TO: ALL PASSENGER CAR MANUFACTURERS
ALL LIGHT-DUTY/MEDIUM-DUTY VEHICLE MANUFACTURERS
ALL OTHER INTERESTED PARTIES

SUBJECT: ON-BOARD DIAGNOSTICS II (OBD II) REGULATORY REVIEW

Background

On September 14, 1989, the Board originally adopted section 1968.1 of Title 13, California Code of Regulations that contains the malfunction detection and diagnostic system requirements known as OBD II. On September 12, 1991, the Board adopted amendments to the regulation to promote consistency with the federal OBD requirements proposed at that time, to address manufacturers' concerns regarding OBD II implementation, and to improve the effectiveness of certain requirements. The regulation was also modified through amendments adopted July 9, 1993, to provide limited relief from the OBD II requirements during the 1994 and 1995 model year phase-in period for the regulation. The Board last adopted amendments to the regulation on December 8, 1994, to address manufacturers' implementation concerns, to improve the monitoring requirements where necessary, and to clarify specific sections of the regulation.

At the December, 1994 hearing, the Board directed the staff to continue to follow manufacturers' progress towards meeting the OBD II requirements, and to report back in two years time should modifications to the requirements be deemed appropriate. This hearing is currently scheduled for December, 1996. Such modifications are not necessarily proposed to address technical feasibility issues, but may be deemed appropriate on the basis that they clarify certain areas of the regulation, provide reasonable compliance flexibility, allow for a more cost-effective implementation of the OBD II requirements, conserve developmental resources, or for similar reasons. The staff will review manufacturers' progress and concerns regarding implementation of the monitoring requirements that are already adopted. Further, proposals for improvement in the availability of diagnostic and service information, and proposals relative to the incorporation of OBD II systems into California's Inspection and Maintenance (I/M) program will be discussed. Despite efforts to be comprehensive in prior regulatory efforts, the staff has identified two previously overlooked non-electronic monitoring requirements that are important for maintaining low emissions in use. Accordingly, the staff is proposing new monitoring requirements for positive crankcase ventilation (PCV) systems and the detection of thermostat malfunctions. The staff requests comments from industry in an effort to refine the proposed requirements and implementation schedules in a manner that will allow for efficient

and effective use of developmental resources. ARB staff has scheduled a workshop for Wednesday, July 24, 1996, from 9:00 A.M. to 5:00 P.M. to discuss these issues and obtain information to further formulate specific proposals prior to the release of the public hearing notice and Staff Report. The workshop will be held at:

Air Resources Board
Annex IV Auditorium
9528 Telstar Avenue
El Monte, CA 91731

ARB's current position and proposals regarding the issues to be discussed are summarized below.

Catalyst Monitoring

At the December, 1994, hearing, the Board adopted modifications to the catalyst monitoring requirements for low emission vehicles to specify a tailpipe emission level malfunction criterion as opposed to the front catalyst efficiency criterion in place at that time. The regulation requires manufacturers to phase-in the use of a malfunction criterion based on 1.5 times the vehicle's HC emission standard. The phase-in stretches between the 1998 and 2000 model years. For low emission vehicles produced prior to inclusion in the phase-in, the regulation contains higher interim emission malfunction criteria.

At this time, it appears that manufacturers generally will be able to meet the 1998 model year 30 percent phase-in requirement with TLEV applications. However, initial indications from manufacturers are that LEV applications also will, with proper catalyst sizing, washcoat formulation, and loading, be able to meet the 1.5 times the standard monitoring requirement. Regarding ULEV applications, the staff has received very little data from manufacturers regarding progress in developing catalyst monitoring strategies. To date, no data has been submitted to demonstrate that ULEV applications cannot be designed to meet the requirements.

Some manufacturers have requested the ARB to accept catalyst monitoring strategies that operate over the "Unified Cycle" instead of FTP driving conditions. This cycle was developed by the ARB for emission inventory purposes, and contains more high speed and load driving conditions than the FTP cycle. The manufacturers have stated that the expanded speed and load regions on this cycle would allow for more flexibility in developing reliable in-use monitoring of the catalyst systems.

Misfire Monitoring

The OBD II regulation requires two types of misfire detection. The first requirement is for the detection of misfire before it is frequent enough to cause a vehicle's emissions to exceed 1.5 times the standards, or before the misfire rate is high enough to cause a vehicle to fail an I/M test. The second requirement is for the more immediate detection of misfire rates that are high enough to cause catalyst damage due to overheating. Through the 1996 model year, manufacturers may limit the operating conditions under which misfire is detected to the engine speed and load conditions encountered during an FTP test. However, beginning with the 1997 model year, manufacturers are required to phase-in systems to detect misfire over nearly all positive torque speed and load conditions. Specifically, the regulation requires a phase-in of 50-75-90-100 percent spanning the 1997 through 2000 model years. Small volume manufacturers are not required to meet the phase-in percentages provided 100 percent implementation is achieved by the 2000 model year.

Manufacturers have made significant progress toward full positive torque misfire detection since the last review on industry's progress. To date, nearly all manufacturers subject to the phase-in requirements have met the 1997 model year requirement by certifying 50% of their projected sales volume to the full range requirements. While manufacturers have generally been able to meet the 1997 model year phase-in percentages, concerns have been expressed regarding some more difficult engines that are to be phased in during the later model years. The industry has stated that misfire detection capability varies depending on a variety of factors, some of which cannot be addressed without potentially substantial engine and/or driveline redesign, or development of potentially costly alternate misfire detection technologies. Further, manufacturers have indicated that extra lead time would be beneficial for some applications to more fully ensure the reliability of misfire detection in-use.

A few concerns have also been expressed regarding the detection of short, intermittent "bursts" of misfire. While most manufacturers agree that these episodes are actual misfire events, many times they are sporadic occurrences of misfire due to brief, abnormal driving conditions or temporary fuel quality effects. While current misfire detection systems are capable of detecting the misfire, technicians may not be able to find or repair such faults because the problem may not recur. Manufacturers would like additional flexibility in identifying such misfire problems to eliminate illuminating the MIL when these isolated events occur and thus, avoid sending consumers for repair of malfunctions which cannot be corrected.

Service Information

The OBD II regulation currently has several requirements for standardization. Fault codes, generic scan tool connections, communication protocols, and emission-related powertrain test information are all required to comply with Society of Automotive Engineers (SAE) standards and/or recommended practices. However, industry and staff have identified several areas that do not adequately address the incorporation of the OBD II system into an enhanced I/M program. Additionally, some of the requirements have been demonstrated to be excessively cumbersome to implement and use and do not satisfy the intended purpose of the regulation. Staff plans to modify the standardization requirements in several different areas to address these concerns.

J2205

The regulation currently requires manufacturers to make readily available to the automotive repair industry effective service procedures which utilize only a generic scan tool and commonly available, non-microprocessor based tools. The intent of the regulation was to make manufacturers document effective diagnosis and repair procedures that the automotive repair industry could utilize with a generic scan tool instead of requiring the use of a manufacturer-specific diagnostic tool. As such, some manufacturers have satisfied this requirement by implementing the recommend practices of SAE J2205 "Expanded Diagnostic Protocol for OBD II Scan Tools." With this standard, some manufacturers have defined proprietary test modes in such a way that a generic scan tool can execute the commands. In practice, this method has been shown to be very difficult and cumbersome for a technician to use and may not substantially aid a technician in making accurate, quick, and cost-effective diagnosis and repairs. Additionally, several manufacturers have expressed a desire to eliminate this standardized service procedure requirement because it is redundant with current manufacturer-specific protocols.

As the intent of this requirement is to help the automotive repair industry make effective diagnoses and repairs, the staff proposes to modify the existing requirement to allow manufacturers additional flexibility while still meeting the overall intent of the regulation. Specifically, the staff plans to allow a second option for manufacturers to meet the requirement. Currently, many manufacturers provide independent service information vendors (e.g., Equipment Tool Institute (ETI)) with the protocol and commands used by the manufacturer's equipment to access additional diagnostic information. The service information vendors in turn distribute the information to service tool manufacturers. This allows independent scan tool manufacturers to produce products containing all of the expanded diagnostic commands and routines that the manufacturer's dealership repair facilities utilize for diagnosis and repair. Thus, staff proposes to allow manufacturers to satisfy this requirement by providing (to independent service information vendors) all the protocol and command information needed to perform any emission-related diagnosis and repair in the same manner (e.g., utilizing the same data list parameters and bi-directional commands) as the manufacturer-specific diagnostic tool. Manufacturers that do not make the information available to service information vendors would need to continue to satisfy the original requirement by making readily available to the repair industry diagnostic and repair procedures which utilize only a generic scan tool and other commonly available tools.

Standardized Reprogramming

Federal law requires manufacturers to provide independent service facilities with equipment and/or information necessary to install field fix recalibrations. However, this equipment can cost thousands of dollars for each vehicle make. Such expense could effectively preclude independent repair facilities from being able to provide service when the vehicle's programming needs to be updated. To address this issue, the staff is requesting comments on the feasibility of developing reprogramming equipment that is capable of interfacing with multiple vehicle makes (e.g., standardized reprogramming platform). The staff is also requesting comments on the feasibility of alternative proposals to address the reprogramming issue such as providing "pass-through" capability to independent service tool manufacturers.

J2008

One of the critiques of the current I/M program is that vehicles are not being properly repaired in the field even after an emission problem has been identified. The independent service and repair industry has often voiced the concern that independent technicians cannot make effective repairs because they do not have access to the same level of information that is provided to a manufacturer-specific facility (i.e., a dealer). In an attempt to address this concern, the U.S. Environmental Protection Agency (EPA) adopted a requirement for manufacturers to specify where an independent technician could find the appropriate service information. Most manufacturers have complied with this requirement by posting a contact(s) on the EPA Internet bulletin board "Fed World" whereby a technician can find information necessary to order the proper service manual. This helps to address the problem by identifying a source for the technician to obtain the proper service information. However, this still requires the technician to order, purchase, and await delivery of the proper diagnosis and repair procedure, or to initially order large amounts of service information, potentially at great expense.

In a further attempt to facilitate access to manufacturer-specific service information, the staff proposes to adopt a requirement for manufacturers to provide "at a fair and reasonable cost," all emission-related diagnostic and service information in the electronic format specified by SAE J2008 Draft Technical Report "Recommended Organization of Vehicle Service Information." All manufacturers would be required to comply with this requirement by January 1, 2000, and the service information requirement would apply to all OBD II-equipped vehicles. Information to be provided would include all emission-related diagnostic and repair information provided to the dealer in any format (e.g., service manuals, technical service bulletins, manufacturer-specific scan tool software, etc.).

By requiring a standardized format for the information, a common hardware and software technician interface could be used to access any manufacturer's repair procedures. Additionally, use of a standardized database format could allow more direct access to the appropriate information by directly linking the technician to the relevant repair procedures. For instance, a technician could input a few parameters identifying the vehicle year, make, and model and the stored diagnostic fault code and the database would automatically return the diagnostic and repair procedure for the specific fault on that particular vehicle. This in turn should allow independent technicians to provide more effective (e.g., accurate, quick, and cost-efficient) repairs to consumers.

Manufacturers would be required to provide the information to independent service information vendors and to the system administrators of Fed World for a reasonable fee. Independent service information vendors, or intermediaries, could then distribute the information to independent technicians. These vendors generally manufacture

products which contain service information for all makes and models of vehicles via a localized database (on CD-ROM or other storage device) and a software program which accesses the information in the database. After initially purchasing the product from the vendor, technicians can then subscribe to some form of update schedule (yearly, quarterly, etc.) to receive additional information as it becomes available. Similarly, the administrators of Fed World could distribute the information via the Fed World Internet connection. After establishing an account with Fed World, technicians could access the information through a personal computer equipped with a modem. The appropriate service information would be requested and then directly downloaded to the technician. Technicians could be billed according to time spent on-line, amount of information downloaded, or any combination of these factors similar to other Internet accounts. With this type of system, technicians would only have to pay for information that they need and would not need to purchase repair procedures for vehicle makes or models which they do not routinely service.

VIN and Calibration ID

The ARB intends for a check of the OBD II system to be incorporated into California's I/M program. The test procedure envisioned would involve downloading the MIL status, stored fault codes, and the readiness code data from the vehicle through the serial data link directly to a database. In order to prevent I/M program fraud analogous to "clean piping," the ARB plans to propose that the Vehicle Identification Number (VIN) be included in the transmitted information beginning with the 2000 model year. For manufacturers that utilize non-reprogrammable on-board computers, additional lead time (until the 2002 model year) would be provided to incorporate the last six digits of the VIN (known as the serial production number).

Additionally, manufacturers would be required to store a calibration identification number in a standardized format and accessible through the serial port on the standardized data link connector. This will enable service and I/M technicians to identify the calibration version that is installed in a particular vehicle. This would serve as another measure to confirm that the vehicle has the correct (and most recent) software calibration installed. Manufacturers often issue software changes after a vehicle has been produced to correct driveability problems or other concerns. As part of this requirement, manufacturers would be required to make available a listing of all manufacturer calibration identification numbers and the vehicles to which they apply in a manner that allows identification of a valid calibration in a particular vehicle and can identify if there is an updated calibration available for a particular vehicle.

Along with the above requirements, ARB is considering requiring manufacturers to support a standardized command whereby a checksum on the vehicle programming would be calculated, and compared to a list of valid checksums for the model in question. Rather than have the on-board computer simply return the check-sum results, the command would be a read-only command (issued from a scan tool) where

the scan tool would actually perform the check-sum on the contents of the on-board computer. Used in conjunction with the VIN and calibration identification number, this would help to ensure the integrity of the on-board computer's code during an I/M test.

Tampering Protection

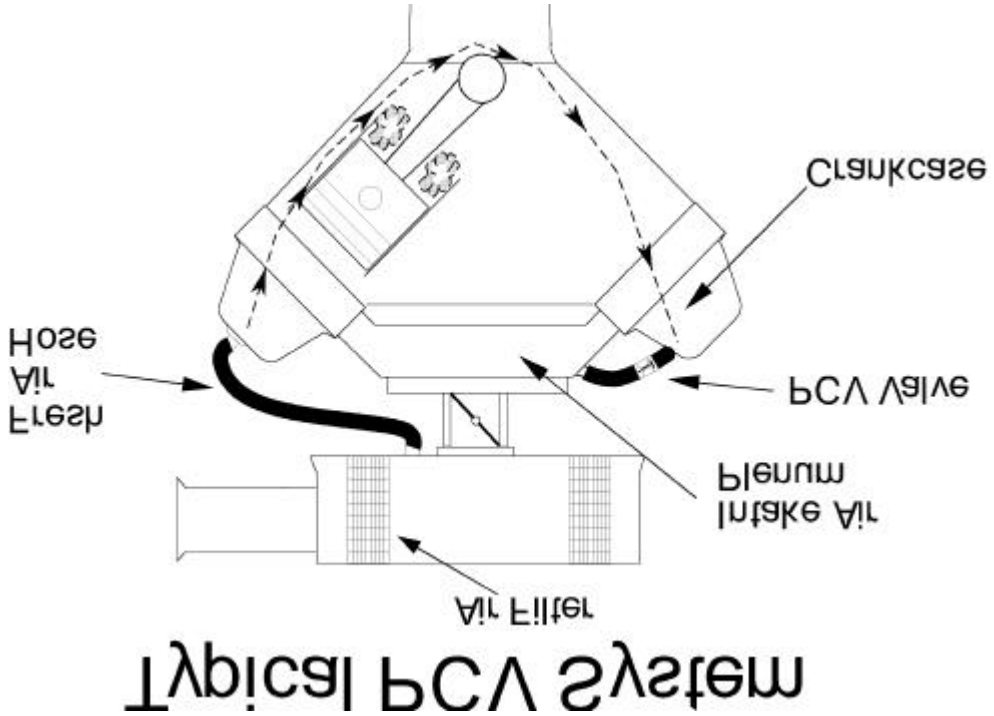
Section (d) of the regulation requires manufacturers to implement measures to make the on-board computer resistant to tampering. Computer chips are not to be changeable without special tools, and electronically reprogrammable on-board computers (i.e., computers using EEPROMs) are to include proven methods to deter unauthorized reprogramming. Beginning with the 1999 model year, electronic reprogramming is to require access to a computer maintained by the manufacturer, and the use of data encryption is also required. The Board adopted these requirements based on staff's concern that tampering with the vehicle programming in a manner that reduces the effectiveness of the OBD II system will diminish the in-use emission reductions expected from these systems, and may prevent the ARB from relying on OBD II system indications as an integral part of future I/M programs.

Regarding electronic reprogramming, vehicle manufacturers claim that the 1999 model year requirements are too restrictive by prescribing specific tamper resistance techniques. As a result, some manufacturers have stated that they will incur significant costs in redesigning equipment to accomplish reprogramming in the manner dictated by the regulation. Further, the manufacturers indicate that they will implement methods to deter unauthorized reprogramming for their own purposes, and that they plan to update these methods as the need arises. To address these concerns, the staff originally contemplated removing just the added specific requirements applicable for the 1999 and later model years. However, after further consideration, the remaining language would likely not be specific enough to enforce, and appears to be unnecessary in light of manufacturers' current practices. Therefore, the staff's proposal is to completely remove the tamper resistance requirements for electronically reprogrammable vehicles. For non-electronically reprogrammable vehicles, the staff believes the requirements to deter chip replacement are enforceable and do not present a technical challenge or significant cost burden to manufacturers.

Positive Crankcase Ventilation (PCV) System Monitoring

Currently, the OBD II regulation does not contain specific requirements for the detection of PCV system failures and monitoring is not required under the comprehensive component monitoring section of the regulation (Section (b)(10)) because PCV systems generally do not use electronic components. However, certain failure modes of the PCV system can cause a substantial increase in emissions by venting crankcase emissions directly to the atmosphere (e.g., disconnection of the system or leakage between the crankcase and the PCV valve). In-use studies conducted relative to vehicles failing I/M tests cite failure rates of up to 5 percent for the PCV system. Further analysis of the data suggests that only a portion (up to 1 percent) of the vehicles tested would result in significantly increased in-use emissions (i.e., in only approximately 1 of 5 of the PCV system incidents would the failure mode result in crankcase emissions being vented to the atmosphere). Nonetheless, with a per vehicle emission increase of approximately 1.2 g/mi HC, at a 1 percent failure rate, the 2003 fleet average standard of 0.062 g/mi HC would be raised by 0.012 grams per mile, nearly a 20 percent increase. To address these excess in-use emissions, staff is proposing to add a PCV system monitoring requirement to the OBD II regulation.

The staff's proposal targets only the failure modes that would most likely result in direct venting of emissions to the atmosphere, namely, disconnection in the system between the crankcase and the intake manifold on the PCV valve side of the system (refer to diagram below). Failure modes of this type are the most likely to cause a substantial increase in emissions (i.e., 1.2 g/mi HC). Other PCV system failure modes include a disconnected fresh air line or a plugged PCV valve but the staff is not recommending that these failure modes require monitoring. This is because disconnection of the fresh air line between the air cleaner and the crankcase may not result in a serious emission problem since most crankcase emissions would still be purged through the PCV valve (an operational PCV valve would cause a negative pressure in the crankcase, resulting in aspirating fresh air through the fresh air line rather than release of crankcase vapors). Further, plugging of the PCV valve will not result in direct venting to the atmosphere unless the fresh air line is also disconnected since pressure build up in the crankcase would likely force vapors through the fresh air line into the air cleaner which would then be inducted into the engine (i.e., this is a closed system). Recognizing the difficulty in detecting a disconnected fresh air line and the limited probability of both malfunctions occurring at the same time, the ARB’s proposal would not require detection of this dual component failure.



Accordingly, the regulation would require only the detection of a disconnection in the system between either the crankcase and the PCV valve (crankcase vapors would escape directly through the opening in the crankcase system), or between the PCV valve and the intake manifold (crankcase vapors would exit through the PCV valve outlet). In terms of effectively monitoring for such occurrences, the latter failure mode will result in a significant intake air leak that should be identifiable with the existing monitoring strategies for the idle air control system or the fuel system. The staff's proposal would not require the stored fault code to specifically identify the disconnection, provided service information generated by the manufacturer directs technicians to examine the connection as a possible cause of the fault. On the other hand, a disconnection in the system between the crankcase and the PCV valve would be significantly more difficult to detect with existing monitors, and may require added hardware to verify integrity (e.g., a pressure switch to ensure flow between the crankcase and the PCV valve). However, in order to facilitate compliance, the staff's proposal would exempt manufacturers from detecting disconnection between the crankcase and the PCV valve if the PCV valve is fastened securely and directly to the crankcase or valve cover (e.g., a threaded connection). This is because such disconnections often occur during service operations wherein technicians will likely remove the PCV valve and hose assembly together if the valve is easily removed from the crankcase (normally through a grommet located in a valve cover). If the technician finds disconnection of the PCV hose from the valve itself much easier because the PCV valve is securely fastened, then the most likely event is a hose disconnection rather than a valve disconnection. Failure to reinstall a hose, however, can be readily detected with existing monitoring strategies whereas failure to reinstall the PCV valve may not be as easily detected. Therefore, slip-on PCV connections via grommets, or other quick release designs would not be exempted.

Under the staff's proposal, implementation of this requirement would begin with the 2000 model year, and would be phased-in through the 2002 model year in percentages of 30, 60, and 100, respectively. Small volume manufacturers would be exempt from the phase-in percentages provided full compliance is achieved by the 2002 model year. For most PCV system designs, the valve could be securely fastened to the valve cover or crankcase. Therefore, in order to achieve compliance with this proposed requirement, the manufacturer would only need to ensure that a disconnection between the PCV valve and the intake manifold would be detected. Some manufacturers have indicated that this is already the case on a portion of their models. In any event, the lead time specified would allow manufacturers to make necessary monitoring system changes, and to relocate the PCV valve within the system, if needed. The staff requests comments on its assessment of the changes necessary to meet this requirement and the associated phase-in schedule.

Thermostat Monitoring

Manufacturers typically use a thermostat to block the flow of coolant within the engine block during cold starts to promote rapid warming of the engine. Once the coolant reaches a specific temperature, the thermostat opens and allows circulation of coolant through the radiator. If a thermostat malfunctions in such a manner that it does not adequately restrict coolant flow during vehicle warm-up, an increase in emissions could occur do to the prolonged operation of the vehicle at temperatures below the stabilized, warmed-up value (i.e., due to cold start fuel control strategies). While the emission impact may vary considerably from one manufacturer to another based on cooling system design and air-fuel control strategies, virtually all manufacturers utilize the engine coolant temperature as an enable criteria for other OBD II diagnostics. If the vehicle never reaches a manufacturer-specified warmed-up coolant temperature, several diagnostics may effectively be permanently disabled from identifying faults in other emission control components. As a result, the staff believes that malfunctioning thermostats are a previously overlooked source of excess in-use emissions and may adversely affect OBD II monitors.

To address these issues, the staff proposes to add a thermostat monitoring requirement to the regulation. Manufacturers would be responsible for detecting thermostat malfunctions that cause vehicle emissions to exceed 1.5 times the applicable FTP standard (during tests conducted at standard FTP temperatures or in accordance with the 50 degree Fahrenheit emission testing requirements in the LEV regulation). Because many ozone episodes occur on days where overnight temperatures are in the 50 degree temperature range, detection of thermostat malfunctions relative to this temperature is especially critical. Further, detection would be required for thermostats malfunctioning such that the coolant temperature does not reach the highest temperature required by the manufacturer to enable other diagnostics (including fuel system monitoring). The malfunction would be required to be detected within a reasonable, manufacturer-specified time interval and manufacturers would be required to submit data to support the specified time. The proposed requirement could be satisfied by verifying that the coolant temperature reaches a stabilized temperature after a period of engine operation, possibly taking into account engine load and coolant temperature at engine start. One manufacturer currently monitors the thermostat for proper operation on all of its 1996 model year vehicles by modeling the engine coolant temperature based on various engine parameters and comparing the calculated coolant temperature with the actual measured temperature. If the actual temperature is significantly lower than the calculated temperature after a specified interval, a fault is indicated. With this type of monitoring strategy, no additional hardware is necessary to satisfy the requirement.

The staff proposes that the monitoring requirement take effect beginning with the 2000 model year, with full compliance by the 2002 model year. Phase-in percentages of 30, 60, and 100 percent are proposed for the 2000 through 2002 model years respectively. Small volume manufacturers would not be required to implement this monitoring strategy until the 2002 model year. Comments are requested regarding the adequacy of the leadtime proposed, taking into consideration changes necessary to implement the monitor and any associated impact on developmental resources.

Other Regulatory Modifications

The staff is considering the following modifications to clarify misunderstood sections of the regulation, provide general guidelines as to minimum monitoring requirements, or address minor concerns that have arisen in implementing the requirements.

General

Section (a)(1.1) would permit the use of the International Standards Organization (ISO) engine symbol as an acceptable alternative to the wording now required for the Malfunction Indicator Light (MIL).

Section (a)(2.0) would clarify that using engine coolant temperature at startup is an acceptable method of determining ambient temperature for disablements below 20 degrees Fahrenheit.

Comprehensive Component Monitoring

Section (b)(12.1.1)(A) would clarify that rationality checks for input sensors should be "two-sided" to the extent feasible.

Section (b)(12.1.1)(C) would provide general guidelines as to the maximum time permitted for closed-loop activation at various engine start conditions. The changes also clarify the allowance for manufacturers to use other vehicle or engine parameters to alter the malfunction criteria for operating conditions which could lead to false indications of a malfunction.

Section (b)(12.1.2)(D) would provide general guidelines as to the maximum allowable malfunction criteria for idle speed control motors/valves.

Monitoring System Demonstration Requirements

Section (g)(2.3) would allow manufacturers to demonstrate fuel system malfunctions by computer modification provided the manufacturer demonstrates that the modification produces equivalent results.

Glossary

Section (n)(13.0) would update the definition of a small volume manufacturer to be consistent with the definition in California's Low-Emission Vehicle regulation.

Workshop Information

If any party wishes the information submitted to be treated as confidential by ARB staff, it should be clearly marked as "confidential" and should be on pages which are easily detachable from other, non-confidential, information. California guidelines (Sections 91000-91002, Title 17, California Code of Regulations, and Health and Safety Code Section 39660 (e)) will be followed in the handling of confidential information.

Manufacturers unable to participate in the workshop or those wishing to supply additional information are encouraged to submit written comments by July 17, 1996. Written comments should be sent to the following address:

Air Resources Board
P. O. Box 8001
El Monte, CA 91734-2301

Workshop participants wishing to discuss unresolved technical issues or confidential data may schedule individual meetings with staff. Please contact Mr. Allen Lyons, Manager, Advanced Engineering Section, at (818) 575-6833 to schedule an individual meeting time and date.

Sincerely,

R. H. Cross, Assistant Chief
Mobile Source Division