State of California
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR RULEMAKING

Ford Motor Company's Petition For Limited Relief From 1994/1995 On-Board Diagnostic II (OBD II) Provisions

Date of Release: May 21, 1993
Scheduled for Consideration: July 8, 1993
Agenda Item No.: [__-__-__]

State of California
AIR RESOURCES BOARD

Staff Report: Initial Statement of Reasons
for Proposed Rulemaking

PUBLIC HEARING TO CONSIDER FORD MOTOR COMPANY'S PETITION FOR LIMITED RELIEF FROM 1994/1995 ON-BOARD DIAGNOSTIC II (OBD II) PROVISIONS

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I. INTRODUCTION

The California Air Resources Board (ARB) adopted comprehensive and technically challenging On-Board Diagnostics II (OBD II) requirements in September, 1989. As technology evolved, the Board revisited the regulations in September, 1991, and adopted amendments which clarified the requirements, improved their effectiveness, or facilitated their implementation. The purpose of OBD II systems is to identify emission control system and emission-related malfunctions as they occur and to notify vehicle operators of the need for repair of such malfunctions by illuminating an instrument panel warning light. The diagnostic systems will also assist repair technicians in identifying and properly repairing any detected malfunctions by generating specific diagnostic information.

The OBD II regulation requires manufacturers to implement comprehensive monitoring systems for all emission-related components beginning with the 1994 model year. Manufacturers, however, may elect to request an exemption for the 1994 and 1995 model years if models are planned to use carry-over on-board computers not powerful enough to fully implement the OBD II requirements. Manufacturers are required to implement OBD II monitoring systems on exempted vehicles by the 1996 model year. As the 1994 model year approaches, a number of manufacturers have worked to comply with the OBD II requirements on at least a small percentage of their engine families. Others have used the exemption provision to obtain relief from the OBD II requirements entirely until the 1995 or 1996 model year. The nature of the exemption provision has given manufacturers the ability to essentially design their own phase-in schedules by balancing in-use experience, developmental resources, and liability, while keeping in mind that all vehicle models are to be equipped with OBD II systems by the 1996 model year.

From the time of original adoption of the OBD II regulation in 1989, many of the requirements have been considered technology-forcing in that the development of new and sophisticated monitoring systems has been necessary (e.g., for misfire detection and catalyst monitoring). Nevertheless, through innovation and a substantial amount of developmental resources, several manufacturers have been able to design OBD systems that appear to meet the minimum requirements of the regulation. Specifically, at this time, the ARB expects that five manufacturers will successfully certify a portion of their product lines to be in compliance with the regulation for the 1994 model year.

Like these manufacturers, Ford Motor Company (Ford) has worked towards introducing OBD II systems on some of its 1994 models. However, despite being able to meet nearly all of the minimum monitoring requirements, Ford's development efforts have fallen short for the 1994 model year with respect to implementing a compliant misfire monitoring system and a strategy to verify proper function of the evaporative purge valve.

Rather than seek an exemption, Ford decided to work towards 1994 model year compliance because of the importance it placed on obtaining early in-use experience with OBD II systems. However, because the OBD II regulation has no provision for certifying partially complying systems, Ford, despite its good faith efforts, is presently unable to certify and market the 1994 models in question.

On March 29, 1993, Ford petitioned the Board and requested a hearing for the Board to consider amending the OBD II regulation to allow for the acceptance of 1994 and 1995 model year diagnostic systems on non-exempted vehicles that do not fully comply with the OBD II regulation when a manufacturer has acted in good-faith to satisfy the OBD II requirements in full.

Subsequent to receiving the petition, the Executive Officer issued his decision to schedule a hearing regarding this matter (attached as Appendix A). This report provides an overview of the history of the OBD II regulation, the current status of the industry overall regarding OBD II implementation, the nature of the non-compliance issues with respect to Ford's 1994 model year OBD II system design, and the ARB staff's recommendation to the Board in light of Ford's request.

II. BACKGROUND INFORMATION

California's On-Board Diagnostic Requirements:

On-board diagnostic systems rely on monitoring strategies integrated into vehicle electronics to identify system and component malfunctions as they occur. For the purposes of the ARB's requirements, the diagnostic systems are to detect and aid in the diagnosis of malfunctions with respect to emission controls and emission-related components and systems. Since all new California vehicles use sophisticated computer electronics to control vital engine functions, these same electronics, with added sensors in some instances, can be used to monitor the vehicle's emission control and emission-related systems for proper emission performance. Malfunctions are to be indicated to the vehicle operator via an instrument panel warning light, and diagnostic information is stored in computer memory for use by service technicians.

The first California regulation requiring electronic diagnostic systems on vehicles, now referred to as OBD I, was adopted in April, 1985. Implementation of OBD I began with the 1988 model year, and required vehicles equipped with feedback fuel control systems and three way catalysts to determine if the EGR valve, the fuel system, and emission-related components providing input to the on-board computer were operating properly.

The OBD I program was seen as an effective first step in more quickly identifying vehicle emission-related problems, and aiding service technicians in more effectively diagnosing and repairing such problems.

The monitoring requirements under OBD II are much more extensive than those required by OBD I. Under OBD II, virtually all emission control systems and electronic components that can affect emissions will be monitored. This includes components and systems that are not monitored under OBD I, such as the catalyst, engine misfire, and the evaporative system. These monitoring requirements were not included in OBD I because suitable monitoring technology was not yet available at the time the OBD I requirements were formulated. Further, OBD II requires malfunctions to be indicated, in general, before component or system performance deteriorates to the point that causes vehicle emissions to exceed the standards by a specified threshold. Previous OBD system designs generally do not have the capability to detect deteriorated, but still operational components and systems.

OBD II systems will also provide substantially more diagnostic information to service technicians than systems developed under OBD I. Manufacturers will be required to implement newly standardized vehicle communication systems that interface with a relatively low-cost, hand-held, universal diagnostic tool. The tool will be able to read specific diagnostic information such as fault codes that guide service personnel to the likely area of any malfunctions, and will provide continuously updated engine parameter data that will further help to isolate fault codes and ensure proper repairs.

<u>OBD II Regulatory Progression:</u>

As mentioned previously, when the OBD II regulation was first adopted in September of 1989 with a 1994 model year implementation date, the Board recognized that some of the requirements were technology forcing. Based on this, the Board directed the ARB staff to follow manufacturers' progress towards meeting the OBD II requirements, and to report back to the Board with its findings within two years.

The ARB staff presented its findings to the Board in September of 1991. At the hearing, the Board found that while compliance with the OBD II requirements still presented a significant challenge, most manufacturers had identified adequate monitoring technology and were working to develop it to a production-ready state. Further, the Board adopted a number of regulatory modifications proposed by the staff. These modifications were made to address concerns expressed by manufacturers, to promote consistency with proposed federal OBD requirements, and to maximize the effectiveness of the requirements in light of monitoring system advances made by industry.

However, because some concern still existed regarding industry's ability to reliably implement OBD II systems beginning with the 1994 model year, the staff was again directed to follow manufacturers' progress in finalizing OBD II system designs. If after discussions with industry it appeared that OBD II implementation in the 1994 to 1995 model year timeframe would not be feasible for a significant number of manufacturers, the staff was to return to the Board with necessary modifications to the regulation by November, 1992.

1994/95 Model Year OBD II Implementation:

Within the timeframe of a November, 1992, hearing, the staff did not receive compelling evidence from industry to delay or modify the OBD II requirements for the 1994 model year. While some manufacturers, including Ford, discussed outstanding compliance issues with the ARB staff, none of them specifically indicated that compliance with the regulation could not be met on any of the non-exempted engine families. Therefore, the ARB staff did not schedule a 1992 meeting with the Board.

Overall, eight manufacturers have to date met with the ARB staff specifically regarding 1994 or 1994 1/2 OBD II implementation. Of the eight, five manufacturers (Mercedes-Benz, Nissan, Toyota, Volvo, and VW/Audi) are expected to certify fully compliant 1994 model year OBD II engine families. Certification documentation from these manufacturers is currently being reviewed. Two manufacturers are expected to introduce OBD II on 1994 1/2 models (system capability details are still pending). One of these manufacturers had planned to implement OBD II on a 1994 model, but decided to delay OBD II implementation when it was determined that some of the minimum requirements could not be met with its system design. Due to the nature of its product line, the manufacturer was able to qualify for exemption for this model.

By the 1995 model year, most manufacturers selling vehicles in California are scheduled to implement OBD II on some engine families. Table 1 illustrates the estimated number of OBD II complying engine families in 1994 and 1995 relative to the total number of families scheduled for sale in California.

III. FORD 1994 MODEL YEAR COMPLIANCE ISSUES

Ford's 1994 OBD II system design includes adequate monitoring strategies for most of the requirements of section 1968.1, Title 13, CCR, including some that are considered to be among the most technically challenging (e.g., catalyst efficiency, and oxygen sensor monitoring). However, with respect to the engine misfire monitoring requirements and the requirement to verify proper function of the evaporative purge valve, Ford's monitoring strategies are not capable of discriminating system and component performance to the level required by the regulation.

Misfire Monitoring

For 1994-1996 model year vehicles, OBD II requires that misfire be monitored under all positive-torque speed and load conditions encountered during a Federal Test Procedure (FTP) driving cycle (section (b)(3.3)). Regarding the degree (or percent) misfire at which point a malfunction is to be indicated, the regulation contains two criteria. The first criterion is met when misfire is detected at a level that is likely to cause the catalyst to overheat, resulting in potential damage. This misfire rate is dependent on the operating conditions of the engine, but generally exceeds 10 percent based on data from industry. When misfire exceeds this level, the warning light on the instrument panel is to blink during the misfire (and to remain illuminated continuously if misfire subsequently ceases), prompting the vehicle operator to seek immediate attention to the problem and to hopefully vary the manner in which the vehicle is driven in order to keep the light

Table 1

Estimated On-Board Diagnostic II Implementation Schedule for 1994 & 1995

Manufacturer	1994 OBD II Engine Families*	Total 1994 Engine Families	1995 OBD II Engine Families	Total 1995 Engine Families
A	0	33	3	33
B	3	32	11	34
C	1	16	3	24
D	3	18	5	18
E	1	9	5	9
F	0	11	1	11
G	0	17	7	18
H	1	8	5	8
I	0	5	2	6
J	0	7	0	7
K	0	6	0	6
L	2	10	3	10
M	2	8	2	8
N	2	6	2	6
O	0	5	0	5

* Includes 1994 1/2 models going into production before April 1, 1994

from blinking (in which case the vehicle would be operating at a less damaging condition). The second criterion is encountered when misfire occurs at a level that will cause vehicle emissions to exceed 1.5 times any of the emission standards. When misfire is detected at this lower rate (generally two to four percent), the warning light will illuminate without blinking.

On the engine families Ford plans to equip with OBD II in 1994, only complete cylinder misfire can be detected with adequate reliability. On an eight cylinder engine, this corresponds to a misfire rate of 12.5 percent (16.7 percent on a 6 cylinder engine). Therefore, it is certain that the monitoring system will not be able to detect misfire prior to its causing emissions to exceed the specified emission-related threshold, and further, it is unlikely that misfire at a rate high enough to cause catalyst damage will be detected in all instances.

Ford has indicated that it has identified the system changes that are necessary to comply with the misfire monitoring requirements, but that the changes cannot be implemented prior to the 1995 model year.

Evaporative Purge Valve Monitor

Although complete evaporative system monitoring is not required by the OBD II regulation until hardware necessary to conduct a high temperature evaporative test is incorporated on California vehicles (generally between 1996 and 1998 for OBD II equipped vehicles), a functional check of the evaporative purge valve is required beginning with the 1994 model year. The Comprehensive Component Monitoring requirement, section (b)(10.0) of the OBD II regulation, states that any electronically controlled component that can affect emissions must be monitored for proper functionality. The regulation states that functionality is established by verifying that the component responds to computer commands to activate.

At present, Ford's system is capable of only conducting an electrical circuit continuity check of the purge valve for 1994 model year vehicles. However, because such valves are subject to mechanical failure modes, proper function cannot be fully determined through a verification of circuit continuity. Ford again has indicated that necessary modifications can be finalized in time for implementation of a compliant strategy on new OBD II applications beginning with the 1995 model year.

IV. OPTIONS CONSIDERED AND STAFF'S RECOMMENDATION

Discussion of Available Options for the 1994 Model Year

In working to develop a recommendation to the Board in response to Ford's petition, the staff considered a number of options in light of the intended 1994 to 1996 OBD II regulatory phase-in schedule.

The regulation as adopted in 1989 provided the simplest solution for 1994 model year OBD II compliance problems by allowing manufacturers the opportunity to apply for exemptions pursuant to subsection (m) of the regulation. This section states that an exemption can be obtained from the OBD II requirements for the 1994 and 1995 model years if the vehicle models in question will be equipped with a pre-existing on-board computer that is not capable of fully implementing the required OBD II monitoring systems. When the regulation was adopted, essentially all existing on-board computers lacked either the input/output capability or processing power to fully implement OBD II; therefore, for all practical purposes, manufacturers could design their own OBD II phase-in schedules as long as 100 percent compliance is achieved by the 1996 model year.

However, as previously mentioned, Ford remained aggressive in its 1994 model year OBD II development efforts beyond the point where it could revert to a previously implemented on-board computer and request exemption from the requirements. Ford has indicated in meetings with the ARB staff and also in its petition to the Executive Officer that it took such action because early introduction of OBD II systems is considered necessary to obtain valuable in-use experience with OBD II technology prior to the required 100 percent implementation of these systems with the 1996 model year. Nevertheless, without an approved exemption, the OBD II regulation contains no provision for the acceptance of diagnostic systems that do not completely meet the minimum requirements.

When the OBD II regulation was developed, the staff worked to make the requirements as effective as possible by basing them on the best capabilities of the industry. As such, the requirements have been considered technology-forcing by both industry and the ARB. Therefore, it was not unexpected that some manufacturers would have difficulty in initially complying with the regulation even though adequate leadtime has been provided. The ARB staff has preferred granting exemption from the requirements as opposed to accepting partial OBD II systems during the phase in-period. It was felt that this would minimize confusion in the service industry regarding which monitoring systems were installed in a particular vehicle as well as minimize certification and enforcement difficulties associated with partially OBD II compliant systems. It was hoped that the flexibility in the phase-in requirements would allow such manufacturers to avoid non-compliance situations by using the exemption provision to obtain leadtime beyond the 1994 model year if necessary. However, as Ford's circumstances indicate, not all 1994 model year compliance problems have been averted.

The ARB staff has also considered denying certification of engine families that do not qualify for a 1994 model year exemption and fall short of the minimum requirements. However, to do so would preclude introduction of OBD systems into the California marketplace that are significantly more sophisticated than what would otherwise be produced on OBD II exempted engine families. Even though Ford's 1994 OBD system falls short of the minimum requirements, it includes major improvements over OBD I systems such as catalyst efficiency monitoring, an oxygen sensor response rate evaluation, EGR flow rate monitoring, a standardized diagnostic link, and other features.

Further, withholding 1994 certification when a good faith effort has been made to comply with the regulation but full compliance has fallen slightly short would penalize such manufacturers for maintaining an aggressive plan to implement OBD II instead of letting other manufacturers take the lead. Ford's good faith effort to comply with the OBD II regulation can be seen in its aggressive overall OBD II implementation plan. By the 1995 model year, Ford plans to have OBD II incorporated into 11 engine families, which is more than any other manufacturer, and constitutes one of the highest implementation percentages prior to the required 100 percent compliance with the 1996 model year. Further, Ford has been forthright in discussions with the staff regarding its OBD II development efforts and data. Ford's data regarding evaporative system leak detection played an important part in the ARB staff's efforts to understand the concerns of industry so that a feasible yet effective monitoring requirement could be finalized. Most recently, Ford has given the staff some insight with respect to meeting the monitoring requirements for close-coupled catalysts to be used on low emission vehicles.

Apart from Ford, a high level of cooperation has been demonstrated in general by the manufacturers which have worked to implement OBD II systems in 1994. Their efforts have been very beneficial to the overall progress of the program. Such manufacturers and their suppliers have made innovative monitoring strategies ready for production that are expected to be highly effective in detecting emission-related malfunctions in-use. The overall feasibility of the OBD II program would probably be less clear at this time if these manufacturers took a conservative approach to OBD II compliance in fear of not being able to certify vehicles.

The ARB staff also considered requiring manufacturers to pay a penalty for failing to introduce fully compliant OBD II systems for 1994 models when no exemption provision applies. This would provide such manufacturers a way to certify vehicles that do not fully comply with the OBD II regulation while attempting to remain equitable to manufacturers capable of meeting all of the requirements in 1994. Because the ARB staff has consistently expressed that OBD II systems are to fully meet the minimum requirements, a penalty would address any potential concerns from manufacturers capable of meeting the requirements. In other words, a penalty would minimize any sense of inequity by successful manufacturers which might otherwise conclude that they have worked towards full compliance in 1994 unnecessarily.

However, after further thought, the staff does not expect that such concern would be expressed because it does not seem that a special 1994 model year provision would appeal to manufacturers capable of producing fully OBD II compliant systems. The fact that essentially all manufacturers could have obtained across-the-board exemption from the regulation for the 1994 and 1995 model years suggests that 1994 implementation is a strategy chosen by manufacturers to ensure high reliability of OBD II systems in-use and as a workload containment issue when 100 percent implementation is required in 1996. As such, the staff believes that manufacturers would want to introduce OBD II compliant technology to the fullest extent possible in order for the in-use experience to be most relevant, and to minimize having to go back and upgrade the OBD II system designs as regulatory provisions established for the first years of OBD II implementation expire. This is evidenced by the fact that some manufacturers are planning to implement diagnostic systems that perform at a level not required until at least the 1996 model year (for example, FTP based catalyst monitoring and high speed misfire monitoring will be introduced on some 1994 models). Therefore, the staff does not believe that 1994 OBD II development efforts by those manufacturers which will be able to implement fully compliant systems will be characterized as unnecessary or wasted should the ARB decide to make exceptions without penalty for 1994 model year systems that fall short in one or more areas of the established minimum requirements.

The ARB staff also does not expect that manufacturers falling slightly short of the minimum requirements on their 1994 systems will realize any economic or competitive advantage over manufacturers producing compliant systems, should the former be allowed to certify the vehicles in question. For example, Ford's 1994 OBD II system will include as much additional hardware as most other manufacturers' 1994 systems. Ford is likely to have incurred at least equal developmental and software design expenses as well. Accordingly, the staff does not believe that penalties for 1994 would be appropriate.

Recommendation for 1994 Models

In view of the foregoing, the staff is proposing an amendment to the regulation that permits the acceptance of OBD II systems with deficiencies in one or more areas on 1994 model year vehicles without penalty. To obtain relief, the provision would require the manufacturer to demonstrate that, overall, the best available technology has been considered, evaluated, and implemented to the fullest extent possible. Further, the resultant monitoring system must be significantly more advanced than current OBD I systems. The ARB staff has met with most manufacturers numerous times over the past few years regarding OBD II implementation, and has been made aware of most OBD II developmental hurdles as well as solutions that have been employed to overcome them. Therefore, it is not expected that a good faith effort on the part of any manufacturer will be difficult to discern.

As mentioned previously, one of the ARB's concerns in accepting partially complying OBD II systems has been the potential for confusion in the service industry regarding which of the monitoring systems have been incorporated into a particular vehicle. However, with respect to the staff's proposal, such confusion is expected to be minimal for the following reasons. First, very few engine families are expected to be certified under this proposal relative to the number of engine families offered for sale in California. Second, in implementing OBD II to the fullest extent possible, non-complying OBD II designs will likely have deficient, but not absent, monitoring strategies. This is true in the case of Ford's 1994 OBD II design. Further, under the SAE Recommended Practices referenced by the OBD II regulation, the complete implementation of the primary monitoring systems can be verified using the standardized diagnostic tool.

Discussion and Recommendation for 1995 Models

At this time, it is not known for certain whether any manufacturers planning to introduce OBD II systems in the 1995 model year will have any OBD II compliance difficulties. The possibility exists, therefore, that non-compliance situations may again arise with 1995 model year certification.

In contrast to the staff's proposal for 1994, the ARB staff proposes for the 1995 model year, with the two exceptions noted below, that manufacturers be required to pay a per-vehicle fine if their OBD II systems do not meet all of the monitoring requirements. The staff believes that penalties are appropriate in that OBD II compliant technology will have already been in production by the 1995 model year on a number of applications. Therefore, 1995 model year compliance will depend mostly on the amount of resources employed to implement adequate OBD II technology, instead of manufacturers' capabilities to develop the technology. The fact that Ford plans to introduce eight OBD II equipped engine families in 1995 that are expected to fully meet the minimum requirements demonstrates that technology development is not a major compliance factor after the 1994 model year. In this case, it would be significantly less equitable to accept deficient OBD II monitoring systems without penalty. Under this proposal, manufacturers would have the option to devote necessary resources or pay the fines, but would not have to alter product offerings or pull back from the California market during the phase-in period for the OBD II requirements.

One exception to the proposed fines would be for vehicles that come in under the 1994 model year provision, and are then carried over into the 1995 model year. In the staff's estimation, it is better for manufacturers to use their resources to ensure that newly introduced 1995 model year OBD II systems are fully compliant rather than return to correct deficient 1994 model year OBD II designs. This determination was made after considering the amount of work manufacturers would have to do to again prove out hardware, and especially software modifications after only 1 model year. The ARB staff believes that with the major monitoring system improvements that even deficient 1994 model year OBD II systems will bring, allowing manufacturers to concentrate on new systems for the 1995 model year will result in more widespread implementation of OBD II technology prior to the 1996 model year.

The other exception would allow the 1994 model year provision to extend to vehicle models for which production begins prior to April 1, 1994. This will allow for the inclusion of late 1994 applications that legally must be classified as 1995 models because production will run past January 1, 1995. From a product development standpoint, such vehicles are generally considered to be 1994 or 1994 1/2 models.

For the components and systems for which specific monitoring requirements are set forth in sections (b)(1) through (b)(9) of the regulation, a $50 penalty per deficiency per new 1995 model year vehicle is proposed if the minimum monitoring requirements are not met. For electronic components whose performance affects emissions but are not monitored for proper function, a $25 per deficiency per vehicle is proposed. To illustrate, if Ford's newly-introduced 1995 model year systems were to contain the same deficiencies as its 1994 model year design, the fines would total $75 per vehicle (a $50 fine for misfire monitoring non-compliance, and a $25 fine for not functionally monitoring the evaporative purge valve). The maximum penalty per vehicle would be $500, in compliance with section 43016 of the Health and Safety Code.

1996 Model Year Considerations

At this time, the staff is not proposing any modifications beyond the 1995 model year. The intent of these proposed regulatory modifications is not to delay the overall implementation of the OBD II regulation, but to provide manufacturers with relief from specific troublesome requirements during the 1994/1995 phase-in period in an effort to better ensure that effective OBD II systems will be produced across the board in the 1996 model year. The feasibility of the OBD II requirements in the specified timeframe is clearly being demonstrated overall by the systems being implemented during the phase-in period. The 1994 and 1995 model year implementation experience, and the additional development time should be adequate for manufacturers to address any compliance issues that could not be resolved in time for phase-in period introduction. Those manufacturers that do not use these two years to gain OBD II in-use experience will be faced with the responsibility of implementing OBD II correctly across their entire product line in one model year. The staff plans to address any remaining OBD II implementation concerns regarding low emission vehicles, or with respect to any of the enhanced monitoring requirements adopted in 1991 (required for the 1996 model year, or later), at a Spring, 1994, Board Hearing.

V. PROPOSED CHANGES TO THE REGULATION

To carry out the above recommendations, the staff proposes that Title 13, CCR, Section 1968.1 be amended by adding subsections (6.0) and (6.1). The proposed modification would give the Executive Officer upon request from a manufacturer the authority to waive one or more of the OBD II requirements for vehicle models or engine families introduced prior to April 1, 1994. In making his determination to grant the waiver, the Executive Officer would consider, among other things, the overall extent to which the OBD II requirements will be met, and whether the manufacturer made a good-faith effort to evaluate, consider, and implement to the extent possible the most advanced monitoring technology in attempting to comply fully with the regulation.

For 1995 model year vehicles for which production begins after March 31, 1994, per vehicle penalties in increments of $25 or $50 per vehicle per deficiency would be assessed under the authority of, and in accordance with, section 43016 of California's Health and Safety Code. The section states that per vehicle fines shall not exceed $500 per vehicle, and that any penalty collected is to be made payable for deposit in the Air Pollution Control Fund.

The full text of the OBD II regulation is attached in Appendix B.

VI. IMPACT ON COSTS, BUSINESS AND ECONOMY OF THE STATE, AND THE ENVIRONMENT

Costs

The proposed regulatory modifications regarding OBD II compliance for 1994 models is not expected to result in any incremental cost per vehicle. No new monitoring, or other requirements are proposed that would impact vehicle costs. For 1995 model year vehicles, only those vehicle models subject to the proposed fines would incur any incremental cost (i.e., non-exempted 1995 models for which non-compliance with one or more of the OBD II requirements is determined). Depending on the number of minimum monitoring requirements not met, fines could vary from $25 to a maximum of $500.

Impact on Business and the Economy of the State

The ARB staff has determined that the proposed amendments will not significantly impact California business or the state's economy. The proposed waiver provisions should benefit businesses and the economy in that it would allow 1994 vehicles and engine families to be certified and available for distribution and sale in California. Similarly, although manufacturers may be subject to fines for failure to fully comply with the regulation, the proposed modifications for 1995 will allow vehicles and engine families to be certified and available for distribution and sale in California. The benefits of certification clearly outweigh any negative impact that potential fines would have in that without the proposed modification, manufacturers would not be able to distribute and sell their non-complying 1995 model year vehicles and engine families in California.

Environmental Impacts

The ARB staff believes that the proposed modifications should not have a significant impact on air quality. Although the staff's proposal permits manufacturers to certify OBD II systems that do not fully meet the requirements of section 1968.1, waivers will be granted only for these systems in which the manufacturers have in good faith fully evaluated, considered and attempted to apply where feasible the most advanced monitoring technology. Prior to granting a waiver, the Executive Officer must consider the overall effectiveness of the OBD II system.

The staff's proposal calls for the implementation of the OBD II requirements to the fullest extent possible on non-exempted applications that do not fully meet the minimum monitoring requirements. The vehicles in question will be required to be equipped with significantly more advanced diagnostic systems than if a manufacturer pulled back its OBD II plans and received a full exemption for the 1994 and 1995 model year. Vehicles that receive an exemption would need only to comply with OBD I requirements, a first generation monitoring system that does not achieve the emission reductions that OBD II systems receiving a waiver would be able to achieve.

Nevertheless, it could be argued that air quality would be better protected by not allowing the sale of non-exempted vehicles if the minimum monitoring requirements are not fully met. However, this argument only has merit if potential new car buyers purchase a comparable, fully OBD II compliant vehicle instead of the vehicle model excluded from the California market. Because relatively few new models will be fully equipped with OBD II in 1994, and still less than half in 1995, on average it is more likely that an OBD II exempted vehicle, using an OBD I system, would be purchased. Further, based on manufacturers' production plans submitted to the ARB, it appears that prior to at least the 1995 model year OBD II will not be introduced on vehicle models that are considered competitors to the Ford models in question, or to the vehicle models of two other manufacturers that may possibly be introduced with OBD II systems under the proposed regulatory provision in 1994 1/2.

Even if it could be argued that the regulatory modifications would possibly have an impact on air quality, the ARB staff believes that overriding economic and social considerations outweigh the identified air quality impacts. As discussed above, the alternative would be to not certify 1994 and 1995 vehicles with the non-complying systems. This would result in economic hardship on the manufacturer, and retailers which could not distribute and sell the vehicles in California. Also, as noted, the majority of vehicles in the California market place in 1994 and 1995 have already received exemptions permitting them to continue using OBD I monitoring systems in the first years of the program. If relief is not granted to the manufacturers which have elected to use OBD II monitoring systems and which cannot now be certified and sell vehicles in California because they are unable to fully comply with the requirements, the void in the marketplace will most likely be filled by vehicles with the OBD I systems. As stated, this will likely result in increased emissions.

VII. CONCLUSION

Nearly four years after the adoption of California's stringent and technology forcing OBD II requirements, several manufacturers have finalized their system designs for 1994 model year introduction. Through aggressive research and development efforts, solutions to the more challenging aspects of the requirements have been found, and initial production of OBD II systems is set to begin.

With respect to Ford Motor Company, 1994 model year OBD II development efforts were largely successful; however, with respect to two of the monitoring requirements, Ford's system design falls short of the minimum requirements of the regulation. Ford's petition to the Board requests special consideration for manufacturers' 1994 and 1995 model year OBD II designs when one or more of the requirements could not be met despite a good-faith effort towards full-compliance. The proposed 1994/1995 model year regulatory provision allowing for the acceptance of such systems works towards maximizing the opportunity for manufacturers to obtain valuable in-use experience with OBD II technology; it would also maintain equity for manufacturers that will be producing fully OBD II compliant systems during this timeframe while maintaining the overall timing of the OBD II program.

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In the Matter of a Petition by: FORD MOTOR COMPANY	DECISION GRANTING PETITION

Pursuant to sections 39600, 39601, and 43013 of the Health and Safety Code and section 11347.1 of the Government Code, the California Air Resources Board (Board) grants the petition of the Ford Motor Company (Ford) requesting a hearing before the Board to consider amendments to Title 13 California Code of Regulations (CCR), section 1968.1. Specifically, the petition requested a Board hearing to consider amendments providing relief to manufacturers who elected in good faith to incorporate enhanced monitoring systems in 1994 model year vehicles and who are now experiencing difficulty in meeting all of the requirements for monitoring as set forth in section 1968.1. In its petition, Ford contends that such relief is necessary because, at this late date, it is impossible for the manufacturer to modify its production plans for the 1994 model year vehicles and reinstall the formerly used first generation on-board diagnostic (OBD I) systems. Ford further contends that even if such production plans were capable of being reversed, the enhanced monitoring system, even with its acknowledged limitations, is a more effective monitoring system than the OBD I system.

Reasonable cause exists for the Board to consider amending Title 13, CCR, section 1968.1, that would grant relief to manufacturers, such as Ford, which elected not to apply for extensions for compliance for the years 1994 and 1995 pursuant to section 1968.1(m)(2.0). It appears that the petitioner attempted in good faith to introduce enhanced monitoring systems during the first year of the program since nearly all monitoring requirements of section 1968.1 will be met. The ARB staff is mindful of the production dilemmas facing such manufacturers. In proposing recommendations to the Board, the staff will consider the potential ramifications that relief permitting early implementation of the enhanced monitoring systems by manufacturers such as Ford will afford to both the manufacturers and the people of California.

Interested persons with questions regarding this decision should contact Michael L. Terris, Senior Staff Counsel, at (916) 322-3283. Copies of the petition are available from the ARB upon request.

By: ______________________
James D. Boyd
Executive Officer

Appendix B

1968.1 Malfunction and Diagnostic System Requirements--1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines [1]

(a) **GENERAL REQUIREMENTS**

(1.0) All 1994 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles shall be equipped with a malfunction indicator light (MIL) located on the instrument panel that will automatically inform the vehicle operator in the event of a malfunction of any powertrain components which can affect emissions and which provide input to, or receive output from, the on-board computer(s) or of the malfunction of the on-board computer(s) itself. The MIL shall not be used for any other purpose.

(1.1) The MIL shall be of sufficient illumination and location to be readily visible under all lighting conditions. The MIL shall illuminate in the engine-run key position before engine cranking to indicate that the MIL is functional and shall, when illuminated, display the phrase "Check Engine" or "Service Engine Soon". The word "Powertrain" may be substituted for "Engine" in the previous phrases.

(1.2) All 1994 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles required to have MIL pursuant to (1.0) above shall also be equipped with an on-board diagnostic system capable of identifying the likely area of the malfunction by means of fault codes stored in computer memory. These vehicles shall be equipped with a standardized electrical connector to provide access to the stored fault codes. Specific performance requirements are listed below. A glossary of terms is contained in subsection (n) at the end of this section.

(1.3) Any reference to vehicles in this regulation shall also include medium-duty vehicles with engines certified on an engine dynamometer.

(1.4) Manufacturers of diesel engines utilizing computer-based electronic powertrain control systems shall submit a plan for complying with these requirements to the Executive Officer for approval at least two years prior to certification. The plan shall be approved based on monitoring all powertrain components which can affect emissions and for which reliable monitoring

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1 Proposed amendments are shown in underline to indicate additions to the text.

techniques are available at costs comparable to other engines meeting these requirements, and on meeting all other applicable requirements (e.g., storing freeze frame conditions, meeting standardization requirements, etc.).

(1.5) For Low Emission Vehicles (LEV), the Executive Officer shall revise the emission threshold for a malfunction on any check if the most reliable monitoring method developed requires a higher threshold to prevent significant errors of commission in detecting a malfunction.

(1.6) For every case in which a malfunction is to be noted when an emission threshold is exceeded (e.g., emissions in excess of 1.5 times the standard), the manufacturer may perform only a functional check (defined in section (n)(16.0)) of a specific component or system if deterioration or failure of such would not cause the vehicle's emissions to exceed the emission threshold.

(1.7) After the 1998 model year, for Non-LEVs, fulfillment of federal On-Board Diagnostic (OBD) requirements shall be deemed to be an acceptable option for the manufacturer for the purpose of meeting these requirements.

(1.8) For 1994 and 1995 model years only, illumination of the malfunction indicator light upon detection of a malfunction shall be optional for catalyst, misfire, and complete evaporative system monitoring. MIL illumination for such vehicles shall be optional for other monitoring requirements, subject to Executive Officer approval, on the basis of use of a new monitoring strategy which is significantly different than that used previously by the manufacturer and/or which entails a high degree of sophistication in its application. Irrespective of the preceeding the MIL shall illuminate on these vehicles in accordance with section 1968.1 for lack of function (see section (n)(16.0)) for electronic components/systems otherwise approved for not illuminating the MIL. Furthermore, setting fault codes for all malfunctions shall continue to conform with requirements of section 1968.1. For components/systems not requiring illumination of the MIL, manufacturers shall provide a plan for approval by the Executive Officer for reporting on the correct performance of the monitoring systems in customer use at 6 month intervals beginning from the start of production each year for at least the first three years after production. Approval of the plan shall be based on obtaining a statistically valid sample size, assuring that adequate resources are available to investigate the potential problems, and assuring that a wide variety of vehicles, operating modes, and mileage accumulation will be included in the evaluation. Should incorrect performance of the diagnostic system be determined by the Executive Officer on the basis of these reports or through other means, manufacturers shall recall the vehicles for correction of the OBD II system in accordance with Article 2.2, Title 13 CCR, or they shall submit an alternate plan for remedying the problem for approval by the Executive Officer on the basis of achieving comparable capture rates and timeliness as an official recall plan.

(1.9) Manufacturers may employ alternate statistical MIL illumination and fault code storage protocols to those specified in these requirements, subject to Executive Officer approval based on comparable timeliness in detecting a malfunction and evaluating system performance.

(b) **MONITORING REQUIREMENTS**

(1.0) **CATALYST MONITORING**

(1.1) Requirement:

(1.1.1) LEVs: The diagnostic system shall individually monitor the front catalyst or catalysts (i.e., any catalyst(s) which receive engine-out untreated exhaust gas), except that front catalysts may be monitored in combination with the next catalyst downstream if it can be demonstrated that a malfunction will be indicated when the front catalyst is alone malfunctioning (see (b) (1.2.1)). Catalysts arranged in parallel with the same inlet and outlet in a single exhaust pipe shall be considered as one catalyst. A separate catalyst incorporated in series into the same container as a front catalyst shall be considered a downstream catalyst.

(1.1.2) If the front catalyst is a small volume catalyst (see (b) (1.2.2)), the diagnostic system shall also monitor the next catalyst downstream of the small volume catalyst either independently of, or (if the conditions in section (1.1.1) are met) in combination with, the small volume catalyst.

(1.1.3) Manufacturers may submit other monitoring strategies, subject to Executive Officer approval, based on equal timeliness and reliability in detecting a catalyst malfunction as these requirements.

(1.1.4) Non-LEVs: The diagnostic system shall monitor the catalyst system for proper performance.

(1.2) Malfunction Criteria:

(1.2.1) LEVs: Each monitored catalyst, or combination of catalysts, shall be considered malfunctioning when average Federal Test Procedure (FTP) total hydrocarbon (HC) conversion efficiency falls between 50 to 60 percent. The efficiency determination shall be based on an FTP test wherein a malfunction is noted when the cumulative total HC emissions measured at the outlet of the monitored catalyst(s) is more than 40 to 50 percent of the cumulative total engine-out emissions measured at the inlet of the catalyst(s). In addition, if a front catalyst is monitored in combination with a downstream catalyst, the front catalyst shall be considered malfunctioning when its efficiency has deteriorated between 40 to 50 percent from its 4000 mile average FTP total HC efficiency.

(1.2.2) For LEVs, each small volume catalyst (i.e., those designed with a conversion efficiency too low to be practically monitored for 50 to 60 percent average FTP total HC efficiency) monitored independently shall be considered malfunctioning when its average FTP conversion efficiency has deteriorated by between 40 to 50 percent from its 4000 mile conversion efficiency.

(1.2.3) Non-LEVs: The catalyst system shall be considered malfunctioning when its conversion capability decreases to the point that HC emissions increase by more than 1.5 times the standard over an FTP test from a test run with a representative 4000 mile catalyst system.

(1.2.4) For 1994 and 1995 model year LEVs and Non-LEVs, as an option to monitoring the catalyst during FTP driving conditions, manufacturers may monitor the front catalyst independently of, or in combination with, the next catalyst downstream. Each monitored catalyst or catalyst combination shall be considered malfunctioning when total HC conversion efficiency falls below 60 percent while in normal closed loop operation. As a guideline, the catalyst(s) should not be considered malfunctioning when its efficiency is greater than 80 percent. The efficiency determination shall be based on a steady state test wherein a malfunction is noted when the total HC emission concentration measured at the outlet of the monitored catalyst(s) is more than 20 to 40 percent of the cumulative total engine-out emissions measured at the inlet of the catalyst(s). Alternatively, if correlation with FTP emissions can be demonstrated, manufacturers may use the malfunction criteria specified in (b)(1.2.1) or (b)(1.2.3). 1994 and 1995 model year vehicles certified to this option shall incorporate FTP based monitoring no later than the 1997 model year (vehicles initially complying with section 1968.1 in the 1996 model year shall utilize an FTP based catalyst monitoring system).

(1.3) Monitoring Conditions:

(1.3.1) A catalyst monitoring check shall occur at least once per trip except for vehicles utilizing steady state monitoring, which shall comply with section (1.3.2). "Trip" is defined in section (n) (5.0). This trip definition applies throughout section 1968.1.

(1.3.2) If steady state efficiency is being monitored (see section (b) (1.2.4)), the manufacturer shall choose a non-closed throttle, reasonably steady speed condition for monitoring the catalyst with the constraints that the check shall (i) occur between 20 mph and 50 mph, or within an engine rpm and torque range determined by the manufacturer to be representative of medium-duty vehicle operating conditions between 20 and 50 mph steady speed conditions with a load equivalent to 50 percent of the maximum load carrying capacity, (ii) take no more than a 20 second interval to determine both that the vehicle is operating in a proper window to perform the check and to actually perform the check, and (iii) be conducted at the earliest such condition encountered after the beginning of closed-loop operation for each driving cycle. Performance of the check may be delayed after engine startup until stabilized coolant temperature is achieved and/or a suitable cumulative time interval of non-closed throttle vehicle operation has elapsed to ensure the catalyst is warmed-up for properly performing the monitoring check. The specified cumulative time interval shall begin from the first non-closed throttle operation either after achieving a stabilized coolant temperature or after engine starting and shall not exceed 180 seconds. These monitoring constraints and conditions may be altered, subject to Executive Officer Approval. Such approval shall be granted if the manufacturer submits data and an engineering evaluation justifying the need for the exception and demonstrates that the requested alteration would yield improved catalyst monitoring. "Reasonably steady" speed interval in this instance means a 20 second period where all accelerations and decelerations are of an average magnitude equivalent to 0.5 mph/second or less over any two second interval during this period. The manufacturer may abort the check if the engine operating conditions change during the check so that the vehicle exceeds the speed or acceleration/deceleration tolerances before the end of the checking interval. The manufacturer may base performance of the catalyst check upon engine RPM and load conditions equivalent to the above monitoring conditions. If a manufacturer develops a means of monitoring catalyst efficiency which cannot utilize a steady state monitoring period (e.g., examining time vs. temperature during catalyst warmup), it may present a monitoring proposal to the Executive Officer for approval based on equivalent accuracy and timeliness as the steady state monitoring protocol in detecting a malfunctioning catalyst.

(1.4) MIL Illumination and Fault Code Storage:

(1.4.1) Except as noted below, upon detection of a catalyst malfunction, the diagnostic system shall store a fault code and the MIL shall be illuminated no later than the end of the next trip if the malfunction is again present.

(1.4.2) For steady state catalyst efficiency checks, upon detection of catalyst efficiency below 60 percent, the diagnostic system may perform up to two successive monitoring checks prior to informing the vehicle operator of a malfunction. These monitoring checks need not occur on the same driving cycle, but shall be performed as soon as proper monitoring conditions occur. If catalyst efficiency remains below 60 percent for the three sequential checks, a fault code shall be stored and the MIL shall then be activated.

(1.4.3) The diagnostic system shall temporarily disable catalyst monitoring when a malfunction exists which could affect the proper evaluation of catalyst efficiency.

(1.4.4) The monitoring method for the catalyst(s) shall be capable of detecting when a catalyst trouble code has been cleared (except diagnostic system self-clearing), but the catalyst has not been replaced (e.g., catalyst overtemperature approaches may not be acceptable).

(2.0) **HEATED CATALYST MONITORING**

(2.1) Requirement:

(2.1.1) The diagnostic system shall monitor all heated catalyst systems for proper heating.

(2.1.2) In addition to the non-heated catalyst requirements in section (b) (1), the HC conversion efficiency of all heated catalysts shall each be monitored. Manufacturers may monitor heated catalysts in combination with another catalyst if it can be demonstrated that a malfunction will be indicated when the heated catalyst is malfunctioning. Otherwise, the heated catalyst shall be monitored independently. If a heated catalyst is a small volume front catalyst, the diagnostic system shall also monitor the next catalyst downstream either independently of, or (if the conditions above are met) in combination with, the small volume heated catalyst.

(2.2) Malfunction Criteria:

(2.2.1) Pre-Start Heated Catalyst Systems: The system shall be considered malfunctioning when the designated pre-start catalyst temperature is not attained before engine starting.

(2.2.2) After-Start Heated Catalyst Systems: The system shall be considered malfunctioning when the catalyst does not reach its designated heating temperature within a requisite time period after engine starting. The time period is to be determined by the manufacturer subject to the requirement that the system shall detect a heating system malfunction causing emissions from a vehicle equipped with the heated catalyst system to exceed 1.5 times any of the applicable FTP standards.

(2.2.3) Manufacturers using other heating or monitoring strategies may submit an alternate plan for approval by the Executive Officer to monitor heated catalyst systems based on comparable reliability and timeliness to these requirements in detecting a catalyst heating malfunction.

(2.2.4) Except as noted in section (b) (1.2.4), the diagnostic system shall use the malfunction criteria specified in section (b) (1.2.1) or section (b) (1.2.2), whichever is applicable, when monitoring the conversion efficiency of a heated catalyst.

(2.3) Monitoring Conditions:

(2.3.1) Pre-Start Heated Catalyst Systems: The diagnostic system shall monitor the heating system for proper operation once per trip. Manufacturers may disable the monitoring system for one engine start if during the previous driving cycle the vehicle traveled less than the equivalent of the first one mile of FTP driving.

(2.3.2) After-Start Heated Catalyst Systems: The diagnostic system shall monitor the heating system for proper operation once per trip. Manufacturers may disable the monitoring system for one engine start if during the previous driving cycle the vehicle traveled less than the equivalent of the first one mile of FTP driving.

(2.3.3) Except as noted in section (b) (1.2.4), the diagnostic system shall monitor the conversion efficiency of all heated catalysts at least once per trip.

(2.4) MIL Illumination and Fault Code Storage:

(2.4.1) Upon detection of a catalyst heating malfunction, the diagnostic system shall store a fault code and the MIL shall be illuminated no later than the end of the next trip if the malfunction is again present.

(2.4.2) For heated catalyst efficiency malfunctions, the MIL shall be illuminated, and a fault code stored according to section (b) (1.4).

(3.0) **MISFIRE MONITORING**

(3.1) Requirement: The diagnostic system shall monitor engine misfire and shall identify the specific cylinder experiencing misfire. If more than one cylinder is misfiring, a separate code shall indicate that multiple cylinders are misfiring (specifying the individual misfiring cylinders under this condition is optional, however, identifying only one misfiring cylinder shall not occur when a multiple misfire code is stored).

(3.2) Malfunction Criteria: The manufacturer shall specify in the documentation provided for certification (see subsection (g) and (h) infra.) a percentage of misfires out of the total number of firing events necessary for determining a malfunction for each of the conditions listed below.

(A) The percent misfire evaluated in 200 revolution increments for each engine speed and load condition which would result in catalyst damage. The manufacturer shall submit in the certification documentation catalyst temperature data versus percent misfire over the full range of engine speed and load conditions. The data shall be obtained from a representative cross section of a manufacturer's engine offerings from small to large displacements. Up to three such engine evaluations shall be documented per manufacturer, though a manufacturer may submit more data if desired. An engineering evaluation shall be provided for establishing malfunction criteria for the remainder of engine families in the manufacturer's product line. The Executive Officer shall waive the evaluation requirement each year if, in the judgment of the Executive Officer, technological changes do not affect the previously determined malfunction criteria;

(B) The percent misfire evaluated in 1000 revolution increments which would cause emissions from a durability demonstration vehicle to exceed 1.5 times any of the applicable FTP standards if the degree of misfire were present from the beginning of the test. If the level of misfire determined under this requirement is significantly lower for an LEV as opposed to a Non-LEV with a similar engine design, the manufacturer may request approval from the Executive Officer to use a higher percentage of misfire as the malfunction criteria for the LEV, not to exceed the level of the Non-LEV. For the purpose of establishing the percent misfire, the manufacturer shall conduct the demonstration test(s) with the misfire events occurring at equally spaced complete engine cycle intervals, across randomly selected cylinders throughout each 1000 revolution increment. However, the percent misfire established shall be applicable for any misfire condition (e.g. random, continuous, equally spaced, etc.) for the purpose of identifying a malfunction. This criterion shall be used for all vehicles with engines containing the same number of cylinders as the demonstration vehicle. The number of misfires in 1000 revolution increments which was determined for the durability demonstration vehicle malfunction criterion may be used to establish the corresponding percent misfire malfunction criteria for engines with other numbers of cylinders. The malfunction criteria for a manufacturer's product line shall be updated when a new durability demonstration vehicle is tested which indicates more stringent criteria are necessary than previously established to remain within the above emission limit;

(C) The degree of misfire evaluated in 1000 revolution increments which would cause a durability demonstration vehicle to fail an Inspection and Maintenance program tailpipe emission test. This criterion shall apply to vehicles with the same number of cylinders as the demonstration vehicle. The number of misfires in 1000 revolution increments which was determined for the durability demonstration vehicle malfunction criterion may be used to establish the corresponding percent misfire malfunction criteria for engines with other numbers of cylinders. The malfunction criteria for a manufacturer's product line shall be updated when a new durability demonstration vehicle is tested which indicates more stringent criteria are necessary than previously established to ensure passing an Inspection and Maintenance test, or when the Inspection and Maintenance test is revised.

(3.3) Monitoring Conditions: For 1997 and later model year vehicles, misfire shall be monitored continuously and under all positive torque engine speeds and conditions. For pre-1997 model year vehicles, misfire shall be monitored continuously during, at a minimum, positive torque operating conditions within the range of engine speed and load condition combinations encountered during an FTP test; nonetheless, subject to Executive Officer approval, manufacturers may disable misfire monitoring under specific conditions within the range of operating conditions encountered during an FTP test if the manufacturer can demonstrate that misfire monitoring is not feasible for the vehicle model in question when such conditions are encountered without making fundamental engine of control unit design modifications. Further, with Executive Officer approval, the manufacturer may disable misfire monitoring when misfire cannot be distinguished from other effects when using the best available monitoring technology. The manufacturer shall present data and an engineering evaluation to the Executive Officer to justify the proposed action.

(3.4) MIL Illumination and Fault Code Storage:

(3.4.1) Except as provided below, upon detection of the level of misfire specified in subsection (3.2) (A), the MIL shall blink once per second during actual misfire conditions and remain continuously illuminated otherwise. In vehicles which provide fuel shutoff and default fuel control to prevent overfueling during misfire conditions, the MIL need not blink and may instead illuminate continuously upon detection of misfire provided that the fuel shutoff and default control shall be activated as soon as misfire is detected. Fuel shutoff and default fuel control may be deactivated only to permit fueling outside of the misfire range.

(3.4.2) Upon detection of the misfire levels specified in subsection (3.2) (B) or (C), the MIL shall be illuminated and a fault code stored no later than the end of the next driving cycle in which misfire is detected, unless driving conditions similar to those under which misfire was originally detected have been encountered (see section (3.4.3)) without an indication of misfire, in which case the initial temporary code and stored conditions may be erased. Furthermore, if similar driving conditions are not encountered during 80 trips subsequent to the initial detection of a malfunction, the initial temporary code and stored conditions may be erased.

(3.4.3) Upon detection of misfire, manufacturers shall store the engine speed, load, and warm-up status (i.e., cold or warmed-up) under which the first misfire event was detected. A trip or driving cycle shall be considered to have similar conditions if the stored engine speed conditions are encountered within 375 rpm, load conditions within 10 percent, and the same warm-up status is present. With Executive Officer approval, other strategies for determining if similar conditions have been encountered may be employed. Approval shall be based on comparable timeliness and reliability in detecting similar conditions.

(4.0) EVAPORATIVE SYSTEM MONITORING

(4.1) Requirement:

(4.1.1) The diagnostic system shall verify air flow from the complete evaporative system. In addition, the diagnostic system shall also monitor the evaporative system for the loss of HC vapor into the atmosphere by performing a pressure or vacuum check of the complete evaporative system.

(4.1.2) Manufacturers may temporarily disable the evaporative purge system to perform a check.

(4.1.3) Manufacturers may request Executive Officer approval to abort an evaporative system check under specific conditions if it can be demonstrated that a reliable check cannot be made when these conditions exist.

(4.1.4) Subject to Executive Officer approval, other monitoring strategies may be used provided the manufacturer provides a description of the strategy and supporting data showing equivalent monitoring reliability and timeliness in detecting an evaporative system malfunction or leak.

(4.1.5) Implementation of this requirement is mandatory only for 1996 and later model year vehicles designed to comply with the requirements of Title 13, California Code of Regulations, Section 1976, "Standards and Test Procedures for Motor Vehicle Fuel Evaporative Emissions," for 1995 and subsequent model year vehicles.

(4.2) Malfunction Criteria: An evaporative system shall be considered malfunctioning when no air flow from the system can be detected, or when a system leak is detected that is greater than or equal in magnitude to a leak caused by a 0.040 inch diameter orifice in any portion of the evaporative system excluding the tubing and connections between the purge valve and the intake manifold. On vehicles with fuel tank capacity greater than 25 gallons, the Executive Officer shall revise the size of the orifice if the most reliable monitoring method available cannot reliably detect a system leak of this magnitude.

(4.3) Monitoring Conditions: The monitoring system shall monitor the evaporative system at least once per trip. Subject to Executive Officer approval, if performance of the check causes vehicles to exceed applicable emission standards when using the best available technology, manufacturers may perform evaporative system monitoring during a steady-speed condition, as defined in section (b) (1.3.2), between 20 and 50 mph.

(4.4) MIL Illumination and Fault Code Storage:

(4.4.1) Upon detection of an evaporative system malfunction or a malfunction that prevents completion of an evaporative system check, the diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next trip if the malfunction is again detected.

(4.4.2) If the diagnostic system is capable of discerning that a system leak is being caused by a missing or improperly secured fuel cap, the manufacturer may notify the vehicle operator through the use of an indicator light other than the MIL. The manufacturer is not required to store a fault code in this case. The indicator light shall conform to the requirements outlined in section (a) (1.1) for location and illumination. As another option, the manufacturer may extinguish the MIL, provided no other malfunctions have been detected, and may erase the fault code corresponding to the problem once the on-board diagnostic system has verified that the fuel cap specifically has been securely fastened. Other equivalent strategies shall be considered by the Executive Officer.

(5.0) **SECONDARY AIR SYSTEM MONITORING**

(5.1) Requirement: Any vehicle equipped with any form of secondary air delivery system shall have the diagnostic system monitor the proper functioning of (i) the secondary air delivery system and (ii) any air switching valve.

(5.2) Malfunction Criteria:

(5.2.1) The diagnostic system shall indicate secondary air delivery system malfunction when the flow rate falls below the manufacturer's specified low flow limit such that a vehicle would exceed 1.5 times any of the applicable FTP emission standards.

(5.2.2) Manufacturers demonstrating that deterioration of the flow distribution system is unlikely may request Executive Officer approval to perform only a functional check of the system. In such a case, the diagnostic system shall indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during a check.

(5.3) Monitoring Conditions: The monitoring of the secondary air delivery system and the air switching valve shall occur once per trip.

(5.4) MIL Illumination and Fault Code Storage: The diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next trip if the malfunction is again detected.

(6.0) **AIR CONDITIONING SYSTEM REFRIGERANT MONITORING**

(6.1) Requirement:

(6.1.1) The diagnostic system shall monitor air conditioning systems for loss of refrigerants which could harm the stratospheric ozone layer or are reactive in forming atmospheric ozone. Any sensor used for such monitoring shall itself be monitored for proper circuit continuity and proper range of operation. A provision for ensuring that a leak has been corrected before extinguishing the MIL shall be provided.

(6.1.2) Manufacturers of a model vehicle which will phase out the use of chlorofluorocarbons in its air conditioning systems by the 1996 model-year or which will use federally-approved refrigerants with substantially less atmospheric ozone depleting potential than CFC-12 need not comply with this requirement for that model.

(6.2) Malfunction Criteria: Manufacturers shall provide a monitoring strategy for approval by the Executive Officer for monitoring a refrigerant leak. The approval shall be based on timeliness and reliability in detecting a leak.

(6.3) Monitoring Conditions: The diagnostic system shall monitor the air conditioning system at least once per trip.

(6.4) MIL Illumination and Fault Code Storage: The diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next trip if the malfunction is again present. The diagnostic system shall not clear a fault code and the MIL shall not turn off unless the leak has been corrected.

(7.0) **FUEL SYSTEM MONITORING**

(7.1) Requirement: The diagnostic system shall monitor the fuel delivery system for its ability to provide compliance with emission standards.

(7.2) Malfunction Criteria: The manufacturer shall establish malfunction criteria to monitor the fuel delivery system such that a vehicle's emissions would not exceed 1.5 times any of the applicable FTP standards before a fault is detected. If the vehicle is equipped with fuel trim circuitry, the manufacturer shall include as one of the malfunction criteria the condition where the trim circuitry has used up all of the trim adjustment allowed within the manufacturer's selected limit(s). Manufacturers may compensate the criteria limit(s) appropriately for changes in altitude or for temporary introduction of large amounts of purge vapor or for other similar identifiable operating conditions when they occur.

(7.3) Monitoring Conditions: The fuel system shall be monitored continuously for the presence of a malfunction.

(7.4) MIL Illumination and Fault Code Storage:

(7.4.1) For fuel systems with short-term trim only capability, the diagnostic system shall store a fault code after the fuel system has attained the criteria limit for a manufacturer-defined time interval sufficient to determine a malfunction. If the malfunction criteria limit and time interval are exceeded, the MIL shall be illuminated and a fault code stored no later than the end of the next driving cycle in which the criteria and interval are again exceeded, unless driving conditions similar to those under which the problem was originally detected have been encountered (see section (7.4.3)) without such an exceedance, in which case the initial temporary code and stored conditions may be erased. Furthermore, if similar driving conditions are not encountered during 80 trips subsequent to the initial detection of a malfunction, the initial temporary code and stored conditions may be erased.

(7.4.2) For fuel systems with long-term fuel trim capability, upon attaining a long-term based malfunction criteria limit independent of, or in combination with, the short-term trim system status, the MIL shall be illuminated and a fault code stored no later than the end of the next trip in which the malfunction is again detected, unless driving conditions similar to those under which the problem was originally detected have been encountered (see subsection (7.4.3)) without an indication of a malfunction, in which case the initial temporary code and stored conditions may be erased. Furthermore, if similar driving conditions are not encountered during 80 trips subsequent to the initial detection of a malfunction, the initial temporary code and stored conditions may be erased.

(7.4.3) Upon detection of a fuel system malfunction, manufacturers shall store the engine speed, load and warm-up status (i.e., cold or warmed-up) under which the malfunction was detected. A trip or driving cycle shall be considered to have similar conditions if the stored engine speed is encountered within 375 rpm, load conditions within 10 percent, and the same warm-up status is present. With Executive Officer approval, other strategies for determining if similar conditions have been encountered may be employed. Approval shall be based on comparable timeliness and reliability in detecting similar conditions.

(8.0) OXYGEN SENSOR MONITORING

(8.1) Requirement:

(8.1.1) The diagnostic system shall monitor the output voltage, response rate, and any other parameter which can affect emissions, of all primary (fuel control) oxygen (lambda) sensors for malfunction. It shall also monitor all secondary oxygen sensors (fuel trim control or use as a monitoring device) for proper output voltage and/or response rate. Response rate is the time required for the oxygen sensor to switch from lean-to-rich once it is exposed to a richer than stoichiometric exhaust gas or vice versa (measuring oxygen sensor switching frequency may not be an adequate indicator of oxygen sensor response rate, particularly at low speeds).

(8.1.2) Either the lean-to-rich or both the lean-to-rich and rich-to-lean response rates shall be checked. Response rate checks shall evaluate the portions of the sensor's dynamic signal that are most affected by sensor malfunctions such as aging or poisoning.

Manufacturers may observe the voltage envelope of the sensor when cycled at a frequency of 1.5 Hertz or greater, as determined by the manufacturer, to evaluate a slow response rate sensor (i.e. a slow sensor cannot achieve maximum and/or minimum voltage as will a good sensor given a properly chosen switching frequency and fuel step change for the check). With Executive Officer approval, manufacturers may use other voltage requirements/fuel-air switching frequencies or monitoring strategies based on a determination of accurate and timely evaluation of the sensor.

(8.1.3) For sensors with different characteristics, the manufacturer shall submit data and an engineering evaluation to the Executive Officer for approval based on showing equivalent evaluation of the sensor.

(8.1.4) For vehicles equipped with heated oxygen sensors, the heater circuit shall be monitored for proper current and voltage drop (note: a continuity check of oxygen sensors is not required). Other heater circuit monitoring strategies would require approval by the Executive Officer based on equally reliable and timely indication of malfunction as current or voltage-based monitoring.

(8.2) Malfunction Criteria:

(8.2.1) An oxygen sensor shall be considered malfunctioning when the voltage, response rate, or other criteria are exceeded and causes emissions from a vehicle equipped with the sensor(s) to exceed 1.5 times any of the applicable FTP standards, or when the criteria of sensors for use as a diagnostic system monitoring device (e.g., for catalyst efficiency monitoring) are exceeded.

(8.2.2) For heated oxygen sensors, the heater circuit shall be considered malfunctioning when the current or voltage drop in the circuit is no longer within the manufacturer's specified limits for proper operation. Subject to Executive Officer approval, other monitoring strategy malfunction criteria for detection of heater circuit malfunctions may be used provided the manufacturer submits data showing monitoring reliability and timeliness to be equivalent to the stated criteria in this paragraph.

(8.3) Monitoring Conditions:

(8.3.1) For primary oxygen sensor(s) used for fuel control, the response rate and output voltage shall be monitored for malfunction before the end of the first idle period after the vehicle has commenced closed-loop operation, if the necessary checking condition for acceptable oxygen sensor(s) performance has been encountered. The performance of the sensor can only be judged acceptable by one or more of the following means: within any 20 second reasonably steady speed condition as defined in (b)(1.3.2), within any deceleration of 3 seconds or more, or during the first idle period of at least 20 seconds after closed loop operation begins (i.e., not during an acceleration condition); not withstanding, unacceptable performance can be determined at any time. Other monitoring conditions may be used provided the manufacturer provides a monitoring strategy and supporting data showing equivalent monitoring reliability and timeliness in detecting a malfunctioning sensor compared to the above monitoring conditions and the Executive Officer approves.

(8.3.2) For secondary oxygen sensors used for catalyst monitoring and/or fuel system trim, the response rate and/or output voltage shall be monitored for malfunction at least once per trip.

(8.3.3) For heated oxygen sensors, the heater circuit shall be monitored for malfunction at least once per trip.

(8.4) MIL Illumination and Fault Code Storage: Upon detection of any oxygen sensor malfunction, the diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next trip if the malfunction is again present.

(8.5) Other (non-lambda) Oxygen Sensors:

(8.5.1) For vehicles equipped with universal exhaust gas oxygen sensors (i.e. sensors which provide an output proportional to exhaust gas oxygen concentration), the diagnostic system shall provide a response rate check (the time required to respond to a specific change in fuel/air ratio) at least once per trip and an out-of-range check for which monitoring shall be continuous. For malfunctions, MIL illumination and fault code storage shall be as in (8.4).

(8.5.2) If a manufacturer utilizes other types of oxygen sensors, the manufacturer shall submit a monitoring plan to the Executive Officer for approval based on equivalent monitoring with conventional sensors.

(9.0) **EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITORING**

(9.1) Requirement:

(9.1.1) The diagnostic system shall monitor the EGR system on vehicles so-equipped for low and high flow rate malfunctions.

(9.1.2) Manufacturers may request Executive Officer approval to temporarily disable the EGR system check under specific conditions if it can be demonstrated that a reliable check cannot be made when these conditions exist.

(9.2) Malfunction Criteria: The EGR system shall be considered malfunctioning when one or both of the following occurs: (1) any component of the system fails to perform within manufacturer specifications, or (2) the EGR flow rate exceeds the manufacturer's specified low or high flow limits such that a vehicle would exceed 1.5 times any of the applicable FTP emission standards.

(9.3) Monitoring Conditions: The diagnostic system shall monitor the EGR system at least once per trip.

(9.4) MIL Illumination and Fault Code Storage: The diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next trip if the malfunction is again present.

(10.0) **COMPREHENSIVE COMPONENT MONITORING**

(10.1) Requirement:

(10.1.1) Input Components:

(A) The diagnostic system shall monitor for malfunction any electronic powertrain component/system which can affect emissions not otherwise described above and which provides input directly or indirectly to the on-board computer.

(B) The monitoring system shall have the capability of detecting, at a minimum, lack of circuit continuity and out of range values ~~to ensure proper operation of the input device. The determination~~ of out of range values shall include logic evaluation of available information to determine if a component is operating within its normal range (e.g., indicating a malfunction in the case of high fuel tank pressure when the coolant temperature is low; an accelerometer output indicating continuous rough road conditions, etc.).

(C) Input components may include, but are not limited to, the vehicle speed sensor, crank angle sensor, knock sensor, throttle position sensor, coolant temperature sensor, cam position sensor, fuel composition sensor (e.g. methanol flexible fuel vehicles), transmission electronic components such as sensors, modules, and solenoids which provide signals to the powertrain control system (see section (b) (10.5)).

(D) The coolant temperature sensor shall be monitored for achieving a stabilized minimum temperature level which is needed to achieve closed-loop operation within a manufacturer-specified time interval after starting the engine. The Executive Officer shall allow disablement of this check under extremely low ambient temperature conditions provided a manufacturer submits data demonstrating non-attainment of a stabilized minimum temperature.

(10.1.2) Output Components:

(A) The diagnostic system shall monitor for proper functional response to each computer command, any powertrain output component/system receiving commands from the computer either directly or indirectly which can affect emissions and which is not otherwise monitored as a component/system in the above monitoring requirements.

(B) Components for which functional monitoring is not feasible shall be monitored, at a minimum, for proper circuit continuity and out of range values, if applicable.

(C) Output components may include, but are not limited to, the automatic idle speed motor, emission-related electronic only transmission controls, heated fuel preparation systems, and a warmup catalyst bypass valve (see section (b) (10.5)).

(10.2) Malfunction Criteria:

(10.2.1) Input Components: Input components/systems shall be considered malfunctioning when, at a minimum, lack of circuit continuity or manufacturer-specified out-of-range values occur. Additionally, the coolant temperature sensor shall be considered malfunctioning if it does not achieve a stabilized minimum temperature necessary for closed-loop operation within a manufacturer-specified time interval after starting the engine.

(10.2.2) Output Components: Output components/systems shall be considered malfunctioning when a proper functional response to each computer command does not occur. Should a functional check for malfunction not be feasible, then an output component/system shall be considered malfunctioning when, at a minimum, lack of circuit continuity or manufacturer-specified out-of-range values occur.

(10.3) Monitoring Conditions: Components/systems in this subsection shall be monitored continuously.

(10.4) MIL Illumination and Fault Code Storage: Upon detecting a malfunction, the diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next trip if the malfunction is again detected.

(10.5) Component Determination: The manufacturer shall determine whether a powertrain input or output component not otherwise covered can affect emissions. If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component cannot affect emissions, the Executive Officer shall require the manufacturer to provide emission data showing that such a component, when faulty and installed in a suitable test vehicle, does not have an emission effect.

(c) **ADDITIONAL MIL ILLUMINATION AND FAULT CODE STORAGE PROTOCOL**

(1.0) **MIL ILLUMINATION** For all emission-related components/systems, upon final determination of malfunction, the MIL shall remain continuously illuminated (except that it shall blink as indicated previously for misfire detection). If any malfunctions are identified in addition to misfire, the misfire condition shall take precedence, and the MIL shall blink accordingly. The diagnostic system shall store a fault code for MIL illumination whenever the MIL is illuminated. The diagnostic system shall illuminate the MIL and shall store a code whenever the engine control enters a default or "limp home" mode of operation. The diagnostic system shall illuminate the MIL and shall store a code whenever the engine control system fails to enter closed-loop operation within a manufacturer specified minimum time interval.

(2.0) **EXTINGUISHING THE MIL**

(2.1) Misfire and Fuel System Malfunctions: For misfire or fuel system malfunctions, the MIL may be extinguished if the fault does not recur when monitored during three subsequent sequential driving cycles in which conditions are similar to those under which the malfunction was first determined (see sections (b) (3.4.3) and (b) (7.4.3)).

(2.2) All Other Malfunctions: Except as noted in section (b) (6.4), for all other faults, the MIL may be extinguished after three subsequent sequential trips in which the malfunction has not recurred and no other malfunction has been identified that would independently illuminate the MIL according to the requirements outlined above.

(3.0) **ERASING A FAULT CODE** The diagnostic system may erase a fault code if the same fault is not re-registered in at least 40 engine warm-up cycles, and the MIL is not illuminated for that fault code.

(d) **TAMPERING PROTECTION** Computer-coded engine operating parameters shall not be changeable without the use of specialized tools and procedures (e.g. soldered or potted computer components or sealed (or soldered) computer enclosures). Subject to Executive Officer approval, manufacturers may exempt from this requirement those product lines which are unlikely to require protection. Criteria to be evaluated in making an exemption include, but are not limited to, current availability of performance chips, high performance capability of the vehicle, and sales volume. Any reprogrammable computer code system (e.g. EEPROM) shall include proven write-protect features which may include copyrightable executable routines or other methods.

(e) **READINESS/FUNCTION CODE** If a full diagnostic check (i.e., the minimum number of checks necessary for MIL illumination) of all monitored components and systems has not been completed since the computer memory was last cleared, the manufacturer shall store a code indicating the need for additional mixed city and highway driving to complete the check.

The diagnostic system check for continuous monitoring of misfire and fuel system faults shall be considered complete for purposes of determining the readiness indication if malfunctions are not detected in these areas by the time all other diagnostic system checks are complete. If monitoring is temporarily disabled under conditions which may lead to false codes for any system, that check shall not be considered in determining diagnostic system readiness. The diagnostic system shall also include a code or acknowledge message indicating that the diagnostic system itself is functioning properly.

(f) **STORED ENGINE CONDITIONS** Upon detection of the first malfunction of any component or system, "freeze frame" engine conditions present at the time shall be stored in computer memory. Should a subsequent fuel system or misfire malfunction occur, any previously stored freeze frame conditions shall be replaced by the fuel system or misfire conditions (whichever occurs first). Stored engine conditions shall include, but are not limited to, calculated load value, engine RPM, fuel trim value(s), fuel pressure (if available), vehicle speed (if available), coolant temperature, intake manifold pressure (if available), closed- or open-loop operation, and the fault code which caused the data to be stored. The manufacturer shall choose the most appropriate set of conditions facilitating effective repairs for freeze frame storage. Only one frame of data is required. Manufacturers may at their discretion choose to store additional frames provided that at least the required frame can be read by a generic scan tool meeting SAE specifications established in SAE Recommended Practices on "OBD II Scan Tool" (J1978), March 1992, and "E/E Diagnostic Test Modes" (J1979), December 1991, which are incorporated by reference herein. If the fault code causing the conditions to be stored is erased in accordance with section (c) (3.0), the stored engine conditions may be cleared as well.

(g) **DURABILITY DEMONSTRATION VEHICLE**

(1.0) **REQUIREMENT** Each year a manufacturer shall provide emission test data for one certification durability vehicle that has not been used previously for purposes of this section. The Executive Officer shall waive this requirement if a manufacturer does not have a certification durability vehicle available which is suitable for this demonstration in a given year, provided a manufacturer submits other data from a representative high mileage vehicle or vehicles (or a representative high operating-hour engine or engines) acceptable to the Executive Officer to demonstrate that malfunction criteria are based on emission performance. The Air Resources Board (ARB) shall determine the demonstration vehicle. Each manufacturer shall notify the Executive Officer prior to running a California durability vehicle in order to allow possible selection as the demonstration vehicle for a given model year unless a vehicle has previously been chosen for the given model year. Demonstration tests shall be conducted on the certification durability vehicle or engine at the end of the required mileage or operating-hour accumulation. For non-LEVs, until a NOx standard applicable for more than 50,000 miles is established in California, the federal 50,000 to 100,000 mile NOx standard shall be used for demonstration purposes.

(1.1) Flexible fuel vehicles shall perform each demonstration test using 85 percent methanol and 15 percent gasoline, and gasoline only. For vehicles capable of operating on other fuel combinations, the manufacturer shall submit a plan for performing demonstration testing for approval by the Executive Officer on the basis of providing accurate and timely evaluation of the monitored systems.

(2.0) **APPLICABILITY** The manufacturer shall perform single-fault testing based on the applicable FTP test cycle with the following components/systems at their malfunction criteria limits as determined by the manufacturer:

(2.1) Oxygen Sensors. The manufacturer shall conduct the following demonstration tests: The first test involves testing all primary and secondary (if equipped) oxygen sensors used for fuel control simultaneously possessing normal output voltage but response rate deteriorated to the malfunction criteria limit (secondary oxygen sensors for which response rate is not monitored shall be with normal response characteristics). The second test shall include testing with all primary and secondary (if equipped) oxygen sensors used for fuel control simultaneously possessing output voltage at the malfunction criteria limit. Manufacturers shall also conduct a malfunction criteria demonstration test for any other oxygen sensor parameter that can cause vehicle emissions to exceed 1.5 times the applicable standards (e.g., shift in air/fuel ratio at which oxygen sensor switches). When performing additional test(s), all primary and secondary (if equipped) oxygen sensors used for fuel control shall be operating at the malfunction criteria limit for the applicable parameter only. All other primary and secondary oxygen sensor parameters shall be with normal characteristics. The Executive Officer may approve other demonstration protocols if the manufacturer can show comparable assurance that the malfunction criteria are chosen based on meeting emission requirements.

(2.2) EGR System: The manufacturer shall conduct only one flow rate demonstration test at the low flow limit.

(2.3) Fuel Metering System:

(2.3.1) For vehicles with short-term or long-term fuel trim circuitry, the manufacturer shall conduct one demonstration test at the border of the rich limit and one demonstration test at the border of the lean limit established by the manufacturer for emission compliance.

(2.3.2) For other systems, the manufacturer shall conduct a demonstration test at the criteria limit(s).

(2.3.3) For purposes of the demonstration, the fault(s) induced may result in a uniform distribution of fuel and air among the cylinders. Non-uniform distribution of fuel and air used to induce a fault shall not cause an indication of misfire. The manufacturer shall describe the fault(s) induced in the fuel system causing it to operate at the criteria limit(s) for the demonstration test (e.g., restricted or increased flow fuel injectors, an altered output signal airflow meter, etc.). Computer modifications to cause the fuel system to operate at the adaptive limit for malfunction shall not be allowed for the demonstration tests.

(2.4) Misfire: The manufacturer shall conduct one FTP demonstration test at the criteria limit specified in (b)(3.2)(B) for malfunction and a second demonstration test showing that the vehicle is capable of passing a California Inspection/Maintenance test when operating at the misfire criteria limit.

(2.5) Secondary Air System: The manufacturer shall conduct a flow rate demonstration test at the low flow limit, unless only a functional check is permitted.

(2.6) Catalyst Efficiency:

(2.6.1) Non-LEVs: The manufacturer shall conduct a baseline FTP test with a representative 4000 mile catalyst followed by one FTP demonstration test using a catalyst system deteriorated to its malfunction limit. If a manufacturer is employing a steady state catalyst efficiency check in accordance with section (b) (1.2.4), demonstration of the catalyst monitoring system is not required.

(2.6.2) LEVs: The manufacturer shall conduct a catalyst efficiency demonstration using a catalyst deteriorated to within the malfunction criteria. If two substrates are integrated into the same container, only the upstream substrate shall be deteriorated for the demonstration.

(2.7) Heated Catalyst Systems: For heated catalyst systems that use an after start heating strategy, the manufacturer shall conduct a demonstration test where the designated heating temperature is reached at the time limit for malfunction after engine starting.

(2.8) Manufacturers may electronically simulate deteriorated components, but may not make any vehicle control unit modifications when performing demonstration tests. All equipment necessary to duplicate the demonstration test must be made available to the ARB upon request.

(3.0) **PRECONDITIONING** The manufacturer shall use the first engine start portion of one applicable FTP cycle for preconditioning before each of the above emission tests. If a manufacturer can demonstrate that additional preconditioning is necessary to stabilize the emission control system, the Executive Officer shall allow an additional identical preconditioning cycle, or a Federal Highway Fuel Economy Driving Cycle, following a ten-minute (or 20 minutes for medium duty engines certified on an engine dynamometer) hot soak after the initial preconditioning cycle.

(4.0) **EVALUATION PROTOCOL**

(4.1) With the exception of short-term trim only vehicles, the manufacturer shall set the system or component at the criteria limit(s) from the beginning of and throughout the applicable preconditioning cycle and FTP test.

(4.2) For short-term trim only vehicles, the fuel system shall operate at the criteria limit from the beginning of closed-loop operation for the manufacturer-defined time interval for determining malfunction (and normally otherwise) for both the applicable preconditioning and FTP test cycles.

(4.3) For misfire demonstration, misfire shall be set at its criteria limit as specified pursuant to section (b) (3.2) (B) throughout the applicable preconditioning cycle and FTP test.

(4.4) For all demonstrations, the MIL shall be illuminated before the hot start portion of the FTP test in accordance with requirements of subsection (b):

(4.4.1) If the MIL does not illuminate when the systems or components are set at their limit(s), the criteria limit or the OBD system is not acceptable.

(4.4.2) Except for catalyst efficiency demonstration, if the MIL illuminates and emissions do not exceed 1.5 times any of the applicable FTP emission standards, no further demonstration shall be required.

(4.4.3) Except for catalyst efficiency demonstration, if the MIL illuminates and emissions exceed 1.5 times any of the applicable FTP emission standards, the vehicle shall be retested with the component's malfunction criteria limit value reset such that vehicle emissions are reduced by no more than 30 percent. Limit value at a minimum includes, in the case of oxygen sensors, response rate and voltage; for EGR systems, EGR flow rate; for secondary air systems, air flow rate; for short-term fuel trim-only systems, time interval at the fuel system range of authority limit; for long-term fuel trim systems, shift in the base fuel calibration; for heated catalyst systems, the time limit between engine starting and attaining the designated heating temperature (if an after-start heating strategy is used); and for misfire, percent misfire. For the OBD system to be approved, the vehicle must then meet the above emission levels when tested with the faulty components. The MIL shall not illuminate during this demonstration.

(4.4.4) For Non-LEV catalyst efficiency demonstration, if HC emissions do not increase by more than 1.5 times the standard from the baseline FTP test and the MIL is illuminated, no further demonstration shall be required. However, if HC emissions increase by more than 1.5 times the standard from the baseline FTP test and the MIL is illuminated, the vehicle shall be retested with the average FTP HC conversion capability of the catalyst system increased by no more than 10 percent (i.e., 10 percent more engine out hydrocarbons are converted). For the OBD system to be approved, the vehicle must then meet the above emission levels when re-tested. The MIL shall not illuminate during this demonstration.

(4.4.5) For LEV catalyst efficiency demonstration, if catalyst efficiency is within the malfunction criteria range over the FTP test and the MIL is illuminated, no further demonstration is required. If catalyst efficiency falls outside of the malfunction criteria range, the catalyst's efficiency shall be adjusted, or the catalyst shall be replaced with another deteriorated catalyst, and the system re-tested. If catalyst efficiency is within the malfunction criteria range over the FTP test and the MIL is not illuminated, the catalyst may be deteriorated further but not below the lower limit of the malfunction criteria range, and the system retested. If the catalyst's efficiency is below the lower limit of the malfunction criteria range and the MIL is not illuminated, the OBD system is not acceptable.

(4.5) If an OBD system is determined unacceptable by the above criteria, the manufacturer may re-calibrate and re-test the system on the same DDV. Any affected monitoring systems demonstrated prior to the re-calibration shall be re-verified.

(h) **CERTIFICATION DOCUMENTATION** The manufacturer shall submit the following documentation for each engine family at the time of certification:

(1) A written description of the functional operation of the diagnostic system to be included in Section 8 of manufacturers' certification applications.

(2) A table providing the following information for each monitored component or system (either computer-sensed or -controlled) of the emission control system:

i. corresponding fault code
ii. monitoring method or procedure for malfunction detection
iii. primary malfunction detection parameter and its type of output signal
iv. fault criteria limits used to evaluate output signal of primary parameter
v. other monitored secondary parameters and conditions (in engineering units) necessary for malfunction detection
vi. monitoring time length and frequency of checks
vii. criteria for storing fault code
viii. criteria for illuminating malfunction indicator light
ix. criteria used for determining out of range values and input component rationality checks

(3) A logic flowchart describing the general method of detecting malfunctions for each monitored emission-related component or system. To the extent possible, abbreviations in Society of

Automotive Engineers' (SAE) J1930 "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms", September, 1991, shall be used. J1930 is incorporated by reference herein. The information required in the chart under (2) above may instead be included in this flow chart, provided all of the information required in (2) is included.

(4) A listing and block diagram of the input parameters used to calculate or determine calculated load values and the input parameters used to calculate or determine fuel trim values.

(5) A scale drawing of the MIL and the fuel cap indicator light, if present, which specifies location in the instrument panel, wording, color, and intensity.

(6) Emission test data specified in subsection (g).

(7) Data supporting the selected degree of misfire which can be tolerated without damaging the catalyst.

(8) Data supporting the limit for the time between engine starting and attaining the designated heating temperature for after-start heated catalyst systems.

(9) For LEVs, data supporting the criteria used by the diagnostic system for establishing a 50 to 60 percent catalyst total HC efficiency level, or a 40 to 50 percent deterioration level.

(10) For Non-LEVs, data supporting the criteria used to indicate a malfunction when catalyst deterioration leads to a 1.5 times the standard increase in HC emissions. If a steady state catalyst efficiency check is employed in accordance with section (b) (1.2.4), data supporting the criteria used by the diagnostic system for establishing a 60 to 80 percent catalyst efficiency level shall be provided instead.

(11) Data supporting the criteria used to detect evaporative purge system leaks.

(12) A description of the modified or deteriorated component used for the fault simulation to drive the fuel system to the criteria limit(s) for demonstrating fuel system compliance with the requirements of subsection (g).

(13) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this section.

(i) **IN-USE RECALL TESTING PROTOCOL** The manufacturer shall adhere to the following procedures for vehicles subject to in-use recall testing required by the ARB:

(1) If the MIL illuminates during a test cycle or during a preconditioning cycle, the fault causing the illumination may be identified and repaired following published procedures readily available to the public including the independent service sector.

(2) The test may be rerun, and the results from the repaired vehicle may be used for emission reporting purposes.

(3) If a vehicle contains a part which is operating outside of design specifications with no MIL illumination, the part shall not be replaced prior to emission testing.

(4) Failure of a vehicle, or vehicles on average, to meet applicable emission standards with no illumination of the MIL shall not by itself be grounds for requiring the OBD system to be recalled for recalibration or repair since the OBD system cannot predict precisely when vehicles exceed emission standards.

(5) A decision to recall the OBD system for recalibration or repair will depend on factors including, but not limited to, level of emissions above applicable standards, presence of identifiable faulty or deteriorated components which affect emissions with no MIL illumination, and systematic erroneous activation of the MIL. For 1994 and 1995 model years only, on-board diagnostic system recall shall not be considered for excessive emissions without MIL illumination (if required) and fault code storage until emissions exceed 2.0 times any of the applicable standards in those instances where the malfunction criterion is based on exceeding 1.5 times any of the applicable standards.

(j) **CONFIRMATORY TESTING** The ARB may perform confirmatory testing of manufacturers' diagnostic systems for compliance with requirements of this section in accordance with malfunction criteria submitted in the manufacturer's approved certification documentation. The ARB or its designee may install appropriately deteriorated or malfunctioning components in an otherwise properly functioning test vehicle of an engine family represented by the demonstration test vehicle(s) (or simulate a deteriorated or malfunctioning component response) in order to test the fuel system, misfire detection system, oxygen sensor, secondary air system, catalyst efficiency monitoring system, heated catalyst system, and EGR system malfunction criteria for compliance with the applicable emission constraints in this section. Confirmatory testing to verify that malfunction criteria are set for compliance with emission requirements of this section shall be limited to vehicles in engine families derived from the demonstration vehicle(s). Diagnostic systems of a representative sample of vehicles which uniformly fail to meet the requirements of this section may be recalled for correction.

(k) **STANDARDIZATION** Standardized access to emission-related fault codes, emission-related powertrain test information (i.e., parameter values) as outlined in subsection (l), emission related diagnostic procedures, and stored freeze frame data shall be incorporated based on the industry specifications referenced in this regulation.

(1.0) Either SAE Recommended Practice J1850, "Class B Data Communication Network Interface", August, 1991, or ISO 9141 CARB, "Road vehicles - Diagnostic Systems - CARB Requirements for Interchange of Digital Information," which are incorporated by reference, shall be used as the on-board to off-board network communications protocol. All emission related messages sent to the J1978 scan tool over a J1850 data link shall use the Cyclic Redundancy Check and the three byte header, and shall not use inter-byte separation or checksums.

(2.0) **J1978 & J1979** Standardization of the message content (including test modes and test messages) as well as standardization of the downloading protocol for fault codes, parameter values and their units, and freeze frame data are set forth in SAE Recommended Practices on "OBD II Scan Tool" (J1978), March, 1992, and "E/E Diagnostic Test Modes" (J1979), December, 1991, which have been incorporated by reference. Fault codes, parameter values, and freeze frame data shall be capable of being downloaded to a generic scan tool meeting these SAE specifications.

(2.1) Manufacturers shall make readily available at a fair and reasonable price to the automotive repair industry vehicle repair procedures which allow effective emission related diagnosis and repairs to be performed using only the J1978 generic scan tool and commonly available, non-microprocessor based tools. In addition to these procedures, manufacturers may publish repair procedures referencing the use of manufacturer specific or enhanced equipment.

(2.2) The J1978 scan tool shall be capable of notifying the user when one or more of the required monitoring systems are not included as part of the OBD system.

(3.0) **J2012 Part C** Uniform fault codes based on SAE specifications shall be employed. SAE "Recommended Format and Messages for Diagnostic Trouble Codes" (J2012), March, 1992, is incorporated by reference.

(4.0) **J1962** A standard data link connector in a standard location in each vehicle based on SAE specifications shall be incorporated. Any pins in the standard connector that provide any electrical power shall be properly fused to protect the integrity and usefulness of the diagnostic connector for diagnostic purposes. The SAE Recommended Practice "Diagnostic Connector" (J1962), June, 1992, is incorporated by reference.

(1) **SIGNAL ACCESS**

(1.0) The following signals in addition to the required freeze frame information shall be made available on demand through the serial port on the standardized data link connector: calculated load value, diagnostic trouble codes, engine coolant temperature, fuel control system status (open loop, closed loop, other), fuel trim (if equipped), fuel pressure (if available), ignition timing advance, intake air temperature (if equipped), manifold air pressure (if equipped), air flow rate from mass air flow meter (if equipped), engine RPM, throttle position sensor output value (if equipped), secondary air status (upstream, downstream, or atmosphere; if equipped), and vehicle speed (if equipped). The signals shall be provided in standard units based on the SAE specifications incorporated by reference in this regulation, and actual signals shall be clearly identified separately from default value or limp home signals.

(2.0) The manufacturer shall publish in factory service manuals a normal range for the calculated load value and mass air flow rate at idle, and at 2500 RPM (no load, in neutral or park). If the total fuel command trim is made up by more than one source (e.g. short-term trim and long-term trim), all fuel trim signals shall be available. The signals shall be provided in standard units based on the incorporated SAE specifications, and actual signals shall be clearly identified separately from default value or limp home signals.

(3.0) Oxygen sensor data that will allow diagnosis of malfunctioning oxygen sensors shall be provided through the data link. In addition, beginning with the 1996 model year, for all monitored components and systems, results of the most recent test performed by the vehicle, and the limits to which the system is compared (except for continuously monitored systems/components) shall be available through the serial data port on the standardized data link connector. Such data shall be transmitted in accordance with SAE J1979. Alternative methods shall be approved by the Executive Officer if, in the judgment of the Executive Officer, they provide for equivalent off-board evaluation.

(m) **IMPLEMENTATION SCHEDULE**

(1.0) These OBD II requirements, except evaporative purge system monitoring (see section (b) (4.1.5)), shall be implemented beginning with the 1994 model year.

(2.0) The Executive Officer shall grant an extension for compliance with the requirements of these subsections with respect to a specific vehicle model or engine family if the vehicle model or engine family meets previously applicable on-board diagnostic system requirements and a manufacturer demonstrates that it cannot modify a present electronic control system by the 1994 model-year because major design system changes not consistent with the manufacturer's projected changeover schedule would be needed to comply with provisions of these subsections.

(2.1) The manufacturer which has received an extension from the Executive Officer shall comply with these regulations when modification of the electronic system occurs in accordance with the manufacturer's projected changeover schedule or in the 1996 model year, whichever first occurs.

(2.2) Any manufacturer requesting an extension shall, no later than October 15, 1991, submit to the Executive Officer an application specifying the period for which the extension is required.

(3.0) Small volume manufacturers as defined in (n) (13.0) shall meet these requirements by the 1996 model year.

(4.0) Manufacturers may at their discretion implement a portion of these regulations prior to the required implementation date provided that the system complies with previously applicable on-board diagnostic system requirements.

(5.0) Vehicles certified to run on alternate fuels, and diesel vehicles, shall meet these requirements by the 1996 model year. Manufacturers may request a delay in the implementation of these requirements for diesel vehicles until 1997, subject to Executive Officer approval, if it is demonstrated that the delay will allow for the development of significantly more effective monitoring systems.

(6.0) The Executive Officer may waive one or more of the requirements of these subsections with respect to a specific vehicle or engine family for which production commences prior to April 1, 1994, and which is not otherwise exempted from compliance in accordance with sections (2.0) and (2.1) above. In granting a waiver, the Executive Officer shall consider such factors as, but not limited to, the extent to which these requirements are satisfied overall on the vehicle applications in question, the extent to which the resultant diagnostic system design will be more effective than systems developed according to section 1968, Title 13, and a demonstrated good-faith effort to meet these requirements in full by evaluating and considering the best available monitoring technology.

(6.1) For 1995 model year vehicles for which production is to commence subsequent to March 31, 1994, and which are not exempted from compliance in accordance with sections (2.0) and (2.1) above, the Executive Officer, upon receipt of an application from the manufacturer, may certify the vehicles in question even though said vehicles may not comply with one or more of the requirements of these subsections. Such certification is contingent upon the manufacturer agreeing to pay a fine in the amount of $50 per deficiency per vehicle for non-compliance with any of the monitoring requirements specified in subsections (b)(1) through (b)(9), and a fine in the amount of $25 per deficiency per vehicle for non-compliance with any other requirement of section 1968.1. Total fines per vehicle under this section shall not exceed $500 per vehicle and shall be payable to the State Treasurer for deposit in the Air Pollution Control Fund in accordance with section 43016 of the California Health and Safety Code.

(n) **GLOSSARY** For purposes of this section:

(1.0) "Malfunction" means the inability of an emission-related component or system to remain within design specifications. Further, malfunction refers to the deterioration of any of the above components or systems to a degree that would likely cause the emissions of an average certification durability vehicle with the deteriorated components or systems present at the beginning of the applicable certification emission test to exceed by more than 1.5 times any of the emission standards, unless otherwise specified, applicable pursuant to Subchapter 1 (commencing with Section 1900), Chapter 3 of Title 13.

(2.0) "Secondary air" refers to air introduced into the exhaust system by means of a pump or aspirator valve or other means that is intended to aid in the oxidation of HC and CO contained in the exhaust gas stream.

(3.0) "Engine misfire" means lack of combustion in the cylinder due to absence of spark, poor fuel metering, poor compression, or any other cause.

(4.0) Oxygen sensor "response rate" refers to the delay (measured in milliseconds) between a switch of the sensor from lean to rich or vice versa in response to a change in fuel/air ratio above and below stoichiometric.

(5.0) A "trip" means vehicle operation (following an engine-off period) of duration and driving mode such that all components and systems are monitored at least once by the diagnostic system except catalyst efficiency or evaporative system monitoring when a steady-speed check is used, subject to the limitation that the manufacturer-defined trip monitoring conditions shall all be encountered at least once during the first engine start portion of the applicable FTP cycle.

(6.0) A "warm-up cycle" means sufficient vehicle operation such that the coolant temperature has risen by at least 40 degrees Fahrenheit from engine starting and reaches a minimum temperature of 160 degrees Fahrenheit.

(7.0) A "driving cycle" consists of engine startup, vehicle operation beyond the beginning of closed loop operation, and engine shutoff.

(8.0) "Continuous monitoring" means sampling at a rate no less than two samples per second.

(9.0) "Fuel trim" refers to feedback adjustments to the base fuel schedule. Short-term fuel trim refers to dynamic or instantaneous adjustments. Long-term fuel trim refers to much more gradual adjustments to the fuel calibration schedule than short-term trim adjustments. These long term adjustments compensate for vehicle differences and gradual changes that occur over time.

(10.0) "Base Fuel Schedule" refers to the fuel calibration schedule programmed into the Powertrain Control Module or PROM when manufactured or when updated by some off-board source, prior to any learned on-board correction.

(11.0) "Calculated load value" refers to an indication of the current airflow divided by peak airflow, where peak airflow is corrected for altitude, if available. This definition provides a unitless number that is not engine specific, and provides the service technician with an indication of the percent engine capacity that is being used (with wide open throttle as 100%).

$$CLV = \frac{\text{Current airflow}}{\text{Peak airflow (@ sea level)}} \times \frac{\text{Atm. pressure (@ sea level)}}{\text{Barometric pressure}}$$

(12.0) "Medium-duty vehicle" is defined in Title 13, Section 1900 (b)(9).

(13.0) "Small volume manufacturer" shall mean any vehicle manufacturer with sales less than or equal to 3000 new light-duty vehicles and medium-duty vehicles per model year based on the average number of vehicles sold by the manufacturer each model year from 1989 to 1991. For manufacturers certifying for the first time in California, model year sales shall be based on projected California sales.

(14.0) "Low Emission Vehicle" refers to a vehicle certified in California as a Transitional Low Emission Vehicle, a Low Emission Vehicle, or an Ultra Low Emission Vehicle. These vehicle categories are further defined in Title 13, sections 1956.8 and 1960.1.

(15.0) "Diesel engines", for the purposes of these regulations, includes diesel derived engines and those using a compression ignition thermodynamic cycle.

(16.0) "Functional check" for an output component means verification of proper response to a computer command. For an input component, functional check means verification of the input signal being in the range of normal operation, including evaluation of the signal's rationality in comparison to all available information.

(17.0) "Federal Test Procedure" (FTP) cycle or test refers to, for passenger vehicles, light-duty trucks, and medium-duty vehicles certified on a chassis dynamometer, the driving schedule in Code of Federal Regulations (CFR) 40, Appendix 1, Part 86, section (a) entitled, "EPA Urban Dynamometer Driving Schedule for Light-Duty Vehicles and Light-Duty Trucks." For medium-duty engines certified on an engine dynamometer, FTP cycle or test refers to the engine dynamometer schedule in CFR 40, Appendix 1, Part 86, section (f)(1), entitled, "EPA Engine Dynamometer Schedule for

Heavy-Duty Otto-Cycle Engines," or section (f)(2), entitled, "EPA Engine Dynamometer Schedule for Heavy-Duty Diesel Engines."

Note: Authority cited: Sections 39600, 39601, ~~and~~ 43013, 43101 and 43104 Health and Safety Code. Reference: Sections 39002, 39003, 39667, 43000, 43013, 43100, 43101, 43101.5, 43102, 43104, 43105 and 43204, Health and Safety Code.