to have great merit and should be carefully considered.

A corollary point to be made is that there seems to be no thought by anyone that the state should get into the automotive maintenance business. The necessary adjustments or repairs would be the responsibility of the vehicle owner and would be done by whomever he selected. Adjustments

and repairs would be made according to manufacturers' instructions except where the instructions were modified by the Air Resources Board in connection with retrofit devices.

Issue 2. How will the system get started?

Issue 3. In what areas will inspection be required?

Issue 4. Which vehicles will be inspected?

These three issues are discussed together because they are closely related. The discussion is based on three ideas. An inspection system should make as large an impact on air pollution as possible and as soon as possible consistent with economy and prudent management. An inspection system should evolve as the population of motor vehicles changes and as our knowledge and understanding increase. And there is no point in having inspection just to have inspection. With these ideas in mind it seems evident that the system should be started first in the South Coast Air Basin, which has the worst air pollution problem, and should apply first to that class of vehicles which is most numerous and about which we know the most, namely light duty vehicles. It should apply to other areas as the need and the state of our knowledge indicate it is desirable. Some areas of the state and perhaps some classes of vehicles would never require inspection.

An obvious way to proceed in this direction would be to start with a pilot program in Los Angeles. It could start with as few as five to ten inspection lanes and initially involve as few as one to two hundred thousand vehicles. These numbers are chosen to be small enough to not require a large initial investment or number of people, but large enough to provide realistic experience.

The major problem in starting such a pilot program concerns the proper way to involve the automotive service industry. The key to its involvement is the standards set for passing the inspection. Initially the standards must not be too strict or the service industry will not be able to respond. Both the number of vehicles to be maintained and the nature of the malfunction and misadjustments to be corrected are of concern. One way to handle the transition period would be to set the standards initially at, say, three times the average emission level for each class of vehicle. That is, if an emission level for any kind of emission measured under any mode of operation exceeded three times the average level for the same measurement for similar vehicles, the vehicle would fail the test. Any such level is associated with a gross malfunction or misadjustment. Averages of measurements on a vehicle should not be used because they would tend to blur the indication of a clear cut and gross problem. Test programs indicate that about ten percent of the vehicles would be affected. These would be the worst emitters and would be the ones showing the most improvement from maintenance and repair. Moreover, they would be the ones with the most obvious problems hence would be the easiest for the service industry to repair. As the worst emitters were found and corrected the standards would automatically tighten somewhat. As the service industry gained experience the standards could be further tightened to cause the rejection of all vehicles that were over emitting. Some such approach as this is needed both to make maximum initial impact and to allow the service industry the time and experience to prepare itself to maintain vehicles for low emissions.

Once the pilot program had shown that the inspection system was working, the system could be expanded in an orderly way to cover the entire air basin. As noted previously, the process would be greatly facilitated by a system of year round registration.

A second stage pilot program should be started as soon after the first one as feasible. Its purpose would be to gather data on heavy duty vehicles and to devise inspection procedures for them. Because of the diversity among this class of vehicles the initial efforts should be devoted to the most numerous types. There might be some types that are so rare that it would never be worthwhile to inspect them. However, with the levels of emissions that will be required for light duty vehicles by the 1975-76 standards such vehicles will be few indeed.

In summary then, the approach proposed for setting up an inspection system is to start with a pilot program in Los Angeles aimed only at light duty vehicles. As the procedures are refined and the personnel trained the system would be expanded to cover the whole air basin. A second stage pilot program would devise procedures and collect data so that heavy duty vehicles could be incorporated into the system. The objective would be to have each vehicle achieve the lowest level of emissions of which it is reasonably capable. The system would be extended to other air basins as needed.

Issue 5. Should diesel vehicles be inspected?

The statement is often made that diesel vehicles are inherently clean. Perhaps a more accurate statement would be that diesel vehicles have different emissions characteristics than gasoline burning vehicles.

To date the problem of diesel vehicles has generally been avoided. No standards have yet gone into effect for diesel vehicles. However, in the post 1976 era when all vehicles should have very low emissions, diesels should also be inspected. It seems highly unlikely that all diesels are putting out the minimum emissions of which they are capable. The familiar smoking exhaust pipe and diesel smell indicate that inspection procedures should be devised and standards set for them too. Given the present situation, though, it will probably not be possible to do that as soon as for some other types of heavy duty vehicles.

It is interesting to note that a similar situation applies to motocycles.

Issue 6. Should vehicles using gaseous fuels be inspected?

It is generally considered that gaseous fuels, natural gas and propane, are inherently clean burning and in a very real sense that is true. Yet, as with any fuel, if the engine is running very rich, either because of malfunction or misadjustment, there will be excessive carbon monoxide in the exhaust just because there is not enough air to burn the fuel completely. Other kinds of improper operation can cause other emission levels to be excessive. So, while the gaseous fuels are clean burning the vehicles using them are still fallible and require maintenance. Periodic inspection is a means for assuring that this maintenance is done.

There is another important reason for requiring that vehicles using gaseous fuels are achieving the low levels of emissions of which they are capable. The state exempts vehicles using gaseous fuels in an

approved fuel system from the fuel use tax until the end of 1975. This tax exemption was set up to encourage conversion of existing vehicles to gaseous fuels by providing a way to recover the cost of conversion. The exemption represents a subsidy by the people of the state and they are entitled to receive the low emissions in return.

Issue 7. How does periodic inspection relate to new vehicle inspection?

As more and more stringent standards have been placed on new vehicles, elaborate engineering tests have been devised to assure that the new vehicles do in fact meet the standards. These tests make use of complex driving cycles intended to simulate typical driving patterns of vehicles in actual use. The original purpose of these tests, which are both lengthy and expensive, was to certify new models of vehicles. They were originally applied only to prototypes. With experience it became evident that vehicles being manufactured in mass did not always meet the standards, either because of changes in design or mismanufacturing. Consequently, it has been required that more and more production vehicles be tested. It may be that in time all of them will be required to be tested.

The question is often raised as to whether this certification test should not be used for periodic inspection. It is usually pointed out in connection with the question that to date no short, simple test has been devised that will yield a determination of the levels of emissions as determined by the certification test. The question misses the point of periodic inspection and confuses the purposes of the two kinds of testing.

Certification testing is to determine whether a vehicle when operated over a specific simulated driving cycle meets some imposed standards for the total amount of each kind of emission. It is not specified how the total emissions are to be distributed over the parts of the cycle. The testing performed under a system of periodic inspection is to determine whether or not a vehicle is operating correctly. The levels of the emissions to be permitted in each mode of operation are determined by taking similar vehicles known to be operating correctly, i.e., that have passed the certification tests, and measuring their levels. In theory, although this doesn't seem to be the case in practice, vehicles of different makes and models that all passed the same certification test could have different emission levels for a given mode of operation. This would merely indicate that the different manufacturers had allocated the permitted total amount of emissions differently over the parts of the simulated driving cycle.

The important point here is that experience shows that any car that passes a properly designed modal test with emission levels determined by testing similar vehicles known to be operating properly will also pass the certification test. Thus a simple modal test can determine whether a vehicle is operating correctly even though it cannot determine the total level of emissions that vehicle would produce in a certification test.

A consequence of this situation is that inspection type testing could replace certification type testing on most production vehicles. The more complete testing is, of course, required for certification and to provide a group of cars that is known to meet the standards. This group of cars

would provide the data to determine the characteristic set of emission levels for the inspection procedure. In addition vehicles would be selected from those coming out of production for complete testing to assure that the design had not changed. The selection would be done according to well established principles of quality control and would be a small percentage of the total. The rest of the vehicles would be tested using the inspection procedure. If they passed it would verify that they were properly manufactured and adjusted and would be able to pass the certification test. Passing the inspection test at the time of manufacture would also verify that they would be able to pass the inspection test in the future with proper maintenance. This approach would resolve the conflict between the EPA, which requires the elaborate test, and the state, which desires 100% inspection to assure proper manufacturing.

Issue 8. Won't new vehicles after 1975 have a warranty of low emissions for 50,000 miles? Doesn't this obviate the need for inspection?

Even though a vehicle may be warranteed for a certain mileage it does not mean that it does not require maintenance or that it may not malfunction or be misadjusted. Such parts as the ignition system and the carburetor typically require repair as well as periodic maintenance well before 50,000 miles. The emission control system is designed to reduce the emissions from a properly operating engine. It is not usually able to cope with the increased emissions from an improperly operating engine. The intent of the warranty is that if the engine is operating correctly and if the emission control system has been properly maintained, then the emissions will remain low for the stated mileage. This guards against designs that

will not tolerate normal engine wear for example. A recent decision by the EPA to permit one replacement of the catalytic reactor during the first 50,000 miles for 1975-76 vehicles emphasizes the need for maintenance.

Another reason for inspecting post 1974 cars is that not uncommon malfunctions can easily increase the emission levels of those cars by several thousand percent. In a situation where so much effort and money will be devoted to reducing emissions, it will be intolerable to allow improperly operating vehicles with emission levels many times those of properly operating vehicles.

Issue 9. Isn't there actually data that shows that inspection and maintenance can actually increase some kinds of emissions?

Vehicles manufactured from 1966 through 1970 had controls on the emissions of carbon monoxide and hydrocarbons but not on oxides of nitrogen. The manufacturers, in order to meet the standards imposed, changed the design of these vehicles in such a way that the oxides of nitrogen emissions were actually increased. Certain kinds of misadjustment, such as running too rich, will reduce the oxides of nitrogen at the expense of increasing hydrocarbons and carbon monoxide. Thus when the engine is properly adjusted the oxides of nitrogen do actually increase. To a certain extent this is also true of earlier vehicles where a gross misadjustment of the air fuel ratio will actually reduce the oxides of nitrogen.

If the inspection and maintenance program were being considered by itself, the situation with respect to oxides of nitrogen would be a problem. However, as Mr. Post has pointed out, [2] an inspection and maintenance program should be considered as part of a larger system which includes

retrofitting existing vehicles with various devices to reduce emissions. Fortunately there are several devices which disconnect the vacuum spark advance mechanism in the distributor (at least under certain conditions of operation) which are either already approved by the Air Resources Board or in the process of being approved. When such a device is installed on a vehicle the oxides of nitrogen are materially reduced and the vehicle can be adjusted with all three kinds of emissions at a low level. In the context being considered here, then, a program of inspection and maintenance would not result in increases of any emissions.

Issue 10. Aren't there other inspection procedures that do not require a dynamometer that are just as effective in reducing emissions?

The key point in this issue is effectiveness. There are many measures of effectiveness. One is cost. Another is cost per unit of emission reduction. Another is total emission reduction. All of these to some extent miss the point of the reason for inspection in the South Coast Air Basin. Since the purpose of the inspection and maintenance program would be to assure that vehicles were operating properly, the criterion for effectiveness for the inspection procedure should be how well it distinguishes proper from improper operation. An adjunct to the criterion is how much diagnostic information it supplies to assist in any required maintenance.

By this criterion it is evident that an idle test or similar test is ineffective because some parts of the overall engine, such as the high speed part of the carburetor, are not tested. Of course these parts, if malfunctioning, would cause the vehicle to over emit.

There is still the question of the diagnostic type of inspection. Basically such an inspection consists of a thorough examination of the various parts of an engine using diagnostic instruments. Presumably, if properly done, the vehicle, if it passes, is operating correctly and would have low emissions. This system suffers from several disadvantages. It costs more for the inspection and takes more time. [1] It is indirect in that the emissions are not measured directly (except possibly for carbon monoxide). It is more specific to the particular make and model of vehicle and requires more skilled personnel. All things considered it is less suitable than the kind of inspection proposed.

Issue 11. Isn't a program of mandatory periodic maintenance just as effective as a system of inspection and maintenance?

The idea here is that periodically all vehicles would have to undergo a mandatory "tune up". An approved procedure would be used, the work would be done by a licensed garage, and a certificate would be issued to show that the work had been done. The certificate would be required to register the vehicle.

There are two problems with this scheme. The first is a purely technical one. The procedure would necessarily have to be a compromise between completeness and cost. It would be very expensive to do a "complete" maintenance on each vehicle. Anything much beyond a check of the ignition system plus replacement of points, condenser, and spark plugs together with an adjustment of the carburetor would result in a great deal of unneeded work. Yet this sort of limited procedure would fail to repair many vehicles with malfunctions that caused serious over emitting. The com-

promise would become even more unsatisfactory as the newer vehicles with more complex emission control systems appeared.

The second problem is in the difficulty in assuring that the work was done properly. There would be an enormous possibility for fraud, perhaps with the collusion of vehicle owners. Any system which requires the public to periodically have work done and where the results of that work may be difficult to perceive would be extremely difficult to make effective. Compared to an inspection system with its built in checks and balances the mandatory maintenance scheme is both ineffective and undesirable.

Issue 12. Should safety inspection be combined with emission inspection?

It is not the purpose of this paper to go into safety inspection in any detail. Certainly emission inspection can stand alone. However, there is evidence to believe that safety inspections are worthwhile and that the two kinds of inspection would tend to reinforce each other. [2][4] What is clear is that a major obstacle to any inspection system is the inconvenience to the owner in periodically bringing a vehicle in for inspection. If there is to be both a safety inspection and an emission inspection they should be done at the same time and the same place.

Issue 13. What agency should do the inspection?

There are several candidate agencies, the Air Resources Board, the Highway Patrol, and the Department of Motor Vehicles for example. The Air Resources Board is the obvious agency to set the standards and procedures for an emission inspection system. The question as to which

agency actually does the inspection, though, (or supervises a not-for-profit which does the inspection), is an administrative question best worked out by the legislature and the agencies involved.

Issue 14. What about vehicles that cannot be repaired?

Although the question is often asked in the form stated, it is not properly posed. Any vehicle can be repaired so that it does in fact operate correctly and emit at a proper level. Even if it had been originally mismanufactured (carburetors seem to be occassionally subject to errors in manufacture) the defects can be corrected. There is a minor cavil that since not all cars have been inspected and repaired it is not possible to know with absolute certainty that an irrepairable car might not sometime be encountered. However, studies to date indicate such a possibility to be remote indeed.

A more pertinent question has to do with the cost of repair. This question is treated under issue 15 below.

Issue 15. Doesn't a mandatory system of inspection and maintenance place too heavy a burden of emission reduction on poor people who tend to drive older and higher emitting cars?

The question as posed includes two tacit assumptions. The one is that it is mostly the older vehicles that over emit and that these vehicles are mostly in the hands of poor people. The second is that there are acceptable alternatives to reducing the emissions from the motor vehicles in the South Coast Air Basin to the lowest level practicable.

The whole system of motor vehicle inspection and maintenance

proposed here is based on the idea that each make and model of vehicle has a proper level of emissions. That level is higher for older vehicles than for newer ones. While an older vehicle may be more likely to need repair or adjustment than a newer one, the cost of repair is likely to be less on the average than for the newer ones, especially the post 1974 models with their very low emissions and complex emission control equipment. Moreover, in the case of older cars, any repairs made are very likely to improve the fuel economy so that much of the cost of repair is recovered in reduced fuel costs. Of course, if a vehicle has a really worn or damaged engine, it could cost more to repair it than it is worth. This sort of vehicle is likely to be undesirable for other reasons, too.

Another point has to do with heavy duty vehicles. Most of these do not ever come into the hands of individuals, much less poor people. Yet they consume a significant portion of the motor fuel and would, under the system proposed, have to be inspected and maintained too.

The question of alternatives is most important. There is general agreement that the air in the South Coast Air Basin is much too polluted by any standards and must be cleaned up. Both the state and federal ambient air quality standards are exceeded a high percentage of the time. There is also general agreement that reduction in emissions from individual sources, predominately automobiles, is preferable to enforced reductions in the use of those sources. Yet it has been shown that even if all reasonable measures are taken to reduce emissions, including a very good inspection and maintenance system, the air will still fall far short of meeting the legal standards. [5] If we are to meet the standards (either state or federal) we

shall have to curtail use. To the extent that we permit any vehicles to over emit, we shall have to either further curtail use or suffer poor quality air.

The question of poor people per se still remains even if they are not being unfairly burdened. In our society a person is considered to be poor if, for whatever reason, he has an income that is insufficient to provide an adequate supply of goods and services. In the usual case such a person is subsidized, usually by the government, so that he will be able to have an adequate supply of goods and services. Where that adequate supply is found to include a car, then the subsidy provides for the car and cost of operation. It would seem that the cost of inspection and maintenance should also be covered in the regular subsidy system rather than to leave a gap in the system of emission control being built at such a cost in effort and money.

Desirable Features of a Mandatory Inspection and Maintenance System

In light of the above discussion a system of mandatory motor vehicle inspection and maintenance should have the following characteristics:

1. The state (or a state supervised not-for-profit organization) should perform the inspection, but maintenance should be done by whomever the owner of the vehicle chooses.

2. Inspection should be tied to registration so that a vehicle would have to pass inspection in order to be driven.

3. The inspection procedure should be arranged so that any vehicle in reasonably good operating condition would pass. Further, the procedure should test the vehicles under a sufficient number of modes of operation (speed and load) to assure that vehicles which pass are really operating correctly. The procedure should provide diagnostic information to aid in the repair of vehicles which do not pass. Finally, the test procedure should be simple, cheap, and rapid.

4. The inspection system should start with a pilot program in Los Angeles devoted to light duty vehicles. As the procedures are verified the system should be enlarged to encompass other areas and other classes of vehicles. At each phase the criteria for the expansion should be need and understanding.

5. If there is a system of safety inspection it should be combined with the system of emission inspections to minimize inconvenience to vehicle owners.

6. Vehicles which use fuels other than gasoline, especially the gaseous fuels, should be included in the system.

A mandatory system of inspection and maintenance having these characteristics would complement and render more effective the program of automotive emission reduction that we now have. Without such a system the present program will probably fail to be fully effective.

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