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Integrating On-Board Diagnostic System Capabilities into the Inspection and Repair Functions of I/M Programs

Technical Information Document For the Early 1990's

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Table of Contents

1.0 INTRODUCTION

At any point in time, a certain percentage of vehicles on the road are emitting in excess of their design standards due to repairable causes. Motor vehicle emissions inspection and maintenance (I/M) programs employ a short screening test to identify high emitters and a retest after repairs to confirm their effectiveness in reducing emissions. It is the initial screening test and the retest after repairs that differentiate I/M from a public information campaign about motor vehicle maintenance or from a program to train automotive mechanics.

Where and how those tests are conducted has been one of the fundamental choices in designing an I/M program. This choice is generally made by the elected officials who establish the necessary authorizing legislation . Two basic types of I/M systems exist: 1) inspection and retest at high volume, test-only lanes (a centralized network), and 2) inspection and retest at privately-owned, licensed facilities (a decentralized network). A combination of centralized and decentralized inspections is also found, the latter usually being for retests only.

This report describes the capability of the newer cars to perform self-diagnosis, and how these capabilities could be integrated into both the inspection function and the repair function. Specific recommendations to I/M programs can be found in the last section of this report.

Also, this report was prepared prior to the enactment of the Clean Air Act Amendments of 1990, which contain new provisions regarding the incorporation of self-diagnostic features into vehicles and I/M programs. This report has been updated to reflect the existence of the new provisions, however, it does not constitute the EPA response to these provisions.

2.0 BACKGROUND

An on-board diagnostics (OBD) system consists of a computer based system incorporated within a vehicle for the purpose of detecting and identifying operational malfunctions within the engine control system. Initial use outside California began in the 1981 Model Year (MY), primarily with General Motors, and generally coincided with closed loop fuel control systems. On-board diagnostics differ from off-board diagnostics in that OBD systems use the vehicle's on-board computer to continuously or periodically monitor engine components for malfunctions while the vehicle is being driven. In contrast, off-board systems rely on an off-board device to access the vehicle's electronic circuitry and search out component malfunctions as the vehicle sits in the repair shop. A primary benefit with OBD is its ability to monitor the engine control system during actual operating conditions. This type of monitoring allows the identification of malfunctions which may not show up in typical repair shop testing performed with current off-board devices (i.e., engine off, engine idling, etc.). Thus, the OBD system, in concept, has the potential to enhance the effectiveness of repairs. Another advantage of the OBD system is that it can advise the operator that service is required through a malfunction indicator light (MIL), thereby inducing a vehicle owner to seek repair at the time of the malfunction as opposed to waiting for the next I/M cycle to require repair. And finally, some observers, most notably General Motors, have argued that a check for malfunctions through the OBD system is a better I/M check than a tailpipe test.

The most sophisticated OBD systems monitor a number of engine components simultaneously, continuously examining how the components are responding to a given operating environment. When an abnormal condition continues for a given amount of time (usually a few seconds), a "trouble code" (indicating the type of abnormal condition) is stored in the Powertrain Control Module (PCM - formerly called an ECU). Some systems will illuminate a MIL to alert the driver that a malfunction has occurred, others don't. Therein lies the dilemma of existing OBD systems.

Putting aside the fact that many 1981 to 1988 model year vehicles do not have an OBD system, of those that do, no two makes are exactly alike. From an emissions standpoint, different manufacturers monitor different systems with vastly different capabilities. These differences make it more difficult for an inspector or mechanic to use the available OBD features. Each manufacturer accesses its trouble codes differently. The code numbers and meanings are different. When diagnostic plugs are available, they are in various locations on different vehicles. Each plug is a different shape requiring a different connector, and where the plug is the same shape, the pin assignments within the plug are sometimes different. On the maintenance side of I/M, unless a mechanic specializes in a few domestic makes and buys the tools for those cars, the accessibility of the OBD system on 1980's vehicles is at best difficult - at worst, practically impossible.

Activities are underway to improve the relevance and usefulness of the current OBD systems. The California Air Resources Board now requires all cars sold in California to be equipped with an OBD system that monitors several emission control parts and parameters, primarily in the fuel and EGR systems. Implementation of these requirements began with the 1988 model year, however the manufacturers were allowed to petition for up to an extra two years lead time. All California vehicles are to have the first generation OBD systems (designated OBD-I) by the 1990 model year.

Although OBD-I can be characterized as a vast improvement, it still has its flaws. Only some of the critical emission control systems are monitored. Systems such as the ignition, secondary air, and evaporative emission system were not included even though studies have shown that mechanics have a poor record in identifying malperformance in these areas (e.g., R.J. Sommerville, et.al., SAE Paper No. 870624). The capability and effectiveness of the required monitors for the fuel and EGR systems also varies greatly between manufacturers. Further, even though the California regulations specify that the readout of stored trouble codes by the mechanic may not require the use of any special tools, no standardization of the codes or read-out method was specified. As a result, some manufacturers used four digit codes, others used two digits. The code read-outs varied between one, two, or four blinking lights flashing out the code number, and were located anywhere from in the instrument cluster to under the hood to under the dash where the mechanics had to lay on their backs to read the codes. The read-out to the driver, the Malfunction Indicator Light (MIL), was standardized, but the circumstances necessary to activate or deactivate the MIL were not fully specified in the regulations, which resulted in interpretive differences during the new vehicle certification process.

Since California has at least mandated a basic OBD system with a MIL on all California vehicles, the idea of checking for an illuminated MIL as component of or in lieu of the I/M tailpipe check seems logical. Upon further consideration this simple idea is fraught with complexities and ambiguities. For instance, the codes can be erased and the MIL extinguished in less than 30 seconds on most vehicles. General Motors and others provide a simple power-interrupt connector at the battery that can be disconnected without even getting one's hands dirty. The codes are erased in 10 seconds. Volvo provides a convenient button under the hood for erasing the codes. If a non-illuminated MIL is a criteria for passing an I/M test, there is no means on current OBD systems for identifying and/or preventing the extinguishing of the MIL immediately prior to the I/M check.

Another problem with checking for an illuminated MIL during the I/M test is that some manufacturers, most notably General Motors, do not illuminate the MIL all of the time, even when a code is stored. For instance, if an oxygen sensor rich fault only occurs at 35 MPH, the MIL will come on at 35 MPH, but will go off at idle. This type of failure would not be detected in an I/M check for an illuminated MIL.

Finally, only California requires a MIL on all cars. No requirement exists at the Federal level. During meetings with various manufacturers on OBD, EPA specifically asked each manufacturer about the likelihood of a spillover of the California OBD systems to the Federal fleet. A few indicated that there would be no difference between the California and Federal fleets. Others said the Federal cars would not have the MIL unless Federal law required that they be equipped with the driver warning lights, even though some from this group indicated that they would store fault codes. One manufacturer even indicated that the Federal cars would have the California 'OBD-I' hardware, but would not have the California software to check all of the OBD-I required functions.

Another possible suggestion to incorporate OBD into the I/M check is to search for any stored trouble codes, either by reading the blinking code light or by attempting to electronically download the codes. This option has the same problems that the mechanic has in accessing and reading the codes. Since there is no commonality in code numbers between the different manufacturers, and because there is no differentiation between emission related and non-emission related codes, the deciphering of proper failure codes would be a monumental task. An inspector could easily confuse an air conditioning fault and an emissions fault, for example. If the blinking code light were to be used as a failure criteria, it would be necessary to assume that the codes were read correctly. For a similar reason, I/M programs have moved away from I/M analyzers with analog meters which required the mechanic or inspector to properly interpret and record the test results. Now, most programs require the use of analyzers that automatically identify and record the proper I/M test value without the mechanic's interpretation. OBD systems are at that same juncture in their development.

Attempting to electronically download the codes has its own set of problems. For instance, all California OBD-I vehicles have a manual means of reading out stored trouble codes, but not all have electronic access to those codes. Of those manufacturers that do have electronic access, which includes most models for General Motors, Ford, and Chrysler, but few imports, there are significant differences between the manufacturers' methods and the equipment necessary to read out the codes. Aftermarket tool makers are attempting to bridge these differences for at least the domestic vehicles. Even so, in a recent study conducted in the Maryland I/M lanes (EPA-AA-TSS-I/M-90-06) using one of the better aftermarket scan tools for downloading stored codes, the scan tool was unable to interrogate a significant number of vehicles for which the tool in question supposedly was compatible.

To get a random sample, every 1983 or later General Motors vehicle, and every 1984 or later Chrysler vehicle was selected (over a short time span) for electronic interrogation at one particular I/M test site in Maryland . After culling from the sample those vehicles whose owners were not willing to participate, those vehicles with an incorrect model year, and those vehicles at the station for a retest or that had been repaired already, an attempt was made to electronically interrogate the OBD system on 431 vehicles. Even with this relatively homogeneous group of vehicles, all late model General Motors and Chryslers, only 378 vehicles were successfully interrogated. A total of 53 cars or 12.3 percent of the sample could not be successfully interrogated. Problems included inability to electronically interface when the scanner should have been able to (9 cars), inability to gain physical access to the test plug (8 cars), physical damage to peripheral components limiting access (2 cars), the scanner was not designed to interface with the specific vehicle model or the vehicle was not equipped with an OBD system (32 cars), and the engine had been replaced with a non-OBD one (2 cars).

Of interest is that the analysis of the data from this study indicated that there were almost no gross emitters among those vehicles failing only for stored trouble codes (i.e., 1 out of 9). Nearly all of the gross emitters, determined by subsequent laboratory testing, were identified by the tailpipe emission test. Overall, the cars that failed by the tailpipe test tended to have higher emissions than those that failed for OBD codes. The failure of current OBD systems (i.e., '83 MY to '88 MY) to identify gross emitters suggests that only marginal emissions reductions may be achieved with the existing OBD systems. Additional studies are underway to better define this initial evidence on current OBD capabilities. Future improvements to OBD systems should improve the OBD to tailpipe relationship.

Prior to completion of the preliminary Maryland OBD study, EPA and others recognized that standard access to OBD systems would have potential benefits not only for vehicle repair, but could be crucial to the success of an I/M program employing OBD codes. EPA, therefore, requested the Society of Automotive Engineers (SAE) to investigate the feasibility of developing industry wide standards for access to OBD systems. SAE responded positively, and formed the Vehicle E/E Systems Diagnostic Committee which is actively pursuing such standards. These standards will be completed by September 1991.

In the meantime, as a result of the perceived weakness in the OBD-I regulations, the California ARB has completed work on new regulatory amendments to upgrade the OBD-I regulations. These new amendments, adopted by the Air Resources Board on September 14, 1989 and commonly called 'OBD-II', would require the OBD system to monitor additional systems such as the catalyst system, the secondary air injection systems, and the EVAP system. Misfire detection, which includes detection of misfires due to fuel system malfunctions and air leaks as well as ignition system malfunctions would also be required. Also specified are improved methods for the monitoring of the fuel system, the EGR system, and oxygen sensor. Most importantly, OBD-II requires a means to identifying any recent erasure of the trouble codes.

In addition to the obvious potential of monitoring additional critical emission components, the OBD-II regulations have two features that could be most useful to I/M programs, and also address the problems encountered in the Maryland study. First, the OBD regulations would require that all manufacturers use the standard OBD access practices developed by SAE (i.e., standard plug, communications link, downloading protocol, codes, etc.) so that trouble codes could be downloaded consistently. With this feature the blinking light for the code readout would be abandoned. Second, the draft would require that certain vehicle control signals be available to the mechanic through a standard plug to aid in repair effectiveness.

The feasibility of implementing an OBD component to the inspection portion as well as to the maintenance portion of an I/M program is greatly enhanced by these two features . The time table for these events is another matter. ARB's schedule calls for these standards to be implemented for the 1994 model year with an optional phase-in period of up to two years. All vehicles would be required to fully comply with the monitoring and standardization requirements by the 1996 model year.

This schedule presents two problems with integrating the OBD component to I/M in the 1990's. The first is obvious. The schedule is one for California vehicles, not Federal vehicles.

Prior to the enactment of the Clean Air Act (CAA) Amendments in November of 1990, EPA had begun the regulatory process necessary to implement requirements for self diagnosis of emission control systems for new cars. The new Clean Air Act Amendments require EPA to promulagate final Federal OBD regulations within 18 months of enactment. To meet this schedule, EPA will need to publish a Notice of Proposed Rulemaking (NPRM) for EPA's OBD regulations during the spring of 1991. The Model Year implementation specified by the CAA Amendments is similar to the California implementation scheme for OBD II. Technical specifications are under internal debate, but systems meeting the expected Federal requirements are also expected to comply with OBD II. Requirements for standardized access to the OBD system are expected to be similar to those in California's OBD-II.

The second issue is that new vehicles, at least in California, will not have a truly I/M compatible system until 1994, and because of the phase-in, some will not be completely compatible until 1996. It will be the year 1999 before all these vehicles are off the new California 3/50 warranty. Given 1994 California start-up date and likely similar Federal start-up date, if OBD is to be a completely compatible component of I/M, it will clearly only be a viable option for the middle to late 1990's.

Even so, California is making preparations now for their next generation I/M analyzer, the TAS 90, to incorporate the OBD into their failure criteria for the program. For OBD-I cars, which would have non-standardized systems, the TAS 90 will prompt the inspector to look for an illuminated MIL and to enter any codes observed. The TAS 90 will be required to interpret the codes, and the TAS manufacturers must offer an option to download the codes electronically for those cars that allow electronic access. When OBD-II cars become available (i.e., beginning with the 1994 MY), existing TAS 90 machines must be capable of interfacing with the OBD-II system. In essence, California will be using a manual type system for pre-1994 cars, and an automatic system for 1994 and later cars.

3.0 DISCUSSION

Given this status of OBD in the current and potentially future I/M fleets, how can OBD be integrated into the inspection portion of I/M? For the moment, ignoring the practical problems, the two options for inspection include:

1) Fail for illuminated MIL

2) Fail for stored codes

The primary issue with failing for an illuminated MIL is there is no current Federal requirement for vehicles to be equipped with a MIL let alone an OBD system, even though some manufacturers have had MILs since 1981. As indicated previously, some manufacturers will not equip their vehicles with a MIL until Federal regulations require it. Thus, to fail vehicles with an illuminated MIL might serve as a disincentive to those manufacturers contemplating the inclusion of a MIL on those vehicles not so equipped. Further, such an inspection failure policy might be considered to unfairly penalize those manufacturers that do equip their vehicles with a MIL as well as being unfair to their customers. Absent Federal regulations, there is also the issue of how and when the MIL comes on and goes off (i.e. a problem off-idle may not turn the MIL on at idle), as well as the issue of the sensitivity of the system to properly identify malperforming components or systems. But, most importantly, without a Federal requirement, such a failure criterion would most assuredly leave unaffected a significant number of vehicles that could not be tested for the OBD inspection component.

Many of the issues involved with failing for an illuminated MIL also apply to failing for stored codes. In addition to those issues are the issues of how to best read the codes. One very strong recommendation is that reading a blinking light to decipher codes should be avoided as an inspection failure criteria. The other option, that of electronically downloading the codes, is the recommended option, but, that recommendation has its own problems with current OBD systems (i.e., lack of standardized access and standardized codes).

Even so, there are some things that can be done given the current patchwork of OBD systems. For instance, all referee stations should have sufficient manuals and equipment to read and/or download trouble codes from as many 1981 model year and later vehicles as possible. The purpose of this requirement would be that no vehicle equipped with an OBD system could be granted a repair waiver without first successfully interrogating the vehicle's OBD system and finding that no codes were present. Other waiver requirements would then control the disposition of the vehicle. Such a requirement for waivers might put a burden on some garages in centralized or decentralized programs that may have been previously authorized to grant waivers, but those who cannot read the codes probably are not sufficiently knowledgeable or have the equipment to properly determine that the car should have received a waiver in the first place.

Additionally, certain 1981 model year and later vehicles have been difficult to test by the usual tailpipe method. Those difficult vehicles equipped with OBD systems could be checked, and if trouble codes exist, the vehicle should be failed. Centralized lanes may require a separate lane or holding area to effectively utilize this option due to the extra time that may be required for these vehicles.

Attempting to read or download trouble codes in a centralized lane for all vehicles, as opposed to special vehicles, with current OBD systems is not practical given the lack of a standard access and current throughput rates. In the centralized Maryland program during the preliminary OBD study, vehicles were pulled to the side to read the codes and administer a vehicle owner's questionnaire. However, when standard access to OBD systems is achieved, and when Federal regulations require all vehicles to be equipped with OBD systems, interrogation of OBD systems in the centralized programs would then be recommended.

With TAS 90 analyzers, the operation of automatically interrogating vehicles might be more convenient to the public in a decentralized program, but the opportunity for fraud (i.e. interrogating a different vehicle) would exist unless each vehicle identified itself over the data link. Currently, ARB has no plans to require such identification. EPA is considering taking comments on such identification through Radio Frequency (RF) Transponders in it's NPRM on On-Board Diagnostics, however, implementation would likely take place at some undecided future date (i.e., not 1994). Certain groups within the SAE Vehicle E/E Systems Diagnostic Committee have also discussed the usefulness of an on-board vehicle I.D. available over the link to assist the service technician in identifying the vehicle for maintenance reasons. No SAE actions are pending.

The primary goal of integrating OBD into the maintenance side of I/M is to direct the mechanic to the proper repair action(s). No OBD system by itself can do the complete job, there will always be a need for some off-board assistance (e.g., diagnostic guides, trouble trees, specifications, etc.). However, mechanics should be encouraged to use OBD where ever possible as a matter of policy. But, the disparity between the OBD systems, and the fact that many Federal vehicles may not have a system, makes it difficult to universally apply such a policy. Quite possibly, if the I/M program office or the State elected to limit the authorization to repair the later model electronically controlled vehicles to mechanics with a special license, then as a matter of licensing requirements, the mechanic or shop might be required to maintain and use one of the better scan tools. At least on the vehicles that the mechanic could access with the scan tool, the diagnostic focus of the real problem could be enhanced.

An important option that should not be overlooked in decentralized programs is the issue of re-equipping existing I/M stations when the current emission analyzers begin to exceed their useful life. If the program chooses not to implement a centralized program at that juncture, and chooses instead to remain with a decentralized program (which may be limited under the requirements for "Enhanced" I/M Programs in the new CAA Amendments), then it makes sense for the program to strongly consider the use of an I/M analyzer similar to the California Bureau of Auto Repair's (BAR) TAS 90. The TAS 90 is designed to be sufficiently expandable so that it will be compatible with the expected standardization in vehicle OBD systems, as well as the electronically stored service manuals that are on the horizon. The expandable portion of the TAS 90 has the capability to enhance the inspection side for future vehicles. Both features, however, will be extremely important to the repair process even in centralized programs. Particularly, the electronically stored manuals will greatly assist those repair shops that service more than one make of vehicle. An anecdotal report from a user with a pre-production electronically stored manual claims that it will save 1 hour of mechanic's time per day (averaged over 5 mechanics). Therefore, in locations where the first or second generation of I/M or repair analyzers will wear out in the early to mid 1990's, stepping up to a TAS 90 generation analyzer could greatly benefit both the inspection side and the repair side of those programs in the middle to late 1990's.

After the periodic inspection (including an MIL illumination and trouble code check) and any necessary maintenance, the vehicle should be free from codes and the MIL should not be illuminated. If the MIL is still illuminated after the initial repair, it obviously should not pass the retest. As indicated earlier, an I/M program may wish to deny a repair waiver to any vehicle with trouble codes, since these should always be repairable without great expense, and with a near-certain improvement in emissions.

Assuming that the vehicle is in compliance when it completes the periodic program, one of the potential advantages of OBD systems (current and future) is that if the MIL illuminates between the last periodic inspection and the next inspection, the responsible owner would be expected to repair the vehicle promptly, resulting in a reduction in excess emissions. Currently, however, there are few incentives for the vehicle owner to repair the car, if it appears to operate correctly when the MIL is illuminated, other than if the car is due for its next periodic inspection shortly. The program should certainly capitalize on public spirit, and educate the public to promptly repair their cars when the MIL illuminates as the individual owner's part in helping clean-up the atmosphere.

On future OBD systems, some manufacturers have informally inquired on whether they could record the mileage interval between the identification of a malfunction and the repair of that malfunction. Such a mileage record, if allowed, could serve as documentation for identifying extended operation of the vehicle while a malfunction of the emission control system existed. In some cases, extended operation could permanently damage certain emission control systems (e.g., catalyst damage due to misfire, or oxygen sensor damage due to very rich mixtures over an extended period of time). Some vehicle manufacturers may propose to consider such extended operation to be "abuse" of the vehicle by the owner, and may want to deny warranty coverage for such extended operation. EPA and ARB have not yet addressed this issue, and all of the possible implications. However, if vehicles ever record mileage intervals. I/M programs will have the option of treating an excessively long period as grounds for denying any applicable waiver cost limits, if the car fails its retest and has difficulty being repaired (i.e., a very long delay in repair would be treated the same as tampering in the waiver policy). Including these elements in the waiver policy would provide an incentive to repair the vehicle shortly after the MIL illuminates regardless of warranty coverage. The public would need to be educated that identification of abuse would void any applicable waiver cost limits, and could void any applicable warranty coverage.

An additional incentive for the owner to respond to the MIL light is to authorize and encourage police agencies to issue "fix it" tickets anytime they observe an illuminated MIL. The police procedure could be as simple as a visual observation, or as complex as a key-off, key-on, engine-run test to verify that the bulb in the MIL was operational. The response to the emission "fix-it" ticket could be similar to a broken tail light - repair the problem, verify that the problem was fixed (with an emission test), provide the appropriate official with the emission documentation (indicating a passing score and the absence of any codes), and demonstrating to the appropriate official that the MIL was off. Failure to repair the vehicle in the specified time would follow the same procedure that any other "fix-it" ticket would follow in the jurisdiction that issued the ticket.

4.0 SUMMARY AND RECOMMENDATIONS

Thus in summary, the recommendations for the inspection side are that only the state of California is truly in a position to use OBD as a primary I/M failure criteria in the near future, and then only on 1989 or 1990 model year and later vehicles. Until Federal regulations require OBD systems, all other I/M locations may have to be content using OBD as at most a secondary I/M failure criteria. If such a secondary failure criteria were used, it would need to be somewhat flexible recognizing that model year coverage would likely be spotty, and operation difficulties could arise from time to time (e.g., physically accessing a vehicle with a scan tool). When Federal regulations require I/M compatible systems on vehicles, the CAA Amendments require that all State Implementation Plans (SIPs), with an I/M element, include a check of the OBD system (on new cars) within 2 years of enactment of the final OBD regulations. Centralized programs will probably be able to incorporate automatic down loading of OBD information into their I/M test procedure much faster than decentralized programs. Part of the centralized advantage is that fewer analyzer systems would need to be upgraded. Additionally, the centralized program would be expected to have greater flexibility to make such a programmatic change unless the decentralized program already had TAS 90 analyzers with the OBD expansion option in the field. California is also in a better position to use OBD systems on the maintenance side of I/M as well. Considering the previous discussion, the following options should be considered by I/M programs for the early 1990's.

4.1 Possible Inspection Options

1. Require all referee facilities to maintain sufficient manuals and equipment to read and decipher trouble codes from most manufacturers and most model lines for 1981 model year and later vehicles that are equipped with OBD systems.

2. Do not allow any vehicle equipped with an OBD system to be granted a waiver without first interrogating the vehicle for stored codes. A list of 1981 and later model year vehicles that are equipped with OBD systems may be needed.

3. Require the OBD system (if present) to be interrogated on all 1981 and later model year vehicles for which the tailpipe test is difficult to conduct in lieu of exempting them or waiving the tail pipe test. Fail vehicles for stored emission related trouble

codes or for illuminated MIL. This option may require a separate lane or holding area for centralized programs.

4. Use an illuminated MIL as a failure criterion for all 1981 and later MY vehicles. Recognize that all vehicles are not equipped with a MIL and accept the task of dealing with any fairness issues that may arise. Because this option would require visual observation of the MIL to determine if it was illuminated, the accuracy of this check would be expected to be far superior in a centralized program.

5. When the program is due for the next analyzer upgrade, require California TAS 90 or equivalent.

6. If existing legislation does not provide for authority to fail vehicles on the basis of electronic codes, seek new authority for at least 1994 and newer vehicles.

7. Implement a "Good Citizen" program to encourage the public to seek repairs when the MIL illuminates as their part to help clean-up the air.

8. If authority exists to issue "fix-it" tickets for illuminated MILs and to require a passing emission test after repair, prepare guidelines for police agencies, and implement a pro-active program to educate the public, to track the issuance of "fix-it" tickets, and to monitor the effectiveness of subsequent repairs for 1984 and later model year vehicles equipped with MILs. If existing legislation does not provide for authority, seek new authority.

9. If EPA (or ARB, if ARB rules are applicable) ever allows the vehicle manufacturer to record the interval between MIL illumination and the repair, or such records of extended operation with malfunctioning emission control systems are ever allowed to be used to judge abuse of the vehicle by the owner, revise waiver policy guide lines to deny waiver coverage for such abuse (i.e., failing to repair vehicle within the prescribed interval between MIL illumination and repair). Additionally, increase efforts to encourage the public to seek repairs when the MIL illuminates, and to warn them of the consequences of ignoring the MIL (e.g., possible loss of waiver coverage, and possible loss of warranty coverage).

4.2 Possible Maintenance Options

1. Require mechanics to have a special license to be allowed to repair 1983 and later model year vehicles. (Significant fractions of earlier model year vehicles used conventional technology for which special qualifications are less essential.) As part of that license, require the licensee to have at the work place access to some form of a scan tool, in working condition. If not provided by the establishment, it would be the mechanic's responsibility to provide one.

2. Require mechanics to have this special license to be able to qualify vehicles for a repair cost waiver (if allowed). This is a less intrusive approach than the option above.

3. Implement awareness programs to strongly encourage mechanics to regularly use scan tools during diagnosis and after repair.

4. Require an upgrade in required repair equipment in both centralized and decentralized programs to a TAS 90 or equivalent. The upgrade should be timed to coincide with planned program changes between 1991 and 1995.