SUMMARY OF BOARD ITEM

ITEM # 02-3-2: **PUBLIC HEARING TO CONSIDER TECHNICAL STATUS AND PROPOSED REVISIONS TO MALFUNCTION AND DIAGNOSTIC SYSTEM REQUIREMENTS AND ASSOCIATED ENFORCEMENT PROVISIONS FOR 2004 AND SUBSEQUENT MODEL YEAR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES AND ENGINES (OBD II)**

STAFF RECOMMENDATION: The staff recommends that the Board adopt California Code of Regulations (CCR), title 13, section 1968.2, Malfunction and Diagnostic System Requirements – 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines; and CCR, title 13, section 1968.5, Enforcement of Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines.

DISCUSSION: The on-board diagnostics II (OBD II) regulation requires all vehicle manufacturers to monitor virtually every emission-control component and system that can cause increases in emissions. When an emission-related malfunction is detected, the OBD II system alerts the vehicle owner by illuminating the malfunction indicator light (MIL) on the vehicle instrument panel. By alerting the owner of malfunctions as they occur, repairs can be sought promptly, which results in fewer emissions from the vehicle. Manufacturers began phase-in of the OBD II requirements in 1994, with full implementation required on all 1996 and newer model year vehicles. The Air Resources Board (ARB) last adopted modifications to the current OBD II regulation, section 1968.1 of title 13, CCR, in 1996.

Since 1996, the ARB has identified several areas in the current regulation that were in need of modification to provide for improved emission-control system monitoring on future model year vehicles. Some of the changes being proposed are in response to California's increasingly stringent tailpipe and evaporative standards, particularly the Low Emission Vehicle II standards. To address this, the proposal would update or expand several previously adopted monitoring requirements and establish monitoring requirements for recently developed new emission-control technologies. Additionally, the ARB staff is proposing new requirements that would improve the diagnostic information available to assist repair and Smog Check technicians in effectively diagnosing and repairing vehicles, as well as requirements that would help facilitate the incorporation of OBD II into the Smog Check program. The United States Environmental Protection Agency (U.S. EPA) recently issued a final rule not only requiring states to perform OBD II checks in Inspection and Maintenance (I/M) programs but also allowing them to be used in lieu of current tailpipe tests.

The proposed requirements would also address enforcement-related issues and problems the ARB staff has identified over the past eight years since the OBD II regulations were first implemented. Specifically, because of the unique issues involved in OBD II enforcement, there have been problems in applying the existing general enforcement protocol that was developed for and historically used in tailpipe and evaporative emission standard enforcement cases. Accordingly, staff is proposing the adoption of enforcement procedures that are specifically tailored to OBD II issues. The proposed procedures would establish a specific protocol for testing the different types of OBD II monitors, and criteria for determining noncompliance and appropriate penalties.

Along with the difficulties in applying the general enforcement requirements to OBD II systems, a specific issue was identified regarding enforcement of monitoring frequency. In the past, the ARB had found vehicles with OBD II monitors that did not run as frequently as required. However, it was difficult to determine whether monitoring frequency was adequate based solely on the written material and data submitted by the manufacturer during OBD II certification. As a result, the ARB staff is proposing the adoption of a standardized methodology for determining the frequency of OBD II monitor operation for most monitors during in-use driving and a minimum operating frequency that manufacturers are required to meet.

SUMMARY AND IMPACTS:

The proposed action would better ensure that manufacturers comply with the OBD II requirements in upcoming model years, with the phase-in of most new or enhanced monitoring strategies starting with the 2005 or 2006 model years.

Generally, the OBD II regulation requires that major components be monitored to indicate malfunctions (i.e., illuminate the MIL) before component deterioration or failure causes emissions to exceed 1.5 times the applicable tailpipe emission standards of the certified vehicle. The proposed regulation continues this threshold for Low Emission Vehicle II and Ultra-Low Emission Vehicle II applications, but allows Super Ultra-Low Emission Vehicles (SULEVs) to use a malfunction criterion of 2.5 times, instead of 1.5 times, the applicable emission standards. Manufacturers, however, are concerned that the proposed MIL illumination emission thresholds are too stringent and not cost-effective (i.e., the MIL would illuminate too soon and result in repairs that yield minimal emission benefits). However, higher MIL illumination thresholds, such as those proposed by the manufacturers, could substantially reduce the emission benefits of the Low Emission Vehicle II program, which is unacceptable in meeting the State Implementation Plan goals. The staff has determined that the proposed thresholds are both technically feasible (three different manufacturers currently sell vehicles that meet these proposed criteria) and cost-effective. Staff's calculations found that the proposed thresholds have a cost-effectiveness of $4.57 per pound of ROG+NOx, well within the range of other measures adopted by the ARB. Additionally, higher thresholds may result in vehicle manufacturers forsaking durability improvements of emission-control components, since such components would be allowed to deteriorate to a greater extent. This may result in vehicles being equipped with less robust parts, requiring more frequent repair. Delaying the repair or replacement of faulty components (i.e., MIL illumination) could lead to damage to other components, which would result in higher repair costs. Accordingly, the ARB staff believes the proposed MIL illumination thresholds are adequate, necessary, and cost-effective. It should also be noted that more than 120 fault codes in typical OBD II systems pertain to malfunctions that are determined not by emission thresholds but on electrical checks, rationality evaluations, functionality, or other similar checks. This further mitigates the effects of emission thresholds on overall program cost-effectiveness.

Manufacturers have questioned the ARB's authority to adopt enforcement procedures specifically for OBD II-related issues (proposed section 1968.5). As stated previously, the current general enforcement provisions were initially adopted for tailpipe and evaporative emission standards. And, as past enforcement cases have illustrated, this resulted in complexity and difficulty when the ARB attempted to apply these general enforcement procedures to OBD II compliance cases. The ARB's authority to adopt OBD II-specific enforcement is pursuant to the general and expressed authority vested to it under the Health and Safety Code. Particularly, section 43105 expressly provides the ARB the authority to order a manufacturer to perform corrective action, including recall, on vehicles that fail to meet established emission standards or test procedures. Since the OBD II regulation establishes both emission standards and test procedures, the ARB has the authority to adopt OBD II-specific enforcement regulation (proposed section 1968.5).

Manufacturers have also questioned the ARB's authority to order a recall of vehicles with OBD II-related problems regardless of tailpipe and evaporative emissions. Specifically, manufacturers believe the ARB cannot order a recall of these vehicles if the manufacturer can show that the subject vehicle fleet, on average, complied with the tailpipe and evaporative emission standards. This would, however, undermine the purpose and intent of the OBD II requirements. The Board originally adopted these requirements because it determined that the OBD II systems were important complements to the success of the ARB's motor vehicle emission reduction programs, such as the Low Emission Vehicle II program and California's Smog Check program. As stated previously, the OBD II systems help ensure that the emission reductions forecasted for these programs are achieved. To prevent the recall and subsequent repair of problematic OBD II systems would effectively reverse the Board's prior determination of the necessity of properly functioning OBD II systems. The OBD II requirements serve very different purposes than the tailpipe and evaporative emission standards, and compliance with the latter two should not excuse non-compliance with the former. Existing enforcement regulations are adequate to catch wide-spread "pattern" failures of a single component while OBD II systems are designed to identify individual vehicles that have failing components, regardless of which component has failed or at what failure rate.

The industry also contends that remedial actions proposed in section 1968.5 may not be cost-effective, and that the cost of an ordered remedy may be spent in other ways that could result in greater emission reductions. The ARB staff believes that for some problematic vehicles, remedial action, including recall, are undeniably appropriate and that the cost of the ordered remedy should not be a factor in the decision. The ARB is not required to consider, at the time of adopting the regulation, the cost-effectiveness of a future remedial order that would bring into compliance a manufacturer which has elected to both ignore the regulation and produce an essentially nonfunctional OBD II system. These manufacturers should bear the burden of not having complied with the regulation and not taking the most cost-effective steps when designing the OBD II system in the first place. The burden for this failure should not be shifted to the general public.

The proposed regulation consists primarily of modifications to the existing computer software and additional verification and, in general, would not require the addition of any new hardware. Manufacturers would incorporate these changes during development of new software that will have to take place for vehicles complying with the Low Emission Vehicle II emission standards (i.e., 2004 to 2007 model years). Therefore, the proposed regulation is expected to result in negligible cost to vehicle manufacturers as well as consumers, since cost per vehicle should not be affected.

The proposed regulation would require California's licensed I/M service facilities to upgrade existing equipment to test vehicles equipped with the Controller Area Network (CAN) OBD II communication protocol at an estimated one-time cost of $500 per station for the approximately 10,000 stations, which would total about $5 million. Use of the CAN protocol would enhance information available to repair technicians, thereby leading to improved and less expensive repairs which would generate savings for consumers.

The proposed regulation would help ensure that emission benefits attributed to adopted motor vehicle exhaust and evaporative emission standards, such as the Low Emission Vehicle II standards, are achieved. Most recently, the ARB quantified the emission reductions from OBD II in conjunction with the Low Emission Vehicle II program to be 57 tons per day in the South Coast Air Basin. This analysis was conducted using the OBD II thresholds detailed in the proposed regulation and assuming that OBD II system checks were integrated into the Smog Check program.

Title 13. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER TECHNICAL STATUS AND PROPOSED REVISIONS TO MALFUNCTION AND DIAGNOSTIC SYSTEM REQUIREMENTS AND ASSOCIATED ENFORCEMENT PROVISIONS FOR 2004 AND SUBSEQUENT MODEL YEAR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES AND ENGINES (OBD II)

The Air Resources Board (the "Board" or "ARB") will conduct a public hearing at the time and place noted below to review the technical status and implementation of California's OBD II requirements. The Board will consider amendments to the OBD II regulation to update the regulation to account for newer emission control technologies and lower tailpipe standards, to increase the amount of standardized data available to repair technicians and Inspection and Maintenance (I/M) inspectors, to clarify the regulation where necessary, to adopt more specific enforcement provisions, and to improve the effectiveness of the regulation for future model year vehicles.

DATE: April 25, 2002

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
1001 "I" Street
Auditorium, Second Floor
Sacramento, Ca 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., April 25, 2002, and may continue at 8:30 a.m., April 26, 2002. This item might not be considered until April 26, 2002. Please consult the agenda for the meeting, which will be available at least ten days before April 25, 2002, to determine the day on which this item will be considered.

This facility is accessible to persons with disabilities. If accommodation is needed, please contact the Clerk of the Board at (916) 322-5594, or TDD (916) 324-9531 or (800) 700-8326 for TDD calls from outside the Sacramento area by April 1, 2002, to ensure accommodation.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected: Proposed adoption of title 13, California Code of Regulations (CCR) section 1968.2 to supersede the general OBD II requirements as set forth in title 13, CCR section 1968.1 for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines; and proposed adoption of title 13, CCR section 1968.5 to supersede the general enforcement procedures as set forth in title 13, CCR sections 2100-2149, as they apply to OBD II-related enforcement, and section 1968.1(i) for 2004 and subsequent model year model year passenger cars, light-duty trucks, and medium-duty vehicles and engines.

Documents Incorporated by Reference:

International Standards Organization[1] (ISO) 9141-2, "Road vehicles – Diagnostic Systems – CARB Requirements for Interchange of Digital Information," February, 1994.

ISO 14230-4, "Road vehicles – Diagnostic systems – KWP 2000 requirements for Emission-related systems," June, 2000.

ISO 15765-4, "Road Vehicles – Diagnostics on Controller Area Network (CAN) – Part 4: Requirements for emission-related systems," December, 2001.

ISO 15031-5, "Road Vehicles – Communication between vehicle and external test equipment for emission-related diagnostics – Part 5: Emission-related diagnostic services," December, 2001.

Society of Automotive Engineers[2] (SAE) Recommended Practice J1850, "Class B Data Communication Network Interface," May, 2001.

SAE Recommended Practice J1930, "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms," May, 1998.

SAE Recommended Practice J1962, "Diagnostic Connector," February, 1998.

SAE Recommended Practice J1978, "OBD II Scan Tool," February, 1998.

SAE Recommended Practice J1979, "E/E Diagnostic Test Modes," September, 1997.

SAE Recommended Practice J2012, "Recommended Practice for Diagnostic Trouble Code Definitions," March, 1999.

Speed Versus Time Data for California's Unified Driving Cycle, December 12, 1996.

Air Resources Board (ARB) Manufacturers Advisory Correspondence (MAC) No. 99-06, "Certification of Direct Ozone Reduction Technologies," December 20, 1999.

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[1] Copies of ISO documents are available through ISO by mail at Copyright Manager, ISO Central Secretariat, 1 rue de Varembe, 1211 Geneva 20 Switzerland; by phone at +41 22 749 0111; by fax at +41 22 734 1079; or by e-mail at iso@iso.ch.

[2] Copies of SAE documents are available through SAE by mail at SAE Customer Sales and Support, 400 Commonwealth Drive, Warrendale, PA 15096-0001, U.S.A.; by phone at 724-776-4970; by fax at 724-776-0790; by e-mail at publications@sae.org; or by website at http://www.sae.org.

ARB Mail-Out #95-20, "Guidelines for Compliance with On-Board Diagnostics II (OBD II) Requirements", May 22, 1995.

Background: Section 1968.1 was originally adopted by the Board on September 12, 1989, requiring manufacturers to implement second generation on-board diagnostic systems on new motor vehicles. The regulation was first implemented beginning with the 1994 model year, and requires that essentially all new 1996 and later model year passenger cars, light-duty trucks, and medium-duty vehicles and engines be equipped with OBD II systems. The section specifically requires monitoring of engine misfire, catalysts, oxygen sensors, evaporative systems, exhaust gas recirculation (EGR), secondary air systems, fuel systems, and all electronic powertrain components that can affect emissions when malfunctioning. The regulations also require OBD II systems to provide specific diagnostic information in a standardized format through a standardized serial data link on-board the vehicles.

In 1989, when initially adopting section 1968.1, the Board directed the staff to provide an update within two years on the progress of manufacturers in designing and implementing monitoring systems to meet the OBD II requirements. It further directed the staff to propose any modifications to the regulations that were deemed necessary based on industry progress to date. On September 12, 1991, the staff reported to the Board and proposed a number of modifications to address manufacturers' implementation concerns, to clarify misunderstood regulatory language, and to enhance the effectiveness of the requirements in some areas. The Board considered further amendments to the OBD II regulations on July 9, 1993, in response to a Petition from Ford Motor Company. At the Hearing, the Board adopted amendments to provide limited compliance relief to manufacturers that attempt in good faith to meet the requirements in full but are unable to certify a fully compliant system.

Another update on manufacturers' progress towards meeting the OBD II requirements was held on December 8, 1994. Again, the Board adopted modifications to the regulations to address manufacturers' implementation concerns, strengthen specific monitoring requirements, and clarify regulatory language. The Board last adopted amendments to the regulations on December 12, 1996, to improve and clarify the monitoring requirements where needed, to add new monitoring requirements, to improve the availability of service information, and to address some issues associated with the implementation of OBD II into Inspection and Maintenance (I/M) programs. By this time, manufacturers and ARB staff had gained considerable experience with OBD II systems, which had, in the great majority of instances, been working reliably in-use to detect emission-related malfunctions.

In addition, at the time that the OBD II regulation was initially adopted, the ARB envisioned that the regulation would be enforced under the general enforcement procedures set forth in title 13, CCR sections 2100-2149, with reference to the provisions of section 1968.1(i). Manufacturers have been on notice since the initial adoption of the OBD requirements that the ARB staff would enforce OBD II regulation after its effective date, and that appropriate remedies, including recall, would be ordered for noncompliance.

Staff Proposal: Since the Board last adopted amendments to the regulation in 1996, staff and manufacturers have identified areas in which modifications to section 1968.1 would provide for improved monitoring system performance. Thus, the staff is proposing the adoption of section 1968.2 to supersede section 1968.1 for 2004 and subsequent model year model year passenger cars, light-duty trucks, and medium-duty vehicles and engines. While most of the monitoring requirements in section 1968.1 are being carried over into section 1968.2, the proposed regulation reflects substantial editing and reorganization to provide improved clarity. The proposed regulation also includes new requirements that apply explicitly to 2004 and subsequent model year vehicles as well as reflects the increased use of certain new or existing emission control technologies. These proposed requirements would further increase the effectiveness of OBD II systems in detecting emission-related malfunctions. Among the provisions being proposed are:

- Catalyst system monitoring of oxides of nitrogen (NOx) conversion efficiency in addition to the current requirement for hydrocarbon (HC) conversion efficiency (section 1968.2(e)(1)).
- Revisions to the misfire monitoring requirements to clarify when manufacturers are allowed to disable misfire monitoring (section 1968.2(e)(3)).
- Revisions to the evaporative system monitoring requirements to allow greater flexibility for manufacturers in detecting larger sized leaks (section 1968.2)(e)(4)).
- Revisions to require secondary air system monitoring for proper airflow during vehicle warm-up (section 1968.2(e)(5)).
- Continuous monitoring for oxygen sensor circuit faults (section 1968.2(e)(7)).
- Increased frequency of rationality monitoring for input comprehensive components (section (e)(16)).
- Expansion of monitoring requirements to include emission sources, such as fuel-fired passenger compartment heaters and on-board reformers (section (e)(17)).
- Specific monitoring requirements for Variable Valve Timing (VVT) systems (section 1968.2(e)(13)), cold start emission reduction strategies (section 1968.2(e)(11)), air conditioning system components (section (e)(12)), and direct ozone reduction systems (section 1968.2(e)(14)).
- New monitoring requirements for diesel vehicles to address emissions resulting from catalyst system malfunctions (section 1968.2(e)(1.5)) and particulate matter trap malfunctions (section 1968.2(e)(15)).
- Allowance for SULEV applications to use a malfunction criterion of 2.5 times, instead of 1.5 times, the applicable FTP standards wherever the latter criterion is required in section 1968.2(e) (section 1968.2(e)(18)).
- A standardized methodology for determining the frequency of monitor operation during in-use driving and a minimum operating frequency for most non-continuous monitors (section 1968.2(d)(3.2)).

- Requirements to improve the availability of diagnostic information to repair technicians to assist them in effectively diagnosing and repairing vehicles (section 1968.2(f)).
- Modifications to existing standardization requirements to assist the implementation of OBD II into the I/M program (section 1968.2)(f)).
- New requirements for post-assembly line testing of production vehicles to verify compliance with the requirements of section 1968.2 (section 1968.2(j)).
- Other minor clarifications to improve the regulation.

Finally, after more than eight years of experience in implementing and enforcing OBD II requirements, the staff is proposing the adoption of section 1968.5, which details in-use enforcement provisions that apply specifically to OBD II systems that conform to the proposed OBD II regulation, section 1968.2. More specifically, section 1968.5 would supersede the general enforcement procedures as set forth in title 13, CCR sections 2100-2149, as they apply to OBD II-related enforcement, and section 1968.1(i) for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines. The proposed enforcement provisions would better address and identify the special circumstances involved in in-use testing and the issuing and implementing of remedial orders to correct any identified deficiencies that are unique to OBD II systems.

To address these objectives, the staff is proposing detailed procedures for in-use enforcement testing of OBD II systems installed on 2004 and subsequent model year vehicles. In addition, the proposal sets forth procedures that would be followed by the ARB if, after such testing, OBD II systems of a tested vehicle group were found to be nonconforming. Among other things, the procedures would authorize the ARB to take remedial action, which may include recall of vehicles in which the nonconforming systems are installed and assessment of monetary penalties against the affected manufacturer. Finally, staff is proposing a specific protocol to be followed by the Executive Officer and affected manufacturers in implementing remedial action plans.

Comparable Federal Regulations: In February 1993, the United States Environmental Protection Agency (U.S. EPA) promulgated final on-board diagnostic requirements for federally certified vehicles. (40 CFR Part 86, sections 86.094-2, 86.094-17, 86.094-18(a), 86.094-21(h), 86.094-25(d), 86.094-30(f), 86.094-35(l), 86.095-30(f), 86.095-35(l); see 58 Fed.Reg. 9468-9488 (February 19, 1993).) The requirements were last modified with a final rule published on December 22, 1998 (63 Fed.Reg. 70681-70697). A central part of the federal regulation is that, for purposes of federal certification of vehicles, the U.S. EPA will deem California-certified OBD II systems to comply with the federal regulations.

On October 3, 1996, the U.S. EPA formally granted California's request for a waiver regarding the OBD II regulation, as last amended in December 1994,[3] recognizing that the OBD II regulation is at least as stringent in protecting public health and welfare as

[3] *California State Motor Vehicle Pollution Control Standards; Waiver of Federal Preemption; Decision,* dated October 3, 1996, 61 Fed.Reg. 53371-53372.

the federal regulation, and that unique circumstances exist in California necessitating the need for the state's own motor vehicle regulations program.

The federal OBD requirements are comparable in concept and purpose with California's OBD II regulation; however, differences exist with respect to the scope and stringency of the requirements of the two regulations. More specifically, California's current OBD II regulations are generally more stringent than the comparable federal requirements. Under OBD II requirements, manufacturers must implement monitoring strategies for essentially all emission control systems and emission-related components, as mentioned in the above summary. Generally, the OBD II regulation requires that components be monitored to indicate malfunctions when component deterioration or failure causes emissions to exceed 1.5 times the applicable tailpipe emission standards of the certified vehicle. However, the regulation also requires that components be monitored for functional performance if the failure of such components does not cause emissions to exceed the 1.5 times the standards threshold.

The federal requirements, in contrast, require monitoring of the catalyst, engine misfire, evaporative emission control system, and oxygen sensors. Other emission control systems or components, such as EGR and secondary air systems, need only be monitored if by malfunctioning, vehicle emissions exceed 1.5 times the applicable tailpipe standards. This also applies to after-treatment devices on diesel applications, such as catalyst systems and particulate matter traps.

With the proposed adoption of section 1968.2, ARB staff is proposing that OBD II be applied to the next generation of low emission vehicles, and thus, in general, would be going even further in making the OBD II regulations more stringent relative to federal requirements. For example, the proposed OBD II regulations would require catalyst system monitoring of NOx conversion efficiency, which federal regulations do not require.

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determinations of the Executive Officer concerning the costs or savings necessarily incurred in reasonable compliance with the proposed regulations are presented below.

Pursuant to Government Code section 11346.5(a)(5), the Executive Officer has determined that the proposed regulations will not impose a mandate on local agencies or school districts. The Executive Officer has further determined pursuant to Government Code section 11346.5(a)(6) that the proposed regulations will result in some additional costs to the Air Resources Board but not to other state agencies. In addition, the Executive Officer has also determined pursuant to Government Code section 11346.5(a)(6) that the proposed regulatory action will not create a cost to any local agency or school district that is required to be reimbursed under Part 7 (commencing with section 17500) of Division 4 of the Government Code or other nondiscretionary costs or savings imposed on local agencies. The Executive Officer further determined that the proposed regulations will not result in costs or savings in federal funding to the state.

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on certain private persons and businesses. The Executive Officer has made an initial determination that the adoption of this regulation may have a significant adverse economic impact on businesses, including the ability of California businesses to compete with business in other states. The Executive Officer has considered proposed alternatives that would lessen any adverse economic impact on business and invites you to submit proposals. Submissions may include the following considerations:

(i) The establishment of differing compliance or reporting requirements or timetables that take into account the resources available to businesses.
(ii) Consolidation or simplification of compliance and reporting requirements for businesses.
(iii) The use of performance standards rather than prescriptive standards.
(iv) Exemption or partial exemption from the regulatory requirements for businesses.

The businesses to which the proposed requirements are primarily addressed and for which compliance would be required are manufacturers of California motor vehicles. There are presently 34 domestic and foreign corporations that manufacture California-certified passenger cars, light-duty trucks, and medium-duty gasoline and diesel fueled vehicles that are equipped with OBD II systems. Only one motor vehicle manufacturing plant (NUMMI) is located in California.

For motor vehicle manufacturers to comply with the proposed regulatory action, the costs are expected to be negligible. The proposed revisions consist primarily of modifications to existing computer software and additional verification testing. Since manufacturers would be provided sufficient leadtime to incorporate the proposed changes when redesigning vehicles to comply with the Low Emission Vehicle II (LEV II) program requirements, incorporation and verification of the revised OBD II software would be accomplished during the regular design process at no additional cost. As a result, costs to manufacturers, and therefore consumers, is anticipated to remain virtually unchanged. Similarly, because manufacturers are fully expected, and required, to comply with the regulations, enforcement costs to manufacturers should also be negligible.

Also affected would be businesses licensed by the Bureau of Automotive Repair as I/M facilities that perform in-use smog check tests using OBD II systems. The proposed regulatory action is expected to result in some increased costs to licensed I/M service stations. The proposed regulatory action would allow for the implementation of a new OBD II communication protocol called CAN (Controller Area Network) on vehicles, which provides more reliable, rapid and less expensive communication between the various electronic systems on vehicles. To accommodate CAN, however, each I/M station would need to upgrade existing equipment at a one-time cost of about $500.

The total cost would be approximately $5 million for all of the 10,000 I/M stations in California. Use of the CAN protocol would enhance information available to repair technicians, thereby leading to improved and less expensive repairs which would generate savings for consumers.

Consistent with this, in developing this regulatory proposal, the ARB staff has found that the proposed regulation will pose no adverse economic impact on private persons and businesses as consumers. The Executive Officer has determined that there will be no, or negligible, potential cost impact on representative private persons or businesses as a result of the proposed regulatory action. The proposed requirements are not expected to increase the rate or the cost of vehicle repairs, so no cost impact on consumers is expected. The proposed requirements would provide improved OBD II information and encourage manufacturers to build more durable vehicles, which may result in savings for consumers.

As set forth above with respect to the additional cost to I/M facilities, the Executive Officer has determined that the proposed requirements will affect small businesses.

In accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed regulatory action should have minor or no impact on the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within California, or the expansion of businesses currently doing business within California.

The proposed regulatory action would continue to require motor vehicle manufacturers to file written reports as is presently required in title 13, CCR section 1968.1. Although the proposed regulation would add several new reporting requirements not present in section 1968.1, such as the requirement to verify production vehicle performance, the requirements should have a negligible impact on vehicle costs. Moreover, the proposed regulation provides motor vehicle manufacturers with greater flexibility in filing certification documents, which should result in savings to the manufacturers. The Executive Officer has determined, pursuant to Government Code section 11346.3(c) and 11346.5(a)(11), that the reporting requirements that apply to the motor vehicle manufacturers are necessary for the health, safety, or welfare of the people of the state. A detailed assessment of the economic impacts of the proposed regulatory action can be found in the Staff Report.

Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the agency or that has been otherwise identified and brought to the attention of the agency would be more effective in carrying out the purpose for which the action is proposed, or would be as effective and less burdensome to affected private persons than the proposed action.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The ARB staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action that includes a summary of the environmental and economic impacts of the proposal, and supporting technical documentation.

Copies of the ISOR and the full text of the proposed regulatory language may be obtained from the ARB's Public Information Office, Environmental Services Center, 1001 "I" Street, First Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing (April 25, 2002).

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the web site listed below.

Inquiries concerning the substance of the proposed regulation should be directed to the agency contact persons for this rulemaking: Mike Regenfuss, Staff Air Pollution Specialist, at (626) 575-7004 or e-mail (mregenfu@arb.ca.gov), or Mike McCarthy, Manager, Advanced Engineering Section, Mobile Source Control Division, at (626) 575-6615 or e-mail (mmccarth@arb.ca.gov).

Further, the agency representative and designated back-up contact persons to whom non-substantive inquiries concerning the proposed administrative action may be directed are Artavia Edwards, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-6070, or Marie Kavan, Regulations Coordinator, (916) 322-6533. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the agency contact persons.

If you are a person with a disability and desire to obtain this document in an alternative format, please contact the Air Resources Board's ADA Coordinator at (916) 323-4916, or TDD (916) 324-9531, or (800) 700-8326 for TDD calls from outside the Sacramento area.

This notice, the ISOR, and subsequent regulatory documents, including the FSOR once it has been prepared pursuant to Government Code section 11346.9(a), will also be available on the ARB internet site for this rulemaking at: http://www.arb.ca.gov/regact/obd02/obd02.htm.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the hearing, and in writing or by e-mail before the hearing. To be considered by the Board, written submissions must be received by no later than 12:00 noon, April 24, 2002 and addressed to the following:

Postal Mail is to be sent to:

Clerk of the Board
Air Resources Board
1001 "I" Street, 23rd Floor
Sacramento, California 95814

Electronic mail is to be sent to: obdii@listserv.arb.ca.gov and received at the ARB no later than 12:00 noon, April 24, 2002.

Facsimile submissions are to be transmitted to the Clerk of the Board at (916) 322-3928 and received at the ARB no later than 12:00 noon, April 24, 2002.

The Board requests, but does not require, that 30 copies of any written submission and that all written statements be filed at least 10 days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The ARB encourages members of the public to bring to the attention of the staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under that authority granted in sections 39600, 39601, 43000.5, 43013, 43016, 43018, 43100, 43101, 43104, 43105, 43105.5, 43106, 43154, 43211, and 43212 of the Health and Safety Code. This action is proposed to implement, interpret and make specific sections 39002, 39003, 39010-39060, 39515, 39600-39601, 43000, 43000.5, 43004, 43006, 43013, 43016, 43018, 43100, 43101, 43102, 43104, 43105, 43105.5, 43106, 43150-43156, 43204, 43211, and 43212 of the Health and Safety Code.

HEARING PROCEDURES AND AVAILIBILITY OF MODIFIED TEXT

The public hearing will be conducted in accordance with the California Administrative Procedure Act, Title 2, Division 3, Part 1, Chapter 3.5 (commencing with section 11340) of the Government Code.

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CALIFORNIA AIR RESOURCES BOARD

Michael P. Kenny
Executive Officer

Date: February 26, 2001

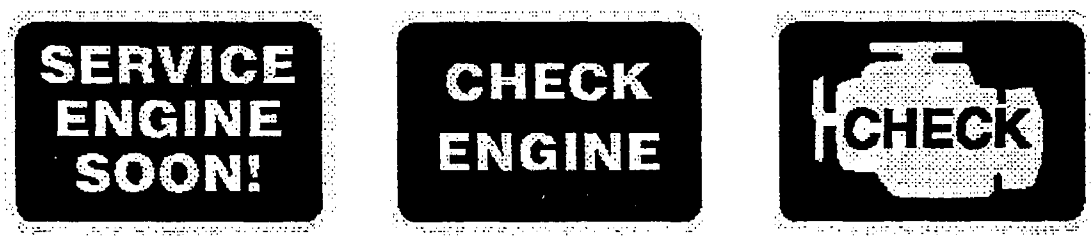
The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs see our Web –site at www.arb.ca.gov.

State of California
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Technical Status and Revisions to Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II)

Date of Release:	March 8, 2002
Scheduled for Consideration:	April 25, 2002



Title 13. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER TECHNICAL STATUS AND PROPOSED REVISIONS TO MALFUNCTION AND DIAGNOSTIC SYSTEM REQUIREMENTS AND ASSOCIATED ENFORCEMENT PROVISIONS FOR 2004 AND SUBSEQUENT MODEL YEAR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES AND ENGINES (OBD II)

The Air Resources Board (the "Board" or "ARB") will conduct a public hearing at the time and place noted below to review the technical status and implementation of California's OBD II requirements. The Board will consider amendments to the OBD II regulation to update the regulation to account for newer emission control technologies and lower tailpipe standards, to increase the amount of standardized data available to repair technicians and Inspection and Maintenance (I/M) inspectors, to clarify the regulation where necessary, to adopt more specific enforcement provisions, and to improve the effectiveness of the regulation for future model year vehicles.

DATE: April 25, 2002

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
1001 "I" Street
Auditorium, Second Floor
Sacramento, Ca 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., April 25, 2002, and may continue at 8:30 a.m., April 26, 2002. This item might not be considered until April 26, 2002. Please consult the agenda for the meeting, which will be available at least ten days before April 25, 2002, to determine the day on which this item will be considered.

This facility is accessible to persons with disabilities. If accommodation is needed, please contact the Clerk of the Board at (916) 322-5594, or TDD (916) 324-9531 or (800) 700-8326 for TDD calls from outside the Sacramento area by April 1, 2002, to ensure accommodation.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected: Proposed adoption of title 13, California Code of Regulations (CCR) section 1968.2 to supersede the general OBD II requirements as set forth in title 13, CCR section 1968.1 for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines; and proposed adoption of title 13, CCR section 1968.5 to supersede the general enforcement procedures as set forth in title 13, CCR sections 2100-2149, as they apply to OBD II-related enforcement, and section 1968.1(i) for 2004 and subsequent model year model year passenger cars, light-duty trucks, and medium-duty vehicles and engines.

Documents Incorporated by Reference:

International Standards Organization[1] (ISO) 9141-2, "Road vehicles – Diagnostic Systems – CARB Requirements for Interchange of Digital Information," February, 1994.

ISO 14230-4, "Road vehicles – Diagnostic systems – KWP 2000 requirements for Emission-related systems," June, 2000.

ISO 15765-4, "Road Vehicles – Diagnostics on Controller Area Network (CAN) – Part 4: Requirements for emission-related systems," December, 2001.

ISO 15031-5, "Road Vehicles – Communication between vehicle and external test equipment for emission-related diagnostics – Part 5: Emission-related diagnostic services," December, 2001.

Society of Automotive Engineers[2] (SAE) Recommended Practice J1850, "Class B Data Communication Network Interface," May, 2001.

SAE Recommended Practice J1930, "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms," May, 1998.

SAE Recommended Practice J1962, "Diagnostic Connector," February, 1998.

SAE Recommended Practice J1978, "OBD II Scan Tool," February, 1998.

SAE Recommended Practice J1979, "E/E Diagnostic Test Modes," September, 1997.

SAE Recommended Practice J2012, "Recommended Practice for Diagnostic Trouble Code Definitions," March, 1999.

Speed Versus Time Data for California's Unified Driving Cycle, December 12, 1996.

Air Resources Board (ARB) Manufacturers Advisory Correspondence (MAC) No. 99-06, "Certification of Direct Ozone Reduction Technologies," December 20, 1999.

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[1] Copies of ISO documents are available through ISO by mail at Copyright Manager, ISO Central Secretariat, 1 rue de Varembe, 1211 Geneva 20 Switzerland; by phone at +41 22 749 0111; by fax at +41 22 734 1079; or by e-mail at iso@iso.ch.

[2] Copies of SAE documents are available through SAE by mail at SAE Customer Sales and Support, 400 Commonwealth Drive, Warrendale, PA 15096-0001, U.S.A.; by phone at 724-776-4970; by fax at 724-776-0790; by e-mail at publications@sae.org; or by website at http://www.sae.org.

ARB Mail-Out #95-20, "Guidelines for Compliance with On-Board Diagnostics II (OBD II) Requirements", May 22, 1995.

Background: Section 1968.1 was originally adopted by the Board on September 12, 1989, requiring manufacturers to implement second generation on-board diagnostic systems on new motor vehicles. The regulation was first implemented beginning with the 1994 model year, and requires that essentially all new 1996 and later model year passenger cars, light-duty trucks, and medium-duty vehicles and engines be equipped with OBD II systems. The section specifically requires monitoring of engine misfire, catalysts, oxygen sensors, evaporative systems, exhaust gas recirculation (EGR), secondary air systems, fuel systems, and all electronic powertrain components that can affect emissions when malfunctioning. The regulations also require OBD II systems to provide specific diagnostic information in a standardized format through a standardized serial data link on-board the vehicles.

In 1989, when initially adopting section 1968.1, the Board directed the staff to provide an update within two years on the progress of manufacturers in designing and implementing monitoring systems to meet the OBD II requirements. It further directed the staff to propose any modifications to the regulations that were deemed necessary based on industry progress to date. On September 12, 1991, the staff reported to the Board and proposed a number of modifications to address manufacturers' implementation concerns, to clarify misunderstood regulatory language, and to enhance the effectiveness of the requirements in some areas. The Board considered further amendments to the OBD II regulations on July 9, 1993, in response to a Petition from Ford Motor Company. At the Hearing, the Board adopted amendments to provide limited compliance relief to manufacturers that attempt in good faith to meet the requirements in full but are unable to certify a fully compliant system.

Another update on manufacturers' progress towards meeting the OBD II requirements was held on December 8, 1994. Again, the Board adopted modifications to the regulations to address manufacturers' implementation concerns, strengthen specific monitoring requirements, and clarify regulatory language. The Board last adopted amendments to the regulations on December 12, 1996, to improve and clarify the monitoring requirements where needed, to add new monitoring requirements, to improve the availability of service information, and to address some issues associated with the implementation of OBD II into Inspection and Maintenance (I/M) programs. By this time, manufacturers and ARB staff had gained considerable experience with OBD II systems, which had, in the great majority of instances, been working reliably in-use to detect emission-related malfunctions.

In addition, at the time that the OBD II regulation was initially adopted, the ARB envisioned that the regulation would be enforced under the general enforcement procedures set forth in title 13, CCR sections 2100-2149, with reference to the provisions of section 1968.1(i). Manufacturers have been on notice since the initial adoption of the OBD requirements that the ARB staff would enforce OBD II regulation after its effective date, and that appropriate remedies, including recall, would be ordered for noncompliance.

Staff Proposal: Since the Board last adopted amendments to the regulation in 1996, staff and manufacturers have identified areas in which modifications to section 1968.1 would provide for improved monitoring system performance. Thus, the staff is proposing the adoption of section 1968.2 to supersede section 1968.1 for 2004 and subsequent model year model year passenger cars, light-duty trucks, and medium-duty vehicles and engines. While most of the monitoring requirements in section 1968.1 are being carried over into section 1968.2, the proposed regulation reflects substantial editing and reorganization to provide improved clarity. The proposed regulation also includes new requirements that apply explicitly to 2004 and subsequent model year vehicles as well as reflects the increased use of certain new or existing emission control technologies. These proposed requirements would further increase the effectiveness of OBD II systems in detecting emission-related malfunctions. Among the provisions being proposed are:

- Catalyst system monitoring of oxides of nitrogen (NOx) conversion efficiency in addition to the current requirement for hydrocarbon (HC) conversion efficiency (section 1968.2(e)(1)).
- Revisions to the misfire monitoring requirements to clarify when manufacturers are allowed to disable misfire monitoring (section 1968.2(e)(3)).
- Revisions to the evaporative system monitoring requirements to allow greater flexibility for manufacturers in detecting larger sized leaks (section 1968.2)(e)(4)).
- Revisions to require secondary air system monitoring for proper airflow during vehicle warm-up (section 1968.2(e)(5)).
- Continuous monitoring for oxygen sensor circuit faults (section 1968.2(e)(7)).
- Increased frequency of rationality monitoring for input comprehensive components (section (e)(16)).
- Expansion of monitoring requirements to include emission sources, such as fuel-fired passenger compartment heaters and on-board reformers (section (e)(17)).
- Specific monitoring requirements for Variable Valve Timing (VVT) systems (section 1968.2(e)(13)), cold start emission reduction strategies (section 1968.2(e)(11)), air conditioning system components (section (e)(12)), and direct ozone reduction systems (section 1968.2(e)(14)).
- New monitoring requirements for diesel vehicles to address emissions resulting from catalyst system malfunctions (section 1968.2(e)(1.5)) and particulate matter trap malfunctions (section 1968.2(e)(15)).
- Allowance for SULEV applications to use a malfunction criterion of 2.5 times, instead of 1.5 times, the applicable FTP standards wherever the latter criterion is required in section 1968.2(e) (section 1968.2(e)(18)).
- A standardized methodology for determining the frequency of monitor operation during in-use driving and a minimum operating frequency for most non-continuous monitors (section 1968.2(d)(3.2)).

- Requirements to improve the availability of diagnostic information to repair technicians to assist them in effectively diagnosing and repairing vehicles (section 1968.2(f)).
- Modifications to existing standardization requirements to assist the implementation of OBD II into the I/M program (section 1968.2)(f)).
- New requirements for post-assembly line testing of production vehicles to verify compliance with the requirements of section 1968.2 (section 1968.2(j)).
- Other minor clarifications to improve the regulation.

Finally, after more than eight years of experience in implementing and enforcing OBD II requirements, the staff is proposing the adoption of section 1968.5, which details in-use enforcement provisions that apply specifically to OBD II systems that conform to the proposed OBD II regulation, section 1968.2. More specifically, section 1968.5 would supersede the general enforcement procedures as set forth in title 13, CCR sections 2100-2149, as they apply to OBD II-related enforcement, and section 1968.1(i) for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines. The proposed enforcement provisions would better address and identify the special circumstances involved in in-use testing and the issuing and implementing of remedial orders to correct any identified deficiencies that are unique to OBD II systems.

To address these objectives, the staff is proposing detailed procedures for in-use enforcement testing of OBD II systems installed on 2004 and subsequent model year vehicles. In addition, the proposal sets forth procedures that would be followed by the ARB if, after such testing, OBD II systems of a tested vehicle group were found to be nonconforming. Among other things, the procedures would authorize the ARB to take remedial action, which may include recall of vehicles in which the nonconforming systems are installed and assessment of monetary penalties against the affected manufacturer. Finally, staff is proposing a specific protocol to be followed by the Executive Officer and affected manufacturers in implementing remedial action plans.

Comparable Federal Regulations: In February 1993, the United States Environmental Protection Agency (U.S. EPA) promulgated final on-board diagnostic requirements for federally certified vehicles. (40 CFR Part 86, sections 86.094-2, 86.094-17, 86.094-18(a), 86.094-21(h), 86.094-25(d), 86.094-30(f), 86.094-35(l), 86.095-30(f), 86.095-35(l); see 58 Fed.Reg. 9468-9488 (February 19, 1993).) The requirements were last modified with a final rule published on December 22, 1998 (63 Fed.Reg. 70681-70697). A central part of the federal regulation is that, for purposes of federal certification of vehicles, the U.S. EPA will deem California-certified OBD II systems to comply with the federal regulations.

On October 3, 1996, the U.S. EPA formally granted California's request for a waiver regarding the OBD II regulation, as last amended in December 1994,[3] recognizing that the OBD II regulation is at least as stringent in protecting public health and welfare as

[3] *California State Motor Vehicle Pollution Control Standards; Waiver of Federal Preemption; Decision,* dated October 3, 1996, 61 Fed.Reg. 53371-53372.

the federal regulation, and that unique circumstances exist in California necessitating the need for the state's own motor vehicle regulations program.

The federal OBD requirements are comparable in concept and purpose with California's OBD II regulation; however, differences exist with respect to the scope and stringency of the requirements of the two regulations. More specifically, California's current OBD II regulations are generally more stringent than the comparable federal requirements. Under OBD II requirements, manufacturers must implement monitoring strategies for essentially all emission control systems and emission-related components, as mentioned in the above summary. Generally, the OBD II regulation requires that components be monitored to indicate malfunctions when component deterioration or failure causes emissions to exceed 1.5 times the applicable tailpipe emission standards of the certified vehicle. However, the regulation also requires that components be monitored for functional performance if the failure of such components does not cause emissions to exceed the 1.5 times the standards threshold.

The federal requirements, in contrast, require monitoring of the catalyst, engine misfire, evaporative emission control system, and oxygen sensors. Other emission control systems or components, such as EGR and secondary air systems, need only be monitored if by malfunctioning, vehicle emissions exceed 1.5 times the applicable tailpipe standards. This also applies to after-treatment devices on diesel applications, such as catalyst systems and particulate matter traps.

With the proposed adoption of section 1968.2, ARB staff is proposing that OBD II be applied to the next generation of low emission vehicles, and thus, in general, would be going even further in making the OBD II regulations more stringent relative to federal requirements. For example, the proposed OBD II regulations would require catalyst system monitoring of NOx conversion efficiency, which federal regulations do not require.

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determinations of the Executive Officer concerning the costs or savings necessarily incurred in reasonable compliance with the proposed regulations are presented below.

Pursuant to Government Code section 11346.5(a)(5), the Executive Officer has determined that the proposed regulations will not impose a mandate on local agencies or school districts. The Executive Officer has further determined pursuant to Government Code section 11346.5(a)(6) that the proposed regulations will result in some additional costs to the Air Resources Board but not to other state agencies. In addition, the Executive Officer has also determined pursuant to Government Code section 11346.5(a)(6) that the proposed regulatory action will not create a cost to any local agency or school district that is required to be reimbursed under Part 7 (commencing with section 17500) of Division 4 of the Government Code or other nondiscretionary costs or savings imposed on local agencies. The Executive Officer further determined that the proposed regulations will not result in costs or savings in federal funding to the state.

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on certain private persons and businesses. The Executive Officer has made an initial determination that the adoption of this regulation may have a significant adverse economic impact on businesses, including the ability of California businesses to compete with business in other states. The Executive Officer has considered proposed alternatives that would lessen any adverse economic impact on business and invites you to submit proposals. Submissions may include the following considerations:

(i) The establishment of differing compliance or reporting requirements or timetables that take into account the resources available to businesses.
(ii) Consolidation or simplification of compliance and reporting requirements for businesses.
(iii) The use of performance standards rather than prescriptive standards.
(iv) Exemption or partial exemption from the regulatory requirements for businesses.

The businesses to which the proposed requirements are primarily addressed and for which compliance would be required are manufacturers of California motor vehicles. There are presently 34 domestic and foreign corporations that manufacture California-certified passenger cars, light-duty trucks, and medium-duty gasoline and diesel fueled vehicles that are equipped with OBD II systems. Only one motor vehicle manufacturing plant (NUMMI) is located in California.

For motor vehicle manufacturers to comply with the proposed regulatory action, the costs are expected to be negligible. The proposed revisions consist primarily of modifications to existing computer software and additional verification testing. Since manufacturers would be provided sufficient leadtime to incorporate the proposed changes when redesigning vehicles to comply with the Low Emission Vehicle II (LEV II) program requirements, incorporation and verification of the revised OBD II software would be accomplished during the regular design process at no additional cost. As a result, costs to manufacturers, and therefore consumers, is anticipated to remain virtually unchanged. Similarly, because manufacturers are fully expected, and required, to comply with the regulations, enforcement costs to manufacturers should also be negligible.

Also affected would be businesses licensed by the Bureau of Automotive Repair as I/M facilities that perform in-use smog check tests using OBD II systems. The proposed regulatory action is expected to result in some increased costs to licensed I/M service stations. The proposed regulatory action would allow for the implementation of a new OBD II communication protocol called CAN (Controller Area Network) on vehicles, which provides more reliable, rapid and less expensive communication between the various electronic systems on vehicles. To accommodate CAN, however, each I/M station would need to upgrade existing equipment at a one-time cost of about $500.

The total cost would be approximately $5 million for all of the 10,000 I/M stations in California. Use of the CAN protocol would enhance information available to repair technicians, thereby leading to improved and less expensive repairs which would generate savings for consumers.

Consistent with this, in developing this regulatory proposal, the ARB staff has found that the proposed regulation will pose no adverse economic impact on private persons and businesses as consumers. The Executive Officer has determined that there will be no, or negligible, potential cost impact on representative private persons or businesses as a result of the proposed regulatory action. The proposed requirements are not expected to increase the rate or the cost of vehicle repairs, so no cost impact on consumers is expected. The proposed requirements would provide improved OBD II information and encourage manufacturers to build more durable vehicles, which may result in savings for consumers.

As set forth above with respect to the additional cost to I/M facilities, the Executive Officer has determined that the proposed requirements will affect small businesses.

In accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed regulatory action should have minor or no impact on the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within California, or the expansion of businesses currently doing business within California.

The proposed regulatory action would continue to require motor vehicle manufacturers to file written reports as is presently required in title 13, CCR section 1968.1. Although the proposed regulation would add several new reporting requirements not present in section 1968.1, such as the requirement to verify production vehicle performance, the requirements should have a negligible impact on vehicle costs. Moreover, the proposed regulation provides motor vehicle manufacturers with greater flexibility in filing certification documents, which should result in savings to the manufacturers. The Executive Officer has determined, pursuant to Government Code section 11346.3(c) and 11346.5(a)(11), that the reporting requirements that apply to the motor vehicle manufacturers are necessary for the health, safety, or welfare of the people of the state. A detailed assessment of the economic impacts of the proposed regulatory action can be found in the Staff Report.

Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the agency or that has been otherwise identified and brought to the attention of the agency would be more effective in carrying out the purpose for which the action is proposed, or would be as effective and less burdensome to affected private persons than the proposed action.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The ARB staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action that includes a summary of the environmental and economic impacts of the proposal, and supporting technical documentation.

Copies of the ISOR and the full text of the proposed regulatory language may be obtained from the ARB's Public Information Office, Environmental Services Center, 1001 "I" Street, First Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing (April 25, 2002).

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the web site listed below.

Inquiries concerning the substance of the proposed regulation should be directed to the agency contact persons for this rulemaking: Mike Regenfuss, Staff Air Pollution Specialist, at (626) 575-7004 or e-mail (mregenfu@arb.ca.gov), or Mike McCarthy, Manager, Advanced Engineering Section, Mobile Source Control Division, at (626) 575-6615 or e-mail (mmccarth@arb.ca.gov).

Further, the agency representative and designated back-up contact persons to whom non-substantive inquiries concerning the proposed administrative action may be directed are Artavia Edwards, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-6070, or Marie Kavan, Regulations Coordinator, (916) 322-6533. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the agency contact persons.

If you are a person with a disability and desire to obtain this document in an alternative format, please contact the Air Resources Board's ADA Coordinator at (916) 323-4916, or TDD (916) 324-9531, or (800) 700-8326 for TDD calls from outside the Sacramento area.

This notice, the ISOR, and subsequent regulatory documents, including the FSOR once it has been prepared pursuant to Government Code section 11346.9(a), will also be available on the ARB internet site for this rulemaking at: http://www.arb.ca.gov/regact/obd02/obd02.htm.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the hearing, and in writing or by e-mail before the hearing. To be considered by the Board, written submissions must be received by no later than 12:00 noon, April 24, 2002 and addressed to the following:

Postal Mail is to be sent to:

Clerk of the Board
Air Resources Board
1001 "I" Street, 23rd Floor
Sacramento, California 95814

Electronic mail is to be sent to: obdii@listserv.arb.ca.gov and received at the ARB no later than 12:00 noon, April 24, 2002.

Facsimile submissions are to be transmitted to the Clerk of the Board at (916) 322-3928 and received at the ARB no later than 12:00 noon, April 24, 2002.

The Board requests, but does not require, that 30 copies of any written submission and that all written statements be filed at least 10 days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The ARB encourages members of the public to bring to the attention of the staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under that authority granted in sections 39600, 39601, 43000.5, 43013, 43016, 43018, 43100, 43101, 43104, 43105, 43105.5, 43106, 43154, 43211, and 43212 of the Health and Safety Code. This action is proposed to implement, interpret and make specific sections 39002, 39003, 39010-39060, 39515, 39600-39601, 43000, 43000.5, 43004, 43006, 43013, 43016, 43018, 43100, 43101, 43102, 43104, 43105, 43105.5, 43106, 43150-43156, 43204, 43211, and 43212 of the Health and Safety Code.

HEARING PROCEDURES AND AVAILIBILITY OF MODIFIED TEXT

The public hearing will be conducted in accordance with the California Administrative Procedure Act, Title 2, Division 3, Part 1, Chapter 3.5 (commencing with section 11340) of the Government Code.

Following the public hearing, the Board may adopt the regulatory language as originally proposed, or with nonsubstantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulatory language as modified could result from the proposed regulatory action; in such event the full regulatory text, with the modifications clearly indicated, will be made available to the public, for written comment, at least 15 days before it is adopted. The public may request a copy of the modified regulatory text from the Board's Public Information Office, 1001 "I" Street, Sacramento, CA 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

Michael P. Kenny
Executive Officer

Date: February 26, 2001

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Table of Contents

I. EXECUTIVE SUMMARY

On-board diagnostics II (OBD II) systems are comprised mainly of software designed into the vehicle's on-board computer to detect emission-control system malfunctions as they occur by monitoring virtually every component and system that can cause increases in emissions. When an emission-related malfunction is detected, the OBD II system alerts the vehicle owner by illuminating the malfunction indicator light (MIL) on the instrument panel. By alerting the owner of malfunctions as they occur, repairs can be sought promptly, which results in fewer emissions from the vehicle. Additionally, the OBD II system stores important information, including identifying the faulty component or system and the nature of the fault, which would allow for quick diagnosis and proper repair of the problem by technicians. This helps owners achieve less expensive repairs and promotes repairs done correctly the first time.

The current OBD II regulation, section 1968.1 of title 13, California Code of Regulations (CCR), was originally adopted in 1989 and required all 1996 and newer model year passenger cars, light-duty trucks, and medium-duty vehicles and engines to be equipped with OBD II systems. The Air Resources Board (ARB) subsequently adopted modifications to this regulation in regular updates to the Board in 1991, 1993, 1994, and 1996 to address manufacturers' implementation concerns, strengthen specific monitoring requirements, add new monitoring requirements, and clarify regulatory language, among other reasons.

Since 1996, the ARB staff has identified several areas in the current regulation in which modifications would provide for improved emission-control system monitoring in future model year vehicles and facilitate incorporation of OBD II systems in the Smog Check program. Due to the number of changes being proposed, the ARB staff has developed a separate set of OBD II requirements, section 1968.2, to supercede section 1968.1 for all 2004 and subsequent model year vehicles. (Proposed section 1968.2, title 13, California Code of Regulations is included herewith as Attachment A.) Some of the changes being proposed are to account for California's increasingly stringent tailpipe and evaporative emission standards, particularly the Low Emission Vehicle II standards. As new vehicles are being designed to meet these stringent standards, the OBD II system must be more capable of detecting smaller increases in emissions associated with the new standards. Although much of the current OBD II requirements of section 1968.1 are being carried over into 1968.2, the staff is proposing some new requirements in the proposed section as well that can be grouped into four categories, which are discussed below.

First, the proposed regulation would address issues regarding the existing requirements, specifically by updating or expanding current monitoring requirements. For example, for 2005 and subsequent model year vehicles, the ARB staff is proposing to include catalyst system monitoring for oxides of nitrogen (NOx) conversion efficiency in addition to the current requirement for monitoring hydrocarbon (HC) conversion efficiency. The ARB staff is also proposing revisions to require secondary air system monitoring for proper airflow during vehicle warm-up, when the system would normally operate, rather than during some other portion of the drive cycle for 2006 and subsequent model year vehicles. The staff is also proposing more frequent monitoring of many components to ensure better detection of intermittent faults and improve overall monitoring reliability. The OBD II regulation currently requires illuminating the MIL for some components when emissions exceed 1.5 times the emission standards. The staff is proposing to increase this threshold for Super Ultra Low Emission Vehicles (SULEVs) to 2.5 times the emission standards to ensure reliable monitoring at extremely low emission levels.

Second, the proposed regulation would include new monitoring requirements to account for new emission-control technologies and would generally be phased in starting with the 2005 or 2006 model year. These include variable valve timing and/or control systems, cold start emission reduction strategies, and direct ozone reduction systems. New monitoring requirements are also being proposed for diesel vehicles to address emissions resulting from catalyst system and particulate matter trap malfunctions, beginning with the 2004 model year.

Third, the staff is proposing requirements to improve the availability of diagnostic information to assist repair technicians in effectively diagnosing and repairing vehicles as well as to assist Inspection and Maintenance (I/M), or Smog Check, technicians. These include provisions that would restrict the area in which diagnostic connectors (where technicians can "plug in" to the on-board computer) may be located to allow technicians to find these connectors more easily and provisions that would require the OBD II system to store more specific fault codes that all technicians can interpret. The staff is also proposing the Vehicle Identification Number (VIN) be stored and made accessible via a generic scan tool on all 2005 and subsequent model year vehicles. This would help deter fraud during I/M inspections by preventing inspectors from falsely passing a "dirty" vehicle by performing testing on a "clean" vehicle. Additionally, the existence of several protocols for communication between a generic scan tool and a vehicle's on-board computer has resulted in communication problems in the field, such as the inability to retrieve vehicle data with a scan tool. To address the problems associated with multiple protocols, the staff is proposing that all 2008 and subsequent model year vehicles use only one protocol, a Controller Area Network (CAN) protocol. To ensure that vehicles are complying with the proposed requirements of section 1968.2, the staff is proposing new requirements that would require manufacturers to conduct post-assembly line testing of production vehicles.

Fourth, the staff is proposing requirements that would address OBD II-related enforcement issues and problems the ARB staff had previously encountered. In past enforcement cases, there were problems applying the current general enforcement procedures to vehicles with OBD II-related problems, largely because the current general enforcement requirements were originally established for tailpipe and evaporative emission standard exceedance issues. This has necessitated a separate enforcement regulation that deals specifically with OBD II-related issues. Therefore, the staff is proposing adoption of section 1968.5, which would supercede the current general enforcement procedures for 2004 and subsequent model year vehicles.

(Proposed section 1968.5, title 13, CCR is included herewith as Attachment B.) Proposed section 1968.5 would apply specifically to OBD II systems that conform to the proposed OBD II regulation, section 1968.2, and would better address and identify the special circumstances involved in in-use testing and the issuing and implementing of remedial orders to correct any problems that are unique to OBD II systems. This includes specific procedures the ARB would have to conduct in order to find a problematic OBD II system and to implement remedial action, which may involve recall of the vehicles of concern.

Along with the difficulties encountered in applying the general enforcement requirements to OBD II systems, a specific issue was identified regarding enforcement of monitoring frequency. In the past, the ARB had found vehicles with OBD II monitors that did not run as frequently as required. However, it has been difficult to determine whether monitoring frequency is adequate based solely on the written material and data manufacturers provided during certification. As such, the ARB staff is proposing the adoption of a standardized methodology for determining the frequency of OBD II monitor operation for most monitors during in-use driving and a minimum operating frequency that manufacturers are required to meet. To ensure that vehicles are able to meet these new requirements (i.e., that the vehicles are calculating and reporting the monitor frequency value and meeting the minimum frequency requirement in accordance with the proposed regulation), the staff is proposing that manufacturers conduct production vehicle testing to verify these specific requirements.

II. INTRODUCTION AND BACKGROUND INFORMATION

Introduction

With on-board diagnostics II (OBD II) systems required on all 1996 and newer cars, more than 70 million vehicles nationwide are currently equipped with these systems. Input from manufacturers, service technicians, pilot Inspection and Maintenance (I/M) programs, and in-use evaluation programs indicate that the program is very effective in finding emission problems and facilitating repairs. The United States Environmental Protection Agency (U.S. EPA), in fact, recently issued a final rule that indicates its confidence in the performance of OBD II systems by requiring states to perform OBD II checks for these newer cars and allowing them to be used in lieu of current tailpipe tests in I/M programs. Overall, the Air Resources Board (ARB) staff is pleased with the significant and effective efforts of the automotive industry in implementing the program requirements. The staff appreciates the many challenges that have been overcome in getting to this point, and pledges to continue working closely with industry in meeting the remaining issues as OBD II is revisited to account for new technologies and/or other issues resulting from adoption of the Low Emission Vehicle II program in November, 1998. While some new requirements are outlined below, most of the proposed regulation is aimed at refining the program, better serving repair technicians, and improving incorporation of OBD II into I/M programs. Additionally, some of the proposed requirements are in response to improperly designed OBD II systems discovered in the field by the staff and the enforcement work associated with pursuing corrective action of those systems. These enforcement actions have revealed a need for the ARB to strengthen and more clearly define appropriate certification and enforcement provisions.

The proposed requirements also reflect a substantial reorganization of the current requirements. As a result of having a regulation originally adopted in 1989 and subsequently modified in 1991, 1993, 1994, and 1996, the existing regulatory language and structure were due for updating. As such, the proposed requirements reflect a new structure that is more consistent with the structure used for other ARB regulations, and should be easier to read than previous versions. For example, in some instances, various but similar requirements that were previously scattered in different areas of the regulation have now been consolidated into a single section. In other instances, requirements covering vastly different subjects that were previously listed in a single section have been moved under more appropriate headings. While this reorganization is significant, the monitoring requirements have not changed very much. This staff report details the changes made to the existing requirements and the need for such changes.

What Problem is Addressed by OBD II Systems?

New vehicles are being designed to meet increasingly stringent exhaust and evaporative emission standards. When emission-related malfunctions occur, however, emissions can increase well beyond the standards the vehicle is intended to meet. One report estimates that approximately 40-50 percent of the total hydrocarbon and carbon monoxide emissions from fuel injected vehicles are a result of emission-related malfunctions.[1] Such malfunctions increasingly occur as vehicles age. Recent data show that the percentage of vehicles failing California's Inspection and Maintenance (I/M) program can range from about 0.6-0.9 percent for two to three-year-old vehicles, to about 10.6 percent for ten-year-old vehicles, to about 26.3 percent for 15-year-old vehicles.[2] The chances for emission-related malfunctions also increase as vehicles continue to show a trend of being driven longer and more often in California. For 2001, projections indicate that 60 percent of all light-duty passenger cars on the road in California will have accumulated more than 100,000 miles, 50 percent will have more than 125,000 miles, and 41 percent will have more than 150,000 miles.[3] This reflects a significant increase even from 1995 when only 44 percent of all light-duty passenger cars had accumulated more than 100,000 miles, 27 percent had more than 125,000 miles, and 17 percent had more than 150,000 miles.[4] Additionally, in 2001, 34 percent of all light-duty passenger car miles traveled will be by cars with more than 150,000

[1] Analysis of Causes of Failure in High Emitting Cars, American Petroleum Institute, Publication Number 4637, February 1996.

[2] Bureau of Automotive Repair: Smog Check, Executive Summary Report, January to December, 2000.

[3] Emission Factors 2000 (EMFAC2000), Version 2.02

[4] California's Motor Vehicle Emission Inventory (MVEI 7G), Version 1.0, September 27, 1996

miles on the odometer, an increase from only 10 percent in 1995. Taking into consideration that more cars are present in California in 2001 than in 1995, the increase in high-mileage vehicles and their miles traveled is substantial. Consequently, there is a significant need to ensure that emission control systems continue to operate effectively not only on relatively new vehicles, but especially on vehicles well beyond the first 100,000 miles. [5]

How Do OBD II Systems Help to Solve the Problem?

OBD II systems are designed into the vehicle's on-board computer to detect emission malfunctions as they occur by monitoring virtually every component and system that can cause emissions to increase significantly. With a couple of exceptions, no additional hardware is required to perform the monitoring; rather, the powertrain control computer is designed to better evaluate the electronic component signals that are already available, thereby minimizing any added complexity. By alerting the vehicle operator to the presence of a malfunction, the time between occurrence of the problem and necessary repairs is shortened. As a result, fewer emissions from vehicles occur over their lifetime. Besides alerting the vehicle operator of the problem by means of a malfunction indicator light (MIL) on the instrument panel, OBD II systems store important information that identify the malfunctioning component or system and describe the nature of the malfunction and the driving conditions under which it was detected. These features allow for quick diagnosis and proper repair of the problem by technicians.

How is OBD II Related to Other ARB Program Requirements?

To meet the very low and near-zero emission standards and the extended useful life requirements of the Low Emission Vehicle II program, manufacturers will need to improve the emission control performance and durability of their vehicles. To this end, ARB currently has in place many programs, including the OBD II requirements, to monitor the low-emission performance of vehicles and ensure that they are performing as required throughout their useful lives and beyond. While these programs are inter-related, the requirements are not redundant and each program serves an important role in achieving and maintaining low emissions at different points in a vehicle's life. It is important to understand that the OBD II program is unique in that it is the only one designed to ensure maximum emission control system performance for the entire life of the vehicles (regardless of mileage), well beyond the authority of the other programs.

To further understand what unique role OBD II serves, a brief overview of the specifics of the other related ARB programs might be helpful:

(a) Certification (Durability Vehicle Testing): The certification process requires manufacturers to demonstrate that vehicle designs are capable of meeting the applicable emission standards throughout their useful life (which, for Low Emission

[5] Current tailpipe emission standards generally only apply to vehicles with less than 100,000 to 120,000 miles.

Vehicle II applications, is defined as 120,000-150,000 miles, depending on their emission category). This has usually done through the use of high mileage durability vehicle testing, typically involving only one or two vehicles. Such testing is performed under tightly controlled conditions by the manufacturers before certification is granted. More recently, most manufacturers have gained ARB approval to conduct "accelerated" durability testing using bench-aged components to simulate high mileage operation, thereby avoiding actual operation of a vehicle up to high mileage.

(b) Warranty Requirements and Warranty Reporting: California emission warranty requirements cover a 3 year/50,000 mile period for most components and a 7 year/70,000 mile period for high cost components (typically only the catalyst and on-board computer). For Partial Zero Emission Vehicles (PZEVs), warranty requirements extend for 15 years/150,000 miles for all emission-related components. Such warranty requirements promote improved durability since manufacturers do not want to be liable for the cost of replacing components within the warranty period. Warranty reporting provisions also exist that require manufacturers to keep track of how often emission related components are replaced during warranty and notify the ARB if any one component exceeds defined failure levels. Vehicles experiencing a high percentage of emission control component replacements may be subject to recall in order to remedy the problem.

(c) In-use Compliance Testing: The in-use compliance testing program has been established to ensure that vehicles continue to meet the adopted tailpipe and evaporative emission certification standards in-use. The ARB may conduct in-use compliance testing of vehicles up through a vehicle reaching 75 percent of its useful life. Thus, for 120,000-mile Low Emission Vehicle II applications, in-use compliance testing can be conducted on vehicles that have up to 90,000 miles, and for vehicles certified according to the 150,000-mile requirements, the testing interval is up to 112,500 miles. The in-use compliance program is a powerful incentive for manufacturers to design durable vehicles that will perform well in-use.

Although all three of these programs are effective in encouraging manufacturers to design durable vehicles that perform well in-use, the effectiveness as they apply to older, high mileage vehicles is limited by the nature and/or the expressed limitations of the different programs. For example, the effectiveness of the certification program is limited by the fact that testing is performed on only a few durability vehicles under very controlled conditions. Similarly, the effectiveness of the warranty and in-use compliance programs is limited by the expressed time and mileage constraints of the respective programs.

The OBD II program is not similarly restricted in that the intent of the program is that OBD II systems be designed to perform for the entire life of the vehicle and be capable of detecting defects beyond a vehicle's applicable useful life. Consequently, the OBD II program is the only program that assures that the ever increasing fleet of high mileage vehicles (e.g., vehicles with more than 100,000 miles) will be properly performing at or near the established emission standards. Given that most emission problems occur as vehicles age and accumulate high mileage, the importance of the OBD II system is underscored.

Further, warranty reporting and in-use compliance testing are most effective in finding systematic failures of the same component that are occurring at a high rate in-use. Today's vehicles, however, are complex systems comprised of many individual components. Only the OBD II system, which individually monitors each of these components, provides an effective method of identifying the specific vehicles in need of repair, regardless of the failure rate of that individual component for the entire fleet. Thus, even if no one component fails at a high enough rate to be discovered during warranty reporting nor in-use compliance testing, the vehicles that do have a failed component are identified, repaired, and returned to tailpipe levels at or near the emission standards.

For these reasons, the OBD II program effectively complements the other certification and in-use programs, ensuring that vehicles, especially those with high mileage, that have emission-related problems are expeditiously repaired so that they perform at or near emission certification levels. Moreover, the OBD II program, in conjunction with the other programs, encourages manufacturers to design and build increasingly durable emission control systems.

What Does the OBD II Regulation Require?

For most emission control systems and components, the OBD II regulation requires malfunctions to be identified before any problem becomes serious enough to cause vehicle emissions to exceed the standards by more than 50 percent (i.e., when emissions exceed 1.5 times the tailpipe emission standards). This requires manufacturers to correlate component and system performance with emission levels to determine when deterioration of the system or component will cause emissions to exceed 1.5 times the tailpipe standard. When this occurs, the regulation requires the diagnostic system to alert the operator to the problem by illuminating the MIL.

For the components and systems in which the 1.5 times the standard criterion is not sufficient or cannot easily be applied, the regulation establishes different malfunction criteria to identify emission problems. For example, in addition to having to detect engine misfire before emissions exceed 1.5 times the standards, the regulation requires that misfire levels be detected that will cause catalyst damage due to overheating.

Further, the 1.5 times the tailpipe emission standard criterion is currently not applicable to evaporative system malfunctions. The regulation requires the OBD II system to detect leaks equivalent or greater in magnitude to a 0.040 inch diameter hole and, by the 2003 model year, a 0.020 inch diameter hole. While data from evaporative system designs show that leaks approaching a 0.020 inch hole begin to rapidly generate excess evaporative emissions (up to 15 times the standard), current monitoring technology and serviceability issues do not permit detecting and repairing smaller leaks.

The 1.5 times the tailpipe emission standard criterion is also not applicable to the monitoring of electronic powertrain components that can cause emissions to increase when malfunctioning, but generally to less than 1.5 times the standard. The regulation requires such components to be monitored for proper function. For example, for components that provide input to the on-board computer, the OBD II system is required to monitor for out-of-range values (generally open or short circuit malfunctions) and input values that are not reasonable based on other information available to the computer (e.g., sensor readings that are stuck at a particular value, or biased significantly from the correct value). For output components that receive commands from the on-board computer, the OBD II system is required to monitor for proper function in response to these commands (e.g., the system verifies that a valve actually opens and closes when commanded to do so). Monitoring of all such components is important because, while a single malfunction of one of these components may not cause an exceedance of the emission standards, multiple failures could synergistically cause high in-use emissions.[6] Further, the OBD II system relies on many of these components to perform monitoring of the more critical emission control devices. Therefore, a malfunction of one of these input or output components, if undetected, could lead to incorrect diagnosis of emission malfunctions, or even prevent the OBD II system from checking for malfunctions.

In addition to malfunction detection requirements, the OBD II regulation requires that diagnostic repair information be provided to aid service technicians in isolating and fixing detected malfunctions. For each malfunction detected, a specific fault code is stored identifying the area and nature of the malfunction (e.g., a mass air flow sensor with an inappropriately high reading). The OBD II system also provides technicians with access to current engine operating conditions such as engine speed, engine load, coolant temperature, fuel system status, etc. The OBD II system even stores the operating conditions that exist at the time a malfunction is detected. All of this information can be accessed with the use of a generic scan tool (i.e., one tool that can access all makes and models of vehicles), and helps assist the technician in accurately diagnosing and repairing problems.

OBD II and Inspection and Maintenance

Current Inspection and Maintenance (I/M) programs (e.g., the "Smog Check" program) rely primarily on tailpipe testing to find vehicles with emission malfunctions. When a high-emitting vehicle is identified, a repair technician must diagnose the cause of the emission failure and then perform necessary repairs. The effectiveness of the

[6] The regulation only requires detection of any single component failure that can affect emissions rather than detection of every combination of multiple component degradations that can cause emissions to exceed the standards, due to the overwhelming time and cost resources that would be required to evaluate the latter.

repairs in bringing the vehicle back into compliance can be known with certainty only when the vehicle again undergoes a tailpipe test.

OBD II systems offer the potential to greatly simplify and improve this process. Instead of measuring tailpipe emissions directly once every two years, the OBD II system monitors virtually every emission control component for malfunctions during normal driving by the vehicle owner. When a malfunction is detected, the MIL will illuminate and the proper fault codes will be stored. If the MIL were not illuminated, nor any fault codes stored, there would be considerable assurance that the vehicle is not emitting excessive emissions (i.e., virtually all the potential sources for an emission problem are operating without defect). In addition, OBD II monitoring includes emission-related components and systems that cannot be otherwise checked during a tailpipe-only I/M test, such as cold start emission reduction devices (e.g., cold start ignition retard strategies, oxygen sensor heaters, or air injection systems)[7], or misfire and fuel system malfunctions that occur exclusively outside of the I/M driving conditions. With an OBD II system, the technician would only have to connect a scan tool to the vehicle to access the data. Thus, an OBD-I/M inspection is faster and more comprehensive than a tailpipe-only I/M inspection, which would require technicians to run an emission-test cycle in order to retrieve emissions data. Further, OBD II malfunction criteria are tailored to the emission control equipment and calibration parameters for each individual vehicle and the emission standards that the vehicle is certified to meet. In contrast, to ensure minimal false errors of commission for all vehicles in a particular model year group, tailpipe emission tests use "cut points" (the test limits above which vehicles are failed) that must take into account the various vehicle types and emission standards pertaining to each group. These cut points do not effectively identify out-of-compliance vehicles until emissions are potentially many times the allowable standard. This shortcoming is especially true in California, where in a single model year, vehicles may be certified to tailpipe standards varying from Federal Tier 1 standards down to the extremely low Super Ultra Low Emission Vehicle (SULEV) standards.

The staff has been working with EPA and other states for the last several years to develop national guidelines for the incorporation of OBD II checks into the I/M program. During this process, pilot test programs, including state-run programs in Wisconsin and Colorado, have been carried out, as well as a 200-vehicle test program conducted by a Federal Advisory Committee Act (FACA) workgroup. Results from these programs confirm the effectiveness of OBD II systems in correctly identifying vehicles with malfunctions and show higher cumulative emission gains for OBD II-based repairs than for IM240/tailpipe-based repairs. As such, EPA recently published its final rule requiring the use of OBD II checks in the I/M program by January 1, 2002. According to this rule, EPA recommends that states may perform an OBD II inspection

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[7] State of California-Smog Check-Inspection Manual instructs technicians to make sure the vehicle engine is at normal operating temperature (i.e., warmed-up) before beginning the inspection. Thus, malfunctions that occur only on cold starts or only affect cold start emission controls are not likely to be detected during an I/M test. Unfortunately, the highest emissions also occur during cold starting and warm up.

in lieu of (as opposed to in addition to) any tailpipe testing for all 1996 and newer model year vehicles. 1995 and older model year vehicles (e.g., pre-OBD II) would still be required to undergo tailpipe testing under the current I/M program.[8]

Although California has already been doing partial "OBD" checks (e.g., failing vehicles with the MIL on) as part of its I/M (Smog Check) program for several years, the OBD II check required by EPA is a more comprehensive check than currently implemented. The ARB is currently working with the Bureau of Automotive Repair (BAR) to determine the most effective method for implementing EPA's required revisions to the current California Smog Check program, which is administered by BAR. The intent of this joint effort is to develop a program that meets EPA's requirements as well as to minimize any inconvenience to consumers. California has already begun pilot testing of OBD II software at a few I/M stations.

III. TECHNICAL STATUS AND PROPOSED MONITORING SYSTEM REQUIREMENTS

As emission standards become increasingly stringent, new technologies and enhancements to existing technologies are being developed to help new vehicles meet these standards. Accordingly, as part of the ARB's biennial reviews of the OBD II regulation, the staff has been meeting with industry to determine changes and additions to the OBD II regulation that are considered necessary for vehicles in meeting the stricter emission standards and ensuring the robustness and effectiveness of the OBD II monitoring systems. In addition to these discussions and reviews, increased experience with OBD II systems in the field as well as ongoing enforcement issues have required rewriting and restructuring of the current regulation, which resulted in the following proposed monitoring requirements.[9]

A. CATALYST MONITORING

NOx Catalyst Monitoring

Virtually all OBD II-equipped vehicles use three-way catalysts (i.e., catalyst systems that simultaneously convert hydrocarbons (HC), carbon monoxide, and oxides of nitrogen (NOx)). The current OBD II regulation (title 13, CCR section 1968.1) requires catalyst monitoring only of HC conversion efficiency. Recently, the staff analyzed emission data from OBD II demonstration vehicles with deteriorated

[8] 40 CFR Parts 51 and 85: "Amendments to Vehicle Inspection Maintenance Program Requirements Incorporating the Onboard Diagnostic Check;" Final Rule.

[9] Many of the requirements set forth in proposed section 1968.2, title 13, CCR for 2003 and subsequent model year vehicles have been carried over from existing section 1968.1, title 13, CCR. The carryover provisions were previously addressed at earlier Board hearings (see 1989, 1991, 1993, 1994, and 1996 Staff Reports – complete titles listed in References section). This staff report will address only those proposed requirements that are new and that substantially change existing requirements in section 1968.1.

catalysts (i.e., catalysts that are detected by the OBD II system as malfunctioning). The data showed that for Low Emission Vehicle I applications, even though only HC conversion efficiency was monitored, HC and NOx emissions both degraded to about equal multiples of their respective standards (e.g., on average, HC and NOx emissions were about 1.5 times the applicable HC[10] and NOx standards, respectively). Thus, despite not having a direct monitoring requirement for NOx conversion efficiency, catalyst malfunctions were generally detected before NOx emissions were unacceptably high.

However, this is not anticipated to occur for Low Emission Vehicle II applications. For these vehicles, the staff does not believe that the HC-only monitoring requirement would provide sufficient protection from high NOx emission levels. While the HC emission standards for Low Emission Vehicle I and II applications are the same, the NOx emission standards for Low Emission Vehicle II applications are approximately one-fourth the levels for Low Emission Vehicle I applications. Therefore, the same NOx emission level that was equivalent to about 1.5 times the Low Emission Vehicle I NOx standard would correspond to an even higher multiple of (i.e., about 6.0 times) the Low Emission Vehicle II NOx standard.

To protect against such high in-use NOx emissions and to maintain the emission benefits of the Low Emission Vehicle II program, the staff is proposing that manufacturers monitor for NOx conversion efficiency of the catalyst. This requirement would apply only to 2005 and subsequent model year vehicles certified to Low Emission Vehicle II standards. For the 2005 and 2006 model years, the staff is proposing an interim malfunction threshold for illuminating the MIL of 3.5 times the Federal Test Procedure (FTP) full useful life standard. For 2007 and subsequent model years, the staff is proposing a final malfunction threshold for LEV II, ULEV II, and medium-duty SULEV II vehicles of 1.75 times the FTP full useful life standard, while the final malfunction threshold for passenger car and light-duty truck SULEV vehicles would be 2.5 times the FTP full useful life standard.

Manufacturers currently use the catalyst's oxygen storage capacity to estimate HC conversion efficiency. With this strategy, a catalyst malfunction is detected when the catalyst's oxygen storage capacity has deteriorated to a predetermined level. To measure oxygen storage, manufacturers typically use a second oxygen sensor located downstream of the monitored portion of the catalyst system (this second sensor is also used to control the precision of the fuel metering system). By comparing the level of oxygen measured by the second sensor with that measured by the primary sensor located upstream of the catalyst, manufacturers can determine the oxygen storage capacity of the catalyst and thus, estimate the HC conversion efficiency.

[10] Regarding HC emission standards, Low Emission Vehicle I and II applications refer to non-methane organic gas (NMOG) emission standards rather than "HC" emission standards. However, only the term "HC" is used in this staff report to avoid confusion.

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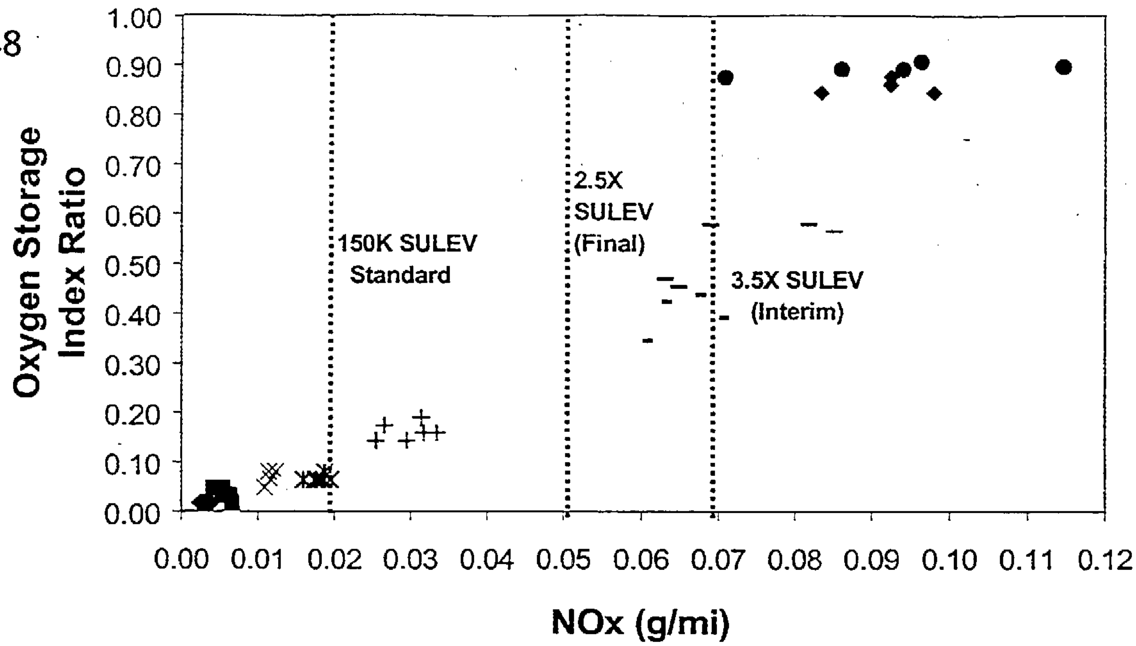

Figure 1

A similar relationship also exists between catalyst oxygen storage capacity and NOx conversion efficiency. Thus, the staff believes that manufacturers will likely use this relationship in conjunction with current monitoring methods to satisfy the proposed NOx requirement. The correlation between oxygen storage and NOx conversion efficiency is generally recognized in the industry as a slightly more linear correlation than the relationship that exists for HC conversion efficiency. Manufacturers presented data identifying this correlation at the July 2001 workshop (see Figure 1 below[11]). In Figure 1, the individual data points represent catalysts that have been subjected to various levels of aging and/or poisoning. The data show that, in general, as the catalyst's NOx conversion capability decreases (i.e., tailpipe NOx emission levels increase along the x-axis), the oxygen storage capacity of the catalyst also decreases. The data points in the lower left corner represent catalysts aged up to 150,000 miles and show that oxygen storage remains very high, while the other data points representing further aging and/or poisoning show decreases in the oxygen storage capacity.

While the data in Figure 1 show that catalysts aged to the proposed OBD II thresholds (e.g., the final or interim thresholds of 2.5 or 3.5 times the NOx standard shown on the graph) appear to have some separation (i.e., difference in oxygen storage index ratio values) from catalysts below the emission standards, manufacturers generally indicate that further separation is needed to accurately detect malfunctions. Ideally, manufacturers like to design the system such that

[11] In Figure 1, tailpipe NOx emission levels ("NOx (g/mi)"), which is inversely proportional to catalyst NOx conversion efficiency, is correlated with the "oxygen storage index ratio". The "oxygen storage index ratio" is the oxygen storage measurement that has been "normalized" to a value between 0.00 and 1.00, with 0.00 representing very high oxygen storage and 1.00 representing no oxygen storage. From a presentation by Paul Baltusis, Ford, at the OBD II Public Workshop, July 18, 2001.

threshold catalysts (i.e., catalysts aged to the OBD II malfunction thresholds) will have very low oxygen storage (e.g., a value on the y-axis of the graph of 0.80 or higher). This determination, however, may depend on the amount of the catalyst system that is monitored. Modification of the monitored volume would alter the relationship between oxygen storage and NOx conversion efficiency. Thus, if a smaller portion of the total catalyst system was monitored, a manufacturer can wait for oxygen storage in the monitored portion of the system to deteriorate further while overall catalyst system NOx conversion efficiency remains high (due to the larger portion of catalyst system that is still functioning properly downstream of the monitored portion of the catalyst system). In addition to modifications to the size or volume of the monitored portion, manufacturers should also be able to alter precious metal loading and washcoat formulations to achieve similar results that would likely allow the system to meet the required emission thresholds.

Accordingly, the proposed regulation would provide additional flexibility to manufacturers in catalyst monitoring by modifying a previous requirement that restricted the minimum volume of the catalyst system to be monitored. By significantly relaxing this minimum volume requirement, the manufacturers should be able to more substantially resize catalyst volume and/or modify catalyst composition materials to meet the final malfunction thresholds.

Other monitoring technologies, such as the use of a NOx sensor, might also be used to meet the proposed requirement.[12] These technologies continue to evolve and may be viable candidates for NOx catalyst monitoring by allowing manufacturers to directly measure NOx concentration levels after the catalyst to determine NOx conversion efficiency. A third possibility for monitoring NOx conversion efficiency would be to evaluate the light off characteristics of the catalyst using a catalyst temperature sensor, as documented in a published Society of Automotive Engineers (SAE) paper.[13] While the paper primarily focused on correlating the temperature sensor readings to HC conversion efficiency for HC-based catalyst monitoring, this method offers similar potential for NOx conversion efficiency monitoring. Additional data and analysis supplied by a manufacturer to ARB showed trends that are similar for NOx emissions and catalyst light-off characteristics. Moreover, the addition of a catalyst temperature sensor or a NOx sensor for monitoring would also provide manufacturers with secondary benefits such as enhanced fuel control.

<u>Catalyst Aging</u>

As discussed above, manufacturers use oxygen storage capacity as a measure of catalyst performance/conversion efficiency. In order to determine the proper OBD II malfunction threshold for catalysts (i.e., the acceptable level of oxygen

[12] NOx sensor technologies have been presented in a number of SAE papers (SAE Reference Numbers 1999-01-1280, 980266, 980170, and 970858).

[13] This method was discussed in SAE paper 1999-01-0311, "Closed Loop Temperature Feedback for Controlled Catalyst Lightoff and Diagnostics for ULEV."

storage capacity at which a malfunction should be indicated), manufacturers progressively deteriorate or "age" catalysts to the point where emissions exceed 1.75 times the standard. The two most common methods of catalyst aging are oven aging and misfire aging,[14] both of which try to replicate excessive temperature conditions.

The OBD II regulation currently allows a manufacturer to infer catalyst system performance from monitoring only a portion of the catalyst volume (e.g., just the front catalyst of a two-catalyst system). When manufacturers age a catalyst system with a partial volume monitor, the monitored portion of the catalyst is aged to the OBD II threshold level and the unmonitored portion is aged to the equivalent of the end of the vehicle's useful life. In the past, the ARB has approved this aging methodology based on the assumption that the monitored portion of the catalyst, which is typically upstream of the unmonitored portion, buffers or protects the unmonitored portion from advanced deterioration by the commonly recognized failure modes (e.g., thermal damage due to misfire or poisoning). However, some manufacturers contend that this assumption is not entirely valid because real world deterioration of the unmonitored catalyst largely depends on total catalyst system design, operating conditions when the monitored catalyst is damaged, failure mode, and fuel control during misfire. So if the unmonitored catalyst is not protected by the monitored catalyst and is deteriorated beyond its normal limits, emission levels will likely exceed the malfunction threshold specified in the OBD II regulation (i.e., generally 1.75 times the standard) when a catalyst malfunction is detected in the real world.

To address this problem, the staff is proposing more specific requirements for aging catalysts and determining the malfunction thresholds (i.e., the oxygen storage capacity level at which a malfunction is indicated) for the catalyst monitor. Under the proposal, manufacturers would be required to use deterioration methods that more closely represent real world deterioration, thereby ensuring that the MIL would illuminate at the appropriate emission level during real world operation. The proposal would further require that the catalyst system be aged as a whole (i.e., manufacturers would simultaneously age the entire system, not just the front catalyst) for most 2005 and subsequent model year vehicles certified to the Low Emission Vehicle II standards. The monitored catalysts would be aged to the malfunction criteria, and the level of deterioration of the unmonitored catalysts would simply be a result of the aging of the monitored catalyst, as is the case during real world operation. However, manufacturers that use fuel shutoff to misfiring cylinders in order to minimize catalyst temperatures may continue to use the current process of aging the monitored catalyst to the malfunction criteria and the unmonitored catalysts to the end of the useful life. Such systems are not subjected to extreme temperatures, so they would likely age with the closest monitored catalyst experiencing most of the deterioration.

[14] Excessive temperature resulting from engine misfire is recognized by industry as a dominant failure mode of catalysts.

B. MISFIRE MONITORING

Under the existing regulation, manufacturers have been allowed to request that the misfire monitor be disabled if necessary to assure that the systems reliably identified misfire. With increasing experience in software development, improvements to sensors and their location, and use of better engine control processors, manufacturers have significantly improved their ability to monitor misfire in recent years. Additionally, since initial promulgation of the misfire requirements, the ARB has provided manufacturers with additional time to evaluate whether misfire is present and sufficiently repeatable. Given these improvements, it is no longer necessary to permit many of the disablements that have been previously allowed.

The proposed misfire monitoring requirements would restrict the number of possible disablements by, in general, limiting disablements to specific conditions. This should help limit the variability that has existed in the ability of certified misfire monitors to reliably detect misfire and should improve the overall quality of the monitors. The proposal would also minimize the time the staff must spend to determine when misfire systems are really active. This has been a concern in the past, when numerous overlapping disablements have made it very difficult to determine whether misfire monitoring was active during most driving conditions. By minimizing the number of allowed disablements, the task of evaluating manufacturers' certification documentation should be less difficult, allowing for a more expeditious certification process. A more comprehensive list would also provide clear direction to engineers developing misfire monitoring systems as to what types of disablements would be allowed.

In general, the proposed requirements would no longer permit misfire monitoring disablement during throttle movements less rapid than occur over the US06 (or "off cycle") driving cycle, automatic transmission shift changes except under wide open throttle conditions, air conditioning compressor on and off cycling, or other conditions that have been shown to be unnecessary. Additionally, because of the availability of better computers, manufacturers should no longer need to disable misfire detection during engine speed changes that, in the past, had taxed their engine computer's ability to keep up with the calculation requirements. Accordingly, such disablements would no longer be allowed on 2005 and subsequent model year vehicles.

For remaining disablements, manufacturers would still be required to list all disablements in their certification applications for review by the ARB staff. Manufacturers would also be required to submit driving traces of the FTP and US06 cycles for selected representative engine groups, showing where disablements occur and indicating the reason for each disablement. Similarly, manufacturers may be required to demonstrate that misfire can be reliably detected during portions of the FTP and US06 driving cycles, prior to the staff granting certification.

Additionally, the staff has added several clarifications to the proposed misfire monitoring requirements. To address industry inconsistency regarding fault code setting and catalyst-damaging temperature, the staff is proposing a better definition of when a single cylinder or multiple cylinder misfire code is set, and establishing a more specific means of determining the temperature at which catalyst damage occurs. The staff is also setting floors of one percent (for a 1000-revolution monitoring interval) and five percent (for a 200-revolution monitoring interval) for detecting emission-related and catalyst damage misfires, acknowledging that successful diagnosis and repair of smaller percentages of misfire is difficult. The staff also recognizes that distinguishing misfire from normal firing is difficult during periods of reduced torque. Therefore, the staff is permitting a reduced threshold for probability of misfire detection when a cold start emission reduction strategy that causes engine torque to be significantly reduced is operative.

C. EVAPORATIVE SYSTEM MONITORING

New Evaporative System Monitoring Strategies

The ARB originally adopted a leak detection requirement for 1996 and subsequent model year vehicles certified to the enhanced evaporative emission standards. The requirement was limited to 0.040 inch leak detection capability because detection of smaller leaks was not feasible at that time. Emissions from leaks smaller than 0.040 inches, however, can be many times the evaporative emission standards. It isn't until the leak size falls below 0.020 inch that evaporative emissions begin to diminish substantially. With improvements in technology, manufacturers were later able to detect leaks as small as 0.020 inch. Accordingly, in1996, the Board adopted the 0.020 inch leak detection requirement for all 2003 and subsequent model year vehicles. To assure that larger leaks (e.g., loose or missing gas cap or disconnected evaporative system hoses) continued to be quickly detected, the OBD II regulation continued to require a separate 0.040 inch monitoring requirement.

Initially, the ARB recognized that the 0.020 inch monitor may require more restrictive monitoring conditions to assure robust monitoring, so that the monitoring frequency of such systems tended to be less than desired. However, recently, manufacturers' abilities to detect 0.020 inch leaks have improved considerably so that monitoring, in general, occurs more frequently. In addition, some manufacturers have developed innovative approaches that are less costly than previous systems, yet provide for more robust detection of the smaller 0.020 inch leaks while maintaining adequate monitoring frequency.

Given these improvements in small leak detection, it may be less important to detect 0.040 inch leaks than in the past. In fact, some manufacturers have suggested that it may now be more beneficial to detect leaks in the 0.090 inch range. They have indicated that such detection would occur more rapidly than detection of 0.040 inch leaks, and that this would be especially true for detection of large leaks in the evaporative control system caused by conditions such as a loose or missing gas cap and split or disconnected vacuum lines. More rapid detection and correction of large leaks would help reduce emissions compared to leak detection systems geared toward detecting 0.040 inch leaks. Accordingly, the staff is proposing greater flexibility for manufacturers in detecting evaporative system leaks for larger hole sizes, as long as their evaporative system leak detection accurately detects 0.020 inch leaks and the overall evaporative system monitor meets minimum monitoring frequency requirements discussed later in section IX.

Standardized Orifices

The current regulation requires the OBD II system to detect leaks greater than or equal to those caused by 0.020 or 0.040 inch diameter orifices in the evaporative system. In recent in-use and enforcement testing, the ARB staff used orifices that consisted of 0.040 inch diameter holes drilled in thin wall stainless steel tubing. Some manufacturers have contended that the use of such orifices does not constitute a rigorous industry standard and that such a standard is necessary. They additionally contended that the orifice shape and length, as well as production tolerances, can significantly affect flow rates and consequently the evaporative system monitor's ability to detect a leak. Various manufacturers have proposed that "standardized" orifices be adopted to address these concerns.

To address this concern, the staff proposes the use of a specific orifice supplied by O'Keefe Controls Corporation, a manufacturer and supplier of precision orifices used by many in the industry. Orifices with equivalent specifications from other suppliers would also be acceptable.

Statistical MIL Illumination

Generally the OBD regulation requires a fault code to be stored and the MIL to be illuminated if a malfunction is detected on two consecutive driving cycles. The current regulation allows the use of other statistical protocols to evaluate monitoring data and illuminate the MIL if the manufacturer can demonstrate that they are equally effective and timely in illuminating the MIL. Strategies that, on average, require more than six driving cycles to illuminate the MIL are not acceptable. As discussed above, when the 0.020 inch requirement was adopted, the ARB recognized the difficulty in monitoring for 0.020 inch leaks and adopted regulatory language that permitted more restrictive monitoring conditions that would run less frequently. Even with this additional latitude, some manufacturers may still not be able to develop a sufficiently robust monitor that can detect a 0.020 inch leak in two consecutive driving cycles or in six driving cycles as currently permitted for statistical protocols.

The staff is proposing to allow a manufacturer even more flexibility to use additional cycles to illuminate the MIL, provided the manufacturer can demonstrate that the overall ability of the monitor to illuminate the MIL when a malfunction is present is approximately two weeks time for 50 percent of the drivers (as defined by meeting the minimum monitoring frequency requirements discussed later in section IX). Thus, alternate strategies that require data from more driving cycles to make a decision but still provide for timely and reliable monitoring would be allowed.

D. SECONDARY AIR SYSTEM MONITORING

Secondary air systems are used on vehicles to reduce cold start exhaust emissions of hydrocarbons and carbon monoxide. Although many of today's vehicles operate near stoichiometric (where the amount of air is just sufficient to completely combust all of the fuel) after a cold engine start, more stringent emission standards may require secondary air systems, generally in combination with a richer than stoichiometric cold start mixture, to quickly warm up the catalyst for improved cold start emission performance. Secondary air systems typically consist of an electric air pump, various hoses, and check valves to deliver outside air to the exhaust system upstream of the catalytic converters. This system usually operates only after a cold engine start for a brief period of time. When the electric air pump is operating, fresh air is delivered to the exhaust system and mixes with the unburned fuel at the catalyst, so that the fuel can burn and rapidly heat up the catalyst.

The OBD II requirements presently allow manufacturers to perform a functional check in lieu of correlating secondary air system airflow to emissions (i.e., 1.5 times the applicable FTP standards) if the design of the system is unlikely to deteriorate. The regulation also allows manufacturers to define the appropriate conditions for operating the monitor with the limitation that the defined conditions are encountered during the first engine start portion of the FTP.

On current vehicles, the majority of vehicle manufacturers with secondary air systems have been able to opt out of correlating airflow to emissions, either by providing data indicating that a total failure of the system would not cause emissions to exceed the malfunction threshold or by submitting data or designs to the ARB demonstrating that system deterioration is unlikely. The ARB had originally incorporated the durability demonstration clause to provide some monitoring relief to manufacturers if they designed a system that was unlikely to fail in use. However, the process of projecting the durability of secondary air designs is a difficult and imprecise task. Furthermore, secondary air system designs are fairly complex and diverse, involving designs that utilize various materials, valves, and other components. To compound the problem, these systems are subjected to rigorous environments. These factors make it difficult to determine the durability of these systems, which may result in the staff approving systems that fail in-use and are not detected by the diagnostic system until they are no longer functional.

Another issue concerns malfunctions that only occur during cold engine starts when the secondary air system is normally active. The current regulation does not restrict diagnostics to the period when the secondary air system is active, so many manufacturers execute their diagnostics after the vehicle is warmed up by intrusively commanding the air pump on when it normally would be off. With this monitoring technique, there is no assurance that the system operates correctly after a cold engine start when the secondary air system is normally on. Certain malfunctions such as sticking check valves or worn pump shaft bearings, for example, may yield decreased pump flow when the system is cold but not when the vehicle is warm.

In order to avoid the uncertainty connected with projecting secondary air system durability and to increase the robustness of the diagnostic system, the staff proposes to require all vehicles to indicate a secondary air system malfunction that causes airflow to diminish such that the vehicle would exceed 1.5 times any of the applicable FTP emission standards. Additionally, this diagnostic would be required to monitor the secondary air system while the system is normally active (e.g., during vehicle warm-up following engine start) and not when the system is intrusively turned on solely for monitoring purposes.

In order for the OBD II system to effectively monitor the secondary air system when it is normally active, linear oxygen sensors (often referred to as wide-range oxygen sensors or air-fuel ratio sensors) would most likely be required. These sensors are currently installed on many new cars and their implementation is projected to increase in the future as more stringent emission standards are phased in. Linear oxygen sensors are useful in determining air-fuel ratio over a broader range than conventional oxygen sensors and are especially valuable for controlling fueling in lean-burn engines and other engine designs that require very precise fuel control. Since linear oxygen sensors are able to determine air-fuel ratio accurately, the amount of secondary airflow needed to keep emissions below 1.5 times the tailpipe emission standard can be correlated to the air-fuel ratio, making linear oxygen sensors useful for secondary air system monitoring.

One concern that some manufacturers have expressed regarding secondary air system monitoring directly after a cold engine start is that the oxygen sensor needs time to warm-up before it becomes active. The staff believes that more powerful heaters available on new oxygen sensor designs should alleviate these concerns since these "quick light-off" sensors are active within about 10 seconds. Since secondary air injection duration typically ranges from about 20 seconds to as high as 40 seconds, the "quick light-off" linear oxygen sensors should become active within a sufficient time to monitor the secondary air system when it is normally active.

These new requirements would apply only to 2006 and subsequent model year vehicles certified to Low Emission Vehicle II standards. For the 2006 and 2007 model years only, a manufacturer may request Executive Officer approval to perform an interim, simpler functional check during the cold start in lieu of the emissions performance diagnostic. This interim check would require a manufacturer to incorporate an additional airflow diagnostic that is correlated to emissions during an intrusive operation later in the same drive cycle. By 2008 model year, only a performance check during cold start conditions would be accepted.

E. OXYGEN SENSOR MONITORING

Maintaining the air-fuel ratio at stoichiometric is an important factor in achieving the lowest engine emissions. In order for the emission control system to operate most efficiently, the air-fuel ratio must remain within a very narrow range (less than 1 percent deviation) around the stoichiometric ratio. Modern vehicles have traditionally performed fuel control with an oxygen sensor feedback system. Oxygen sensors are typically located in the exhaust system upstream and downstream of the catalytic converter. The front or upstream oxygen sensor is generally used for fuel control and is often called the "primary" oxygen sensor. The rear or downstream oxygen sensor is generally used for adjusting the front oxygen sensor as it ages and for monitoring the catalyst system and is often called the "secondary" oxygen sensor.

The OBD II regulation currently requires the diagnostic system to monitor the output voltage, response rate, and any other parameter that can affect emissions and/or other diagnostics of the primary and secondary oxygen sensors. For heated oxygen sensors, the heater circuit must be monitored to detect when the current or voltage drop within the circuit deteriorates below the manufacturer's specified limits for proper operation.

Like many of the other major system monitors, the current OBD II regulation requires the oxygen sensor diagnostics to only operate once per driving cycle. The comprehensive component monitors, on the other hand, generally require continuous monitoring for many common electrical failure modes (e.g., shorted or open circuits). As a result of the current structure of the regulation, manufacturers have been able to execute all of the oxygen sensor diagnostics, including basic electrical diagnostics for open and shorted circuits, once per trip rather than continuously. However, recently the ARB has found that some manufacturers were having difficulties detecting some oxygen sensor malfunctions such as intermittent oxygen sensor circuit malfunctions, which have less chance of being detected when the diagnostic is run only once per trip.

Since the oxygen sensor is a critical component of a vehicle's fuel and emission controls, the proper performance of this component needs to be assured in order to maintain low emissions. Thus, it is important that any malfunction that adversely affects the performance of the oxygen sensor is detected by the OBD II system. Hence, the staff is proposing to require virtually continuous monitoring of the primary oxygen sensor's circuit continuity and out-of-range values and the secondary oxygen sensor's out-of-range values for malfunctions. A manufacturer may request Executive Officer approval to disable the continuous oxygen sensor monitoring when an oxygen sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). For heated oxygen sensors, continuous monitoring will also be required for all circuit continuity faults of the heater circuit that conflict with the commanded state of the heater. For example, in a situation where a heater is turned on by supplying 12 Volts, the manufacturer would be required to monitor for open circuits or shorts to ground (0 Volts) while the heater is commanded on and monitor for open circuits or shorts to battery (12 Volts) when the heater is commanded off. In addition, continuous monitoring for any malfunction of the primary oxygen sensor that causes the fuel system to stop using the oxygen sensor as a feedback input (e.g., causes default or open loop operation) would be required. It should be noted that many of the manufacturers' current fuel system monitors may already identify some of these oxygen sensor malfunctions. However, fuel system faults are generally one of the most difficult faults to diagnose and repair because of the substantial number of possible causes. As such, these changes would help to pinpoint the oxygen sensor as the malfunctioning component if a circuit problem is occurring. This requirement would apply only to 2006 and subsequent model year vehicles certified to Low Emission Vehicle II standards.

F. ENGINE COOLING SYSTEM MONITORING

Manufacturers generally utilize engine coolant temperature as an input for many of the emission-related engine control systems as well as the diagnostics for these systems and components. The engine coolant temperature is often one of the most important factors in determining if closed-loop fuel control will be allowed by the engine's powertrain computer. If the engine coolant does not warm up sufficiently, closed-loop fuel control is usually not allowed and the vehicle remains in open-loop fuel control. Since open-loop fuel control does not provide precise fuel control, this results in increased emission levels. Engine coolant temperature is also used to enable many of the diagnostics that are required by the OBD II regulation. If the engine coolant does not warm-up sufficiently due to a malfunctioning thermostat or if the engine coolant temperature sensor malfunctions and remains at a low or high reading, many diagnostics would not be enabled.

The current OBD II regulation requires monitoring of the thermostat and engine coolant temperature sensor. Starting in the 1994 model year, manufacturers have been required to monitor the engine coolant temperature sensor to ensure that the vehicle achieved the closed-loop enable temperature (or for diesel vehicles, the minimum temperature needed for warmed-up fuel control to begin) within a manufacturer-specified time after start up. The current regulation also requires that the coolant temperature sensor be monitored for rationality, electrical, and out-of-range failures. In the 2000 model year, additional diagnostics to monitor the thermostat for proper operation were phased-in. Although manufacturers, in general, determine when the coolant temperature is taking too long to reach the closed-loop enable temperature, the current regulation places a maximum warm-up time of two minutes for engine starts at or above 50 degrees Fahrenheit and five minutes for engine starts between 20 degrees and 50 degrees Fahrenheit. For the thermostat monitor, the current regulation requires the diagnostic to detect malfunctions when the engine coolant temperature does not achieve the highest temperature required to enable other diagnostics or warm up to within 20 degrees Fahrenheit of the manufacturer's thermostat regulating temperature.

Currently, the engine coolant temperature sensor and thermostat monitoring requirements are identified in different sections of the OBD II regulation or in separate advisory mail-outs.[15] In order to clarify the various engine cooling system requirements,

[15] Mail-Out s #95-20, "Guidelines for Compliance with On-Board Diagnostics II (OBD II) Requirements," (May 22, 1995), and #98-01, "On-Board Diagnostic II Compliance Guidelines," (January

the staff is consolidating them into one section of the OBD II regulation under the "engine cooling system" diagnostic heading. Most of the requirements themselves are not new.

Due to increasingly stringent emission standards, manufacturers have been lowering the engine coolant temperature required to enable closed-loop fuel control. By enabling closed-loop fuel control more quickly, manufacturers have been able to reduce their cold-start emission levels and comply with the new stringent emission standards. As a result, the times to achieve the manufacturer-specified closed-loop enable temperature after engine start are now considerably shorter than the times projected when the engine coolant temperature monitoring requirement was first adopted. Therefore, the current maximum allowable warm-up time thresholds may be too lenient.

The staff is proposing to modify the time-to-closed-loop monitor's malfunction criteria to better reflect the lower enable requirements used on current vehicles. For engine starts that are up to 15 degrees Fahrenheit below the closed-loop enable temperature, the diagnostic would be required to indicate a malfunction if the enable temperature is not achieved within two minutes of engine start (rather than allowing two minutes above 50 degrees Fahrenheit, regardless of the manufacturer-specific closed-loop enable temperature). For engine starts that are between 15 and 35 degrees Fahrenheit below the closed-loop enable temperature, a malfunction would be required to be indicated when the enable temperature is not achieved within five minutes of engine start (rather than five minutes above 20 degrees Fahrenheit). Vehicles that do not utilize engine coolant temperature to enable closed-loop fuel control would continue to be exempted from time-to-closed-loop monitoring. These new limitations would apply to 2006 and subsequent model year vehicles certified to Low Emission Vehicle II standards.

Concerning the thermostat monitor, some of the manufacturers' largest vehicles require a high capacity passenger compartment heating system. In cold weather, use of the heaters may not allow sufficient coolant temperature to be achieved in order to avoid illumination of the malfunction light, even when the thermostat is functioning normally. As a result, manufacturers have been forced to select very restrictive monitoring conditions that may not be frequently encountered in-use to ensure an accurate decision.

Therefore, the staff is proposing that vehicles that do not reach the temperatures specified by the malfunction criteria would be allowed to use alternate malfunction criteria and/or temperatures that are a function of coolant temperature at engine start. This provision would apply only for engine starts below 50 degrees Fahrenheit and would require the manufacturer to demonstrate why the standard malfunction criteria are not sufficient. Above 50 degrees Fahrenheit, the monitor would need to meet the standard malfunction criteria.

22, 1998.

For the coolant temperature sensor, manufacturers have been monitoring the sensor for various rationality faults including readings that are inappropriately low or inappropriately high. However, some confusion has arisen among manufacturers as to what temperature ranges the rationality faults should cover. Typically, for non-temperature sensors, a rationality monitor is sufficient if it can verify the sensor is not reading inappropriately high at a single point where it should be reading low and not reading inappropriately low at a single point where it should be reading high.

However, the engine coolant temperature sensor is an essential sensor used extensively for both fuel and spark timing control as well as for several other OBD II monitors. And for some manufacturers, proper sensor performance is crucial in enabling nearly all of the other major OBD II monitors. If a malfunction occurs that causes the engine coolant temperature sensor to read a lower than actual temperature, monitors that only run when the sensor indicates the car is warmed-up can be delayed or even disabled. If a sensor malfunction occurs that causes the sensor to read higher than normal (e.g., due to corrosion on the sensor terminals, etc.), monitors that only run on cold starts may run less frequently or be disabled altogether. Accordingly, staff has continually worked with manufacturers to determine the level of rationality monitoring necessary based upon the extent the manufacturer relies on the engine coolant temperature sensor for other monitors. Further complicating the issue are the exemptions identified in OBD II Mail-outs[15] which exempt the manufacturer from portions of the rationality monitoring dependant on the actual hardware used by the manufacturer (e.g., dashboard gauge or warning light, single or dual element sensors, etc.).

With the years of experience now gathered by industry and the staff, it is appropriate for the proposed language to more specifically elaborate on the necessary level of monitoring and clarify when the exemptions do or do not apply. As such, the proposed language includes clarifications that rationality monitoring for engine coolant temperature sensors must identify sensors that read inappropriately low (and thus, disable or delay operation of other monitors) or sensors that read inappropriately high (again, disabling or delaying operation of other monitors). Additionally, the language clarifies which monitoring requirements a manufacturer will be exempted from when utilizing specific hardware configurations.

G. COLD START EMISSION REDUCTION STRATEGY MONITORING

The largest portion of exhaust emissions are generated during the brief period following a cold start before the engine and catalyst have warmed up. In order to meet increasingly stringent emission standards, manufacturers are developing hardware and associated control strategies to reduce these emissions. Most efforts are centering around reducing catalyst warm-up time. A cold catalyst is heated mainly by two mechanisms, heat transferred from the exhaust gases and heat that is generated in the catalyst as a result of the catalytic reactions.

Manufacturers are implementing various hardware and control strategies to quickly light off the catalyst (i.e., reach the catalyst temperature at which 50 percent conversion efficiency is achieved). Most manufacturers use substantial spark retard and/or increased idle speed following a cold start to quickly light off the catalyst. However, customer satisfaction and safety (i.e., vehicle driveability and engine idle quality) limit the amount of spark retard or increased idle speed that a manufacturer will use to accelerate catalyst light off. On a normally functioning vehicle, engine speed drops when the ignition timing is retarded, therefore causing the idle speed control system to compensate and allow more airflow (with a corresponding increase in fuel) to the engine in order to maintain idle speed stability during spark retard. Since idle quality is given a high priority, spark retard is typically limited to the extent that the idle control system can quickly respond and maintain idle quality. A poorly responding idle control system may cause the computer to command less spark retard than would normally be achieved for a properly functioning system, thereby causing delayed catalyst light off and higher emissions. The OBD II regulation currently requires monitoring of the idle control system and monitoring of the ignition system by the misfire monitor. However, the idle control system is normally monitored after the engine has warmed up, and malfunctions that occur during cold start may not be detected by the OBD II system, yet have significant emission consequences.

Given the escalating cost of precious metals, there is an industry trend to minimize their use in catalysts. To compensate for the reduction in catalyst performance, manufacturers will likely employ increasingly more aggressive cold start emission reduction strategies. It is crucial that these strategies be successful and properly monitored in order to meet the new, more stringent emission standards in-use.

Considering the issues outlined above, the staff is proposing a requirement to monitor the key parameters used to implement cold start emission reduction strategies. This would ensure that the target conditions necessary to reduce emissions or catalyst light-off time are indeed achieved and emissions do not exceed 1.5 times the tailpipe standard. These parameters would be monitored while the strategy is active. For example, if the target idle speed for catalyst light-off could not be achieved or maintained adequately to maintain emissions below 1.5 times the standard, a malfunction would need to be indicated. Similarly, if the target spark retard necessary for catalyst light-off could not be achieved due to an idle control system malfunction, a fuel system malfunction, or any other malfunction, a fault would need to be indicated.

Monitoring techniques that are projected to be used for cold start monitoring strategies mainly involve software modifications. For example, if ignition retard is used during cold starts, the commanded amount of ignition retard would have to be monitored if the timing can be limited by external factors such as idle quality or driveability. This can be done with software algorithms that compare the actual commanded timing with the threshold timing that would result in emissions that exceed 1.5 times the standard. Cold start strategies that always command a predetermined amount of ignition retard independent of other factors do not require monitoring of the commanded timing. However, other factors that ensure the actual timing has been reached, such as increased mass air flow and/or increased idle speed, require monitoring when the strategy is active. Since mass air flow and idle speed are both currently monitored by the OBD II system, monitoring these components when the cold start strategy is invoked should require only minor software modifications.

As required for other OBD II monitors, the stored fault code would, to the fullest extent possible, be required to pinpoint the likely cause of the malfunction to assist technicians in diagnosing and repairing these malfunctions. The industry has expressed concern that this monitoring requirement, while feasible, would require significant time-intensive calibration work. In response to these concerns, the proposal would allow a manufacturer to develop calibrations on representative vehicles and apply the calibrations to the remainder of the product line. To provide manufacturers with sufficient leadtime to comply with the new requirements, a phase-in is proposed beginning with the 2006 model year for Low Emission Vehicle II applications.

H. AIR CONDITIONING SYSTEM COMPONENT MONITORING

The use of air conditioning systems can significantly affect tailpipe emissions. Accordingly, in July 1997, the Board adopted a new test cycle (A/C Test) and accompanying emission standards for measuring emissions with air conditioning systems in operation.[16] Vehicle manufacturers are required to begin meeting the new A/C Test standards in 2001 with complete phase-in of their product line by the 2004 model year. Generally, the new standards ensure that emissions occurring during air conditioning operation remain well-controlled (the staff plans, however, to revise the current standards for vehicles certified to the Low Emission Vehicle II emission standards). To ensure good emission control during air conditioning operation, manufacturers have employed revised fuel control, spark control, and other strategies. Some manufacturers, however, maintain that no revisions are needed to their engine control strategies to meet A/C Test emission standards.

In determining appropriate OBD II monitoring requirements for air conditioning systems, it seems unnecessary to monitor most aspects of the proper operation of the driver-operated controls or the various sensors for sunlight load, passenger compartment temperature, passenger skin temperature and others. This is because the A/C Test procedure ensures that the A/C compressor is operating virtually full time during the test, and therefore represents a worst case condition. At worst, failure of the above components could result in more A/C operation than otherwise selected by the driver, but the vehicle should still be capable of meeting the A/C Test standards. The exception would be for manufacturers that utilize an alternate engine control strategy for reducing emissions during air conditioning operation. Should the air conditioning system be commanded on but fail to become operational, the alternate engine control strategy would be invoked without increasing the engine load. Under these conditions, the level of emissions would be uncertain since the engine control strategy is not properly matched to the engine load. The other possibility is that failure of some components could result in the operation of the air conditioning system but not the

[16] Refer to title 13, CCR sections 1960.1(q) and 1961(r).

alternate engine control strategy, which would also result in the mismatching of the engine load and control strategy. For example, should a manufacturer employ a richer fueling strategy to reduce NOx emissions, and this strategy was not invoked when the air conditioning was operating, higher NOx emissions might result.

The staff is proposing that manufacturers using alternate engine control strategies be required to monitor for the two types of malfunctions mentioned above. Manufacturers would need to monitor for failures of electronic components that yield emissions exceeding 1.5 times the applicable FTP or A/C Test standard. Generally, the FTP test would be applicable for malfunctions occurring when a special engine control strategy has been invoked, but the compressor has not been engaged. The A/C Test would be appropriate for malfunctions that result in compressor engagement but with an accompanying A/C engine control strategy that is not active.

Manufacturers using the alternate engine control strategies would be required to perform electrical circuit and rationality diagnostics on input components that could cause emissions to exceed 1.5 times the applicable standard. For output components, manufacturers would be required to perform electrical circuit and functional checks for malfunctions that could cause emissions to exceed 1.5 times the applicable standards (e.g., verify the component accomplished the command given by the control unit). Also, malfunctions that would disable other monitors would require monitoring. By conducting electrical circuit checks in combination with monitoring of compressor cycling performance during appropriate periods or in response to commands issued as part of an intrusive monitoring strategy, manufacturers should be able to discern failed electrical components, including relays, pressure switches, compressor clutches, or others that cause emissions to exceed the emission threshold. To provide manufacturers with sufficient leadtime to comply with the new requirements, a phase-in is proposed beginning with the 2006 model year for Low Emission Vehicle II applications

The staff expects very few A/C components to require monitoring under this proposal, but wants to ensure that adequate safeguards exist in case they are needed.

I. <u>VARIABLE VALVE TIMING AND/OR CONTROL SYSTEM</u>

Many of today's vehicles utilize variable valve timing primarily to optimize engine performance. Variable valve timing and/or control has many advantages over conventional valve control. Instead of opening and closing the valves by fixed amounts, variable valve timing controls can vary the valve opening and closing timing (as well as lift amount in some systems) depending on the driving conditions (e.g., high engine speed and load). This feature permits a better compromise between performance, driveability, and emissions than conventional systems. With more stringent NOx emission standards being phased in under the Low Emission Vehicle II program, even more vehicles are anticipated to utilize variable valve timing. By utilizing variable valve timing to retain some exhaust gas in the combustion chamber to reduce peak combustion temperatures, NOx emissions are reduced. Manufacturers utilizing variable valve timing are often able to remove external exhaust gas recirculation (EGR) valves and controls from their vehicles, offsetting the cost increase for the system. While the OBD II regulation does require monitoring of the individual electronic components used in the variable valve timing system, it currently does not contain specific monitoring requirements for the detection of variable valve timing system malfunctions.

Since valve timing can directly affect exhaust emissions, the staff is proposing specific requirements for monitoring variable valve timing and/or control systems. Beginning in the 2005 model year on all Low Emission Vehicle II applications, manufacturers would be responsible for detecting target errors and slow response malfunctions of these systems. For target error and slow response malfunctions, the diagnostic system would be required to detect malfunctions when the actual valve timing and/or lift deviates from the commanded valve timing and/or lift such that 1.5 times the applicable FTP emission standard would be exceeded. For variable valve timing and/or control systems that cannot cause emissions to exceed 1.5 times the FTP standard or are used on vehicles prior to the 2005 model year phase-in, manufacturers would still be required to monitor the system for proper functional response under the comprehensive component requirements. This is the same requirement that is currently applicable to variable valve timing and/or control systems. Manufacturers are currently monitoring for these types of malfunctions, and the staff's proposal would correlate detection of these malfunctions to exceedance of emission standards.

J. DIRECT OZONE REDUCTION MONITORING

Direct ozone reduction systems consist of a special catalytic coating placed on a vehicle's radiator (or other surfaces such as the air conditioning condenser) that promotes ozone-reduction reactions in the ambient air. As the air passes across the warmed coated surfaces during normal driving, ambient ozone is converted into oxygen. While vehicles do not directly emit ozone from the tailpipe, they do emit hydrocarbon (HC) and nitrogen oxide (NOx) emissions, which are precursors to the formation of ozone. As such, ARB adopted a policy, detailed in Manufacturers Advisory Correspondence (MAC) No. 99-06, which allows manufacturers to offset higher tailpipe emissions by equipping vehicles with direct ozone reduction systems. Under this policy, manufacturers may receive NMOG credit, calculated in accordance with specific procedures described in ARB MAC No. 99-06, for its direct ozone reduction system.

The ozone conversion performance of the direct ozone reduction system will likely deteriorate over time, due to constant deposition of airborne particulate matter onto the coating, or by the gradual flaking of the coating due to age. Additionally, the loss of the entire coating, either gradually or suddenly, results in no ozone conversion at all. Currently, the OBD II regulation does not contain specific monitoring requirements for the detection of direct ozone reduction system failures, since it is a relatively new emission control technology. While manufacturers are not required to utilize direct ozone reduction systems in their vehicles, as they are not needed to meet the applicable emission standards, several manufacturers are pursuing the technology for use on future model year vehicles since they can receive emission credit for doing so. If a manufacturer chooses to implement a direct ozone reduction system in its vehicles, it will be required to implement OBD II monitoring of such devices. Therefore, the addition of specific direct ozone reduction system monitoring requirements to the OBD II regulation is being proposed.

OBD II requirements for direct ozone reduction systems were developed in ARB MAC No. 99-06 and were structured analogous to conventional tailpipe emission reduction device monitoring requirements. The proposed requirements follow those established for direct ozone reduction system monitoring as set forth in ARB MAC No. 99-06, and formally incorporate them into the OBD II regulation.

Accordingly, if the direct ozone reduction system qualifies for a relatively small emission reduction credit (i.e., the NMOG credit assigned to the direct ozone reduction system is less than or equal to half the applicable FTP NMOG emission standard to which the vehicle is certified), manufacturers would only be required to perform a functional check of the direct ozone reduction system to verify that the coating is still present on the radiator. In other words, the OBD II system would indicate a malfunction when it is unable to detect some degree of ozone conversion.

Alternatively, if the direct ozone reduction system qualifies for a relatively large emission reduction credit (i.e., the NMOG credit assigned to the direct ozone reduction system is greater than half the applicable FTP NMOG emission standard to which the vehicle is certified), manufacturers would be required to monitor the ozone conversion efficiency of the system. The OBD II system would indicate a malfunction when the ozone reduction performance deteriorates to a point where the difference between the NMOG credit assigned to the properly operating direct ozone reduction system and the NMOG credit calculated for a direct ozone reduction system performing at the level of the malfunctioning system exceeds 50 percent of the applicable FTP NMOG standard. This is analogous to OBD II monitoring of other components, where the OBD II system indicates a malfunction prior to tailpipe emissions exceeding 1.5 times the applicable standards.

In developing monitoring strategies for the direct ozone reduction system, manufacturers have identified physical and electrical properties of the coating that correlate to its ozone conversion performance. To date, three different potential monitoring strategies have been presented to the ARB. The electrical (resistive) approach monitors the resistance change of the coating. This method involves an electrical probe that is used to indicate changes in the resistive properties of the coating that correlate to changes in the thickness of the coating. The second, an optical (reflective) approach, uses reflective light to monitor the capability of the coating. This method uses certain spectrums of light (e.g., red, white, near infrared) to obtain voltage readings from the radiator surface in order to distinguish between properly coated and deteriorated or uncoated surfaces. Both methods are essentially indirect approaches for detecting the presence or loss of the catalytic coating. The third approach involves the use of an ozone sensor that directly measures ozone conversion efficiency.

While some manufacturers are highly confident that the identified strategies will meet the monitoring requirements by the 2005 model year, none of the monitoring technologies is currently sufficiently developed for immediate implementation. To allow for proper development, the proposed requirements would allow manufacturers to use the direct ozone reduction system to offset tailpipe HC emissions for three years without meeting the monitoring requirements. Since the direct ozone reduction system does not directly affect any other tailpipe or evaporative emission control system or diagnostic, malfunctions or improper operation of the direct ozone reduction system that go undetected, due to the lack of an OBD II monitor, will not cause higher tailpipe or evaporative emissions nor will it affect the proper operation of any other OBD II monitor. However, to account for the lack of monitoring, the proposed requirements would only allow manufacturers to use 50 percent of the NMOG/HC emission credits assigned for the direct ozone reduction system as calculated in accordance with the guidelines set in ARB MAC No. 99-06. It is a reasonable expectation that if the direct ozone reduction device meets the durability guidelines outlined in ARB MAC No. 99-06, the radiator and direct ozone reduction system (i.e., coating) will likely be effective for at least half of the life of the vehicle.

According to the current guidelines, manufacturers are allowed to use the NMOG credit assigned to the direct ozone reduction system to offset NMOG tailpipe emissions. Consistent with this offset, manufacturers have requested ARB approval to also offset the OBD thresholds, where appropriate. The ARB staff agrees and is proposing requirements that would allow a manufacturer to adjust the malfunction threshold for other monitors (e.g., catalyst, oxygen sensor, etc.) to account for the direct ozone reduction NMOG credit. In other words, if a manufacturer implements a direct ozone reduction system in its vehicles, it may set the OBD II malfunction threshold at 1.5 times the applicable HC standard plus the direct ozone reduction credit (i.e., (1.5 x HC std.) + direct ozone reduction credit).

K. PASSENGER CAR AND LIGHT-DUTY TRUCK SULEV THRESHOLDS

The most stringent Low Emission Vehicle I standard is the ULEV standard for the passenger car and light-duty truck category, with emission levels of 0.055 grams/mile non-methane organic gas (NMOG), 2.1 grams/mile CO, and 0.3 grams/mile NOx at the useful life regulatory interval. The Low Emission Vehicle II standards, however, include a SULEV standard for passenger cars and light-duty trucks that is even more stringent. The SULEV standard has significantly lower emission levels of 0.01 grams/mile NMOG, 1.0 grams/mile CO, and 0.02 grams/mile NOx. The current OBD regulation does not specify malfunction thresholds for vehicles certified to the SULEV standard. However, the ARB recently certified a vehicle meeting the SULEV emission standard, with OBD II malfunction thresholds of 1.5 times the SULEV standard for most monitors and 1.75 times the SULEV standard for the catalyst monitor.

While it is feasible for SULEV vehicles to use the current malfunction thresholds, industry and others have expressed concern that these thresholds are too low. After considering these comments, the staff is proposing thresholds of 2.5 times the applicable standards (referred to in this section as "2.5 threshold") for passenger car and light-duty truck SULEVs[17], which are appropriate for a number of reasons:

- Measuring emissions at SULEV levels using current emission measurement technologies is a recognized challenge by government and industry. This is due to the fact that test-to-test variability (due to production vehicle variability and test equipment variability) constitutes a larger percentage of the standard for SULEV vehicles than for ULEV and less stringent vehicles. In order to ensure compliance on production vehicles, manufacturers certify to both the applicable tailpipe and evaporative emission standards and the OBD II standards with some amount of compliance margin. Given this increased relative variability, a manufacturer is forced to certify to a lower absolute level of emissions than for other vehicles. A 2.5 threshold would reduce a manufacturer's in-use SULEV's liability while providing the time necessary for industry to reduce vehicle variability and to improve the capability of emission-measuring equipment.

- The stringency of the SULEV standards will require manufacturers to develop and produce some emission control components with tighter tolerances. However, industry to date has had minimal production experience with SULEV emission levels and tolerances. Accordingly, if industry used an OBD II malfunction threshold of 1.5 times the tailpipe standards on SULEV vehicles with current production tolerances, the OBD II system could falsely illuminate the MIL for components that are in fact good (i.e., still within production tolerances). A higher threshold would provide manufacturers with sufficient separation between "good" components that are at the limits of production tolerances and "bad" components that are malfunctioning.

- The 2.5 threshold would allow manufacturers to use similar levels of component deterioration on SULEV vehicles as those used on vehicles certified to less stringent standards (e.g., ULEV vehicles). Manufacturers have production and in-use experience with malfunction thresholds, production tolerances, and deterioration on ULEV vehicles. Using a similar level of component deterioration on SULEV vehicles would provide greater assurance that a component is truly malfunctioning and not just at the limits of production tolerances.

Because the SULEV standards are so low, thresholds at 2.5 times the standards would still provide some reasonable level of protection against high emissions while recognizing the challenges associated with vehicles certified to the SULEV standards. The staff will monitor the industry's progress in meeting these challenges and propose revising the thresholds as necessary.

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[17] For these SULEV applications, the proposed NOx catalyst monitoring requirement would be phased in with an interim threshold of 3.5 times the applicable NOx standard, beginning with the 2005 model year, and with a final threshold of 2.5 times the applicable NOx standard required for 2007 and subsequent model year applications.

L. CATALYST AND PARTICULATE MATTER TRAP MONITORING FOR DIESELS

The current OBD II regulation specifically excludes catalyst monitoring for diesels. Unlike gasoline vehicles, current diesels do not have sensors in the exhaust stream that are sufficient for monitoring the catalyst system. Additionally, current diesel vehicles do not require extensive aftertreatment to meet the applicable standards. However, as manufacturers design systems to meet increasingly stringent NOx and particulate matter (PM) emission standards applicable to future diesel light-duty and medium-duty vehicles, many will likely use NOx adsorbers, selective catalytic reduction devices, oxidation catalysts, and PM traps to achieve the necessary emission levels. In order to protect against unacceptably high emissions on vehicles using these technologies, the U.S. EPA adopted requirements for diesel catalyst and PM trap monitoring on 2004 and subsequent model year vehicles with a gross vehicle weight rating (GVWR) of less than 6,000 pounds and 2005 and subsequent model year vehicles with a GVWR between 6,000 and 14,000 pounds.

However, since the U.S. EPA originally adopted its requirements, substantial progress has been made in the development of diesel aftertreatment devices. While it originally appeared unlikely that diesel vehicles would use these devices to any significant extent before the 2007 model year (when more stringent tailpipe standards take effect), there has been some recent indication that manufacturers will use these types of devices to allow light-duty vehicles to meet LEV II program emission standards in the near future. As such, the staff is proposing diesel catalyst and PM trap monitoring requirements that reflect the capability of these new systems and are consistent with gasoline vehicle monitoring requirements.

For 2005 and 2006 model year medium-duty vehicles and engines, the proposed requirements are identical to the U.S. EPA's requirements and are adequate for the level of technology expected to be used on those vehicles. For the 2004 and subsequent model year light-duty vehicles and 2007 and subsequent model year medium-duty vehicles and engines, however, the proposed requirements reflect more stringent monitoring requirements, consistent with both the expected technology to be used and with the current requirements for gasoline vehicles.

For 2005 and 2006 model year medium-duty vehicles, the proposed catalyst requirements would require monitoring of reduction catalysts (i.e., catalysts primarily involved in reducing NOx emissions via reduction processes) for proper conversion capability. Monitoring of oxidation catalysts (i.e., catalysts primarily involved in reducing HC emissions via oxidation processes), which generally have a relatively small emission impact on diesel vehicles, would not be required. Manufacturers would be required to indicate a reduction catalyst malfunction when the conversion capability of the catalyst system decreases to the point that emissions exceed 1.5 times the applicable NOx or PM standard. If a malfunctioning reduction catalyst cannot cause emissions to exceed the emission threshold of 1.5 times the applicable standards, a manufacturer may request an exemption from the requirements for diesel reduction catalyst monitoring.

For 2004 and subsequent model year light-duty vehicles and 2007 and subsequent model year medium-duty vehicles, the proposed catalyst monitoring requirements would require monitoring for both HC and NOx conversion capability. Manufacturers would be required to indicate a catalyst malfunction when the conversion capability of the catalyst system decreases to the point that emissions exceed 1.5 times the applicable HC, NOx, or PM standard. Consistent with all other OBD II monitoring requirements, if a malfunctioning catalyst cannot cause emissions to exceed the emission threshold of 1.5 times the applicable standards, a manufacturer would only be required to functionally monitor the system and indicate a malfunction when no HC or NOx conversion efficiency could be detected. Additionally, through the 2009 model year, no monitoring would be required if the conversion efficiency of the catalyst system was less than 30 percent.

For 2005 and 2006 model year medium-duty vehicles, the proposed requirements for PM traps would require monitoring for proper performance. The malfunction threshold for a PM trap, however, would not be based on a specific emission level. Rather, manufacturers would be required to indicate a PM trap malfunction when catastrophic failure occurs (e.g., a cracked trap substrate). Similar to catalyst monitoring, a manufacturer could be exempted from PM trap monitoring if catastrophic failure would not cause emissions to exceed 1.5 times the applicable standards.

For 2004 and subsequent model year light-duty vehicles and 2007 and subsequent model year medium-duty vehicles, the proposed requirements for PM traps would require monitoring for proper performance. Manufacturers would be required to indicate a PM trap malfunction when the capability decreases to the point that emissions exceed 1.5 times any of the applicable standards. If a malfunctioning PM trap cannot cause emissions to exceed the emission threshold of 1.5 times the applicable standards, a manufacturer would only be required to perform functional monitoring of the system and indicate a malfunction when no PM trap capability could be detected.

Technological Feasibility

In order to comply with future emission standards, diesel engine manufacturers are expected to utilize NOx adsorbers, lean NOx catalysts, oxidation catalysts, and PM traps. Manufacturers may use various groupings of these devices in a system, including some devices that are combined (e.g., a combined trap/NOx adsorber). Diesels will require precise fuel control to optimize aftertreatment device efficiencies and to limit losses in fuel economy due to fueling strategies associated with the devices. With NOx adsorbers, the frequency of fuel addition to the exhaust, intended to reduce NOx emissions, should be minimized to optimize fuel economy. This would suggest the use of a NOx sensor to determine when fueling should occur (manufacturers could rely on engine mapping to achieve the same result, but this might result in excess fueling strategies to provide a safety factor for meeting emission standards). This sensor could also be used to monitor the NOx conversion efficiency of the adsorber. Similarly, selective catalytic reduction systems that rely on the urea additive to accomplish NOx reduction could also rely on a NOx sensor to meter the additive as well as for monitoring purposes. For clean-up oxidation catalysts, the possible use of linear oxygen sensors could be employed for monitoring purposes. Non-passively regenerated traps will likely rely on pressure sensors to determine optimum regeneration frequency to prevent trap damage due to delayed regeneration that could lead to excess temperatures. The same pressure sensor could also be utilized to evaluate the suitability of the trap for controlling particulate emissions.

At this time, diesel control systems are evolving and production intent systems are continuing to be developed. Nonetheless, it appears that the same sensors necessary for aftertreatment device operation can also be utilized for diagnostic purposes. The staff has examined one prototype light-duty diesel vehicle expected to meet the Low Emission Vehicle II standards and believes that monitoring of the aftertreatment systems consistent with the requirements being proposed can be done with the aftertreatment control sensors. The staff will be developing monitoring requirements for heavy duty engines next year and will further evaluate monitoring strategies and requirements for diesel vehicles at that time.

M. COMPREHENSIVE COMPONENT MONITORING

The current OBD II regulation, title 13, CCR section 1968.1, requires the monitoring of comprehensive components, which covers all other electronic powertrain components or systems not mentioned above that either can affect vehicle emissions or are used as part of the OBD II diagnostic strategy for another monitored component or system. They are generally identified as input components, which provide input directly or indirectly to the on-board computer, or as output components or systems, which receive commands from the on-board computer. Typical examples of input components include the mass air flow sensor, manifold absolute pressure sensor, intake air temperature sensor, vehicle speed sensor, and throttle position sensor. Typical examples of output components/systems include idle speed control valves and automatic transmission solenoids.

The OBD II regulation currently requires input components to be monitored continuously for out-of-range and circuit continuity faults (e.g., shorts, opens, etc.) and "once-per-driving cycle" for rationality faults (e.g., where a sensor reads inappropriately high or low but still within the valid operating range of the sensor). The regulation currently requires output components and systems to be monitored once per driving cycle for proper functional response (e.g., when the component is commanded to do something by the on-board computer, the OBD II system verifies that the action has occurred). If functional monitoring is not feasible, circuit continuity monitoring is required.

Monitoring of comprehensive components is essential since the proper performance of these components can be critical to the monitoring strategies of other components or systems. Generally, these components are also essential for proper fuel control or driveability, and malfunctions of them often cause an increase in emissions or impact fuel economy and/or vehicle performance. Because of the vital role that some of these components play and because they continuously provide input to and are used by the on-board computer, the proposal would require more frequent monitoring for some specific components. Specifically, for 2005 and subsequent model year vehicles, rationality monitoring of input components would be required each time all manufacturer-defined enable conditions are met instead of once per driving cycle as previously required in section 1968.1. This would provide earlier detection of components that are beginning to fail, especially those exhibiting intermittent failure.

For output components and systems, the proposal would specifically require functional monitoring of the idle speed control system to be done each time the vehicle is operated at idle and meets the manufacturer-defined monitoring conditions. This change would help ensure that idle speed control system malfunctions are detected as quickly as possible and minimize the chance for problems to go undetected because the system was operating properly the one time during the driving cycle that monitoring occurred. Further, because idle speed control system problems often can prevent other monitors from running and are frequently noticeable to the driver (e.g., stalling or erratic idle), proper detection is essential.

For input components, the proposed regulation would also require manufacturers to store different fault codes that distinguish rationality faults from faults due to lack of circuit continuity and out-of-range values. This would help technicians repair vehicles expeditiously and efficiently by enabling them to perform repair procedures specific to the malfunction present rather than using a lengthy general troubleshooting procedure that covers all possible failure modes. Additionally, for input component lack of circuit continuity and out-of-range circuit faults, manufacturers would be required to store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit). Again, this would enable technicians to find and repair malfunctions more efficiently. However, in cases where lack of circuit continuity faults cannot be distinguished from out-of-range circuit faults, manufacturers would not required to store separate fault codes for each distinct malfunction.

N. OTHER EMISSION CONTROL OR SOURCE DEVICE MONITORING

While the OBD II regulation lists very specific requirements for most emission controls commonly used today, the automotive industry is continually innovating new emission control technologies in addition to refining existing ones. In cases where the technology simply reflects refinements over current technology, the OBD II monitoring requirements are generally sufficient to ensure the improved devices are properly monitored. However, in cases where the new technology represents a completely different type of emission control device, the monitoring requirements for existing emission controls are not easily applied. Typical devices that fall under this category include hydrocarbon traps, NOx storage devices, and thermal storage devices. The purpose of OBD II, however, is clearly to monitor all emission-related and emission control devices. Accordingly, with the regulatory changes that occurred in 1996, a provision was included that required manufacturers to submit a monitoring plan for ARB's review and approval for any new emission control technology prior to introduction on any future model year vehicles. To date, this policy has worked effectively by allowing manufacturers and ARB staff to evaluate the new technology and determine an appropriate level of monitoring that was both feasible and consistent with the monitoring requirements for the conventional emission control devices. As such, the proposed regulation would continue this provision.

However, modifications would be made to provide further guidance as to what type of components would fall under the requirements of this section instead of under the comprehensive component section. Specifically, the staff is concerned that without these changes, confusion may arise for emission control components or systems that can also be defined as electronic powertrain components because they fit the definitions of both sections. As such, the proposal would delineate the two by requiring components/systems that fit both definitions but are not corrected or compensated for by the adaptive fuel control system to be monitored under the provisions of the "other emission control devices" requirements rather than under the comprehensive component requirements. A typical device that would fall under this category instead of the comprehensive components category because of this delineation is a swirl control valve system. Such delineation is necessary because emission control components generally require more thorough monitoring than comprehensive components to ensure low emission levels throughout a vehicle's life. Further, emission control components that are not compensated for by the fuel control system as they age or deteriorate can have a larger impact on tailpipe emissions relative to comprehensive components that are corrected for by the fuel control system as they deteriorate.

Also, to ensure that all devices that can generate emissions on hybrids and other advanced vehicle propulsion technology vehicles are properly monitored, the proposal would expand the requirement to require monitoring of "emission source devices" in addition to emission control devices. For purposes of the proposed regulation, "emission source devices" would be defined as components or systems that emit pollutants that are subject to vehicle evaporative and exhaust emission standards (e.g., NMOG, NOx, PM, etc.). These may include non-electronic components and non-powertrain components such as fuel-fired passenger compartment heaters and on-board reformers. For these devices, manufacturers would be required to submit a plan for Executive Officer approval of the OBD II monitoring strategy, malfunction criteria, and monitoring conditions in the same manner used for emission control devices.

IV. REVISIONS TO STANDARDIZATION REQUIREMENTS

One of the most important aspects of OBD II is the requirement for manufacturers to standardize certain features in the OBD II system. Effective standardization assists all repair technicians by providing equal access to essential repair information, and requires structuring the information in a consistent format from manufacturer to manufacturer. To facilitate the requirements, the ARB has worked closely with the Society of Automotive Engineers (SAE) over the last 15 years to jointly develop standards for OBD II systems.

These standards include specifications for items including the tools used by service technicians, the methods for accessing information in the on-board computer, the numeric fault codes stored when a malfunction is detected, and the terminology used by the manufacturer in service manuals. With continual evolution of technology and the extensive feedback received from technicians in the field and pilot Inspection and Maintenance (I/M) programs around the nation, the ARB is proposing to clarify and update existing requirements and modify others as necessary to assist technicians and ease implementation of OBD II into the I/M program.

A. Phase-in of Controller Area Network (CAN) communication protocol

The current OBD II regulation allows manufacturers to use one of four protocols for communication between a generic scan tool and the vehicle's on-board computer. Currently, a generic scan tool must automatically cycle through each of the allowable protocols to establish communication with the on-board computer. While this has generally worked successfully in the field, some communication problems have arisen due, in part, to the use of multiple protocols. Additionally, the current protocols do not take advantage of many of the technological advances that have occurred over the last several years.

In keeping up with advances in communication technology, the proposed requirements would allow the use of a fifth protocol known as International Standards Organization (ISO) 15765 on 2003 and subsequent model year vehicles. This protocol, a Controller Area Network (CAN) protocol, incorporates significant improvements over those protocols that are currently being used including faster update rates to the scan tool and standardization of more data. Further, to reduce the chance for problems in the field due to the use of multiple protocols and to make sure all vehicles are equipped with the added features available through the CAN protocol, the staff is proposing phasing out the other four currently allowed protocols by the 2007 model year. Thus, all 2008 and subsequent model year vehicles would be required to use CAN as the communication protocol.

The proposal would also modify a provision that currently exists for manufacturers to use an alternate protocol known as SAE J1939 to eliminate the specific reference to SAE J1939 as the allowable alternate protocol. The current provision allows manufacturers of medium-duty vehicles to request Executive Officer approval to use J1939 in lieu of virtually all of the other standardized requirements including communication protocol, diagnostic connector, and access to diagnostic data. This provision was originally intended to allow manufacturers that produce engines for use in both heavy-duty vehicles (not currently required to have OBD II systems) and medium-duty vehicles to use a protocol that was being designed for heavy-duty vehicles. To date, all of the medium-duty vehicles certified to OBD II requirements have used one of the other four allowable protocols and no manufacturer has submitted a request to use the SAE J1939 protocol[18]. Additionally, the California Bureau of Automotive Repair (BAR) has indicated a desire to include all light-duty and medium-duty vehicles in the current I/M (Smog Check) program. To this end, BAR has indicated that the elimination of this provision would ensure that I/M stations in California would be able to inspect all medium-duty vehicles certified for sale in California without having to purchase additional equipment for vehicles using the SAE J1939 protocol.

Recently, the U. S. Environmental Protection Agency (EPA) has begun work on developing OBD regulations for heavy-duty vehicles. ARB has also indicated its intentions to do the same. However, at this time, neither agency has conclusively determined which protocol (or protocols) are appropriate for the standardized requirements that will be used by all manufacturers. ISO, a body similar to SAE but with a larger European influence, has also developed a protocol for heavy-duty vehicles similar to, but not identical to, SAE J1939. Rather than prematurely determining the appropriate protocol for heavy-duty vehicles in the OBD II requirements for light- and medium-duty vehicles, staff has modified the existing provision to allow manufacturers to use whatever protocol ends up being designated as acceptable for heavy-duty OBD rather than specifically designating SAE J1939 as the only allowable exception. With this change, the original intent of the provision is maintained (i.e., engines used in both medium-duty and heavy-duty vehicles can use the same protocol) without creating potential conflicting requirements between future EPA and ARB heavy-duty OBD regulations and the existing OBD II regulation. And while this will not resolve BAR's desire to maintain a single protocol throughout light- and medium-duty applications, it will ensure that if medium-duty applications do differ from light-duty, they will be common with heavy-duty applications (another group of vehicles not currently subject to BAR Smog Check testing but under investigation for possible future inclusion).

B. Readiness status

Readiness status has become a major issue in I/M testing, especially with the recent publishing of U.S. EPA's final rule requiring the use of OBD II checks in state I/M programs (and recommending it be done in lieu of traditional tailpipe emission tests). The readiness status of several major emission control systems and components is checked to determine if the OBD II monitors have performed their system evaluations. When the vehicle is scanned, the monitor reports a readiness status of either "complete" (if the monitor has run since the memory was last cleared), "incomplete" (if the monitor has not yet had the chance to run since the memory was last cleared), or "not applicable" (if the monitored component in question is not contained in the vehicle). The readiness information allows a technician or I/M inspector to determine if the memory in

[18] Subsequent to learning of staff's proposal to eliminate specific reference to SAE J1939, two manufacturers have indicated that future product plans currently exist that would utilize SAE J1939 on engines sold for use in medium-duty vehicles in California. It is anticipated, however, that these products would only utilize SAE J1939 if EPA and ARB allow SAE J1939 in the heavy-duty OBD requirements. As the proposed regulatory change would allow a common (but not yet determined) protocol for heavy-duty OBD and medium-duty OBD, these two manufacturers would not be affected if SAE J1939 is ultimately determined to be the required protocol for heavy-duty OBD in California.

the on-board computer has been recently cleared (e.g., by a technician clearing fault codes or disconnecting the battery).

Readiness flags were developed to prevent fraudulent testing. Prior to their development, drivers or technicians have tried to avoid "fail" designations by disconnecting the battery and clearing the computer memory prior to an I/M inspection. In such occurrences, any pre-existing fault codes are erased and the malfunction indicator light (MIL) is extinguished. The presence of unset readiness flags will cause the vehicle to be rejected from testing and required to return for a re-test at a later date. Unfortunately, the presence of unset readiness flags may also be due to circumstances beyond the driver's control (i.e., the car was not driven under the conditions necessary to run some of the monitors) and these drivers will also be rejected from testing. In addition, as they should, technicians routinely clear the computer memory after repairing an OBD II-detected fault in order to erase the fault code and extinguish the MIL, which consequently also resets the readiness status. As in the previous cases, a vehicle that has not had sufficient time to operate after repair services by a technician may have unset readiness flags and be rejected from I/M testing.

To address these issues, the staff is proposing several provisions to help technicians determine if the memory had recently been cleared, either after repairs or fraudulently. Beginning with 2005 model year vehicles using the CAN communication protocol, vehicles would be required to make available data on the distance elapsed and the number of warm-up cycles since the fault memory was last cleared. By accessing these data, technicians would be able to determine if unset readiness flags or an extinguished MIL are due to recent clearing of the memory or circumstances beyond the driver's control. This would allow an I/M program to be setup to allow I/M technicians to reject only those vehicles with recently cleared memories from the I/M inspection.

Provisions have also been added to make it easier for technicians to prepare the vehicle for an I/M inspection following a repair by providing real time data which indicates whether certain conditions necessary to set all the readiness flags to 'complete' are currently present. This data will indicate whether a particular monitor still has an opportunity to run on this driving cycle or whether a condition has been encountered that has disabled the monitor for the rest of the driving cycle. While this data won't provide technicians with the exact conditions necessary to exercise the monitors (only service information will do that), this information in combination with the service information should facilitate technicians in verifying repairs and/or preparing a vehicle for inspection.

The revised OBD II-I/M program has raised issues regarding the effect on consumers because of possible rejection from I/M testing due to unset readiness flags. To address this, some manufacturers have requested the option to communicate the vehicle's readiness status directly to the vehicle owner without the use of a scan tool. This would allow the vehicle owner to be sure that the vehicle is ready for inspection prior to taking the vehicle to an I/M station. As such, the staff is proposing to allow manufacturers the option of communicating readiness status to the vehicle owner using the MIL as an indicator. If manufacturers choose to implement this option, though, they would be required to do so in the standardized manner prescribed in the proposed regulation. On vehicles equipped with this option, the vehicle owner would be able to initiate a self-check of the readiness status, thereby greatly reducing the possibility of being rejected at the I/M inspection.

C. Use of manufacturer-specific fault codes

Fault codes are the means by which malfunctions detected by the OBD II system are reported and displayed on a scan tool for service technicians. The current OBD II regulation requires manufacturers to report all emission-related fault codes using a standardized format whenever possible and to make them accessible to all service technicians, including the independent service industry. SAE J2012 ("Recommended Practice for Diagnostic Trouble Code Definitions") defines many generic fault codes to be used by all manufacturers. If a manufacturer cannot find a suitable fault code in J2012, unique "manufacturer-specific" fault codes can be used. However, these manufacturer-specific fault codes are not as easily interpreted by the independent service industry. As the use of manufacturer-specific fault codes increases, the time and cost for vehicle repair may also increase.

The ARB is proposing to further restrict the use of manufacturer-specific fault codes. If a generic fault code suitable for a given malfunction cannot be found in J2012, the regulation would require the manufacturer to pursue SAE approval of additional generic fault codes to be added to J2012. This proposal would affirm the original intent of the OBD II regulation to standardize as much information as possible and would benefit the independent service industry and vehicle owners by potentially reducing the time and costs required to repair vehicles.

D. Access to additional data through a generic scan tool

Currently, manufacturers are required to report approximately 15-20 "real-time" data parameters in a format that a generic scan tool can process and read. These parameters, which include information such as engine speed and oxygen sensor voltages, are used by technicians to help diagnose and repair emission-related malfunctions by watching instantaneous changes in the values while operating the vehicle. The set of 15-20 standardized parameters is, however, only a subset of all the information that is actually available on a vehicle. Scan tools designed and built specifically for dealer technicians sometimes offer access to over 300 different parameters.[19] While the standardized items available through a generic scan tool were never intended to duplicate the function of a vehicle-specific scan tool, they were

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[19] It should be noted that, while the generic scan tool does not provide for access to these additional data parameters, separate service information regulations require manufacturers to make information available to scan tool designers so that they may incorporate the additional features into their tools.

intended to provide a technician with the minimum amount of information necessary to perform emission-related repairs.

As technology has advanced, new components that do not fit well in the previously defined standardized definitions are becoming more commonplace. Additionally, feedback from technicians in the field has identified the need for some additional standardized parameter definitions. As such, the proposed regulation defines over 20 additional parameters that manufacturers would be required to report to generic scan tools. These parameters should provide technicians with the additional information necessary to make cost-effective emission-related repairs. The new parameters should also provide technicians and I/M inspectors with valuable information that will enable them to more easily prepare a vehicle for an OBD II-based I/M inspection. Lastly, the proposed regulation would provide further clarification for two existing parameters (engine load and throttle position) to ensure consistent use by all manufacturers. To provide a smooth transition, the staff is proposing that manufacturers be required to make the additional information available on all 2005 and subsequent model year vehicles equipped with CAN as the generic scan tool communication protocol.

E. Reporting of pending fault codes

For most OBD II strategies, the same malfunction must occur on two separate driving events to illuminate the MIL. This "double" detection ensures that a malfunction truly exists before alerting the owner. The first time a malfunction is detected, a "pending" fault code, which identifies the failing component or system, is stored in the on-board computer. If the same malfunction is again detected the next time the vehicle is operated, the MIL is illuminated and a "confirmed" fault code is stored. When the MIL is illuminated (alerting the vehicle operator to a problem) and a vehicle is brought in for service, a technician uses the "confirmed" fault code to determine what system or component has failed. A "pending" fault code, however, can be used by service technicians to help diagnose intermittent problems as well as to verify that repairs were successful. In these instances, a technician can use the "pending" fault code as a quicker, earlier warning of a suspected (but as yet unconfirmed) problem.

Presently, manufacturers are allowed to use two different strategies to report "pending" malfunctions to a scan tool, but this has led to unnecessary confusion and difficulty for repair technicians. In some instances, the "pending" malfunction is reported as a numeric fault code in the same manner that "confirmed" fault codes are reported. In other instances, however, the "pending" malfunction is reported as a numeric test result and a numeric maximum or minimum allowable limit for the test result. In the latter case, a technician must translate the test result and limits to engineering units using manufacturer specific conversion factors and determine if the test result is a "passing" value or a "failing" value. The proposed regulation would require manufacturers to report all "pending" malfunctions in the form of a "pending" fault code so technicians will not need to interpret test results to determine if a "pending" fault has been detected. Additional clarification is also added to ensure that all manufacturers store and erase pending fault codes in a manner that provides a consistent message that technicians can understand and rely on.

F. Software Calibration Identification Number (CAL ID) and Calibration Verification Number (CVN)

OBD II diagnostics are comprised of software routines and calibrated limits and values to determine if a component or system is malfunctioning. Manufacturers often release updates to the software in the on-board computer to add new features and improvements or to correct errors or "bugs" found in the system. To determine if the correct software has been installed, amendments were adopted in 1996 that required manufacturers to phase-in reporting of two additional items. The first item, Calibration Identification Number (CAL ID), identifies the version of software installed in the vehicle. The second item, Calibration Verification Number (CVN), helps to ensure that the software has not been inappropriately corrupted, modified, or tampered with. CVN requires manufacturers to develop sophisticated software algorithms that can verify the integrity of the emission-related software and ensure that the diagnostic routines and calibration values have not been modified inappropriately.

Both CAL ID and CVN requirements were adopted to ensure the integrity of the OBD II system during I/M inspections. As pilot OBD II-based I/M programs have been tested across the nation, several improvements have been identified as necessary to allow for effective use of the CVN in an I/M inspection. Therefore, several changes are proposed for the CVN requirements that would help an I/M technician access and correctly use the CVN results. Most notably, these changes include a requirement that the CVN result be available at all times to a generic scan tool (instead of allowing manufacturers to only generate a result during key on, engine off conditions). Due to other factors, OBD II-based I/M testing is currently being performed only during engine running conditions, which creates an incompatibility with CVN results that are only calculated when the engine is off. Accordingly, the proposal includes a delay in the current CVN requirements from the 2002 to the 2005 model year to allow manufacturers additional time to meet the proposed changes.

G. Vehicle Identification Number (VIN)

The Vehicle Identification Number (VIN) is a unique, 17-digit, alphanumeric number assigned by the manufacturer to every vehicle built. The VIN is commonly used for purposes of ownership and registration to uniquely identify every vehicle. As such, the VIN is also used during an I/M inspection to identify the exact vehicle being tested. Current I/M programs require the inspector to enter the VIN at the time of inspection by manually typing it in or, in some cases, using a bar code reader to "scan" it in. However, when the VIN is manually entered, errors can and do occur. In addition, a long standing criticism of current I/M programs, including California's Smog Check program, is that it is very easy for an inspector to fraudulently pass failing vehicles by entering the VIN of one vehicle and performing an emissions test on a known "clean" vehicle (a practice known as "clean-piping").

In order to reduce the number of errors related to VIN entry, to facilitate entry of the VIN, and to further deter fraud during I/M inspections, the proposed regulation would require the VIN to be stored in the vehicle's on-board computer and accessible electronically via a generic scan tool. This would be required on all 2005 and newer model year vehicles. While this would not eliminate the possibility of a technician performing a fraudulent inspection, it would make it significantly more difficult.

H. Service Information

OBD II requirements have traditionally required manufacturers to make all emission-related vehicle service information available to all service technicians, including independent and after-market service technicians. Amendments adopted in 1996 and scheduled to take effect for the 2002 model year further required that service information be made available in an SAE-defined standardized electronic format to try and improve the accessibility of the information.

With the advances in Internet technology, however, recent legislation has been adopted in California that requires service information to be made available through the Internet. As a result, the Board recently approved the adoption of a stand-alone service information regulation in December 2001 that identifies, in a single regulation, all of the service information requirements that manufacturers must meet. The service information regulation, however, does not require manufacturers to make service information available before January 1, 2003, whereas the OBD II regulation requires service information to be available before then, although not via the Internet. The staff is proposing inclusion of language in the OBD II regulation to clarify that, to the extent the service information regulation is effective and operative, it would supercede any redundant service information requirements in the OBD II regulation.

V. REVISIONS TO DEMONSTRATION TESTING REQUIREMENTS

Some manufacturers have raised issues regarding the demonstration testing requirements in the OBD II regulation in light of recently adopted abridged certification procedures. The current regulation requires a manufacturer to provide OBD II-related emission test data from one certification durability vehicle per model year. With Executive Officer approval, a representative high mileage vehicle may be used instead of the certification durability vehicle. Manufacturers indicate that certification durability vehicles are not readily accessible to their OBD II engineering groups and that it is often difficult to obtain suitable high mileage vehicles for OBD II demonstration purposes prior to emission certification. In addition, new alternative durability programs (ADP) that simulate high mileage by bench aging only a few of the vehicle components reduce the number of actual high mileage vehicles available for OBD II demonstration testing. Further, the ARB has concerns regarding the effect the trend in industry toward consolidation of manufacturers will have on the representativeness of the relatively small number of demonstration vehicles. Consolidation reduces the number of demonstration test vehicles that the ARB can select each year (one per manufacturer) although the number of different engine families/test groups remains much the same.

In considering these issues, the ARB proposes to increase the number of demonstration vehicles to be tested by a manufacturer each year. The required number of demonstration vehicles would vary from one to three depending on the total number of test groups a manufacturer plans to certify in a particular model year. Additionally, the proposal expands the required testing to include nearly all monitors calibrated by the manufacturer to indicate a fault prior to a prescribed tailpipe emission level (e.g., 1.5 times the FTP standards). However, to minimize the testing burden this places on manufacturers who are required to test more than one vehicle per year, the proposed regulation would allow manufacturers to use a less rigorous test procedure (e.g., internal 'sign-off' quality testing as opposed to official FTP test procedures) for some of the testing. Manufacturers would still be liable for meeting the emission thresholds if ARB conducted confirmatory testing using the official FTP test procedures. But the manufacturers would be able to save considerable time and resources during the certification process by using less rigorous, but still representative, test procedures.

To address industry's concern regarding the reduced availability of certification durability or appropriate high mileage vehicles, the staff is proposing that manufacturers be allowed to submit data from vehicles aged to high mileage with an approved ADP process. It should be noted, however, that even though the proposal would allow the OBD II system to be demonstrated on a simulated high mileage vehicle, manufacturers would remain liable for compliance with OBD II emission thresholds on vehicles in-use. For this reason, the ARB encourages manufacturers to continue to calibrate their OBD thresholds on high mileage vehicles where all components are deteriorated to some degree. Actual high mileage vehicles could result in relatively higher emissions when a single component fails than if a low mileage vehicle is used with only a couple of bench-aged components present. If a high mileage vehicle is not used during calibration, a manufacturer would likely need to allow more margin when determining its malfunction thresholds.

VI. REVISIONS TO CERTIFICATION REQUIREMENTS

A. Certification Application

At the time of adoption of the LEV II program, modifications to the certification, assembly-line, and in-use test requirements were also adopted. These modifications, known as CAP 2000[20], provide manufacturers with added control and flexibility in the certification process. Previously, certification procedures required manufacturers to submit all certification information prior to certification. Under CAP 2000, only the most essential certification information is required before Executive Officer approval is issued. The remainder of the information has to be submitted either by January 1st of the model year or upon request by the ARB, depending on the information. In developing the CAP

[20] Refer to title 13, CCR sections 2037, 2038, 2062, 2106, 2107, 2110, 2112, 2114, 2119, 2130, 2137, 2139, 2140, and 2143-2146.

2000 requirements, changes to the OBD II approval process and certification submittal requirements were also negotiated. The proposed regulation reflects changes to the number of applications required to be submitted each model year and the deadlines by which specific information must be submitted.

The proposal would allow manufacturers to establish OBD II groups consisting of test groups with similar OBD II systems and submit only one set of representative OBD II information from each OBD II group. The staff anticipates the representative information will normally consist of an application from a single representative test group. In selecting the representative test group, the manufacturer would need to consider tailpipe and evaporative emission standards, OBD II phase-in requirements (i.e., if a representative test group meets the most stringent monitoring requirements), and the exhaust emission control components for all the test groups within an OBD II group. For example, if one test group within an OBD II group has additional emission control devices such as secondary air or EGR, that test group should be selected as the representative test group. If one test group does not adequately represent the entire OBD II group, the manufacturer may need to provide information from several test groups within a single OBD II group to ensure the submitted information is representative.

The proposal would also require only the OBD II information necessary for certification evaluation of the OBD II systems to be submitted prior to certification. Requirements for the additional information currently required to be submitted at the time of certification have been modified to allow submittal by January 1 of the model year for some of the information and upon request by the ARB for other portions.

Lastly, the proposal would require manufacturers to submit a portion of the certification documentation in a standardized table format previously issued by the ARB in a mail-out regarding OBD II compliance guidelines (Mail-Out #95-20). In combination with the standardized table format, manufacturers would be required to use a common set of engineering units to simplify and expedite the review process by the ARB staff.

B. Model Year Designation for Certification

In the existing OBD II regulation, manufacturers of medium-duty vehicles that utilize engines certified on an engine dynamometer have additional flexibility in designating the appropriate model year (and thus, the requirements that the engine must be certified to). Specifically, engine manufacturers are allowed to determine the appropriate model year not based on the model year of the vehicle in which the engine is installed and sold but rather on the calendar year in which the engine was built. Originally, this requirement was to permit engine manufacturers to continue to build and certify engines on a calendar year basis rather than conforming to the conventional model year designations used by vehicle manufacturers (e.g., the introduction of new 2002 model year vehicles near the end of the 2001 calendar year). For engine manufacturers, this flexibility also makes it easier for them to sell the same engine to numerous chassis or vehicle manufacturers no matter what model year the chassis or vehicle manufacturer will ultimately designate on the vehicle.

However, this additional flexibility has caused some confusion during certification as well as presents additional difficulty for the inclusion of medium-duty vehicles into the California Smog Check program. For instance, vehicle manufacturers of full-size pick-ups will typically have 2001 model year engines installed in trucks designated as 2002 model year vehicles and built before January 1, 2002. The same truck model built after January 1, 2002, will also be designated a 2002 model year vehicle but will have a 2002 model year engine installed. In situations where the certification requirements have substantially changed (e.g., lower emission standards, phase-in of other requirements, etc.), the two "versions" of the same vehicle are quite different. And, with California Department of Motor Vehicle (DMV) registration records as well as BAR records typically tied to the model year of the vehicle, not the engine, this can result in vehicles being tested to inappropriate standards. For example, when Smog Check inspections are performed, the standards (or in some cases, type of testing) are typically based on the model year of the vehicle, not the engine.

To avoid further confusion and simplify introduction into the Smog Check program, the proposed regulation would eliminate this flexibility for medium-duty vehicles beginning with the 2004 model year. From that time on, engines would be required to be certified to the OBD II requirements applicable to the designated vehicle model year. Like vehicle manufacturers, engine manufacturers would be required to phase-in new monitoring requirements with the same leadtime as provided for vehicle manufacturers. As the OBD II requirements only apply to engines installed in medium-duty applications, the requirements for engines produced for heavy-duty applications are unaffected. Likewise, since this change is only used for purposes of determining compliance with the OBD II monitoring requirements, all other certification requirements for engines (e.g., emission standards) would remain unaffected and would continue to be applied as they are currently.

VII. PRODUCTION VEHICLE EVALUATION AND VERIFICATION TESTING

A. Verification of Standardized Requirements

An essential part of OBD II systems is the numerous standardized requirements that manufacturers have to design to. These standardized requirements include items as simple as the location and shape of the diagnostic connector (where technicians can "plug in" to the on-board computer) to more complex subjects concerning the manner and format in which fault information is accessed by technicians via a "generic" scan tool. The importance of manufacturers meeting these standardized requirements is essential to the continued success of the OBD II program, since it would ensure access for all technicians to the stored information in the on-board computer in a consistent manner. The need for consistency is even higher now as states across the nation, including California, are moving towards implementation of OBD II into the I/M program (which relies on access to the information via a "generic" scan tool). In order for I/M inspections to work effectively and efficiently, it is essential that all vehicles are designed *and built* to meet all of the applicable standardized requirements.

While the vast majority of vehicles are indeed complying with all of the necessary requirements, some problems involving the communication between vehicles and "generic" scan tools have occurred in the field. The cause of the problem can range from differing interpretations of the existing standardized requirements to oversights by the design engineers to hardware inconsistencies or last minute production changes on the assembly line. Due to some of these problems, EPA has proposed "special handling," or recommended procedures to be taken by I/M technicians, for a few makes and models of vehicles in an OBD II-based I/M program. To try and minimize the chance for such problems on future vehicles, the staff is proposing that manufacturers be required to test a sample of production vehicles from the assembly line to verify that the vehicles have indeed been designed and built to the required specifications for communication with a "generic" scan tool.

Under the proposal, manufacturers would be required to test one vehicle per software "version" released by the manufacturer to ensure it complies with some of the basic "generic" scan tool standardized requirements, including those that are essential for proper I/M inspection. With proper demonstration, manufacturers would be allowed to group different calibrations together and demonstrate compliance on a single vehicle. Such testing should occur early enough to provide manufacturers with early feedback of the existence of any problems and time to resolve the problem prior to the vehicles being introduced into the field.

To verify that all manufacturers are testing vehicles to the same level of stringency, the proposed regulation would require the vehicle manufacturers to get ARB approval of the testing equipment used by the manufacturer to perform this testing. ARB approval of the testing equipment would be based upon whether the equipment can verify that the OBD II system complies with the standardized requirements and will likely communicate properly with any off-board test equipment (e.g., generic scan tools) that is also designed to meet the standardized requirements. Staff anticipates that the vehicle manufacturers and scan tool manufacturers will likely develop a common piece of hardware and software which could be used by all vehicle manufacturers at the end of the assembly line to meet this requirement. In fact, both SAE and ISO have workgroups considering the development of standards for such equipment. This "gold standard" equipment would be designed exactly to the applicable SAE and ISO specifications for "generic" scan tools and would serve as a "check-valve" at the end of assembly line. Consistent with the proposal to eliminate all protocols except one (CAN) by the 2008 model year, this testing will only be required on 2005 and subsequent model year vehicles using CAN as the generic communication protocol.

It is important to note, however, that this "gold standard" equipment would not replace the function of existing "generic" scan tools used by technicians or I/M inspection stations. This equipment would be custom designed and used expressly for the purposes of this assembly line testing and would not include all of the necessary features for technicians or I/M inspectors. While this verification testing would not completely eliminate the chance for problems in the field, it would be expected to greatly reduce the number of problems that dictate "special" handling in an I/M test.

B. Verification of Monitoring Requirements

The OBD II regulation requires comprehensive monitoring of virtually every component on the vehicle that can cause an increase in emissions. To accomplish this task, manufacturers develop sophisticated diagnostic routines and algorithms that are programmed into software in the on-board computer and calibrated by automotive engineers. This translates into thousands of lines of software programmed to meet the diagnostic requirements but not interfere with the normal operation of the vehicle. While most manufacturers have developed extensive verification or "sign-off" test procedures to ensure that the diagnostics function correctly, problems can and do happen. Moreover, many times the majority of this validation testing is focused on finding problems that will cause the MIL to falsely illuminate when no malfunction really exists rather than verifying that the MIL will indeed illuminate when a malfunction does exist.

The problems that occur can vary greatly in severity from essentially trivial mistakes that have no noticeable impact on the OBD II system to situations where significant portions of the OBD II system and normal vehicle fuel and emission control system are disabled. Furthermore, it is often very difficult to assess the impact the problem may or may not have on vehicles that will be on the road for the next 10-30 years. The cause of the problems can also vary from simple typing errors in the software to carelessness to unanticipated interactions with other systems or production or component supplier hardware changes.

In an attempt to minimize the chance for significant problems going undetected and to ensure that all manufacturers are devoting sufficient resources to verifying the performance of the system, the staff is proposing that manufacturers be required to perform a thorough level of validation testing on one to three actual production vehicles per model year and submit the results to ARB. Manufacturers would be required to individually implant or simulate malfunctions to verify that virtually every single diagnostic on the vehicle correctly identifies the malfunction. The testing would be required to be completed and reported to ARB within 120 days after a manufacturer begins full-scale production to provide early feedback on the performance of every diagnostic on the vehicle. As an incentive to perform this thorough testing, a manufacturer could request that any problem discovered during this self-testing be evaluated as a deficiency. In contrast, problems discovered later by the ARB staff during in-use testing would become noncompliance issues and handled in accordance with the proposed OBD II-specific enforcement regulation (discussed in detail in section XIII of this report).

C. Verification and Reporting of In-use Monitoring Performance

The staff is proposing that manufacturers track the performance of several of the most important monitors on the vehicle to determine how often they are executing during in-use operation. These requirements are discussed in more detail in section IX. Essentially, the proposed regulation would standardize a method for measuring and determining how often monitors are executing in the real world and set a minimum acceptable performance level. Monitors that perform below the acceptable levels would be subject to remedial action including potential recall.

In conjunction with the proposal to measure in-use monitoring frequency, the staff is also proposing that manufacturers be required to collect this in-use data during the first six months after production begins. This information would provide the ARB with early indication as to whether or not the system is performing adequately. Manufacturers would be required to submit frequency data from a sample of at least 30 vehicles that are representative of California driving. Before acquiring this data, manufacturers would be required to gain ARB approval of the manufacturer sampling plan to assure the data collected would be representative, as judged by the ARB staff. This would allow each manufacturer to identify the most cost-effective way to obtain the data. Some manufacturers may find it easiest to collect data from vehicles that come in to its dealerships for routine maintenance or warranty work during the initial six months, while others may find it more advantageous to hire a contractor to collect the data. Further, upon good cause, the Executive Officer may extend the time period for the collection of data from six months to one year to cover situations where manufacturers have difficulty in gathering the required data in the first six months.

The data collected in this program is not intended to be a substitute for testing performed by the ARB to determine if a manufacturer is complying with the minimum acceptable performance levels established in the OBD II regulation. In fact, the data collected under this program would not likely meet all the required elements for testing by ARB to make an official determination that the system is noncompliant. Rather, this data is primarily intended to provide an early indication that the systems are working as intended in the field and provide information to "fine-tune" (if necessary) the proposed requirements for tracking the performance of monitors.

VIII. DEFICIENCIES

One important aspect to the success of the OBD II program so far is the allowance for deficiencies. Originally adopted in 1993, this allows manufacturers who make a good-faith attempt to design compliant systems but fall short of one or more of the requirements to still certify vehicles for sale. To prevent manufacturers from abusing the deficiency allowance by using it for product planning purposes or subjecting the OBD II system to cost-cutting efforts just to avoid monitoring, several criteria have been established: (1) to qualify for a deficiency, manufacturers are required to demonstrate that a good-faith effort was made to comply with the requirements in full; (2) limitations have been set on how many model years a manufacturer may "carry-over" the deficiency before it has to be corrected; and (3) manufacturers are subject to fines for every vehicle built with more than two deficiencies.

The current requirements allow two "free" deficiencies through 2003 before dropping to one "free" deficiency thereafter. As can be expected, the deficiency provisions were used most often in the early model years of OBD II implementation. However, as new OBD II requirements have been continually added or phased-in and as tailpipe emission standards continue to go lower, manufacturers continue to occasionally encounter situations where deficiencies are needed.

To address this, the staff is proposing to continue indefinitely the existing provisions that allow two "free" deficiencies before vehicles and manufacturers are subject to fines. The existing fine structure, qualifications for a deficiency, and limitations on carry-over would continue to apply.

The proposed regulation would modify the existing deficiency provisions in section 1968.1 of title 13, CCR to clarify that deficiencies, with one exception, are only available prior to certification and cannot be applied retroactively (e.g., if a problem is discovered later in the field, etc.). The exception allows manufacturers that discover a problem within the first four months after production begins to apply for a deficiency retroactive to the start of production. All of the other deficiency qualifications (e.g., good faith effort, etc.) would still have to met in addition to the manufacturer demonstrating that the problem could not have reasonably been anticipated. This should provide additional incentive to manufacturers to more thoroughly test production vehicles and inform the ARB of any identified problems discovered during this testing rather than gamble on whether or not the problem may be discovered later by ARB during in-use testing.

The proposed regulation would also clarify that carry-over of deficiencies would not be automatically granted. As mentioned above, one of the primary qualifications necessary to receive a deficiency is a demonstration of a good faith effort by the manufacturer to meet the requirements in full. As part of this good faith effort, ARB takes into account the manufacturer's efforts to remedy the deficiency in a timely manner. Accordingly, manufacturers would only be allowed to carry-over deficiencies when the situation warrants the additional time.

Lastly, the proposed deficiency provisions would explicitly prohibit the Executive Officer's authority to grant a deficiency in some situations. As discussed in more detail in section XIII, the proposed enforcement test procedures would mandate the recall of the most serious nonconforming OBD II systems (section 1968.5(c)(3)(A)). Accordingly, the proposed regulation would specifically prohibit the granting of a deficiency in situations where a recall would be subsequently mandated under the proposed enforcement test procedures.

IX. A STANDARDIZED METHOD TO MEASURE REAL WORLD MONITORING PERFORMANCE

A. Background

In designing an OBD II monitor, manufacturers must define enable conditions that bound the vehicle operating conditions where the monitor will execute and make a judgment as to whether a component or system is malfunctioning. Manufacturers must design these enable conditions so that the monitor is: (a) robust (i.e., accurately making pass/fail decisions), (b) running frequently in the real world, and, (c) in general, also running during an FTP emission test. If designed incorrectly, these enable conditions may be either too broad and result in inaccurate monitors, or overly restrictive and prevent the monitor from executing frequently in the real world. While the vast majority of manufacturers have been successful in designing monitors that meet all three goals, a few have not. Additionally, some manufacturers have asked for increased specificity as to how frequently monitors are required to run in the real world. Since the primary purpose of an OBD II system is to continuously monitor for and detect emission-related malfunctions while the vehicle is operating in the real world, a standardized methodology for quantifying real world performance would be beneficial to both the ARB and vehicle manufacturers. Furthermore, it would better ensure that all manufacturers are held to the same standard for real world performance. Lastly, while the current OBD II regulation requires monitoring to occur frequently during real world driving, it does not explicitly state a minimum acceptable monitoring frequency. In-use testing conducted by the ARB has indicated that some manufacturers have designed systems with excessively restrictive enable conditions preventing routine execution of the monitors. Accordingly, the staff believes it is necessary to propose procedures that will ensure that monitors operate properly and frequently in the field.

Staff is therefore proposing that all manufacturers be required to use a standardized method for determining real world monitoring performance and hold manufacturers liable if monitoring occurs less frequently than a minimum acceptable level, expressed as minimum acceptable in-use performance ratio. The proposed amendments would also require manufacturers to implement software in the on-board computers to track how often several of the major monitors (i.e., catalyst, oxygen sensor, exhaust gas recirculation, secondary air, and evaporative system) execute during real world driving. The on-board computer would keep track of how many times each of these monitors has executed as well as how often the vehicle has been driven. By measuring both these values, the ratio of monitor operation relative to vehicle operation can be calculated to determine monitoring frequency.

The proposed requirements would establish a minimum acceptable frequency that was derived from a two week time period. More specifically, a monitor that can illuminate the MIL in less than two weeks of driving after a malfunction occurs would meet the minimum frequency requirement. As stated before, the vast majority of manufacturers have been able to successfully design compliant OBD II monitors for the past five years and, as such, the proposed minimum acceptable frequency should be consistent with the performance of most of the current monitors. For those manufacturers that are unsuccessful, however, the proposal would likely make it easier for the ARB to identify problematic monitors.

The proposed minimum acceptable frequency requirement would apply to many of the OBD II system monitors. Currently, most monitors are required to operate either continuously (e.g., all the time) or "once-per-driving-cycle" (e.g., once per driving event). For components or systems that are more likely to experience intermittent failures or failures that can routinely happen in distinct portions of a vehicle's operating range (e.g., only at high engine speed and load, only when the engine is cold or hot, etc.), monitors are required to be continuous. Examples of continuous monitors include the misfire monitor, fuel system monitor, and most electrical/circuit continuity monitors. For components or systems that are less likely to experience intermittent failures or failures that only occur in specific vehicle operating regions or for components or systems where accurate monitoring can only be performed under limited operating conditions, monitors are required to be run "once per driving cycle". Examples of "once-per-driving-cycle" monitors include catalyst monitors, EGR system monitors, and evaporative system leak detection monitors.

Monitors that run continuously, by definition, will always be running and a minimum frequency requirement is unnecessary. The new frequency requirement would essentially apply only to those monitors that were previously designated as "once-per-driving-cycle". For all of these monitors, manufacturers will be required to define monitoring conditions that ensure adequate frequency in-use. Specifically, the monitors will need to run often enough that the measured monitor frequency on in-use vehicles would exceed the minimum acceptable frequency. However, even though the minimum frequency requirement would apply to nearly all "once-per-driving-cycle" monitors, manufacturers would only be required to implement software to track and report the in-use frequency for a few of the major monitors. These few monitors generally represent the most critical emission control components and the most difficult to run monitors. Standardized tracking and reporting of only these monitors should, therefore, provide sufficient indication of monitoring performance.

In order to ensure that a standardized methodology is used by the ARB and manufacturers to determine if this level of performance is met, the proposed amendments would also include a test procedure to be used for compliance testing of real world vehicles. This test procedure would identify how vehicles are selected, how many vehicles are selected, how the data are gathered, and what criteria are used to analyze the data and make a determination. The test procedure would ensure that a sufficient number of cars are sampled to accurately determine if vehicles do or do not comply with the minimum acceptable frequency.

B. Detailed description of software counters to track real world performance

As stated above, manufacturers would be required to track monitor performance by counting the number of monitoring events (i.e., how often each diagnostic has run) and the number of vehicle driving events (i.e., how often has the vehicle been operated). The ratio of the two would give an indication of how often the monitor is operating relative to vehicle operation. Thus:

$$\text{In - Use Performance (Ratio)} = \frac{\text{Number of Monitoring Events (Numerator)}}{\text{Number of Driving Events (Denominator)}}$$

To ensure all manufacturers are tracking performance in the same manner, the proposed amendments include very detailed requirements for defining and incrementing both the numerator and denominator of this ratio. Manufacturers would be required to keep track of separate numerators and denominators for each of the major monitors, and to ensure that the data are saved every time the vehicle is turned off. The numerators and denominators would be reset to zero only in extreme circumstances when the non-volatile memory has been cleared (e.g., when the on-board computer has been reprogrammed in the field, when the on-board computer memory has been corrupted, etc.). The values would not be reset to zero during normal occurrences such as when fault codes have been cleared or when routine service or maintenance has been performed.

Further, the numerator and denominator would be structured such that the maximum value each can obtain is 65,535, the maximum number that can be stored in a 2-byte location, to ensure manufacturers allocate sufficient memory space in the on-board computer. If either the numerator or denominator for a particular monitor reaches the maximum value, both values for that particular monitor will be divided by two before counting resumes. In general, the numerator and denominator would only be allowed to increment a maximum of once per driving cycle because most of the major monitors are designed to operate only once per driving cycle. Additionally, incrementing of both the numerator and denominator for a particular monitor would be disabled (i.e., paused but the stored values would not be erased or reset) only when a fault has been detected (i.e., a pending or confirmed code has been stored) that prevents the monitor from executing. Once the fault is no longer detected and the pending fault code is erased, either through the allowable self-clearing process or upon command by a technician via a scan tool, incrementing of both values would resume.

To handle many of these issues, staff has been and continues to work with industry and SAE to develop standards for storing and reporting the data to a generic scan tool. This would also help ensure that all manufacturers report the data in an identical manner and thus help facilitate data collection in the field.

1. Number of monitoring events ("numerator")

For the numerator, manufacturers would be required to keep a separate numeric count of how often each of the particular monitors has operated. However, this is not as simple as it may seem. More specifically, manufacturers would have to implement a software counter that increments by one every time the particular monitor meets all of the enable/monitoring conditions for a long enough period of time such that a malfunctioning component would have been detected. For example, if a manufacturer requires a vehicle to be warmed-up and at idle for 20 seconds continuously to detect a malfunctioning catalyst, the catalyst monitor numerator can only be incremented if the vehicle has actually operated in all of those conditions simultaneously. If the vehicle is operated in some but not all of the conditions (e.g., at idle but not warmed-up), the numerator would not be allowed to increment because the monitor would not have been able to detect a malfunctioning catalyst unless all of the conditions were simultaneously satisfied.

Another complication is the difference between a monitor reaching a "pass" or "fail" decision. At first glance, it would appear that a manufacturer should simply increment the numerator anytime the particular monitor reaches a decision, be it "pass" or "fail". However, many monitoring strategies have a different set of criteria that must be met to reach a "pass" decision versus a "fail" decision. As a simple example, a manufacturer may appropriately require only 10 seconds of operation at idle to reach a "pass" decision but require 30 seconds of operation at idle to reach a "fail" decision. Manufacturers would only be allowed to increment the numerator if the vehicle was at idle for 30 seconds even if the monitor actually executed and reached a "pass" decision after 10 seconds. This is necessary because the primary function of OBD II systems is to detect malfunctions (i.e., to correctly reach "fail" decisions, not "pass" decisions), and thus, the real world ability of the monitors to detect malfunctions is the parameter that needs to be measured. Therefore, monitors with different criteria to reach a "pass" decision versus a "malfunction" decision would not be able to increment the numerator solely on the "pass" criteria being satisfied.

It is imperative that manufacturers implement the numerators correctly to ensure a reliable measure for determining real world performance. "Overcounting" would falsely indicate the monitor is executing more often than it really is, while "undercounting" would make it appear as if the monitor is not running as often as it really is. Manufacturers would be required to demonstrate the proper function of the numerator incrementing strategy to the ARB prior to certification, and to verify the proper performance during production vehicle evaluation testing. Additionally, the ARB plans to conduct in-use testing to verify performance in the field.

2. <u>Number of driving events ("denominator")</u>

The proposed amendments would also require manufacturers to separately track how often the vehicle is operated. In the simplest of terms, the denominator would be a counter that increments by one each time the vehicle is operated.

There has been considerable discussion with industry concerning a standardized definition for vehicle operation to ensure all manufacturers increment the denominator in the exact same way. The ARB originally proposed a simple definition where the denominator would be incremented every time the vehicle is started (e.g., ignition key on, engine speed > 400 rpm for one second, etc.). This is often referred to as "key-starts" or "ignition cycles". While this is the most basic measure of vehicle operation and would ensure all vehicle operation is counted in the denominator, it does not exclude data from some extremely short trips (e.g., repeated engine start and immediate shut-down events, re-parking from garage to driveway events, etc.) or trips at extreme conditions (e.g., above 8000 feet in elevation, ambient temperature below 20 degrees Fahrenheit, etc.), when most monitors are legitimately disabled or have little chance of completing.

Industry, on the other hand, suggested the use of a definition that "filters out" these particular driving events. It proposed the denominator only be incremented when certain criteria are met that indicate the vehicle was operated in a manner that should have allowed most monitors to run. The proposed "filtered" denominator includes a minimum trip length of 10 minutes, a minimum of 5 minutes at vehicle speeds above 25 mph, at least one continuous idle of 30 seconds or longer, ambient temperature between 20-100 degrees Fahrenheit, and an altitude less than 8000 feet. Additionally, industry proposed the use of separate denominators for each of the specific monitors and some additional criteria for the secondary air monitor and evaporative system monitor denominators.

Despite the added complexity involved with industry's proposal, staff concurs with industry that the "filter" denominator definition should provide more meaningful data. Thus, the proposed requirements, including the calculation of the minimum acceptable in-use performance ratio, are structured around industry's proposed definition of a "filtered" denominator. However, to ensure that the dynamics of this "filtering" are accurately understood, the staff is proposing that manufacturers be required to implement both the ARB's definition for an ignition cycle counter and the industry's definition for a "filtered" denominator. This would allow data to be collected during the first few years of implementation, which would be used to better quantify how often the "filtered" denominator occurs in the real world. The data collected would provide valuable information needed to "fine-tune" the minimum acceptable in-use performance ratio to closely agree with the design target of a malfunction indication in two weeks for the majority of the people.

C. Proposed standard for the minimum acceptable in-use performance ("ratio")

Determining how frequent is "frequent enough" for monitors to operate is a complex task that requires consideration of several different factors, including the technical capability of OBD II systems, the severity of the malfunction, the consequences of delayed detection and repair of the malfunction, and expected driving patterns and habits. The proposed amendments would attempt to simplify this task by specifying a minimum acceptable monitoring frequency in a quantifiable format, known as the minimum acceptable in-use performance ratio. In establishing the appropriate value for this ratio, the factors listed above were considered as well as the monitoring frequency of typical current monitors and estimated consumer response/reaction in responding to detected malfunctions.

Industry in general supports a lower monitoring frequency than the ARB deems adequate. Some in industry believe that since the biennial Inspection and Maintenance (I/M) program, also known as Smog Check, is the only real mechanism that requires OBD II-related repairs to be made, consumers will tend to ignore MILs when they illuminate and will only be inclined to get these repairs done just prior to such inspections. For that reason, they suggest that having OBD II monitors run at a lower frequency (e.g., once every two years) is sufficient, since the air quality benefits are not fully realized until repairs are done. However, OBD II is not designed solely as a replacement for the current biennial I/M program, but to ensure that vehicles meet the increasingly stringent tailpipe and evaporative standards throughout their entire lives. If the OBD II monitors do not run frequently and emission-related malfunctions are not readily corrected, the emission benefits of the Low Emission Vehicle II program would not be met. In fact, the results of a recent survey showed that at least 50 percent of consumers would contact a dealer or a mechanic in response to an illuminated MIL, and that only five percent of consumers would ignore the MIL.[21] In other words, the findings suggest that consumers are more likely to readily respond to illuminated MILs and get their vehicles repaired rather than ignore the MIL until forced to repair it at a later date. Further, the interaction of monitored components is such that "failure of one component will more than likely have a noticeable adverse effect on engine performance, forcing the vehicle owner to bring the car or truck in for service".[22]

Taking this and other factors into account, the ARB staff has set the proposed minimum acceptable in-use performance ratio to ensure that most monitors would be capable of detecting malfunctions within two weeks for the vast majority of drivers. While most monitors only require a day or two to detect a malfunction, when real world variability in driving habits is factored in, it is reasonable to expect that essentially all drivers would have encountered enough driving within two weeks to execute the monitors and allow for detection of a malfunction. This should provide a reasonable time for drivers to cover the majority of their particular driving patterns (e.g., weekday commuting, errands, weekend excursions, etc.). As such, the proposed amendments would define a minimum acceptable in-use performance ratio that was derived from in-use driving data to try and ensure a malfunction is detected within two weeks for 90 percent of the population. By deriving the minimum ratio around "90 percent of the population" instead of "100 percent", manufacturers would not be held liable for vehicles operated in extremely unique or rare manners, and the ARB would not have to accept a minimum ratio that is extremely low to account for these last/remaining 10 percent of vehicles. Additionally, as a reminder, the in-use performance ratio only accumulates data when the vehicle has been operated on trips that meet the filtered trip definition (e.g., longer than ten minutes and within certain ambient temperature regions). This further limits (or essentially eliminates) manufacturers' liability for vehicles that are operated very infrequently, primarily on trips shorter than ten minutes, or during extreme ambient temperatures.

1. <u>Frequent monitoring is important</u>

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[21] From the "Human Factors Research" study conducted by the National Center for Vehicle Emissions Control and Safety (NCVECS). More information can be found on Colorado State University's OBD II Research Center website at www.obdiicsu.com.

[22] From "What The Heck's The Problem", Xpressions, DaimlerChrysler Corporation's Trade Magazine for Aftermarket Professionals, November/December 2001.

As stated before, it is important that monitors run frequently to ensure early detection of emission-related malfunctions and, consequently, maintain low emissions. Allowing malfunctions to continue undetected, and thus go without repair, for long periods of time allows emissions to increase unnecessarily. In other words, the sooner the emission-related malfunction is detected and fixed, the fewer the excess emissions that are generated from the vehicle.

Frequent monitoring can also help assure that intermittent emission-related faults (i.e., faults that are not continuously present, but occur for days and even weeks at a time) are detected. The nature of mechanical and electrical systems is that intermittent faults can and do occur, and the less frequent the monitoring, the less likely these faults will be detected and repaired. Additionally, for both intermittent and continuous faults, earlier detection is equivalent to preventative maintenance in that the original malfunction can be detected and repaired prior to it causing subsequent damage to other components. This can help consumers avoid more costly repairs that would have resulted had the first fault gone undetected.

2. Two weeks is the appropriate standard

Industry has questioned the basis for setting the in-use performance ratio based on a time period of two weeks to illuminate the MIL, arguing that a longer time period, such as four weeks, would be just as sufficient from an air quality standpoint. However, as identified above, the emission benefit is only one of the factors that must be considered in determining how often monitors should run. Additional factors were considered in determining the appropriateness of the proposed in-use performance ratio, including the typical capability of current monitoring strategies, the effectiveness of the requirement in assuring all vehicles achieve some acceptable level of monitoring in-use, and the impact on the service and repair industry as well as vehicles owners.

Regarding the impact on the service and repair industry, monitors that have unreasonable or overly restrictive enable conditions (i.e., that are unlikely to detect a malfunction and illuminate the MIL within two weeks) could hinder vehicle repair services. In general, upon completing an OBD II-related repair to a vehicle, a technician will attempt to verify that the repair has indeed fixed the problem. Specifically, a technician will ideally operate the vehicle in a manner that will exercise the appropriate OBD II monitor and allow the OBD II system to confirm that a malfunction is no longer present. This affords a technician the highest level of assurance that the repair was indeed successful.

However, if OBD II monitors operate infrequently and are therefore difficult to exercise, technicians may not be able (or may not be likely) to perform such testing. Despite current and pending U.S. EPA and ARB service information regulations that require manufacturers to make all of their service and repair information available to all technicians, including the information necessary to exercise OBD II monitors, technicians will have difficulty in exercising monitors that require infrequently encountered vehicle operating conditions (e.g., abnormally steady constant speed operation for an extended period of time). Furthermore, this information and the time required by the technician to perform this verification are not free. Ultimately, vehicle owners pay for this information and labor time through their repair bills. Additionally, to execute OBD II monitors in an expeditious manner or to execute monitors that require unusual or infrequently encountered conditions, technicians may be required to operate the vehicle in an unsafe manner (e.g., at freeway speeds on residential streets or during heavy traffic, etc.). If unsuccessful in executing these monitors, technicians may even take shortcuts in attempting to validate the repair while maintaining a reasonable cost for consumers. These shortcuts, however, will likely not be as thorough in verifying repairs and could increase the chance for improperly repaired vehicles being returned to the vehicle owner or additional repairs being performed just to ensure the problem is fixed. In the end, monitors that operate less frequently can result in unnecessary increased costs and inconvenience to both vehicle owners and technicians.

While technicians (and/or consumers) may elect not to spend the additional time and money to validate a routine repair, repairs made in the context of passing an I/M (Smog Check) test require this validation. For an OBD II-based I/M inspection, the driver or technician must exercise the OBD II monitors and verify that the repairs are successful before the inspection can be performed. This is because this inspection requires specific internal flags in the OBD II system known as readiness flags to be set before the vehicle can pass the inspection. These flags would only set upon each of the major OBD II monitors executing and completing at least once since the last time fault codes were erased. Vehicles failed during an I/M inspection (due to the presence of a malfunction) are required to have malfunctions repaired (and thus, fault codes cleared) before returning for re-testing to verify the repairs. If OBD II monitors are incapable of executing frequently and verifying repairs in a timely manner, technicians would have a difficult time preparing a vehicle for re-inspection or would be able to do so only with considerable effort, and thus, at considerable cost to the vehicle owner. With especially troublesome monitors, vehicle owners may have to wait several weeks or months before the repair is verified, the readiness flag is set by the OBD II system, and the vehicle can be re-inspected at the I/M station.

In contrast, monitors that function frequently would be easier for technicians and even vehicle owners to exercise. Clearly, monitors that function infrequently would subject vehicle owners to unnecessary delays and/or increased repair costs that would hinder the effectiveness and efficiency of the I/M program. The proposed standard of two weeks for the majority of vehicles would ensure that monitors run in just a few days for the average driver and no longer than two weeks for the vast majority of drivers. Given the common practice of consumers taking their vehicle in for inspection shortly before their registration expires, even slightly less frequent standards such as four weeks would have a substantial impact on the I/M program. Such reduced frequency would lengthen the period of time required between completion of repair and re-inspection (which is necessary to complete their registration renewal) resulting in registration delays and/or additional costs to consumers.

Based on the current performance of OBD II monitors, most manufacturers should already be able to meet the proposed in-use performance ratio. Since the beginning of the OBD II program, staff has periodically tested vehicles to verify compliance with the OBD II requirements. Staff has compiled these in-use testing data and investigated the frequency at which current OBD II monitors are performing. The data were collected from a total of 29 different 1997-2002 model year vehicles from various manufacturers that were operated by the ARB staff in their normal commute, evening, and weekend driving. The results, which are displayed in the table below, consist of the average number of days it took for a particular monitor to execute ("Avg. days/monitor execution") and, consequently, the average number of times the MIL would illuminate every two weeks ("Avg. MILs/two-weeks").[23]

Monitor	Avg. days /monitor execution	Avg. MILs/two-weeks for 90% of drivers	Avg. MILs/two-weeks for 50% of drivers
Equivalent Result for Proposed Minimum In-use Performance Ratio	-	≥1.00	≥1.00
Oxygen Sensor	1.32	5.31	-
Catalyst	1.64	4.26	-
Exhaust Gas Recirculation (EGR)	1.23 (1.75)*	5.71 (4.00)*	-
Secondary Air	1.75	-	4.00
Evaporative System (0.020 inch leak)	2.34	-	2.99

* Two sets of data were available for the EGR monitor: the first set was for those reaching "pass" decisions, and the second set (in parenthesis) was for those reaching "fail" decisions.

While these data are not proof that all current monitors will meet the required ratio, they do indicate that many monitors, when tested by the staff, operated three to five times more frequently than the ratio proposed by the staff. Again, these data are not intended to be representative of actual population sample data, but rather to show that current OBD II monitors exist that are very likely able to meet the ARB's proposed ratio. Further, these data were collected for some of the "major" monitors that generally involve some of the most restrictive enable criteria (i.e., are the

[23] The "Avg. MILs/two-weeks" values were calculated based on the fact that most monitors require two trips (i.e., monitor executions) to make a decision.

hardest to run). Many of the other monitors that would be required to meet the in-use ratio use much simpler and broader enable criteria (i.e., easier to run) and would easily meet the minimum ratio.

Two weeks is also appropriate because monitoring frequency can depend to some extent on vehicle operator habits. Two drivers with identical vehicles may have entirely different driving habits and patterns, which can affect how often some monitors run. And directionally, the less frequently that monitoring occurs, the higher the risk that some drivers may rarely or even never get a monitor to run. In fact, by establishing the requirements around the time it takes most drivers (i.e., 90 percent) to detect a malfunction, a portion of the population is already excluded (or, allowed to have a much lower monitoring frequency). For these vehicles, it is possible that monitoring may rarely, if ever, operate. To minimize the potential for this to happen, it is essential that monitoring occur frequently on the majority of vehicles so that even vehicles that are not part of the "majority" would still have some level of monitoring during in-use driving. A further reduction in monitoring frequency would not only increase the time it takes for most drivers to detect a malfunction but would increase the likelihood that a portion of the population would never get certain monitors to run.

During discussions, some manufacturers have indicated a concern that an increase in monitoring frequency would result in an increase in false MILs (e.g., the MIL inappropriately illuminating when no malfunction is present). They contend that forcing monitors to run under broader conditions (to ensure adequate in-use performance) would result in decreased accuracy. However, the data compiled by the staff, and as seen in the table above, indicate that many current monitors are likely already operating on a more frequent basis than the ARB's proposed minimum in-use performance requirement. Further, the data are from actual monitors put into production by vehicle manufacturers -- monitors that would not have been put into production if they had "false MIL" problems from running so frequently. As a reminder, the proposed in-use performance requirement is not intended to force all manufacturers to design more frequent monitors, but rather to adopt an objective standard and an easier way to identify monitors that are operating unnecessarily infrequently during in-use driving. It is expected that the majority of monitors for most manufacturers would not require any changes to meet this requirement.

3. <u>Derivation of the minimum ratio values</u>

For purposes of defining an appropriate minimum in-use performance ratio for monitors, the ARB staff analyzed in-use driving data known as the Tri-City database, which was used as a representative collection of driver habits (for detailed analyses of the Tri-City database, refer to Appendix IV and V of the staff report). This database, which was initiated by the U.S. EPA, consisted of collecting data of driving habits from three different cities by equipping vehicles with equipment that logged time, engine speed, and vehicle speed. Using this database, analysis was carried out that derived the minimum in-use performance ratio necessary to ensure monitors completed for most drivers in two weeks.

Working with the manufacturers, a definition for the denominator of the ratio was developed to measure vehicle activity (referred to hereafter as "filtered trips" or "f-trips"). Then, from the data, the distribution of vehicle activity was analyzed to determine how often vehicles encountered "f-trips" (i.e., trips meeting the denominator criteria). The distribution of vehicle activity was calculated and found to have a mean of 1.79 f-trips per day with a standard deviation of 1.11.

Populations of vehicles with different mean ratios were then modeled to determine what minimum ratio was necessary to ensure 90 percent of the vehicles would detect a malfunction within two weeks time. From the analysis, a mean ratio of 0.336 was found to be the minimum acceptable ratio that would ensure 90 percent of the vehicles would detect a malfunction within two weeks.

Though the minimum acceptable in-use performance ratio calculated above (i.e., 0.336) is appropriate for most monitors, it may not be appropriate for monitors that are more dependent on ambient conditions or cold starts (i.e., engine starts after the vehicle has been shut-off for more than six to eight hours) such as the secondary air system and 0.020 inch and 0.040 inch evaporative system monitors. For these monitors, a cold start is usually essential for accurate detection. Further, ambient temperatures and seasonal changes can have a more significant impact on how often these monitors function, especially the 0.020 inch evaporative system monitor. To eliminate manufacturers' liability for the large discrepancies between vehicles operated in various regions of the state (e.g., Palm Springs, Lake Tahoe, etc.), it is appropriate to modify the denominator (or measure of vehicle activity) for these monitors. As such, further "filtering" of the denominator is done by only counting vehicle trips that meet certain cold start criteria and occur during more restricted ambient conditions (i.e., between 40 and 95 degrees Fahrenheit).

Lastly, because of the larger ambient temperature and driver habit (e.g., cold starts) influence on these monitors, an accurate ratio can only be calculated if there is a high level of confidence in the representativeness of the in-use driving data. While the Tri-City database is the best existing database available to staff for vehicle activity, it does have limitations because it was generated from a rather small number of vehicles (~200) over a fairly short time (~ one week of data per car). To account for the larger impact of driver habits and ambient temperatures on these two monitors, the minimum ratio was conservatively derived to ensure that a malfunction is detected within two weeks for 50 percent of the drivers instead of 90 percent. This substantially reduces the minimum monitoring frequency for these monitors, effectively providing manufacturers a significantly higher margin of error for these more difficult monitors.

Following the methodology outlined above, the minimum ratio for secondary air and 0.020 inch leak detection evaporative system monitors was found to be 0.260. However, 0.040 inch leak detection evaporative system monitors (which were completely phased-in by the 1998 model as opposed to the 2003 model year for 0.020 inch monitors), have undergone significant improvements and most run much more frequently than 0.020 inch monitors. In fact, these systems usually run much more than twice as often as the 0.020 inch monitors. This increased frequency is essential to help quickly identify large leaks in the evaporative system (such as disconnected hoses, missing gas caps, etc.) that have substantial emission impacts. In accordance with the less restrictive monitoring conditions used by manufacturers for 0.040 inch monitors and the very conservative ratio established for 0.020 inch monitors, the proposed requirements establish an 0.040 inch monitor minimum ratio of 0.520 (exactly double that of an 0.020 inch monitor). It is also important to remember that this does not mean that the 0.040 inch monitor has to operate on half of all driving cycles. The denominator in the ratio simply represents a measure of vehicle activity and is not incremented on every key start. In fact, the denominator is not even incremented on every cold start (the condition most 0.040 inch monitors require). It is expected that the 0.040 inch monitor will often complete (and increment the numerator of the ratio) on many trips that do not also meet the denominator criteria. This will result in the numerator being incremented much more frequently than the denominator and should be consistent with the monitoring frequency of many 0.040 inch monitors today. As more data become available during the first few years of implementation, staff will revisit the calculated minimum frequency and modify it accordingly to ensure sufficient monitoring frequency for these monitors.

4. Manufacturers can design a system to comply with the in-use performance ratio

Some manufacturers have questioned how they would be able to confirm compliance with the in-use performance requirement. More specifically, they wanted to know what methodology or test procedure they would need to conduct to verify that the minimum in-use performance ratio is met or exceeded, if it is at all possible. The ARB staff believes that such confirmation is achievable and would not require much deviation from current practices used by the manufacturers.

With the establishment of a standardized ratio and defined measure of monitor frequency, manufacturers can develop a test procedure that specifically assesses the performance of monitors. Currently, manufacturers conduct testing over various cycles to simulate emissions on high-mileage vehicles in order to verify compliance with the tailpipe and evaporative emission standards. By developing test cycles that simulate "real world" driving, manufacturers can evaluate the frequency of monitor operation. In fact, manufacturers likely already have such driving cycles used for assessing driveability, durability, and OBD II or other emission control system performance.

Additionally, because OBD II monitors have been required to operate in-use from the start of the OBD II program in 1994, manufacturers already have a level of investigative experience regarding the frequency with which their monitors perform. Manufacturers have been making design decisions and improvements based on test findings of in-use performance, among other factors. By testing the monitors that have the most restrictive enable criteria, manufacturers would be able to use engineering analysis to determine the monitoring frequency for monitors that have less restrictive enable conditions. For many monitors, the enable conditions required to execute them may be so broad (i.e., would result in very frequent execution of the monitors during in-use driving) that this kind of validation testing would not even be needed.

Even today, most manufacturers (if not all) already perform some sort of OBD II verification testing that includes operation of vehicles in-use by various drivers in all different kinds of environmental conditions (e.g., temperature, altitude, etc). Manufacturers also perform exhaustive testing under a vast array of driving conditions and patterns to ensure adequate driveability and OBD II system performance. When a manufacturer identifies inadequate performance (be it insufficient frequency of monitoring, inaccurate monitoring results, etc.), calibration or design changes are made to improve the system performance to acceptable levels. The proposed requirements would not fundamentally change this process. The changes would, however, establish a much more objective and measurable parameter for manufacturers to use to determine if monitors are indeed performing adequately during development, and subsequently, in-use.

Since implementation of this requirement would not start until the 2005 model year, manufacturers would have a few years to collect data on the performance of the monitors, and adjust the monitoring conditions accordingly based on the feedback from the field. Data collected during this time period may also be used by manufacturers to ensure their development process provides sufficient assurance of in-use compliance. Further, manufacturers' liability for in-use monitor frequency is greatly reduced for 2005 and 2006 model years giving them even more time to gather data on a larger scale and make any necessary modifications. For 2005 and 2006 model year vehicles, manufacturers would not be subject to remedial action for insufficient monitoring frequency unless the measured ratio was extremely low relative to the required minimum ratio. Again, this should also allow manufacturers extra time to refine and adjust monitors such that compliance with the minimum ratio is achieved.

D. Compliance testing sampling procedure

The last part of this real world monitoring performance proposal includes provisions that would define a test procedure to be followed by the Executive Officer in determining compliance with the minimum ratio. The proposed procedures are detailed in section XIII of this report.

E. Monitoring requirements for vehicles produced prior to phase-in of the ratio

While the proposed regulation adopts a standardized methodology for determining acceptable levels of in-use performance to be phased-in on 2005 and subsequent model year vehicles, vehicles produced prior to or not included in the phase-in would be certified to the same monitoring condition requirements used since the 1996 model year. The language for these monitoring conditions has, however, been clarified from the language that exists in the current regulation. And while the existing language has been adequate to communicate to manufacturers what is expected of OBD II system monitors, the language has been criticized for not explicitly stating the obvious.

Specifically, despite the clear intent of the OBD II requirements to have manufacturers monitor emission-related components during in-use driving (e.g., the "real world"), the existing language does not explicitly state that monitoring is required during operation of a vehicle in-use. To eliminate the notion that monitoring is not required during operation of the vehicle in the real world, the monitoring conditions language would be modified to explicitly state monitoring is required during conditions "which may reasonably be expected to be encountered in normal vehicle operation and use."[24] This language is copied directly from language used by ARB and the U.S. EPA regarding the prohibition of defeat devices.[25] Determinations as to whether a manufacturer's monitoring conditions meet this requirement would continue to be made in the same manner as they are today. That is, manufacturers would discuss proposed monitoring conditions with staff, determine conditions that meet the requirements, and submit the conditions in their certification applications for staff review. During the review, the determinations would be made case by case based on the expert judgment of staff. In the same process as used today, in cases where staff is concerned that the documented conditions may not be met during reasonable in-use driving conditions, the staff would ask the manufacturer for data or other engineering analysis used by the manufacturer to determine that the conditions will occur in-use. Further, even though this language does not impose a specific minimum monitoring frequency as the proposed ratio would for future vehicles, the monitoring condition requirements would continue to be enforced in the same manner as the existing OBD II requirements.

X. ANALYSIS OF ENVIRONMENTAL IMPACTS AND ENVIRONMENTAL JUSTICE ISSUES

The proposed regulations help ensure that forecasted emission reduction benefits from adopted motor vehicle exhaust and evaporative emission standards programs are achieved. Monitoring of a motor vehicle's emission control system through the use of OBD II systems helps guarantee that vehicles initially certified to the very low and near-zero emission standards maintain their performance throughout the entire vehicle life. It would make little sense to require very low emissions from new vehicles and then allow them to deteriorate to much higher levels as they age. The proposed regulations achieve these emission benefits in two distinct ways. First, to avoid customer dissatisfaction that may be caused by frequent illumination of the MIL because of emission-related malfunctions, it is anticipated that the manufacturers will produce increasingly durable, more robust emission-related components. Second, by

[24] Section (d)(3.1.1) of the proposed title 13, CCR section 1968.2.

[25] See 40 CFR Part 86, section 86.094-2 and the well-established requirement that vehicles are expected to comply with federal regulations in-use.

alerting vehicle operators of emission-related malfunctions and providing precise information to the service industry for identifying and repairing detected malfunctions, emission systems will be quickly repaired. The benefits of the OBD II regulation become increasingly important as certification levels become more and more stringent and as a single malfunction has an increasingly greater impact relative to certification levels.

Most recently, the ARB identified emission reductions of 57 tons per day from the Low Emission Vehicle II program in the South Coast Air Basin (see Appendix I for Environmental Impact Analysis from "Staff Report: Initial Statement of Reasons for Proposed Amendments to California Exhaust and Evaporative Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles" (LEV II), September 18, 1998). In developing the emission benefits for the LEV II program, the integration of an OBD II system check into the California Inspection and Maintenance (I/M) program ("Smog Check") was assumed. Therefore, in calculating the approximate 57 tons-per-day emission benefits from the Low Emission Vehicle II program in the South Coast Air Basin, the ARB staff assumed vehicle emissions would remain within the OBD II thresholds contained in the present proposal (and which have generally been carried over from previous OBD II thresholds applicable to Low Emission Vehicle I program vehicles). Given the substantial shortfall in emission reductions still needed to attain the National and State Ambient Air Quality Standards and the difficulty in identifying further sources of cost-effective emission reductions, it is vital that the emission reductions projected for the LEV II program be achieved. The proposed regulation, which specifically modifies the requirements of OBD II systems to better address LEV II vehicles, is necessary to accomplish this goal.

Having identified that the proposed regulations will not result in any adverse environmental impacts but rather will help ensure that measurable emission benefits are achieved both statewide and in the South Coast Air Basin, the regulations should not adversely impact any community in the State, especially low-income or minority communities.

XI. COST IMPACT OF THE PROPOSED REQUIREMENTS

A. Cost of the Proposed Requirements

The vast majority of the requirements in the proposed regulation (section 1968.2) are already required under the current regulation (section 1968.1). For the few that are newly proposed, most will only necessitate revisions to existing software and/or development of new software. In general, because the proposed regulation carries over the OBD II requirements of 1968.1, no new hardware will be required to be added to 2004 and subsequent model year vehicles. Implementation of the proposed changes would generally be accomplished during development of new software that will have to take place for vehicles complying with the Low Emission Vehicle II emission standards (i.e., 2004 to 2007 model years). It is also not unusual for manufacturers to upgrade their controllers to more advanced versions during extensive emission control revisions to achieve higher communication speed, greater processing capability, increased memory, and cost reduction. The staff has been receptive to manufacturers' requests for leadtime to permit implementation of the proposed revisions during regularly scheduled new model software development and computer upgrades to minimize any need for additional resources. Additionally, it is expected that the proposed requirements would be addressed primarily with the existing motor vehicle manufacturer workforce, although in some cases additional employees may be required. Overall, however, the proposal is not expected to significantly affect per vehicle cost considering the high number of vehicles utilizing each software set.

As stated above, the proposed requirements are generally not expected to result in additional vehicle hardware since most revisions would involve computer software. However, as one exception, certain manufacturers may utilize a linear (also described as a wide range) oxygen sensor instead of a conventional one to accomplish secondary air injection monitoring during cold starts.[26] The use of this sensor, however, would have other benefits that offset the $3 - $5 incremental cost relative to a conventional oxygen sensor. For example, the linear oxygen sensor provides improved fuel control during the cold start and initial warm-up period that may permit a reduction in catalytic converter precious metal loading. Many Asian and European manufacturers have already incorporated linear oxygen sensors in their products to take advantage of these other benefits. For diesels, it appears that linear oxygen sensors, as well as pressure transducers and NOx sensors, will be incorporated into the control strategies for particulate matter traps, NOx adsorbers, oxidation catalysts, selective catalytic reduction systems, and other components. These sensors should also be capable of performing OBD II monitoring without additional hardware. The staff will continue to closely analyze diagnostic requirements for diesels and will adjust the requirements proposed in this rulemaking as needed when developing heavy-duty vehicle OBD requirements next year. The requirements applicable to light- and medium-duty diesels in this proposal, however, do represent the direction the staff will be taking in the heavy-duty rulemaking based on a current review of rapidly evolving technology.

B. <u>Cost Effectiveness of the Proposed Requirements</u>

In conducting the cost-effectiveness analysis for these proposed requirements, the staff revisited the cost estimates of the Low Emission Vehicle II program and updated that analysis to include the effects of OBD II, the staff's proposed MIL illumination thresholds, and industry's proposed thresholds. Using EMFAC2001, ARB's model for estimating real world emissions, the staff has augmented its analysis of the cost-effectiveness in dollars per pound of pollutant reduced that was reported in the 1998 Low Emission Vehicle II Staff Report (see Appendix III). The 1998 analysis generally covered the first 120,000 miles of vehicle operation, which is the useful life period for most Low Emission Vehicle II applications. In updating this portion of the 1998 analysis, the staff has also taken into account changes to the Zero Emission Vehicle (ZEV) requirements at the January 2001 Board hearing that allowed for increased numbers of Partial Zero Emission Vehicles (PZEVs) to satisfy a portion of the ZEV requirement. For the useful life period, cost-effectiveness for the light-duty fleet

[26] It should be clarified that not all vehicles use or are expected to use secondary air systems.

was determined to be $2.18.

The staff has additionally determined the cost-effectiveness of Low Emission Vehicle II applications beyond 120,000 miles attributable to repairs resulting from the proposed MIL illumination thresholds. The results from these analyses were then summed to determine total cost-effectiveness over the full vehicle lifetime. The cost-effectiveness beyond 120,000 miles was determined to be $4.57 per pound of pollutant reduced, which is well within the range of other emission measures adopted by the Board. The methodology used for the analysis is detailed in the attachment to the staff report.

The staff also examined the impact that would occur if higher MIL thresholds were adopted as suggested by the motor vehicle manufacturers (see section XIV.B. below). This analysis was conducted again using EMFAC2001 to simulate the emission thresholds proposed by industry (generally 7 or more times the tailpipe emission standards) by removing the emission benefits of the Smog Check Program from the model for Low Emission Vehicle II applications. Under this scenario, more vehicles are permitted to remain at high emission rates, simulating vehicles attaining higher emission levels (i.e., the higher thresholds proposed by industry) before repair and some reduction in repair rate. For this, the staff assumed approximately 25 percent fewer repairs would be made.[27] The emissions of reactive organic gas (ROG) plus NOx lost in the South Coast Air Basin in 2010 would be 3.9 tons-per-day (tpd) and 31.4 tpd in 2020. Cost-effectiveness for this scenario averaged $5.43 per pound, which is *worse* than the staff proposal. This is because the industry proposal achieves substantially fewer emission reductions than the staff's proposal relative to their reduced repair costs. Even if the staff assumed that industry's proposal would achieve a 50 percent reduction in repairs, the cost-effectiveness would be $3.84 per pound. This would mean that the emissions lost from their proposal would need to be recovered by a program that would cost less than $1.00 per pound, which is highly unlikely anymore. Given the considerable need for additional emission reductions, the industry proposal would set back the ARB's efforts at achieving all cost-effective emission reductions.

XII. ECONOMIC IMPACT ANALYSIS

Overall, the proposed regulations are expected to have no noticeable impact on

[27] It should also be mentioned that only the major monitors (e.g., fuel system, catalyst efficiency, oxygen sensor performance, exhaust gas recirculation flow, etc.) have associated thresholds for illuminating the MIL that are linked to some multiple of the emission standards. The vast majority of the typically more than 120 fault codes in an OBD II system are linked to components that are determined to need service based on evaluations of circuit continuity, functional response to computer commands, rationality of electronic signals or other similar approaches apart from their level of emission consequence (e.g., throttle position sensors, manifold absolute pressure sensors, thermal sensors, purge valves, shift solenoids, etc.). For most OBD II components, then, the evaluation of adequate performance is based on criteria that are no different for LEV category vehicles or SULEV category vehicles. This is why staff estimates that repair rates under the industry proposal would not be more than 25 percent fewer than the rates under staff's proposal. If manufacturers were to take advantage of higher thresholds and build less durable parts, there might well be no change in repair rates.

the profitability of automobile manufacturers. These manufacturers are large and are mostly located outside California although some have some operations in California. The proposed changes involve development and verification of software already incorporated into OBD II systems. Because manufacturers would be provided sufficient lead time to incorporate the proposed changes when redesigning vehicles that comply with the Low Emission Vehicle II (LEV II) program, incorporation and verification of the revised OBD II software would be accomplished during the regular design process at virtually no additional cost. Any additional engineering resources needed to comply with the proposed program would be small, and when spread over several years of vehicle production, these costs would be negligible. Staff believes, therefore, that the proposed amendments would cause no noticeable adverse impact in California employment, business status, and competitiveness.

A. Legal requirements

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. Section 43101 of the Health and Safety Code similarly requires that the Board consider the impact of adopted standards on the California economy. This assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination, or creation, and the ability of California business to compete.

B. Affected businesses and potential impacts

Any business involved in manufacturing, purchasing or servicing passenger cars, light-duty trucks and medium-duty vehicles could be affected by the proposed amendments. Also affected are businesses that supply parts for these vehicles. California accounts for only a small share of total nationwide motor vehicle and parts manufacturing. There are 34 companies worldwide that manufacture California-certified light- and medium-duty vehicles and heavy-duty gasoline engines. Only one motor vehicle manufacturing plant is located in California, the NUMMI facility, which is a joint venture between GM and Toyota.

The proposed regulations would also affect the California licensed I&M service facilities that perform emission verification testing using OBD II systems. There are approximately 10,000 I&M stations in California. It is anticipated that licensed I&M service stations will experience a one-time pretax cost of approximately $500 to upgrade existing equipment to test vehicles equipped with the Controller Area Network (CAN) OBD II communication protocol. Based on financial data from Dun & Bradstreet, the ARB staff has concluded that the cost of the equipment upgrade should have a negligible economic impact on the State's I&M test facilities.[28]

[28] "Industry Norms & Key Business Ratios, Desk-Top Edition 1999-2000", Dun & Bradstreet, p.178. The report shows that the typical automotive repair facility had gross revenues in excess of $1 million dollars and net profits in excess of $43,000. Most likely, facilities will pass on the after-tax cost (approximately $300) of the equipment upgrade to consumers; but, even assuming that a typical facility elects to absorb the full after-tax cost, it should result in a one-time reduction in profitability of less than

C. Potential impacts on vehicle operators

The proposed requirements would provide improved OBD II information and encourage manufacturers to build more durable vehicles, which should result in the need for fewer vehicle repairs and savings for consumers. Additionally, as stated above, the OBD II regulations are anticipated to have a negligible impact on manufacturer costs and new vehicle prices. Similarly, if I&M facilities decide to pass the anticipated one-time equipment upgrade cost to consumers, the cost should be negligible when spread over several years and number of vehicles tested.

D. Potential impacts on business competitiveness

The proposed regulations would have no adverse impact on the ability of California businesses to compete with businesses in other states as the proposed standards are anticipated to have only a negligible impact on retail prices of new vehicles. The one-time equipment upgrade cost for I&M test facilities will have no impact on their ability to compete with businesses in other states in that California vehicles must be tested by California licensed I&M facilities.

E. Potential impacts on employment

The proposed regulations are not expected to cause a noticeable change in California employment because California accounts for only a small share of motor vehicle and parts manufacturing employment. Since the regulations are not expected to have an adverse impact on California I&M test facilities, the proposed regulations should not impact on employment at such facilities.

F. Potential impact on business creation, elimination or expansion

The proposed regulations are not expected to affect business creation, elimination or expansion.

XIII. PROPOSED ADOPTION OF ENFORCEMENT PROVISIONS SPECIFIC TO OBD II SYSTEMS

A. Overview

The staff is proposing that the Board adopt a comprehensive in-use enforcement protocol that applies specifically to the OBD II regulation, title 13, CCR section 1968.2, pursuant to the Board's general and specific authority to adopt procedures that ensure compliance.[29] Among other things, the staff is proposing procedures for the in-use testing of OBD II systems installed in motor vehicles and engines. The proposal would

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one percent.

[29] Health and Safety Code, sections 39600, 39601, 43013(b), 43018, 43102, 43104, and 43105.

further provide the Executive Officer with authority to order motor vehicle manufacturers to take remedial action when in-use testing indicates that a class of motor vehicles is equipped with OBD II systems that do not meet the OBD II certification requirements of title 13, CCR section 1968.2.

The staff is proposing the specific enforcement protocol for OBD II systems after more than eight years of experience in implementing and enforcing the OBD II requirements. The staff believes that that the general enforcement procedures found at title 13, CCR, Section 2, Articles 2.0 through 2.4, and the specific provisions set forth at title 13, CCR section 1968.1(i) do not adequately address the unique issues involved in enforcing the OBD II regulation. This fact was underscored in a recent administrative enforcement action conducted under the above provisions, which were initially adopted for the purpose of in-use enforcement of the California tailpipe and evaporative emission standards. In that case, contrary to the position taken by the ARB, it was determined that motor vehicles with a nonconforming OBD II system should not be recalled because, among other things, the motor vehicles, on average, still met the applicable exhaust (tailpipe) and evaporative emission standards for such vehicles despite not meeting the OBD II requirements.

B. The Need for OBD II-Specific Enforcement Procedures

The staff believes that specific OBD II enforcement provisions are necessary to better address and identify the special circumstances involved in in-use testing and remedying identified nonconformities with OBD II systems. Experience has revealed that the existing general enforcement procedures, which were specifically adopted to enforce noncompliance with tailpipe and evaporative emission standards, do not allow for effective enforcement of the OBD II requirements and standards. Accordingly, attempting to apply the provisions to OBD II-related noncompliance has apparently led to some confusion as to the applicability of specific sections of the existing procedures to OBD II-related enforcement. For example, over the past several years, questions have arisen as to whether a noncomplying OBD II system is a failure of an emission-related component or a failure to conform to an emission standard, which requires a completely different analysis.[30] With the existing requirements, the distinction is crucial because if a noncomplying OBD II system is considered a failure of an emission-related component, it is then presumed under title 13, CCR section 2123(b) that the failure would result in an exceedance of a tailpipe or evaporative emission standard of the affected vehicle class. In such cases, a recall of the affected vehicle class would be appropriate unless the manufacturer could overcome the presumption by showing that emissions of the vehicle class, on average, comply with applicable tailpipe emission standards.[31] On the other hand, if the noncompliance was found to be a failure to conform to an OBD II emission standard, the Executive Officer could order an emission-related recall upon finding that the nonconformity applied to the vehicle class, on

[30] Emission-related component failures are analyzed under the first part of section 2123(a) of title 13, CCR, whereas the second type of failure is analyzed under the second part of that same section.

[31] See title 13, CCR section 2147.

average. In such a case, recall would be appropriate irrespective of whether the affected vehicle class also complied with tailpipe and evaporative certification levels.

The two-part approach of section 2123 does not neatly apply to the OBD II regulation. First, the OBD II regulation includes both emission standards and other non-emission-related requirements, such as test procedures and standardization requirements. Second, OBD II systems are comprehensive and exceedingly complex. In-use enforcement of OBD II systems involves a myriad of issues that do not arise in the enforcement of tailpipe and evaporative emission standards. Over time, it has become apparent that the simplified enforcement approach of section 2123 does not address the unique issues involved in the in-use operation of OBD II systems. Distinct testing and enforcement procedures will allow the Executive Officer to perform more appropriate testing of OBD II systems to assure that they properly perform in-use. Defined protocols will likewise provide manufacturers with notice and guidance on how such testing will be conducted and applied.

The adoption of OBD II-specific enforcement provisions would also help clarify that a manufacturer cannot escape liability for failing to comply with the OBD II standards and requirements by demonstrating that vehicles with the nonconforming OBD II system, on average, comply with certification standards for tailpipe and evaporative emissions. As set forth elsewhere, the OBD II emission standards and requirements serve very different purposes from the tailpipe and evaporative emission standards, and compliance with the latter two standards should not excuse noncompliance with the former.

Further, to allow a manufacturer to overcome the need to remedy a nonconforming OBD II system by showing that the failure would not result in the motor vehicle class, on average, failing to conform to the tailpipe and evaporative emission standards would undermine the purpose and intent of the OBD II requirements. In adopting the OBD II regulation, the Board specifically determined that functional OBD II systems were necessary and should be equipped on all 1996 and subsequent model year vehicles. In so determining, the Board found that functional OBD II systems are a vital complement to the success of the ARB's motor vehicle emission reduction programs in general. For example, all vehicles certified to the Low Emission Vehicle II emission standards are required to be equipped with OBD II systems. The system is intended to insure that all the Low Emission Vehicle II applications achieve forecasted emission reductions in-use by alerting motor vehicle operators of malfunctions to the vehicles' emission control systems and providing the service and repair industry with information that will assure expeditious and proper repairs. To apply the provisions of section 2147 and not require the remedying (recall and repair) of nonconforming OBD II systems would be speculative (section F below) and effectively reverse the Board's prior determination that functional OBD II systems are necessary. Thus, it is imperative that OBD II-related violations be enforced under OBD II-specific enforcement provisions that would make it clear that OBD II requirements are not interchangeable with tailpipe or evaporative emission standards.

Similarly, the proposed enforcement procedures would supersede the provisions at title 13, CCR section 1968.1(i) for in-use testing and recall of noncomplying OBD II systems. In attempting to implement and enforce the existing OBD II requirements, the staff has become aware that the provisions of section 1968.1(i) have not been fully understood by all stakeholders and need to be clarified. The proposal addresses these problems by setting forth clear and specific criteria for in-use testing of OBD II systems and when remedial action would be appropriate.

C. Applicability of the Proposed Enforcement Procedures

The proposed enforcement procedures would, in general, apply to 2004 and subsequent model year vehicles that are equipped with OBD II monitoring systems that have been certified for sale in California, pursuant to the requirements of title 13, CCR section 1968.2. Most, if not all, of the requirements for the 2004 model year have been carried-over from the requirements set forth in section 1968.1 for vehicles manufactured prior to the 2003 model year. Those requirements became operative in September 1997 and manufacturers will have had six years or more of leadtime in developing and incorporating all of the monitoring requirements into the 2004 model year vehicles. Additionally, for most requirements, the OBD II systems have been in production for at least several years, and manufacturers have been able to observe the performance of the systems in the field.

It is equally true that manufacturers have been on notice since the initial adoption of the OBD requirements in 1990 that the ARB staff would enforce the OBD II regulation after its effective date, and that appropriate remedies, including recall, could be ordered for noncompliance. Manufacturers, however, argue that the proposed enforcement procedures "substantially alter the legal effect of past events." Seemingly, the concern of the manufacturers is the perceived belief that the proposed enforcement procedures substantially change existing protocol. That is, manufacturers would not be allowed to overcome the recall of a nonconforming OBD II system by showing that emissions of the affected vehicle fleet, on average, comply with the applicable tailpipe and evaporative emission standards. The staff does not agree with the manufacturers' concerns, believing that, for the most part, the proposed enforcement protocol only seeks to clarify existing Board authority to enforce the OBD II regulation. However, even accepting for purposes of argument the manufacturers' position, the proposed enforcement procedures, as stated, are intended to only apply prospectively, and not before the 2004 model year. By that time, manufacturers should have sufficient opportunity to make certain that their systems are in full compliance with the OBD II requirements.

D. Authority to Adopt Enforcement Procedures

Depending upon the nature of the nonconformity of the OBD II system and the circumstances surrounding the nonconformity's existence, recall may be an appropriate remedy. Health and Safety Code section 43105 authorizes the Executive Officer to order recalls, if a manufacturer has violated emission standards or test procedures and has failed to take corrective action.

The adopted OBD II regulation, title 13, CCR sections 1968.1, and the proposed regulation for 2004 and subsequent model year vehicles, title 13, CCR section 1968.2, establish both emission standards and test procedures for certification to those standards. The ARB expressly adopted title 13, CCR section 1968.1 pursuant to authority granted by the Legislature to adopt and implement emission standards and test procedures under the Health and Safety Code.[32] Likewise, the staff is proposing that section 1968.2, title 13, CCR be adopted pursuant to the same authority. In so acting the Board has not, and will not have, exceeded its authority under the statute. The existing and proposed regulations clearly establish quantitative emission standards for most, if not all, of the major monitoring systems (e.g., detection of malfunctions before emissions exceed 1.5 times the applicable tailpipe emission standard). These malfunction criteria establish specified limitations on the discharge of air contaminants into the atmosphere and thus meet the definition of "emission standards" as defined at section 39027 of the Health and Safety Code.

In adopting Senate Bill 1146, the Legislature expressly recognized that the OBD II requirements are emission standards, stating:

> Recent emission standards adopted and implemented by the State Air Resources board for motor vehicles manufactured after 1993 have resulted in the development by vehicle manufacturers of "on board diagnostic computers" that interface with the many component parts of a vehicle's emission control system. (Stats. 2000, Ch. 1077, Sec. 1; emphasis added.)

In granting California a waiver of federal preemption, pursuant to section 209(b) of the federal Clean Air Act, to adopt the OBD regulation, the U.S. Environmental Protection Agency (EPA) expressly found that the requirements of the California OBD II regulation were emission standards.[33] Indeed, in the proceedings to determine California's request for a waiver, the Association of Automobile Manufacturers (AAMA)[34]

[32] See "Notice of Public Hearing to Consider Adoption of Regulations Regarding On-Board Diagnostic System Requirements for 1994 and Later Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles with Feedback Fuel Control," July 18, 1989, and subsequent notices of public hearings to consider technical status update and proposed revisions to malfunction and diagnostic system requirements, issued on July 16, 1991, October 11, 1994, and October 15, 1996; see also Resolutions 89-77, 91-42, 93-50, 94-67, and 96-60.

[33] For purposes of the waiver only, recognizing the special nature of the OBD II requirements, the Executive Officer contended that the OBD regulation, when considered as a whole, might be described as an enforcement procedure. EPA rejected this position, finding that, for purposes of a waiver determination, both California and federal OBD regulations should be considered emission standards. It should be noted that the definition of "emission standard" set forth at section 302(k) of the CAA, is similar to the definition found at section 39027 of the Health and Safety Code. As defined under the CAA, an emission standard "means a requirement established by the State or the Administrator which limits the quantity, rate, or concentration of emissions of air pollutants on a continuous basis . . . ."

[34] AAMA was the automobile manufacturers association representing General Motors Corporation, Ford Motors Corporation, and the former Chrysler Corporation at the time of the OBD II waiver request hearing.

recognized that the California OBD II requirements are emission standards. As the U.S. Environmental Protection Agency (EPA) summarized in its decision granting the waiver:

> AAMA states that the requirements for OBD systems are emission control standards under section 202 of the [Clean Air] Act. AAMA notes that Congress' inclusion of the OBD requirements in the emission standards section of the Act (section 202) is a clear indication of its intent that OBD is to be considered an emission control standard [citation omitted] . . . AAMA states that EPA has referred to the federal and California OBD regulations as being requirements for which vehicles are certified, and, as AAMA points out, vehicles are certified to applicable standards, not to enforcement procedures.[35]

In granting California its waiver of federal preemption for the OBD II regulation, EPA concurred with AAMA, finding:

> OBD requirements appear to be closer in their application and effect to standards than to enforcement procedures: they establish specific levels of emissions that beyond which the MIL must be illuminated and fault codes be stored; they create direct requirements on the manner in which manufacturers build their vehicles; the OBD II requirements set forth how a vehicle must operate at time of certification and in use, and not how the state would ensure that the vehicle is operating properly as is typical of an accompanying enforcement procedure.

Beyond being emission standards, the OBD II regulation sets forth specific test procedures that manufacturers must follow to assure certification and compliance to the established standards. For example, sections 1968.2(g), (h), and (j) set forth specific requirements for demonstration test vehicles, certification documentation, and production vehicle evaluation testing. Accordingly, Health and Safety Code section 43105 expressly authorizes the ARB to adopt regulations regarding corrective actions, including recall, that the Board may take for violations of the OBD II emission standards and the test procedures established to certify vehicles to those standards.

In addition to the express authority of Health and Safety Code section 43105 to adopt enforcement procedures, the Board has unmistakable implied authority to adopt such regulations. The general powers granted to the Board in Health and Safety Code section 39600 provides that the Board shall do such acts as may be necessary for the proper execution of the powers and duties granted to it. The OBD II requirements were adopted pursuant to general authority granted under sections 43013, 43018, and 43101 among others. Specifically, sections 43013(a) and 43101 authorize the Board to adopt

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[35] California State Motor Vehicle Pollution Control Standards; Waiver of Federal Preemption; Decision (October 11, 1996), at 18-19, citing AAMA comments, dated December 1, 1995, to Robert Maxwell, Director, Vehicle Program Compliance Division, EPA.

and implement motor vehicle emission standards. And section 43018-directs the Board to take whatever actions are necessary, cost-effective, and technologically feasible in order to achieve specific emission reductions, including the adoption of standards and regulations that will result in, among other things, reductions in motor vehicle in-use emissions through improvements in emission system durability and performance.

Although the Legislature did not expressly authorize the adoption and implementation of OBD II requirements, the Legislature recently gave its imprimatur to the regulation.[36] Having implicitly authorized the Board to adopt the OBD II regulations in furtherance of the Board's mission, it cannot reasonably be argued that the Legislature has not also entrusted the Board with authority to properly enforce the adopted standards and test procedures to ensure compliance.[37]

E. <u>In-Use Testing Procedures</u>

The proposed in-use enforcement test procedures set forth the testing protocol to be followed by staff to assure that OBD II systems on production motor vehicles and engines comply with the requirements of section 1968.2 and conform with motor vehicles and engines certified by the ARB. To this end, the ARB is proposing that it periodically evaluate vehicles for compliance with the OBD II regulation.

The proposed procedures set forth how enforcement testing to determine OBD II compliance would be conducted, including, among other things, how the Executive Officer would initially determine the scope of vehicles to be tested, the number of vehicles to be tested (i.e., the size of the test sample group), and the type of testing to be conducted. OBD II enforcement testing would be grouped into three different categories depending on the nature of the OBD II noncompliance issue to be tested. Specifically, the protocol proposes that separate guidelines and procedures be followed for OBD II emission testing, OBD II ratio testing, and "other" OBD II testing.

The OBD II emission testing procedures would be used when the measurement of tailpipe emission levels relative to the tailpipe emission standards is essential to determining OBD II system compliance. Emission testing for OBD II compliance is comprised of two distinct parts: (1) emission testing in accordance with the test procedures used by the Executive Officer for in-use testing of compliance with tailpipe emission standards in accordance with title 13, CCR sections 2138 and 2139; and (2) on-road and/or dynamometer testing with the vehicle being driven in a manner that reasonably ensures that all of the monitoring conditions disclosed in the manufacturer's certification application for the tested monitor are encountered. The latter testing will be conducted to determine the MIL illumination point and the former testing will be conducted to determine the tailpipe emission level at the MIL illumination point.

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[36] See section 43105.5(a)(4), Stats. 2000, Ch. 1077, Sec. 4; see also Sec. 1.

[37] See *California Drive-In Restaurant Ass'n* v. *Clark* (1943) 22 Cal.2d 287, 302 [140 P.2d 657], "the authority of an administrative board or officer, . . . to adopt reasonable rules and regulations, which are deemed necessary to the due and efficient exercise of the powers expressly granted, cannot be questioned."

Together, these two parts of testing are necessary to determine if the MIL illuminates prior to exceeding the tailpipe emission levels as required in the OBD II regulation.

For this testing, the vehicle selection process -- e.g., size of test sample group and protocol for procuring vehicles -- would be essentially similar to the procedures presently used by ARB staff in determining compliance with tailpipe emission standards. The only differences between the procedures used for tailpipe emission standard enforcement testing and OBD II emission testing would be those that are needed specifically for OBD II testing. For example, the proposed OBD II emission test procedures allow the Executive Officer to group like vehicles together into a single "class" based on OBD II system similarities rather than solely on certification emission standard similarities. Additionally, in contrast to vehicles subject to in-use tailpipe emission testing, vehicles to be OBD II emission tested would be scrutinized by staff to ensure that there are no signs of tampering or use of aftermarket parts that would cause the OBD II system not to comply with the OBD II requirements.

Of course, to properly conduct OBD II emission testing, the Executive Officer must implant a malfunction into the vehicle and then determine if the OBD II system properly detects the malfunction at the required tailpipe emission levels. To perform this testing, the Executive Officer would implant actual or simulated malfunctions consistent with the malfunction criteria established in the OBD II regulation. However, this testing is often easiest accomplished by using sophisticated simulation test equipment and/or specially developed aged or deteriorated components. To facilitate the Executive Officer's ability to perform this testing and reproduce results generated by manufacturers during development, the proposed regulation would require manufacturers to retain specific test equipment and/or aged components used during the calibration and development process. Upon request by the Executive Officer, the manufacturer would be required to make such equipment available for the Executive Officer's use in enforcement testing. And, as such testing must be performed by the Executive Officer within a vehicle's full useful life (e.g., 10 years and 100,000 miles), the manufacturer would only be required to retain the components for the useful life period. It is important to note that this does not require manufacturers to retain every single component or simulator ever used during calibration but is limited only to "threshold" components that are used for one of the major monitors (e.g., the component that produces emissions at or just below 1.5 times the standard for a monitor calibrated to 1.5 times the standards).

The OBD II ratio testing procedures would be used when the in-use monitor performance is tested for compliance with the minimum acceptable in-use monitor performance requirements (i.e., does the monitor run often enough?). Under these procedures, the Executive Officer would follow some of the same procedures that are proposed for use in OBD II emission testing. The test sample group for ratio testing, however, would require collecting data from at least 30 vehicles in contrast to the minimum of 10 vehicles that would be required for OBD II emission testing. Also, because tailpipe emission testing is not part of the ratio testing, the vehicle selection criteria and sampling process for ratio testing would differ from that which would be used in OBD II emission testing. Those areas would be modified to eliminate items that are only essential for tailpipe emission performance. Specifically, the criteria for including vehicles in the sample for ratio testing would be targeted solely to exclude vehicles that have problems (e.g., tampering, abuse, aftermarket parts, etc.) that would affect the OBD II system performance. Criteria that are used to weed out vehicles with problems that would affect tailpipe emission levels (e.g., proper maintenance, tampering that affects tailpipe levels but not OBD II monitor performance, etc.) would not be used for ratio testing. It is necessary to eliminate the above criteria because they are not relevant to ratio testing and the pared criteria will help assure that a sufficient number of representative vehicles are available for procurement and testing.

In cases where the monitor being tested has a ratio that is required to be tracked and reported to a scan tool in standardized manner, the actual ratio testing of procured vehicles would be a rather expeditious and straightforward process. The data used to determine compliance with in-use monitor performance are required, under title 13, CCR 1968.2, to be stored in the on-board computers of the vehicles themselves. The "testing" of the 30-plus vehicles will be as simple as electronically downloading the stored data from the vehicles with a diagnostic tool (e.g., an OBD II scan tool).

For testing of monitors that are required to meet the ratio but are not required to track the data in the on-board computer or report it in a standardized manner, the process would be lengthier and slightly more involved. In these cases, rather than downloading information stored in the on-board computer, each test vehicle would be equipped with instrumentation that would record and collect vehicle activity data and monitor activity. Each test vehicle would then be returned to the vehicle operator for accumulation of data. After collection of sufficient data (the same amount of data as required for the ratios that are tracked and reported), the data would be analyzed to determine the ratio for the tested monitor for each vehicle. This method is directly analogous to that used for the ratios that are required to be tracked and reported in the on-board computer by effectively tracking and reporting the ratio in an "off-board" computer (i.e., the instrumentation attached to the vehicle).

The final area of OBD II testing would cover in-use testing of all other OBD II requirements that cannot effectively be grouped into one of the other two categories (i.e., emission or ratio testing). The selection and testing procedures for such testing would be determined on a case-by-case basis. This is necessitated because of the breadth of this residual category and the many nuances of the complex systems that may affect some aspects of the system performance. Given this complexity, it is impossible to predict every possible permutation or noncompliance that might occur in the future. As such, it is also impossible to prescribe exact test procedures that will adequately address every possible noncompliance scenario. For example, a problem could be as simple as a system not complying with the MIL wording requirements (e.g., using "check emissions" instead of "check engine" on the dashboard light). In such a case, the number of vehicles tested and how they are procured would essentially be irrelevant. The noncompliance would likely be confirmed by using a visual examination of as few as one or two vehicles obtained through a car rental agency. As another example, the problem could be the inability of the OBD II system to properly detect malfunctioning thermostats that cause the engine to warm up too slowly. Such a malfunction could cause a vehicle to have increased emissions and/or cause the disablement of other diagnostics. As manufacturers have attested, dynamometer testing of the thermostat monitor in a laboratory is not representative of the performance of the monitor in the real world because the airflow over the vehicle on a dynamometer is significantly different than the airflow that occurs during on-road driving. And this difference in airflow can significantly affect the warm-up characteristics of the thermostat. In contrast to the first example, testing could not be conducted to confirm noncompliance by performing a visual inspection on as few as two vehicles. Accordingly, for the "other" OBD II testing category, the proposed regulation, rather than setting forth specific selection and testing procedures as for emission and ratio testing, defines general guidelines to be followed by the Executive Officer when conducting testing in this area. The Executive Officer would have discretion to determine, on a case-by-case basis, the most appropriate procedures for selection and testing of vehicles based on the nature of the OBD II noncompliance and the projected number of affected vehicles. The Executive Officer would be required to provide notice of the selection and testing procedures to the manufacturer of the vehicles subject to such testing (see discussion below).

The proposed regulation would also set forth the decision criteria that would be used by the Executive Officer to determine if a system is noncompliant for each type of testing. For example, for OBD II emission testing, the regulation specifies that the system would be determined to be noncompliant if 50 percent or more of the tested sample vehicles are unable to properly detect a malfunction and illuminate the MIL before tailpipe emissions exceed the malfunction criteria thresholds set forth in title 13, CCR section 1968.2(e). For OBD II ratio testing, the system would be noncompliant if the average in-use performance of the sample vehicles is below a critical ratio that indicates the average ratio for the entire motor vehicle class is below the required minimum in-use monitor performance ratio set forth in title 13, CCR section 1968.2(d)(3.2). And, for the "other" testing, the system would be determined to be noncompliant if 30 percent or more of the sample vehicles fail to meet the same requirement that falls within the residual-testing category.

The last-mentioned criterion is consistent with the criterion set forth in the existing tailpipe emission enforcement procedures, which provides that a test group or sub-group of vehicles shall be considered nonconforming when a specific emission-related failure occurred in three or more test vehicles from a sample that includes a minimum of 10 in-use vehicles (see title 13, CCR sections 2137 and 2140[38]). Additionally, the staff believes that use of the definitive 30 percent criterion is preferable to the use of the term "substantial number of a class or category of vehicles that ...experience a failure of the same emission-related component...", that is used in the

[38] As discussed elsewhere in this staff report, the tailpipe or evaporative emissions of the fleet as a whole are not relevant when considering nonconformance of an OBD II system.

definition of nonconformity in the existing enforcement procedures.[39] The specific percentage will provide clear notice to all parties of what is expected for compliance with the regulations.

If any of the above testing indicates that the OBD II system is suspected of being noncompliant, the Executive Officer would be required to provide the manufacturer with a notice of the test results. The proposed regulation would require that such notice include all relevant supporting information that the Executive Officer relied upon in making his or her determination of nonconformance of the OBD II system.

Manufacturers would have the opportunity to respond to the preliminary notice and present test results and other data that they believe rebut the preliminary findings of noncompliance. Upon consideration of the information submitted by the manufacturer, the Executive Officer may decide to perform additional in-use testing if necessary. The Executive Officer would consider all information submitted by the manufacturer in ultimately determining whether an OBD II system is nonconforming.

Lastly, the Executive Officer would be required to issue a notice of final determination to the manufacturer as to whether the OBD II system is nonconforming. If the Executive Officer finds the OBD II systems to be nonconforming, the regulation would require the notice to set forth the factual bases for the determination.

F. Remedial Action

1. Introduction

After notification of noncompliance from the Executive Officer, a manufacturer would have 45 days to elect to conduct an influenced recall and repair of the affected vehicles. If the manufacturer takes no action, the Executive Officer could order the manufacturer to take appropriate remedial action scaled to the level of noncompliance. The regulation would set forth a detailed set of factors that the Executive Officer would consider in determining the appropriate remedy.

2. Emissions Impact.

As explained in section B. above, the proposed regulation would clarify that in ordering a recall of a nonconforming OBD II system, the Executive Officer would not need to demonstrate that the nonconforming system directly causes a quantifiable increase in the tailpipe or evaporative emissions of the entire group of affected vehicles nor would a manufacturer be able to overcome the recall by making such a showing. The recall of an effectively nonfunctional monitoring system is necessary because the existence of such a noncomplying system effectively defeats the purposes and objectives of the OBD program and potentially undermines the emission reduction benefits that have been projected from adopted motor vehicle emission reduction programs. It has been the long-standing position of the ARB that it is necessary to

[39] title 13, CCR section 2112(h)

repair or replace such nonconforming systems because they are not capable of detecting future malfunctions of the vehicle's emission control systems and that this would likely lead to future emission increases.[40] This position is consistent with the Senate Committee on Environment and Public Works when considering federal adoption of onboard diagnostic regulations.[41]

California's problems with ozone pollution continue to be the worst in the nation. In an effort to meet federal and state ambient air quality standards and comply with the federally mandated State Implementation Plan (SIP) to meet those standards, California has continued to be in the forefront in adopting the most stringent motor vehicle emissions control program in the nation. The OBD II regulation is an essential part of that program. In recent years, the ARB adopted the most stringent tailpipe and evaporative emission certification standards for new motor vehicles (Low Emission Vehicle II). The proposed OBD II requirements are an essential part of this emission reduction program. The proposed requirements of title 13, CCR section 1968.2, which guarantee that the new motor vehicle emissions systems will be properly monitored in-use, are necessary to assure that new motor vehicles continue to meet California's stringent emission standards in-use over the life of the vehicle. This will ensure that the emission reduction benefits from the Low Emission Vehicle II program and other new motor vehicle emission regulations are realized, a crucial step towards compliance with the ambient air quality standards.

As stated, it is beyond dispute that as motor vehicles age and accumulate high mileage, their emission control systems deteriorate and increasingly malfunction,

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[40] See Manufacturers Advisory Correspondence No. 87-06 (July 1, 1987), in which the ARB stated.

> A recall . . . would be appropriate based on . . . the underlying defect identified by the OBD system even where the vehicles could pass the FTP, assuming a substantial number of vehicles in the class or category being tested contained that defect.

[41] P.L. 101-549, Clean Air Act Amendments of 1989, S.Rep. 101-228, 101st Cong., lst Sess. 1989, 1990 U.S.C.C.A.N. 33855, 1989 WL 2326970 et seq. , in which the Committee reported:

> The amended section 202 of the [CAA] authorizes the Administrator to promulgate regulations for [emission control diagnostics (ECD)]. Existing section 207(c) of the [CAA] provides for recall of vehicles which do not conform to the regulations adopted under section 202, thus providing clear authority for the Administrator to recall classes or categories of vehicles determined to have malfunctioning ECD systems during their full useful life. This authority will enable EPA to ensure that the emission components and the ECD system operate properly. A vehicle will be recalled or repaired if, during the useful life of the vehicle, the ECD system itself is broken or malfunctions such that it would no longer be able to serve its intended function of alerting the vehicle operator to the need for emission related maintenance and properly storing such information for subsequent retrieval by inspection or maintenance personnel. The ECD system is intended to alert the operator to the need for maintenance which may head off further emission deterioration or damage to the emission control system. Therefore, the Administrator may order a recall and a repair of the ECD system in cases wherever there is systematic misdiagnosis, even if the vehicle is passing emission standards, either by not alerting the operator to the need for necessary repair or by flagging a repair which is not necessary.

causing emissions from motor vehicles to increase.[42] The ARB adopted the OBD II requirements to address this problem and, specifically, to provide assurance that when malfunctions in emission control systems do occur, they will be expeditiously discovered and repaired. To properly perform these objectives, the OBD II system itself must be functional and capable of detecting malfunctions when they occur. To minimize potential emission increases in future years, it is imperative that the identified, effectively nonfunctional OBD II systems be recalled and repaired at the time noncompliance of the systems is discovered. No one knows or can accurately predict how well emission control systems of different manufacturers will work 10, 20, or more years from now. This is especially true when vehicles are being required to meet increasingly stringent emission standards, requiring new and complex technologies to be utilized.

Contrary to the contentions of the automobile manufacturers, any forecasting of future compliance with tailpipe and evaporative emissions standards would be much more difficult to do in the case of an OBD II nonconformity than in the case of failed emission related component.[43] In the latter case, the manufacturer knows specifically what emission-related component has failed (and the manner in which it has failed) and can conduct in-use emission testing of the vehicle fleet with the known failed part. In the case of the nonconforming OBD II system, the only thing known is that the OBD II monitor is not working. At the time of such failure, neither the Executive Officer nor the manufacturer knows what emission-related part or combination of parts might fail in the immediate or distant future without illumination of the MIL. Such an evaluation, which entails the ability to accurately predict which part(s) will fail, in what manner, at what failure rate, and at what point in the vehicle's life, would be, at best, extremely speculative. As stated before, appropriate remedial action should be based solely on compliance (or lack of) with the OBD II requirements.

The ability of the Executive Officer to order appropriate remedies, including recall, irrespective of a finding of direct emissions consequences, is also necessary so that California can continue to meet its obligations under the federal CAA that the states incorporate OBD checks as part of their inspection and maintenance (I/M) programs.[44] This has been an objective of the OBD II regulation since its inception.[45] The ARB agrees that requiring OBD checks in the state's I/M program will improve the I/M program and obtain greater emission reductions. The ARB further believes that OBD-

[42] California Department of Consumer Affairs, Bureau of Automotive Repairs, Executive Summary Report, January to December, 2000.

[43] See title 13, CCR section 2147.

[44] Refer to section 202(m)(3) of the CAA; 40 CFR part 51, subpart S.

[45] See Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider New Regulations Regarding Malfunction and Dianostic System Requirements Applicable to 1994 and Later New California Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles With Feedback Fuel Control Systems (OBD II), July 28, 1989 (1989 Staff Report).

I/M checks are the most reliable and cost-effective means for testing the increasingly lower emission standards that California requires for certification. A pilot program conducted by EPA found that OBD technology is a viable I/M test and that emission reductions that can be achieved from using OBD checks are at least as large if not larger than the emission reductions obtained from I/M tailpipe tests.[46] The study found that in addition to identifying the same high emitters as the tailpipe emission test, the OBD checks additionally identify components that have degraded and may cause future emission problems. The motor vehicle manufacturers themselves share many of these same views and conclusions.[47]

To protect the benefits of an OBD-based I/M check, it is imperative that functional and viable OBD II systems are installed in all certified vehicles. To assure that they are, it is necessary to assure that all OBD II systems that are found to be effectively nonfunctional be recalled and repaired, irrespective of whether one can make a showing that the vehicles, equipped with such nonfunctioning systems, on average comply with applicable tailpipe certification standards.

3. Mandatory Recall

[46] Evaluation of On Board Diagnostics for Use in Detecting Malfunctioning and High Emitting Vehicles, August 2000.

[47] See September 28, 2000 letter from the Alliance of Automobile Manufacturers and the Association of International Automobile Manufacturers to the Wisconsin Division of Motor Vehicles, a copy of which was submitted to EPA as part of the Associations' October 13, 2000 response to Amendments to its Vehicle Inspection Maintenance Program Requirements Incorporating On-Board Diagnostics (OBD) Checks, Notice of Proposed Rulemaking, September 20, 2000. In the September 28, 2000 letter, the Associations stated in relevant part:

> We are writing to support changes to your vehicle inspection and maintenance (I/M) program that replace conventional I/M testing with a check of the on-board diagnostic (OBD) system for 1996 and later model year gasoline vehicles....Such changes would not only benefit air quality but also drastically reduce test times for consumers.
>
> The OBD system continuously monitors the vehicle's emission control system for any failure that could cause emissions to increase beyond the failure threshold. In contrast, conventional I/M programs take a one-time snapshot of the vehicle's emissions either annually or biennially. Furthermore, the OBD system is more accurate than conventional I/M tests, and the OBD failure thresholds are based on the certification standards applicable to that particular vehicle model (LEV, Tier I, Tier II, etc.). Thresholds for conventional I/M testing are grouped based on model year or even multiple model years. Finally, in the event of failure, the vehicle's OBD system stores information about the failure, allowing a technician to diagnose and repair the vehicle faster and with more accuracy. If a vehicle fails a conventional test and does not have any OBD information stored, it may be very difficult to diagnose and repair.
>
> From the customer's standpoint, OBD checks reduce test times and allow I/M check stations to focus on the detection and repair of vehicles with emissions equipment not functioning as designed. Herein lies the greatest potential for air quality improvement, which is the primary reason for the existence of I/M programs.

The staff is proposing that the most seriously design-flawed nonconforming OBD II systems be subject to mandatory recall. Under section 1968.5(c)(3)(A) of the proposed regulation, the Executive Officer would be required to order the recall of OBD II systems that have at least one major monitor that performs so egregiously that it cannot effectively detect malfunctions or cannot be validly tested in accordance with the procedures of the California I/M program. Requiring mandatory recall of systems that cannot effectively function in-use is consistent with the objectives of the OBD II regulation that motor vehicles be certified with OBD II systems that monitor all emission-related components so that malfunctions may be quickly detected and repaired.[48] The regulation was developed to provide assurance that vehicles retain their emission control capabilities near certification levels throughout their life in-use by alerting vehicle operators and service technicians that emission-related components are deteriorating, if not fully failing. To be viable and to obtain the benefits of the OBD II program, OBD II systems must be able to function with reasonable frequency in-use and detect malfunctions at or near the in-use thresholds established by the regulation. Monitors that perform at levels significantly below the established criteria thresholds in-use run the risk of undermining the potential benefits of the OBD II program. In proposing the cut-points for mandatory recall, the ARB staff has relied on their expert judgments regarding system performance and the years of experience in development, certification, and enforcement of the OBD II regulation. The ARB staff has concluded that systems that operate below these levels are essentially nonfunctional and need to be repaired or replaced.

By specifying minimum performance levels, below which a system would be considered nonfunctional and in need of recall, the Executive Officer would be providing manufacturers with clear notice and direction as to what the ARB considers to be a totally unacceptable system. With such knowledge, manufacturers can better plan and design their product lines and perform necessary internal testing to assure proper performance of the OBD II systems that they manufacture and distribute. The minimum performance levels that would be established by the regulation for recall are fair and reasonable. The levels have been set so as to provide a liberal margin of error that distinguishes between a monitor that fails to meet the threshold levels required for proper detection of malfunctions and a monitor that performs so poorly that it cannot be considered functional.

4. Discretionary Remedial Action

Additionally, section 1968.5(c)(3)(B) of the proposed regulation would provide the Executive Officer with discretionary authority to order remedial action when he or she finds an OBD II system to be nonconforming for reasons other than those requiring mandatory recall. The Executive Officer would have discretion to order a graduating scale of remedies. In determining appropriate remedial action, the Executive Officer would consider all relevant circumstances surrounding the existence and discovery of

[48] Refer to the 1989 Staff Report and 1991Staff Report: Initial Statement of Reasons for Proposed Rulemaking, July 26, 1991.

the nonconformity, including the factors specifically set forth in sections 1968.5(c)(3)(B). For example, in cases where the nonconformity is limited, the OBD II system is largely functional, and the manufacturer has voluntarily identified the nonconformity, the Executive Officer would have authority to order a lesser form of remedial action, comparable to a deficiency. In the most serious cases, where the Executive Officer determines that the OBD II system, when considered in its totality, is unacceptably ineffective, he or she would have discretion to order the recall of the nonconforming systems.

5. Monetary Penalties

Pursuant to authority granted under the Health and Safety Code, the Executive Officer may seek monetary penalties against a manufacturer for a nonconforming OBD II system on a case by case basis.[49] In determining whether to seek penalties, the Executive Officer would consider all relevant circumstances, including, but not limited to, the factors set forth in title 13, CCR, section 1968.5(c)(4).

G. Notice to Manufacturer of Remedial Order and Availability of Public Hearing.

The proposed regulation would also require the Executive Officer to notify the manufacturer of the ordered remedial action and/or his or her intent to seek monetary penalties in an administrative or civil court. The notice would be required to include a description of each class of vehicles or engines covered by remedial action and the factual basis for the determination. The notice would further provide a date at least 45 days from the date of receipt of such notice for the manufacturer to submit a plan outlining how it proposes to comply with the remedial order or to request a public hearing to consider the merits of the ordered remedial action.

H. Requirements for Implementing Remedial Action

The proposed regulation would also set forth requirements and procedures to be followed by the manufacturer in implementing either a voluntary, influenced, or ordered remedial action. Among other things, the regulation would establish specific provisions requiring manufacturers to establish remedial action plans, provide notice to owners of vehicles and engines affected by the remedial action, and maintain and make available specific information regarding the remedial action. The proposed requirements and procedures are similar, but not identical, to those required in title 13 CCR sections 2113 – 2121 and sections 2123 – 2132, the existing general recall provision.[50] As with the

[49] Refer to Health and Safety Code, section 43016, 43154, 43211-43212.

[50] The proposal includes a requirement that manufacturers subject to an OBD II recall shall report on the progress of the remedial action campaign by submitting reports for eight consecutive quarters. See section 1968.5(d)(B). Although the eight consecutive quarter requirement differs from the reporting requirements of title 13, CCR sections 2119(a) and 2133(c), the proposal is in fact consistent with ARB practice. See "Voluntary and Influenced Recall Recordkeeping and Reporting," MAC #96-08, July 26, 1996. Similarly, the proposed reporting requirements require manufacturers subject to vehicle recall to provide the ARB with a list of data elements and designated positions in the submitted reports that

existing enforcement provisions, the proposed requirements for implementing remedial action provide clear directions to a manufacturer subject to a remedial action on its obligations and responsibilities in carrying out a remedial action campaign. This should assure effective and expeditious implementation of proposed remedial action plans and compliance with the OBD II requirements. The proposed requirements also assure that all manufacturers follow consistent reporting requirements that allows for full and effective monitoring of the remedial action campaign by the ARB.

Although the requirements for implementing remedial actions are very similar to the existing provisions that manufacturers and the ARB staff alike have had years of experience working with, separate provisions for OBD II-related remedial actions are being proposed. This is being done for obvious reasons. As previously stated, the OBD II enforcement issues are considered, in many ways, unique, and for purposes of clarity should be self-contained. As noted, the existing enforcement requirements primarily focus on general failures of emission control components and general violations of the ARB tailpipe and evaporative emission regulations and do not specifically address the unique issues that pertain to OBD II systems. Finding a serious need for specific enforcement procedures, it makes sense that the requirements and procedures for implementing OBD II-related remedial actions should be included within the self-contained OBD II enforcement procedures. Having a single regulation with all OBD II enforcement provisions should prove helpful and convenient to both affected manufacturers and ARB staff. This will also avoid the need for the general tailpipe and evaporative emission implementation requirements to set forth specific exceptions that apply only to OBD II enforcement issues. The result should be a clearer, more readily understandable document.

I. Penalties for Failing to Comply with the Requirements of Section 1968.5(d).

The staff is proposing a regulation that would make it clear that a manufacturer could be subject to penalties for failing to comply with the proposed requirements for implementing remedial action. Such failures would be considered a violation of the Health and Safety Code and would subject the noncompliant party to penalties prescribed under Health and Safety Code section 43016. The proposed authority to assess monetary penalties should encourage compliance with the requirements and encourage thorough and timely implementation of both voluntary and ordered remedial action campaigns.

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indicate all vehicles or engines subject to the recall that have not as yet been corrected. See section 1968.5(d)(6)(B)(ix). Although not expressly set forth in the existing recall reporting requirements, the information required under the proposed provision has a long-standing ARB requirement. See "Revision to Mail-Out 91-13 (Implementation of Air Resources Board's (ARB) and Department of Motor Vehicles' Registration Renewal/Recall Tie-In Program), Mail-Out 91-19, April 10, 1991.

XIV. ISSUES OF CONTROVERSY

A. Why shouldn't the ARB have the responsibility of identifying every failure mode that manufacturers are required to detect?

The automobile manufacturers have expressed concern about their liability for identification of all possible failure modes that could occur in a vehicle's emission control system. They contend that failure modes found in-use, but not anticipated by manufacturers nor identified as relevant by the ARB at the time of vehicle certification, should not be used as a basis for finding an OBD II system to be nonconforming.[51] The ARB staff disagrees. From the onset of the OBD II program, the OBD II requirements have been structured to require manufacturers to identify components that perform outside design specifications for any reason as opposed to components that only malfunction due to commonly known failures. As such, neither the ARB nor the manufacturers are responsible (or "liable") for pre-identifying every possible failure mode to design a compliant OBD II diagnostic. Manufacturers are solely responsible for designing an OBD II system that can identify components performing outside of the defined performance criteria, otherwise known as the malfunction criteria.

To understand the issue, one must understand the distinction between the terms "failure mode" and "malfunction criteria." A "failure mode" is the specific mechanism or way in which a component can fail; in other words, it is the underlying cause of a component's inability to perform or work properly. "Malfunction criteria" are general objective performance criteria that are based on the output signal(s) and/or functional response of the component and define the boundaries for "good" operation (e.g., within design specifications) and "bad" operation (e.g., outside of design specifications) irrespective of the "failure mode." There are typically one or more different failure modes for a specific malfunction criterion. For example, an electronic sensor can experience a circuit continuity failure such as an open circuit. The open circuit is the defined "malfunction criterion." The "failure mode" which causes an open circuit can vary greatly, such as internal circuit failures of the sensor, loose, broken, or disconnected wiring between the sensor and the on-board computer, or an internal circuit failure of the on-board computer. The "malfunction criterion", on the other hand, is the same in all cases and simply requires manufacturers to detect an open circuit (typically sensed by a circuit within the on-board computer), regardless of where the open circuit occurred or what caused the open circuit.

Manufacturers have recently expressed the position that they believe that it is the responsibility of the ARB to identify all possible types of failure modes that OBD II systems are required to detect and to specify those, rather than the malfunction criteria, in the regulation. The ARB, however, does not possess the experience and intimate knowledge needed to be able to anticipate all potential failure modes that occur in every variation of emission control systems used by each manufacturer. Therefore, it would

[51] All references to contentions raised by Industry refer to letters jointly submitted by the Alliance of Automobile Manufacturers and Association of International Automobile Manufacturers, dated August 21 and September 7, 2001.

be impossible for the ARB staff to identify the specific failure modes in the regulation that would adequately address every type of emission control system variation that manufacturers currently (or will ever in the future) use. Given the large variation in hardware, software, and emission control strategies used by manufacturers, a "one-size-fits-all" list of failure modes is inappropriate and not technically feasible. Moreover, requiring manufacturers to detect specific failure modes would necessitate significant redesigns of diagnostic systems since current diagnostic systems are generally unable to distinguish between the different failure modes of a component malfunction. On the other hand, by not detailing specific failure modes in the proposed OBD II regulation, the ARB staff is attempting to continue to allow manufacturers more flexibility in designing their own emission control and diagnostic systems.

The regulation currently defines fixed malfunction criteria to evaluate performance characteristics of a component, regardless of the unique variations of its implementation by different manufacturers. More specifically, the malfunction criteria are based on the same signals and/or information that the on-board computer uses for emission control and diagnostic purposes and do not vary based on the specific hardware or software strategy utilized by the manufacturer. Accordingly, the ARB believes that the malfunction criteria set forth in the proposed regulation are sufficient in identifying/diagnosing virtually all failure modes for the vast majority of the emission control components and systems and clearly define the extent of the manufacturer's liability. For example, the OBD II regulation requires the exhaust gas recirculation (EGR) system monitor to detect a malfunction that results in low, high, or no flow through the system. This means manufacturers must ensure that any failure mode that results in the EGR system meeting any of the three malfunction criteria is detected by the OBD II system regardless of the underlying cause (i.e., failure mode) for the low, high, or no flow malfunction. Accordingly, manufacturers design diagnostics that determine or measure the flow and compare it to the low and high limits. In most cases, manufacturers are unable to separately determine the failure mode (e.g., a broken EGR valve, plugged flow delivery tubes, etc.) that caused the flow malfunction but can determine whether the overall flow of the system falls within acceptable bounds. Furthermore, manufacturers are only responsible for failure modes that meet or exceed the malfunction criteria specified in the regulation. If a failure mode exists that does not meet or exceed the specified malfunction criteria (e.g., erratic but not too high or too low flow), manufacturers are not required to detect it.

While the vast majority of the components monitored by the OBD II system have very specific malfunction criteria, there are a few instances where the relationship between the malfunction criteria and the failure mode is not as well-defined, which poses more difficulty in developing a monitoring strategy to detect when the component is no longer performing within acceptable limits. For example, the HC conversion efficiency of a catalyst system is generally inferred by the oxygen storage capability of the catalyst. As such, manufacturers rely on a correlation (which they determine during the development process) between HC conversion and oxygen storage. However, the failure mode of the catalyst (e.g., repeated exposure to overly high temperature due to misfire, poisoning, etc.) can, in some cases, alter the correlation. This requires manufacturers to determine the most representative and "worst-case" failure modes and design their OBD systems accordingly. Manufacturers have now indicated that they cannot predict every possible failure mode and account for them in their design, especially since some failure modes may be due to vehicle operator actions beyond their control (e.g., the use of leaded gasoline in an unleaded vehicle which would cause irreversible poisoning of the catalyst). As such, they believe it is appropriate for the ARB staff to enumerate each of the specific failure modes for which the manufacturer will be held. Clearly, however, design engineers for the vehicle manufacturers and their suppliers are better qualified than the ARB staff to determine the specific failure modes for each of their unique catalyst systems since they are generally required to perform extensive investigation of all possible failure modes (commonly referred to as a Failure Mode and Effects Analysis (FMEA)) as part of their routine engineering duties. Further, manufacturers regularly require parts replaced under warranty at dealerships to be sent back to the manufacturer's facility for analysis. These "real world" failed parts are typically studied and used to validate, verify, and adjust the manufacturer's internal design process, failure analysis, and determination of representative and worst-case failure modes. Thus, as manufacturers have been successfully doing for the past six years, they will continue to be responsible for identifying catalysts that have a conversion efficiency below the minimum acceptable level. However, to alleviate manufacturers' concerns regarding failure modes that are beyond their control, language has been added that clarifies that manufacturers will not be responsible for identifying catalysts or other components that have failed in a manner solely due to vehicle operator action.[52]

In some cases the malfunction criteria are not well defined because they are dependent on how a component is used as part of the emission control system or the diagnostic system. For example, while the OBD II regulation identifies some specific oxygen sensor characteristics (response rate, voltage amplitude, and drift or bias that all manufacturers are responsible for monitoring), the malfunction criteria also require manufacturers to monitor for a malfunction of any "other characteristic(s)" that would cause emissions to exceed 1.5 times the applicable standards. In this case, manufacturers have the task of identifying any failure modes of other sensor characteristics that would fall under this category. Again, manufacturers' design engineers are in the best possible position to determine the failure modes that could cause emissions to exceed the applicable standards. As in the case of catalysts, over the past six years, manufacturers have been successful at making such determinations. For instance, each manufacturer develops its own fuel control strategy, and therefore uses the oxygen sensor signals in slightly different ways from another manufacturer. While one characteristic of a sensor may be extremely crucial to proper fuel control for one manufacturer, it may be completely irrelevant for another manufacturer's fuel control system. This places design engineers at a considerable advantage over the

[52] Section (b)(4)(A) of the proposed OBD II enforcement regulation (1968.5), which states that for enforcement testing, the "Executive Officer may not use components deteriorated or simulated to represent failure modes that are solely caused by vehicle operator action(s) beyond the vehicle manufacturer's control and that could not have been foreseen to occur (e.g., the use of leaded gasoline in an unleaded vehicle, etc.)."

ARB staff in being able to identify any other characteristics specific for the type or brand of sensor used and the manner in which they process the sensor signals for fuel control purposes. Based on these facts, manufacturers are in a much better position to identify other characteristics, if any, that could deteriorate without any corresponding deterioration in the characteristics specifically identified in the regulation.

B. <u>MIL illumination thresholds are too stringent and not cost-effective.</u>

The automobile manufacturing industry contends that the proposed MIL illumination thresholds are too stringent and impose unfair economic costs on consumers. In this regard, some manufacturers have suggested that the low malfunction criteria thresholds would result in consumers having to replace components that would produce minimal emission benefits and would not be cost-effective. The staff has reexamined this issue in light of comments received and believes that the proposed MIL illumination thresholds are necessary to ensure that manufacturers design durable emission control systems whose emissions remain close to the certification standards for the entire life of the vehicle. This must occur in order to achieve all the potential emission benefits of the Low Emission Vehicle II program. Further, the staff believes that this can be done cost-effectively.

Although the manufacturers suggest the thresholds proposed by the ARB staff are too small, allowing higher emission thresholds could substantially reduce the emission benefits of the Low Emission Vehicle II program. Additionally, with higher MIL illumination thresholds, vehicle manufacturers may forsake improving durability of emission control components for cost savings since such components would be allowed to deteriorate to a greater extent. For example, additional precious metal loading is generally used to improve durability of catalytic converters by providing more active sites for catalytic activity. However, given the high cost of precious metals, there is currently a very intense activity in the industry to minimize or "thrift" the precious metal content in catalysts. Under the higher thresholds proposed by industry, manufacturers would likely continue this "thrifting" effort, further undermining the long-term effectiveness of catalysts and the benefits of the Low Emission Vehicle II program.

In so finding that the proposed malfunction emission criteria levels are appropriate, the staff also rejects the motor vehicle industry's objections that the proposed levels do not provide a sufficient emission compliance margin. The manufacturers contend that the proposed MIL illumination thresholds affect an OBD II monitor's ability to report valid test results (i.e., to correctly detect a malfunction as opposed to indicating a malfunction when no fault is actually present). They argue that if they fail to provide enough "separation" between the certification emission level of the vehicle and the emission level at which the MIL illuminates, the MIL could illuminate prematurely, leading to customer dissatisfaction. The staff, however, believes that the proposed thresholds provide a sufficient emission compliance margin to avoid such problems. Accordingly, the proposed MIL illumination thresholds would promote lower average emissions from the vehicle fleet.

Some manufacturers have suggested that higher MIL illumination thresholds would not affect their product designs and that their primary motivation for wanting more relaxed thresholds is to ensure that consumers can make more cost-effective repairs in I/M programs. Many believe that with higher MIL illumination thresholds, detection of malfunctions would not be as frequent, resulting in fewer replacements and repairs. However, as stated above, the ARB staff is concerned that higher thresholds would encourage manufacturers to reduce the long-term durability and performance of their emission control components. Given the intense competition in the automobile industry, the staff believes that any relaxation in the requirements will result in manufacturers trying to maximize vehicle cost savings. This may result in vehicles being equipped with less robust parts, requiring more frequent repair. Thus, the staff believes that higher MIL illumination thresholds will not necessarily result in less frequent detection of malfunctions and fewer replacements and repairs. Indeed, the fear is that vehicles would be able to operate at much higher emission levels in use, without any associated reduction in consumer service and repair costs. Even if higher MIL illumination thresholds did result in fewer vehicle repairs, the loss in emission benefits would be unacceptable in that they are essential in meeting the State Implementation Plan goals.

The staff further disagrees with motor vehicle manufacturers' contentions that the proposed malfunction criteria thresholds are not cost-effective. While the ARB staff proposes, in general, that components be replaced when they cause emissions to increase to 50 percent above the standards, manufacturers argue that it would be more cost-effective to repair vehicles when emissions increase to 7 times the standards or more. For example, they claim that under the ARB's proposed thresholds, a consumer would be required to replace a SULEV catalyst system when it is still 98 percent efficient at a cost of $750. In contrast, under their proposed thresholds, the catalyst system would be replaced at 95 percent efficiency. However, such an example where cost-effectiveness is relatively low fails to demonstrate the overall program is not cost effective. In evaluating the cost-effectiveness of the OBD II program, the staff revised the analysis for the Low Emission Vehicle II program using average repair costs from current I/M programs and making assumptions about repair rates that could be expected from these advanced vehicles through 230,000 miles (the analysis can be found in Appendix III). During this analysis, the staff found that repair costs varied widely, with some repairs being very inexpensive while others were more costly. The staff concluded that proper assessment of a program cannot be based on worst case scenarios. Rather, a proper analysis requires that conclusions be drawn after thoroughly reviewing the program in its entirety.

The catalyst repair example cited above also misconstrues the efficiency level of the catalyst under the ARB's proposed thresholds as well as overstates catalyst repair costs. Generally, when conducting catalyst system monitoring on a SULEV, the OBD II system monitors only the front catalyst. Using ARB's proposed thresholds, a malfunction is typically indicated when the efficiency of the front catalyst drops substantially, not just a small amount (e.g., 1-2 percent) as the comment suggests. This is because the rear catalyst efficiency typically increases to effectively compensate decreases in front catalyst efficiency when the front catalyst is damaged or deteriorated.

Thus, the front catalyst efficiency typically drops substantially before the rear catalyst is unable to compensate enough to achieve near-SULEV emissions at 98 percent overall efficiency of the system. Also, replacement of a front catalyst alone would not cost the $750 suggested by the industry. Rather, an aftermarket catalyst meeting new provisions currently being developed for application on OBD II vehicles would cost between $200 to $250.

There are other reasons for not delaying illumination of the MIL until further emission deterioration has taken place. For example, misfire problems can quickly lead to high emissions and consequent damage to other components if not caught quickly and repaired. Some misfire repairs might consist of reconnecting a loose cable, replacing a spark plug, or rebuilding a cylinder head assembly, all at very different costs. To wait for further emission consequence before making repairs, as industry is proposing, would be unwise since many faults could be repaired fairly inexpensively, and waiting would not necessarily lower costs, but could damage other expensive components, requiring more costly repairs. Also, it should be noted that most of the more than 120 fault codes in OBD II systems pertain to components for which there are no emission thresholds for determining a malfunction. They are judged on the basis of electrical checks, rationality evaluations, functionality, or other similar checks. Thus, any "relaxing" of the emission thresholds would have no impact whatsoever on the vast majority of OBD II diagnostics. This further mitigates the effects of emission thresholds on overall program cost-effectiveness.

By examining the overall program (as opposed to just one example), the staff determined that implementing industry's proposed higher MIL illumination thresholds would be less cost-effective than ARB's proposed thresholds (see Appendix III for more details). The higher thresholds proposed by industry would result in substantially lower emission reductions with little cost savings relative to the staff's proposal. The shortfall in emission reductions substantially affects the cost-effectiveness of industry's proposal, in that it is difficult to recover the loss in reductions at a comparable cost-effectiveness value. Further, as mentioned earlier, stricter emission thresholds lead to more durable components, which benefits consumers.

C. <u>Is OBD II an emission standard, and if not, under what authority does ARB believe it can order a recall?</u>

The motor vehicle manufacturers have posed a number of challenges to ARB's authority to recall vehicles equipped with noncompliant OBD II systems. Among other things, they contend OBD II requirements are not emission standards, and the ARB consequently does not have authority to recall OBD II systems under section 43105 of the Health and Safety Code. According to the industry, that section provides that the ARB may only recall vehicles that fail to comply with either adopted emission standards or test procedures. Industry consequently asserts that it is unaware of any statutory basis that allows for the ARB to order a recall if a manufacturer can show that the subject motor vehicle fleet is not in violation of established emission standards or test procedures.

As explained in detail in section XIII above, the ARB's authority to adopt OBD II-specific enforcement procedures is pursuant to general and expressed authority vested to it under the Health and Safety Code.[53] Section 43105 expressly provides that the ARB has authority to order a manufacturer to undertake corrective action, including recall, on vehicles that fail to meet established emission standards or test procedures. Contrary to industry, the ARB believes that the OBD II regulation incorporates both emission standards and test procedures. Section 39027 of the Health and Safety Code defines "emission standards" as "specified limitations on the discharge of air contaminants into the atmosphere." For virtually all of the major OBD II monitors, the OBD II regulation requires malfunctions to be detected before emissions exceed 1.5 times the applicable tailpipe emission standards. In other words, the emission thresholds linked to these monitors specify the level of discharge of pollutants into the atmosphere beyond which a malfunction indicator light must illuminate to signal the need for repair. For many of the other monitors, inclusion of components under the monitoring requirements is based on whether a malfunction of the component could cause a "measurable increase" in emissions, so that comprehensive components are regulated, in part, relative to their ability to increase emissions by a measurable amount. These criteria clearly establish quantitative emission standards that govern a malfunction determination, thereby limiting the discharge of emissions into the atmosphere. Therefore, they meet the Health and Safety Code definition of "emission standards." Furthermore, these findings have been affirmed by the California Legislature and are consistent with findings by the United States Environmental Protection Agency (see section XIII above). Lastly, some OBD II requirements cover vehicle evaluation testing (e.g., monitoring system demonstration testing, production vehicle testing) and specify test procedures to be conducted either by the manufacturer or the ARB to ensure OBD II systems are working properly. Therefore, the ARB considers the OBD II requirements to be both emission standards and test procedures. Furthermore, as discussed in Section XIII and Issue of Controversy D. below, this inability of the OBD II requirements to fit "cleanly" into only one of these two categories is one of the very reasons the staff is proposing a stand-alone set of enforcement procedures (proposed section 1968.5 of title 13, CCR) specifically for OBD II.

In summary, given that the OBD II regulation establishes both emission standards and test procedures that are required for certification of new motor vehicles, the ARB has undisputed authority under Health and Safety Code section 43105 to adopt the OBD II-specific enforcement regulation. Beyond this express grant of authority, Health and Safety Code, section 39600 further entrusts the ARB with general powers to do such acts as may be necessary for the proper execution of the powers and duties granted to it under Health and Safety Code. The ARB adopted the OBD II regulation pursuant to the powers and duties granted to the ARB under Health and Safety Code sections 43013(a), 43018, 43101 and 43104. Accordingly, under its

[53] See Health and Safety Code sections 39600-39601, 43013(a), 43018, 43101, 43104,and 43105.

general powers, the ARB is authorized to adopt all necessary enforcement regulations to assure compliance with the OBD II requirements.

D. Has ARB demonstrated a "justifiable need" for OBD II-specific recall provisions?

Industry had questioned the need for a separate, OBD II-specific recall regulation (proposed section 1968.5 of title 13, CCR). They consider the general enforcement requirements set forth in title 13, CCR, Section 2, Articles 2.0 through 2.4, and the specific provisions contained in section 1968.1(i) sufficient for dealing with OBD II-related enforcement issues. Staff disagrees believing that the existing enforcement procedures do not adequately address the unique issues involved in enforcing the OBD II regulation. The staff's conclusion is based on more than eight years of experience in implementing and enforcing the OBD II regulation under these provisions. The general enforcement provisions found at title 13, CCR section 2, Articles 2.0 through 2.4 were initially adopted for general enforcement of tailpipe and evaporative emission standards. The staff has found that application of these provisions to OBD II enforcement has resulted in confusion and uncertainty as to the applicability of certain of its provisions, which, in turn, has raised questions among manufacturers as to what is expected of them for purposes of compliance. This has impacted the ARB's ability to enforce the regulation in an expeditious manner and has resulted in unnecessary litigation and delayed compliance. Similarly, the ARB has found the testing protocol found at section 1968.1(i) to be unclear to at least several manufacturers, resulting in unnecessary disputes as to its meaning and application, which has also impacted effective enforcement and compliance.[54]

In proposing OBD II-specific enforcement provisions, staff recognizes the need and importance for properly functioning OBD II systems on in-use vehicles and the benefit of OBD II systems in ensuring that projected emission benefits from ARB motor vehicle emission reduction programs are achieved. Recent enforcement proceedings involving nonconforming OBD II systems under the existing recall regulations have highlighted the complexity and difficulty of applying the current enforcement procedures to OBD II compliance cases. As stated above, the central problem lies in the fact that the general recall enforcement procedures were not intended to apply to the unique issues that arise in cases involving OBD II noncompliance. Although, when first adopted, staff initially envisioned that OBD II enforcement could be effectively performed under the general enforcement provisions, experience has proven otherwise. Particular confusion under the existing enforcement provisions has occurred over the issue of whether nonconformance with OBD II requirements is, itself, a violation of an emission standard that subjects a manufacturer to recall or merely a defect of an emission related part that does not necessarily require such a remedy.[55]

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[54] See discussion in Issue of Controversy E. below.

[55] Refer to title 13, CCR section 2123, which provides that the ARB may directly recall of vehicles failing to comply with emission standards but provides manufacturers the opportunity to avoid recall if a faulty emission control component is discovered and average emissions of the vehicle fleet do not exceed the applicable tailpipe emission standards.

Admittedly, and perhaps belatedly, the ARB has come to realize that the language in the existing enforcement procedures, and specifically section 2123, does not address the special issues involved with nonconforming OBD II systems. Contrary to claims by some motor vehicle manufacturers, the ARB has intended since the OBD II regulation was first adopted that poorly designed and effectively nonfunctional OBD II systems should be subject to recall. The ARB has maintained that position regardless of whether a manufacturer can demonstrate that vehicles equipped with the nonconforming systems, on average, meet the tailpipe or evaporative emission standards.

To the extent that a reading of the existing enforcement procedures would not permit the recall of such poorly designed OBD II systems, the staff believes that it is necessary to adopt OBD II-specific enforcement procedures. The need for an OBD II specific protocol is readily apparent when one realizes that noncompliance with the OBD II requirements is not directly tied to emission control system failures that cause increased emissions or result in failure to meet the tailpipe or evaporative emission standards. Rather, the purpose of the OBD II system is to operate as an independent watch for emission control system failures and to notify the driver of any problems, when found, so that they may be immediately remedied. In adopting the regulation requiring OBD II systems, the Board was specifically concerned that failures in high mileage and older vehicles be detected. Many of these failures are not expected to occur for at least 10, 20, or more years into the future. Therefore, it is virtually impossible to forecast, with any degree of certainty, the size and scope of potential problems that the OBD II system may uncover and the emission consequences of those problems. This is especially true because the vehicles being evaluated today are being required to meet increasingly stringent emission standards that require the application of new and challenging technology.

E. Should fleet-average emissions be considered in requiring a recall for an OBD II noncompliance?

As stated above in Issue of Controversy D., the staff is proposing that manufacturers may not be able to overcome a finding that an OBD II system is nonconforming by showing that, on average, vehicles equipped with a noncomplying OBD II system comply with tailpipe and evaporative certification standards. Industry believes, however, that it must be provided an opportunity to demonstrate this, and that if successful, a recall could not be required. For example, if a particular monitor for a group of vehicles was not capable of detecting a component malfunction, then manufacturers want the opportunity to show the component is unlikely to fail at a rate such that emission standards would be exceeded on average. The staff, however, does not believe industry's position makes practical sense for OBD II systems. This is because it is not possible to reliably predict the failure rate of components on older vehicles or their emission impacts. Further, to limit any such analysis to the useful life period, as industry suggests, would be virtually meaningless since the primary usefulness of OBD II systems is to discover problems that occur later in the vehicle life.

Section XIII of the staff report sets forth in detail the reasons why evidence of compliance with tailpipe and evaporative emission standards is insufficient to overcome a finding of nonconformance with the OBD II requirements.

In contrast to the existing enforcement protocol, the proposed OBD II enforcement procedures do not excuse OBD II noncompliance if a manufacturer can show that the affected vehicles comply with the tailpipe and evaporative emission standards. The OBD II requirements are independent requirements for which compliance is mandated. This is not a change in ARB policy. As one example, ARB has requirements for the fuel filler pipe on gasoline vehicles that address physical dimensions and accessibility to the filler pipe to ensure proper mating with the vapor recovery refueling nozzles required at gas stations in California. This is a separate requirement from other tailpipe or evaporative emission standards and a noncompliance with the fuel filler pipe specifications cannot be excused by a showing of adequate tailpipe emissions from the manufacturer's vehicle fleet. Even within the context of "tailpipe emission standards", ARB has distinct standards such as the 50° Fahrenheit tailpipe emission standard and the normal FTP tailpipe emission standard (conducted between 68-86° Fahrenheit). Just as manufacturers are not excused from a violation of the ARB's 50° Fahrenheit tailpipe emission standards by demonstrating that the normal FTP tailpipe emission standards are being met, they cannot be excused from noncompliance with the OBD II standards by a showing of compliance with other emission standards such as tailpipe or evaporative emission standards. The OBD II regulation requiring the development and implementation of OBD II systems was adopted to fill an identified void in the ARB emission reduction program. As explained in section XIII, OBD II systems complement other programs, such as the Low Emission Vehicle program and the California Smog Check program, and help assure that the emission reductions that have been forecasted for those programs are, in fact, achieved. To allow a manufacturer to overcome the need to remedy a nonconforming OBD II system by showing that the failure would not result in the affected vehicles failing to comply with other emission requirements within their useful lives would undermine the specific purpose and intent of the OBD II regulation.

Moreover, as previously stated, the staff does not believe that manufacturers would ever be able to make such a showing, believing that the exercise would be too speculative. In contrast to the procedures that exist in title 13, CCR section 2147, which allow manufacturers to overcome a finding that an emission related part is failing, the complexity of OBD II systems and the myriad of potential failure modes that can be involved make the exercise far too speculative. This is especially true, at this time, when vehicles are being required to meet increasingly stringent tailpipe and evaporative emission standards, involving new and complex technologies.

As stated before, the ARB believes it is not possible to reliably predict the failure rate of components on older vehicles or their emission impacts. Once vehicles pass their useful life (120,000 to 150,000 miles), there are no formal requirements relative to emission control component durability. However, many vehicles in the fleet last 15, 20, or even more years and will accumulate in excess of 200,000 miles before retirement.

The effects of aging, high mileage, variability in quality of parts initially installed on the vehicle, latent parts design flaws, collisions, maintenance, repairs (by persons of varying skills), installation of used parts, changing fuel compositions, abuse, neglect, and many more make it virtually impossible to predict what components on older vehicles will deteriorate or fail and what the emission impacts would be. Industry has countered that if ARB is able to perform sophisticated analyses of emission inventories well into the future, then it should also be able to predict the failure rates of components on vehicles. Making a projection of future trends for large groups of vehicles as is done for estimating the emission inventory, however, is far different than identifying which components on a specific vehicle will fail and when the failures will occur for all the reasons cited above. If it were possible to identify which components on older vehicles will fail and when, then there would be no need for OBD II systems.

Contrary to the claims of industry, the ARB has not in the past considered compliance with other emission standards as a primary factor in determining compliance with the OBD II requirements and proposed remedies. Industry, however, asserts that title 13, CCR section 1968.1(i)(5) clearly indicates that compliance with tailpipe and evaporative standards has been relevant to the inquiry. This interpretation of the section is in error. Section 1968.1(i)(5) provides that in making a decision to recall vehicles for noncompliance with the OBD II regulation, the ARB would consider, among other factors, the level of emissions above applicable standards.

The reference to level of emissions above applicable standards does not refer, as industry contends, to whether the vehicle class, on average, complies with either the tailpipe or evaporative emission standards. In fact the section does not in anyway refer to vehicle fleet averages. Rather the reference is to the level of emissions above the malfunction criteria thresholds set forth in section 1968.1(c) that must be achieved before a monitoring system indicates a malfunction. For example, if the malfunction criterion threshold is 1.5 times the hydrocarbon emission standard, the ARB would consider the level that emissions exceed that standard before the malfunction indicator light (MIL) illuminates (e.g., 1.6 times the standard or 2.5 times the standard, etc.). This reading is consistent with the context of section 1968.1(i)(5) when read as a whole. The later part of the section specifically carves out an exception to recall, stating that "[f]or 1994 through 1997 model years, on-board diagnostic systems recall shall not be considered for excessive emissions without MIL illumination. . . 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."

F. Should the cost-effectiveness of a remedial action be considered?

The automotive industry contends that remedies proposed in title 13, CCR section 1968.5 may not be cost-effective and suggests that perhaps the cost of an ordered remedy may be better spent in other ways that could result in greater emission reductions. The staff, on the other hand, believes that for certain nonconforming systems, remedial action, including recall, is undeniably appropriate and that the cost of the ordered remedy should not be a factor in the decision. The staff has identified specific criteria in the proposed regulation for determining when a specific remedy should be required. In general, the criteria mandating recall reflect a serious lack of effort or commitment of resources on the part of the manufacturer in developing an OBD II monitor, with the consequence that the system is virtually non-functional. Some of these criteria include a monitor that operates rarely in-use, a malfunction that illuminates the MIL only after emissions far exceed the emission threshold at which the MIL should have been illuminated, an OBD II system that cannot be tested in an Inspection and Maintenance (I/M) program so that valid test results can be obtained, and others. For OBD II monitors that are noncompliant but are more functional, the proposed regulation would allow the Executive Officer to consider a number of factors in determining an appropriate remedy that may or may not require a recall.

In developing requirements such as those in title 13, CCR section 1968.2 for OBD II systems, the ARB staff does consider whether the regulation and the benefits derived therefrom are cost effective (see cost-effectiveness discussions above). But, the ARB is not required to consider, at the time of adopting the regulation, the cost-effectiveness of a future remedial order that would bring into compliance a manufacturer which has elected to ignore the regulation and to produce an essentially nonfunctional OBD II system. The Board has made it unmistakably clear since the OBD II regulation was first adopted that functional OBD II systems are to be installed on all motor vehicles produced for sale in California. To consider cost of compliance when ordering a nonfunctional system to be recalled would potentially undermine the purpose of the regulation. Moreover, if such systems were not replaced because of cost considerations, the effectiveness of the OBD II-based I/M program would also be jeopardized and that program is the only mechanism available to ensure that vehicles maintain low emissions in the latter part of their lives. For example, taking industry's position on remedial costs one step further, a manufacturer could potentially design an expensive non-reprogrammable computer that fails to incorporate a functional major OBD II monitor. If discovered by the ARB, the manufacturer could potentially argue that replacing the computer in all of its vehicles would be too expensive and not cost-effective and that the manufacturer should be excused from having to recall and replace the computers. If that were to occur, such vehicles would continue to be without a functional monitor and could not be effectively tested under the California I&M program. In other words, a manufacturer could knowingly design vehicles that would be too expensive to fix and could be potentially insulated from recall. In such cases, the manufacturer should bear the burden of not having complied with the regulation and taking the most cost-effective steps when designing the OBD II system in the first place. The onus for this failure should not be shifted to the general public.

G. Under what authority may ARB seek civil penalties when a manufacturer undertakes a recall corrective action?

Industry maintains that the ARB does not have authority to seek monetary penalties against a manufacturer for a nonconforming OBD II system once the agency has decided to address the nonconformity through a recall of affected vehicles. It

With the proposed regulation, section 1968.2, the ARB staff is proposing the addition of a fifth protocol, ISO 15765, a Controller Area Network (CAN) protocol, beginning with the 2003 model year. While automobile manufacturers have generally supported the usage of CAN on their vehicles, they disagree with the ARB staff on the phase-in schedule for this implementation. Additionally, the California Bureau of Automotive Repair (BAR) has expressed concern that the ARB's proposed allowance for CAN will require a costly upgrade to inspection and maintenance (I/M) stations statewide and thus should not be included or, at a minimum, should be delayed until a later date. However, the ARB believes that the proposed implementation schedule allows sufficient time for both vehicle manufacturers and I/M stations, and that the implementation of CAN in nearly all vehicles is imminent, as indicated by manufacturers themselves, so that incorporation of CAN into I/M stations will become a necessity.

The ARB originally proposed requirements that would allow manufacturers to implement CAN as early as the 2003 model year and require vehicle manufacturers to implement CAN on all of their vehicles by model year 2007. However, industry proposed to extend this deadline to model year 2009, stating that the 2007 deadline did not allow enough time for full compliance. In response to comments received at the workshop, tentative phase-ins submitted by some manufacturers and meetings with individual manufacturers, the staff has revised the proposal to require all cars to comply by the 2008 model year instead of the 2007 model year. This time frame should provide manufacturers with sufficient lead time to make any necessary changes as well as avoid unnecessary delays in getting the benefits of CAN to service technicians (e.g., faster and more comprehensive trouble-shooting data).

As a result of allowing CAN to be one of the protocols vehicle manufacturers can use, I/M stations that incorporate a check of the OBD II system would need to upgrade their equipment to incorporate CAN software. BAR has expressed concern that such an upgrade would result in significant costs to I/M stations and that the allowance for CAN as early as the 2003 model year does not provide stations with sufficient time for this upgrade. BAR has also asked the ARB to reconsider whether or not to allow the use of CAN altogether. Lastly, BAR has asked the ARB to consider requiring all future vehicles to be "backwards-compatible" (i.e., no matter what technology any future vehicle uses, it will also be equipped with the hardware and software necessary to communicate using one of the existing four protocols).

The ARB staff has considered the cost of implementing the CAN protocol on California's I/M stations. It has determined that such stations would be required to purchase and install special equipment that could support the CAN protocol, and that such equipment would cost approximately $500 per station. While not finding this amount to be inconsequential, the staff believes that the benefits of the CAN protocol outweigh this one-time upgrade cost. The faster information rate and greater repair information access available with the CAN protocol would benefit technicians when diagnosing and making repairs. The protocol would also provide improvements to the standardization requirements, thereby minimizing chances for problems that could cause a vehicle not to be inspected or repaired properly. Further, nearly all manufacturers have indicated that they are going to use the CAN protocol on all vehicles in the near future as the "core" communication protocol between the various control modules on the car (ABS, air bag, climate control, engine control, etc.). They state that this will occur regardless of the position taken by the ARB on OBD II communication. Therefore, if the ARB were to reconsider the use of the CAN protocol for OBD II communication, manufacturers would be forced to continue the use of one of the existing communication protocols. In such a case, vehicles would be equipped with both this existing protocol for OBD II communication and the CAN protocol for all other communications. As a result, manufacturers would need to equip these vehicles with software and hardware that could support both protocols, which would result in additional costs. These costs, which are invariably passed onto consumers in the price of a new car, will far exceed the one-time upgrade cost to I/M stations.

Regarding the 2003 model year start date, the ARB had been working with industry and participating in ISO committee meetings for several years in the development of the CAN protocol and even stated its intent at the 1999 OBD II workshop to allow use of the protocol in 2003 model year vehicles. Consequently, some manufacturers have developed and designed their cars accordingly. Delaying the implementation of the protocol would not provide I/M stations significant relief, since all manufacturers will eventually be implementing the protocol, and would simply postpone the inevitable upgrade for the I/M stations.

There is also one notable exception regarding the standardized communication protocols. The existing OBD II requirements allow vehicle manufacturers to request ARB approval to use a different protocol for medium-duty vehicles. This protocol, SAE J1939, was originally designed for use in heavy-duty vehicles. However, many of the engines that are used in heavy-duty vehicles are also used in medium-duty vehicles. As such, the provision was put into the OBD II regulation to allow manufacturers who produce engines for medium-duty and heavy-duty applications to use a common protocol. While reducing complexity (and cost) to the engine manufacturer, a common protocol would also help minimize costs for repair technicians, since most medium-duty vehicles are serviced at the same repair shops as heavy-duty vehicles. Failure to allow the use of a common protocol would potentially require these heavy-duty repair technicians to incur additional cost by purchasing additional scan tools or scan tool upgrades to work on the medium-duty vehicles, even though they use the same engines as the heavy-duty vehicles.

BAR, however, has expressed a concern regarding the cost to upgrade the I/M stations to accommodate SAE J1939. Similar to CAN, this upgrade would require additional software and hardware at each I/M station. Accordingly, BAR has asked the ARB to eliminate the provision for SAE J1939 or any other alternate protocol for medium-duty applications. Further, since no manufacturer has yet used this provision, BAR argues that the provision could be dropped now, thus eliminating the need for this upgrade to the stations.

While the ARB appreciates BAR's desire to minimize costs to I/M stations, the ARB staff must also consider the associated costs to the vehicle manufacturer and to repair technicians. If the use of SAE J1939 was not allowed for medium-duty vehicles, a manufacturer of medium-duty and heavy-duty vehicles would have to implement one of the protocols required for light-duty applications solely for OBD II purposes. The associated costs to the vehicle manufacturer, and ultimately to a purchaser of a new medium-duty vehicle, would likely far outweigh the cost of the one-time upgrade to the I/M stations, much like the case for the CAN protocol. Further, though the individual cost to a repair technician to upgrade his/her equipment would likely be the same as the individual cost to an I/M station to upgrade the equipment, there are generally many more repair technicians than I/M inspection stations. Thus, the total cost to businesses or individuals in the State of California would be higher. These scenarios are also applicable for any alternate protocol other than SAE J1939 that is used for heavy-duty applications. In short, when the protocol used for heavy-duty applications is different than the one used for medium-duty applications, there will be additional costs associated with the presence of two protocols that would likely exceed the costs of upgrades to I/M stations to accommodate one common protocol.

As such, the proposed requirements would not completely eliminate the provision for medium-duty vehicles to use an alternate protocol. Though the proposed requirements eliminate the direct reference to SAE J1939 as the allowable alternate protocol, they still include an allowance for medium-duty vehicles to utilize an alternate protocol as long as it is the same protocol that the ARB adopts for use in heavy-duty applications (which will be decided in a separate regulatory item for heavy-duty OBD at a later date). This compromise would allow engine manufacturers and repair technicians to work with a common protocol on engines in both medium-duty and heavy-duty applications. Additionally, while this does not eliminate the need for I/M stations to upgrade, it does offer the potential for an upgrade that would allow heavy-duty vehicles, which are generally not required to undergo I/M inspections, to also be incorporated into the Smog Check program.

I. Issue of leadtimes

One of the main issues discussed between the ARB and industry has been the leadtime required for implementation of various aspects of the proposed requirements. In earlier drafts of the proposed regulation, the ARB originally proposed leadtimes that were generally more aggressive than those the ARB is presently proposing. In general, most of the proposed requirements for the catalyst, misfire, oxygen sensor, evaporative system, secondary air, and other monitors were originally required to be implemented either by model year 2003 (for some minor changes), or with a three-year phase-in starting with model year 2004. Industry believed this did not provide sufficient time for implementation of the proposed requirements. For most of the monitors, they proposed three-year phase-in periods starting with the 2005 or 2006 model years. During the July 2001 workshop, the ARB took the manufacturers' concerns into consideration, and, where warranted, extended the leadtime.

In general, the phase-ins have been revised to allow manufacturers to incorporate these changes at the same time they are implementing substantial software changes to meet the Low Emission Vehicle II standards (2004-2007 model years). This would allow manufacturers to incorporate the changes in the most cost-effective manner.

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Resolution 93-50, adopted July 9, 1993.

Documents related to the September 1991 OBD II Board Hearing:

Final Statement of Reasons for Rulemaking Including Summary of Comments and Agency Response, "Public Hearing to Consider Technical Status Update and Proposed Revisions to Malfunction and Diagnostic System Requirements Applicable to 1994 California Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles – (OBD II)", considered September 12, 1991.

"Notice of Public Hearing to Consider Technical Status Update and Proposed Revisions to Malfunction and Diagnostic System Requirements Applicable to 1994 and Subsequent California Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles – (OBD II)" and Staff Report: Initial Statement of Reasons for Rulemaking, "Technical Status Update and Proposed Revisions to Malfunction and Diagnostic System Requirements Applicable to 1994 and Subsequent California Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles – (OBD II)", July 1991.

Technical Support Document, "Technical Status Update and Proposed Revisions to Malfunction and Diagnostic System Requirements Applicable to 1994 and Subsequent California Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles with Feedback Fuel Control Systems– (OBD II)", July 1991.

Resolution 91-42, adopted September 12, 1991.

Documents related to the September 1989 OBD II Board Hearing:

"Notice of Public Hearing to Consider Adoption of Regulations Regarding On-Board Diagnostic System Requirements Applicable to 1994 and Later Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles with Feedback Fuel Control Systems" and Staff Report: Initial Statement of Reasons for Rulemaking, "Public Hearing to Consider New Regulations Regarding Malfunction and Diagnostic System Requirements Applicable to 1994 and Later California Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles with Feedback Fuel Control Systems– (OBD II)", Mail-Out #89-25, July 1989.

Technical Support Document, "Revisions to Malfunction and Diagnostic System Requirements Applicable to 1994 and Later California Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles with Feedback Fuel Control Systems– (OBD II)", July 1989.

Final Statement of Reasons for Rulemaking Including Summary of Comments and Agency Response, "Public Hearing to Consider Adoption of Regulations Regarding On-Board Diagnostic System Requirements for 1994 and Later Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles – (OBD II)", considered September 14, 1989.

Resolution 89-77, adopted September 14, 1989.

APPENDIX I

Section VII.A., "Air Quality Benefit," from Staff Report: Initial Statement of Reasons, "Proposed Amendments to California Exhaust and Evaporative Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles 'LEV II'," September 18, 1998.

A. AIR QUALITY BENEFIT

California's plan for achieving the one-hour federal ambient ozone standard is contained in the SIP that was approved by the Board in 1994. The SIP calls for emission reductions of 25 tpd of ROG plus NOx by 2010 from light-duty vehicles (Mobile Source Measure M2) in the South Coast Air Basin and additional emission reductions in the South Coast Air Basin of approximately 75 tpd ROG plus NOx (the inventory of these emissions is referred to as the "Black Box"). Although the emission reduction strategies identified in this report are designed to meet the ozone SIP commitment for the SoCAB, the remainder of the state would also achieve needed emission reductions in ozone and particulate matter precursor pollutants. The reductions will also ensure continued statewide progress toward meeting state and new federal air quality standards for ozone and particulate matter. The proposed emission standards will also provide additional reductions for CO.

Using EMFAC7G, the proposed LEV II amendments are estimated to provide approximately 57 tpd ROG plus NOx emission reductions for the SoCAB in 2010. This proposal would meet the M2 SIP commitment, provide additional emission reductions to cover shortfalls in defined measures, and make progress in reducing the Black Box.

The emission reductions anticipated from the proposed tailpipe standards are:

Table VII-1
PROJECTED IMPACT OF LEV II TAILPIPE PROPOSAL
(EMFAC7G; tpd SoCAB)

2010	PCs	LDT2s <6000 lbs. GVW	LDT2s 6000 - 8500 lbs. GVW	MDVs >8500 lbs. GVW	Total Reduction
ROG	1.17	0.93	1.19	0.01	3.30
CO	45.33	41.73	32.44	0.94	120.44
NOx	15.29	19.83	15.66	0.71	51.49

The emission reductions anticipated from the proposed evaporative standards are:

Table VII-2
PROJECTED IMPACT OF THE EVAPORATIVE PROPOSAL (tpd ROG)

	2010	2020
South Coast Air Basin	2.4	8.1
Statewide	6.4	24.4

1. **Impact of Proposed LEV II Exhaust Emission Standards.** In determining the anticipated emission reductions, staff relied on the current emission inventory model, EMFAC7G with minor adjustments.

In order to calculate the emission reductions, staff assumed a fleet average implementation rate for NMOG according to the Tables II-7 and II-8. For NOx emission reductions and implementation of the 120K standard, staff assumed a 25/50/75/100% implementation of the LEV II standards beginning in the 2004 model year. The emission rate for SULEVs was the same as that used for ULEVs times a ratio of the ULEV to SULEV standards. To account for the projected growth rates for trucks and SUVs the vehicle mix was adjusted to 51% for passenger cars, 33% for light-duty trucks, and 16% for medium-duty vehicles less than 8,500 lbs. GVW. The total population of these vehicles, the number of vehicle miles traveled per vehicle and the number of starts per vehicle were held constant. It should also be noted that the baseline includes the emissions attributable to the Supplemental Federal Test Procedure standards. The analysis for medium-duty vehicles over 8,500 lbs. GVW assumed a baseline emission standard of 0.230 g/mi NMOG, 5.5 g/mi CO and 0.7 g/mi NOx.

2. **Impact of Proposed Evaporative Emission Standards.** To estimate the emission benefits of the reduced diurnal-plus-hot-soak standards and proposed extended durability requirements, the emission inventory model EMFAC7G was used for the diurnal and hot soak analyses, and the model EMFACX (to be released in late 1998) was used for the running loss analysis (consisting only of the extended durability.) Adjustments to the model were made to account for the proposed phase-in schedule of 40 percent, 80 percent, and 100 percent beginning in the 2004 model year. Other adjustments include temperature and Reid vapor pressure correction factors to account for these conditions in the enhanced evaporative test procedure as compared to those in the model. The methodology was performed only for vehicles in SoCAB, and scaling factors were developed in order to project emissions for statewide purposes.

3. **Impact of Proposed CAP2000 Amendments.** The proposed CAP 2000 amendments would not be expected to result in any increase in emissions and thus would not be expected to adversely impact the environment. Rather, it is anticipated that the implementation of the manufacturer-conducted in-use test program would likely

decrease emissions because vehicles would be more likely to comply with the standards in-use, which would provide greater protection of our air quality.

4. Net Impact. The total estimated reductions from the LEV II proposal for passenger cars, light-duty trucks and medium-duty vehicles less than 8,500 lbs. GVW for 2010 are 6 tpd ROG (exhaust and evaporative emissions) and 51 tpd NOx in the SoCAB in 2010.

APPENDIX II

Section II.D., "Cost Analysis," from Staff Report: Initial Statement of Reasons, "Proposed Amendments to California Exhaust and Evaporative Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles 'LEV II'," September 18, 1998.

D. COST ANALYSIS

The ARB staff has performed a comprehensive cost analysis of the proposed LEV II exhaust emission requirements applicable to passenger car, light-duty trucks and medium-duty vehicles. Specifically, staff estimated the incremental cost of a ULEV II compared to a ULEV I vehicle for passenger car, light-truck (3751 lb. LVW- 8500 lb. GVW), and medium-duty (8500-10,000 lb. GVW) applications and the incremental cost of a SULEV vehicle for four and six-cylinder passenger car and light-truck applications.

In performing the cost analysis, the cost of parts was not particularly difficult to obtain, but internal corporate costs would have been more difficult since accounting procedures within each company vary, and such costs are not generally revealed. Nonetheless, most vehicle manufacturers now rely increasingly on suppliers of many emission-related parts (e.g., catalysts, air pumps, and many others) to assume more of the engineering development costs and involve them very early in the vehicle development process. Manufacturers rely on these suppliers to produce the final components, rather than source the parts through its own internal facilities. By obtaining parts prices from suppliers, much of the internal costs of automobile manufacturers do not need to be calculated separately, since they are already included in the final cost of parts produced completely by suppliers.

From the following analysis, the following conclusions were drawn:

Incremental retail costs of ULEV II and SULEV vehicles compared to a ULEV I vehicle are:

Category	ULEV II (in $)	SULEV (in $)
PC	71	131
LDT 1	46	105
LDT 2	184	279
MDV 2	208	-
MDV 3	209	-
MDV 4	134	-

The cost-effectiveness of vehicles meeting the LEV II program requirements relative to the LEV I program would be favorable, averaging approximately $1.00 per pound of pollutants reduced. Motor vehicle control measures typically range up to $5 per pound of emissions while stationary source controls range up to $10 per pound of emissions reduced. Further, the incremental cost-effectiveness of a SULEV light-truck compared to a ULEV II vehicle is reasonable, ranging from $2.19 per pound to $4.76 per pound, depending on the calculation method used.

1. Cost methodology. The ARB cost estimates reflect many of today's low cost producers that rely heavily on suppliers to assist in the development of vehicles from the initial concept stage through the final production process. The present supplier industry is highly competitive and usually incurs lower labor costs than the automobile manufacturers.

The first step taken by the staff in assessing costs was to define the systems and technologies that would likely be used by manufacturers to meet the required emission levels. The ARB continues to emission test the latest available hardware from component suppliers on numerous passenger-cars and light-trucks that have been assembled by ARB engineering staff. Based on ARB's testing, plus considerable discussion with industry engineers and component suppliers, consensus is forming on the most likely emission system configurations needed to meet the LEV II program requirements. From some of the discussions, and looking back at cost estimates provided for the LEV I program, it appears to ARB staff that manufacturers tend to overestimate the level of technology and amount of hardware needed to meet distant development goals.

For the most part, the cost to the manufacturers for the individual components in each of the systems currently under development are now fairly well established. Once emission systems have been defined and hardware costs determined, ARB's assessment of further costs to vehicle manufacturers becomes less clear since these costs are closely guarded by individual manufacturers and they may vary significantly within the industry, as noted above. Besides the cost of hardware, ARB considered additional variable costs including costs of assembly, shipping and warranty. Further, support costs (research, legal and administrative), investment recovery (machinery and equipment to manufacture the parts, assembly plant changes, vehicle development, and costs of capital recovery) and dealer costs (dealership operating costs and costs of capital recovery) are also included.

2. Cost Analysis. In performing this cost study, ARB departed from industry practice of assigning a fixed percentage of the manufacturer's variable cost to cover indirect costs (which include research, legal, and administrative costs), and instead, analyzed where such long term costs would actually occur. The reference vehicles for this cost study are 2003 model-year ULEV I vehicles for which ARB staff estimated the likely technology content based on early production current LEV I and ULEV I vehicles. For medium-duty vehicles, since currently there are very few engine families certified to

ULEV I standards, the likely technology content on a 2003 ULEV I vehicle was estimated based on some confidential pre-production information supplied by automobile manufacturers. Also, staff assumed that engines are generally 4, 6, and 8 cylinder designs, although there are small volumes of 3, 5, 10 and 12 cylinder engines as well. Staff also focused on assessing the cost of ULEVs, and did not analyze LEVs, which would only be less costly than ULEVs. LEVs are really a transitional technology since by 2010, nearly all vehicles will be ULEV II calibrations with some portion of SULEVs and/or ZEVs in order to meet the fleet average requirements. Staff also expects that in order to meet the fleet average requirements, any SULEVs produced would likely be 4-cylinder designs, or maybe some 6-cylinder designs since smaller engines are easier and less costly control than larger ones. Therefore, no SULEV estimate was made for 8-cylinder engines. For SULEVs, staff estimated that neither HC adsorbers or EHCs would be needed to meet a 0.01 g/mi NMOG standard (staff received some input from industry confirming this for at least the 4-cylinder engines).

Tables II-29 thru II-38 detail the cost analysis and since these tables are in Microsoft Excel format, they are attached to the end of the staff report instead of being interspersed in the text.

a) Variable Costs. In this section the cost of new parts added, additional assembly operations, any increases in the cost of shipping parts and any new warranty implications are addressed.

1) Cost of Part. In order to determine the increases in the cost of parts for meeting ULEV II and SULEV standards, an information gathering and analysis effort was conducted to determine the expected emission system configurations and technologies that would be utilized. Tables II-29-33 provide a detailed breakdown of component usage and costs for all of the emission control systems.

Universal Exhaust Gas Oxygen Sensors (UEGO). Discussions with manufacturers suggest that about half believe an UEGO sensor is important to helping achieve ULEV I or ULEV II emission levels (except for medium-duty vehicles greater than 8500 lb. GVW), while the remainder seem to believe they offer little additional benefit. In any event, the incremental cost of an UEGO continues to decrease, so that the latest estimate is a $10 incremental cost compared to a conventional oxygen sensor. For SULEVs, staff estimated that all manufacturers would use UEGOs for their incremental benefit. They would be used only for primary fuel control, with conventional sensors used downstream.

Air Assist Fuel Injection. For ULEV I or ULEV II vehicles, manufacturers also appear split on the use of air assist fuel injection as well, so that staff estimated manufacturers using them for ULEV I vehicles would continue to use them for ULEV II vehicles. Air assist fuel injection is primarily a technology used for improved HC control, and HC emission requirements are unchanged for the passenger cars. It is expected that light-duty trucks would utilize them in the same proportion as passenger cars for meeting ULEV II requirements. For SULEVs, all vehicles will likely need to utilize this technology in order to avoid more costly controls such as adsorbers or electrically heated catalysts. The cost of air assist fuel injection was estimated to be the same as in previous estimates, or about $2 additional per injector.

Heated Fuel Injectors. Improved HC control for larger displacement engines could result from improved vaporization of fuel from heated fuel injectors. Achieving ULEV II and SULEV HC levels when heating larger exhaust volumes and associated catalysts of the larger light-trucks will possibly lead to utilization of this approach on about half of these vehicles. The incremental cost is estimated to be $3 per injector.

Individual Cylinder Fuel Control. Perhaps one of the most important enablers for achieving ULEV II (including medium-duty vehicles in the 8500-10,000 lb. GVW category) or SULEV NOx emission levels will be the use of individual cylinder fuel control. Accordingly staff estimated all such future vehicles will use it. Although resources will be needed to develop this technology (research and development costs have been included under support costs), no additional hardware would be needed. Discussions with manufacturers indicated they would be utilizing computers with the processing capability needed to carry out this real time modeling for other purposes, so that additional computer costs were not included.

Retarded Spark Timing at Startup/ Electric Air Injection. Quick heating of the exhaust during the cold starting period will require use of retarded spark timing on all ULEV II and SULEV vehicles. In some cases it will be accompanied by modified fuel control and air injection. Modified timing and fuel control would not add hardware cost since these would require only calibration revisions. In those instances where electric air injection is used to further enhance this HC and NOx reduction strategy, staff assumed a cost of $50 for 4-cylinder vehicles and $65 for 6-cylinder and 8-cylinder vehicles for a complete system. The system cost was increased to $75 for medium-duty applications greater than 8500 GVW to account for the higher capacity electric air pump required on such applications. Manufacturers indicated that injecting air at the exhaust valve outlet assisted significantly in reducing HC emissions. Accordingly staff assumed that manufacturers would utilize engine heads with cast air injection passages, and that each head would require its own check valve.

Abbreviated Engine Start-up. Some manufacturers are exploring faster engine cranking speed to achieve near instant engine starting and reduced HC emissions. This could be achieved with an integral starter/alternator design. Staff allowed an additional $10 for this system relative to its emission benefits, although for the total system cost may be greater, especially in initial volumes (but there are cost savings from eliminating other mechanical/hydraulic systems that could all be electrically powered and, therefore, more efficient). This technology was estimated to be most important for SULEVs.

Low Thermal Capacity Exhaust Manifold. The lower thermal mass of these stainless steel manifolds aids retention of exhaust heat for quicker catalyst light-off, and was assumed to be used on about 75 percent of ULEV II vehicles (100 percent of 8 cylinder light-trucks) and all SULEVs.

Improved Catalyst Systems. For each vehicle category, staff considered whether any increases in catalyst volume, precious metal loading, and higher cell density were required in order to meet LEV II program standards and accordingly, estimated associated costs. Except for ULEV II passenger cars and 4-cylinder ULEV II trucks, catalyst volumes were increased for all other vehicles. All ULEV II and SULEV vehicles were assumed to use advanced thermally durable double-layer washcoats, increased precious metal loadings (including rhodium) and higher cell density substrates. ULEV II vehicles were assumed to use 600 cpi substrates while SULEV vehicles were assumed to use 900 cpi substrates. While passenger cars and LDT1 vehicles are estimated to achieve ULEV II standards without an increase in catalyst volume, six and eight cylinder light-trucks may require a significant increase in catalyst volume compared to that needed to meet ULEV I standards.

The specific increase in catalyst volume for various catalyst configurations was calculated by first estimating the sales-weighted catalyst volume of all 1998 models certified in a vehicle category and then applying to it an estimated percent increase applicable to that category. The estimated catalyst volume was then converted to a cost increase, by assuming that a typical catalyst would cost \$50/liter. For example, SULEV vehicles are expected to incorporate additional close-coupled pipe catalysts, equivalent to a 20 percent increase in catalyst volume in order to provide additional compliance margin with the standards. It was also assumed that the rhodium loading of the catalyst systems would be increased in order to achieve and maintain very low NOx levels. ULEV II vehicles (including medium-duty vehicles 8500-10,000 lb. GVW) were assumed to use 12 gm/cu. ft. rhodium loading while SULEV vehicles were assumed to use 15 gm/cu. ft. loading. The additional rhodium costs were estimated using a price of \$675/troy ounce. The additional catalyst volume, rhodium, and increased cell density costs for the various categories are detailed in Table II-34. Some manufacturers have expressed concern that LEV II requirements can potentially cause shortages of precious metals, thereby driving prices to unacceptable levels. However, industry experts in precious metals have indicated to staff that given adequate leadtime, mines typically increase production to meet market demand with very little temporary price increases, if any. Looking at the time-period from 1969 to 1989, although the demand for precious metals increased many fold, production has been able to keep pace and market forces have continued to keep prices competitive. Consequently, in taking a historical perspective, it appears that concerns regarding the availability of precious metals may be overstated by the automobile industry.

Engine Modifications. Additional cost for engine modifications to improve emissions was ascribed to 6 and 8 cylinder ULEV II vehicles and 4 and 6 cylinder SULEV vehicles. In some cases manufacturers could place an additional spark plug in the combustion chamber for improved combustion stability (and on a 4 valve per cylinder engine, it could delete an exhaust valve and related hardware to partially offset the cost), or they may add a swirl control valve, or make other changes to further improve engine-out emissions and/or increase cold start exhaust temperatures. Ten dollars was allowed for 4 and 6 cylinder engines, \$15 for 8 cylinder engines and \$20 for medium-duty applications greater than 8500 GVW that have typically lagged in sophistication relative to lighter-duty vehicles.

2) **Cost of Assembly**. As in the LEV I program, the LEV II program will rely on refinements to conventional technology. Judging from the detailed analysis in the LEV I program concerning increased assembly costs, which included a detailed evaluation of the likely array of catalyst designs and an associated estimate of increased catalyst welding costs, another detailed analysis for the LEV II program assembly costs would likely yield about the same small incremental assembly costs. Most of the assembly cost increase for LEV II program vehicles would be for the installation of greater numbers of electric air injection systems, where needed. Electrically heated catalysts do not seem likely to be needed. In comparing ARB's previous cost study of the LEV I program (April, 1994), staff estimated an incremental cost per vehicle of $2 for assembling an air-injection system and $0.25 for assembly of an additional catalyst per vehicle.

3) **Cost of Shipping**. Additional shipping costs were allowed for the increased number of vehicles using electric air injection systems (an additional $0.25 per vehicle using an air pump system).

4) **Cost of Warranty.** Incremental warranty costs were added wherever air-injection systems were estimated to be utilized at the rate of $150 per system ($100 for parts and $50 for labor) and a failure rate of 0.1 percent was assumed.

Assembly, shipping and warranty costs are detailed in Tables II-39-40.

b) **Support Costs**. Support costs affecting the retail price of emission requirement changes include research costs, legal coverage for new issues, and administrative increases.

1) **Research Costs**. Manufacturers have until 2007 to fully phase-in vehicles meeting the LEV II standards. Providing a long leadtime permits large cost savings to the vehicle industry. Incorporation of the required changes can take place systematically within the existing new vehicle development process without incurring redesign to accommodate planned revisions due to frequently changing emission requirements.

Despite the cost savings permitted by long range standards setting, allocation of some additional cost to manufacturers for performing advance system development work is justified when engineering new types of technologies. Consequently, staff has added development cost that includes personnel, overhead and other miscellaneous costs for new technologies such as individual cylinder fuel control and advanced catalyst evaluations. Allowance also has been made for the cost of a fleet of advance development vehicles to carry out the activity. Each advance development vehicle was assumed to cost $100,000. Details of this assessment are shown in Table II-35. The costs incurred under this category have been distributed over 100,000 vehicles per year for a total of 8 years.

2) **Legal and Administrative Costs**. The ARB does not believe that the most likely hardware to be used will introduce liability issues or administrative increases, especially since manufacturers have had considerable experience for some years now with technologies likely to be used to meet LEV II standards. Consequently, no extra cost beyond what has been included under the LEV I program has been included.

c) **Investment Recovery**. This portion of the cost analysis includes accounting for machinery and equipment to manufacture parts, assembly plant changes (automation), vehicle development (engineering), and cost of capital recovery.

1) **Machinery and Equipment to Manufacture Parts**. Since all of the new components will be produced by suppliers, the costs of machinery and equipment to manufacture the part are already included in the piece costs.

2) **Assembly Plant Changes (Automation)**. The primary changes from an assembly point of view are in the exhaust system configuration. Since exhaust systems are usually installed as an assembly, this should not affect the current assembly plant operation. Installation of an electric air pump system (i.e., the pump, power switch, shut-off valve, hoses, tubing and check valves) on those vehicles requiring one probably would not lend itself to automation. Therefore, no additional investment in automatic tooling is expected for air-injection systems (labor costs for installation of the pumps and associated parts was covered earlier).

3) **Vehicle Development**. Once the vehicle development program is handed off from advance engineering, calibration/certification engineers complete the emission control system design process. Since the new parts expected to be required on LEV II vehicles are not substantially different from current systems, no additional costs have been added beyond those already included under the LEV I program. Please note substantial costs were included in the LEV I program for investment costs for vehicle development such as additional dynamometers, low-emission measurement upgrades and others.

4) **Cost of Capital Recovery**. The cost of capital recovery (return on investment) was calculated at six percent of the total costs to the manufacturer. At least one large-volume manufacturer employs such an approach to calculate the cost of capital recovery. Table II-36 & II-37 show the calculations for the various vehicle applications.

d) **Dealer Costs**. Dealership costs include accounting for operating costs and the cost of capital recovery. Since the price of the vehicle would increase due to the LEV II program, it is appropriate to account for the additional interest that the dealer would pay for financing the cost of the vehicle and to cover the commission sales

Table II-29
Passeenger Car and LDT1: Incremental Cost of a ULEV II Compared to a ULEV I Vehicle

Emission Control Technology	4-cylinder				6-cylinder				8-cylinder			
	Tech. cost est. (In dollars)	Tech. on 2003 MY ULEV I (%)	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)	Tech. cost est. (In dollars)	Tech. on 2003 MY ULEV I (%).	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)	Tech. cost est. (In dollars)	Tech. on 2003 MY ULEV I (%)	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)
Universal exhaust gas oxygen sensor (a)	10.00	50	50	0	20.00	50	50	0	20.00	50	50	0
Air-assisted fuel injection (b)	8.00	50	50	0	12.00	50	50	0	16.00	50	50	0
Individual cylinder fuel control (c)	0	50	100	0	0	50	100	0	0	50	100	0
Retarded spark timing as start-up (c)	0	0	100	0	0	25	100	0	0	100	100	0
Low thermal capacity manifold (upgrade)	20.00	25	75	10.00	40.00	25	75	20.00	40.00	25	75	20.00
Greater catalyst loading (d)	13.59	0	100	13.59	22.02	0	100	22.02	36.59	0	100	36.59
Imp. double layer washcoat & 600 cpl cell density	1.80	0	100	1.80	2.92	0	100	2.92	4.86	0	100	4.86
Engine modifications (e)	0	0	0	0	10.00	0	100	10.00	15.00	0	100	15.00
Air injection (electric) (f)	50.00	0	0	0	65.00	0	50	32.50	65.00	25	75	32.50
Total incremental component cost				$25.39				$87.44				$108.94

(a) Only the front oxygen sensor in an UEGO type sensor
(b) Air assistedfuel injection requires minor redesign of the idle air control valve at no additional cost and the addition of an adaptor to each injector at a cost of $2 each
(c) Individual cylinder fuel control and retarded spark-timing at start-up constitute sofware changes only, at no additional hardware cost.
(d) Catalyst volume on a ULEV II vehicle is estimated to be virtually the same as on a ULEV I vehicle.
(e) Types of engine modifications may be less uniform throughout the industry and may include items such as additional spark plug per cylinder,addition of a swirl control valve or other hardware needed to achieve cold combustion stability, improved mixing and better fuel injector targeting.
(F) Cost of air injection includes an electric air pump with integrated filter and relay, wiring, air shut-off valve with integral solenoid, check valve, tubing and brackets

Table II-30
Light-Duty Truck (3751 lbs. LVW- 8500 lbs. GVWR): Incremental Cost of a ULEV II Compared to a ULEV I Vehicle

	4-cylinder				6-cylinder				8-cylinder			
Emission Control Technology	Tech. cost est. (In dollars)	Tech.on 2003 MY ULEV I (%)	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)	Tech. cost est. (In dollars)	Tech. on 2003 MY ULEV I (%)	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)	Tech. cost est. (In dollars)	Tech. on 2003 MY ULEV I (%)	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)
Universal exhaust gas oxygen sensor (a)	10.00	50	50	0	20.00	50	50	0	20.00	50	50	0
Air-assisted fuel injection (b)	8.00	25	50	2.00	12.00	50	50	0	16.00	50	50	0
Heated fuelinjectors	12.00	0	0	0	18.00	0	0	0	24.00	0	50	12.00
Individual cylinder fuel control (c)	0	25	100	0	0	25	100	0	0	0	100	0
Retarded spark timing as start-up (c)	0	0	100	0	0	25	100	0	0	100	100	0
Low thermal capacity manifold	20.00	25	75	10.00	40.00	25	75	20.00	40.00	25	100	30.00
Increaseed catalyst volume	0	0	100	0	55.50	0	100	55.50	35.10	0	100	35.10
Greater catalyst loading	21.15	0	100	21.15	34.03	0	100	34.03	49.66	0	100	49.66
Imp. double layer washcoat & 600 cpi cell density	2.81	0	100	2.81	4.52	0	100	4.52	6.59	0	100	6.59
Engine modifications (d)	0	0	0	0	10.00	0	100	10.00	15.00	0	100	15.00
Air injection (electric) (e)	50.00	0	0	0	65.00	0	50	32.50	65.00	50	100	32.50
Total incremental cost				$35.96				$156.54				$180.8 5

(a) Only the front oxygen sensor in an UEGO type sensor
(b) Air assisted injection requires minor redesign of the idle air control valve at no additional cost and the addition of an adaptor to each injector at a cost of $2 each
(c) Improved precision fuel control envisioned here and retarded spark timing at start-up constitute software changes only, at no additional cost
(d) Types of engine modifications may be less uniform throughout the industry and may include items such as an additional spark plug per cylinder, addition of a swirl control velve or other hardware needed to achieve cold combustion stability, improved mixing and fuel injector targeting.
(e) Cost of air injection includes an electric air pump with integrated filter and relay, wiring, air shut-off valve with integral solenoid, check valve, tubing and brackets

Table II-31
Medium-Duty Vehicle (8500-10000 GVW): Incremental Cost of a ULEV II Compared to a ULEV I Vehicle

Emission Control Technology	8-cylinder and higher: Tech. cost est. (In dollars)	Tech.on 2003 MY ULEV I (%)	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)
Universal exhaust gas oxygen sensor (a)	20.00	0	0	0
Air-assisted fuel injection (b)	16.00	0	0	0
Heated fuelinjectors	24.00	0	0	0
Individual cylinder fuel control (c)	0	0	100	0
Retarded spark timing as start-up (c)	0	100	100	0
Low thermal capacity manifold	40.00	0	0	0
Increased catalyst loading	39.65	0	100	39.65
Greater catalyst loading	42.07	0	100	42.07
Imp. double layer washcoat & 600 cpi cell density	7.44	0	100	7.44
Engine modifications (d)	20.00	0	100	20.00
Air injection (electric) (e)	75.00	0	0	0
Total incremental cost				$109.17

(a) Only the front oxygen sensor in an UEGO type sensor
(b) Air assisted injection requires minor redesign of the idle air control valve at no additional cost and the addition of an adaptor to each injector at a cost of $2 each
(c) Improved precision fuel control envisioned here and retarded spark timing at start-up constitute software changes only, at no additional cost
(d) Types of engine modifications may be less uniform throughout the industry and may include items such as an additional spark plug per cylinder, addition of a swirl control velve or other hardware needed to achieve cold combustion stability, improved mixing and fuel injector targeting.
(e) Cost of air injection includes an electric air pump with integrated filter and relay, wiring, air shut-off valve with integral solenoid, check valve, tubing and brackets

Table II-32
Passenger Car & LDT1: Incremental Cost of a SULEV Compared to a ULEV I Vehicle

Emission Control Technology	4-cylinder Tech. cost est. (In dollars)	Tech.on 2003 MY ULEV I (%)	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)	6-cylinder Tech. cost est. (In dollars)	Tech. on 2003 MY ULEV I (%)	Proj. Tech. on ULEV II (%)	Inc. Cost (In dollars)
Universal exhaust gas oxygen sensor (a)	10.00	50	100	5.00	20.00	50	100	10.00
Air-assisted fuel injection (b)	8.00	50	100	4.00	12.00	50	100	6.00
Individual cylinder fuel control (c)	0	50	100	0	0	50	100	0
Retarded spark timing as start-up (c)	0	0	100	0	0	25	100	0
Abbreviated engine start-up (d)	10.00	0	25	2.50	10.00	0	25	2.50
Low thermal capacity manifold (upgrade)	20.00	25	100	15.00	40.00	25	100	30.00
Close-coupled pipe catalyst(s) (e)	14.78	0	100	14.78	23.94	0	100	23.94
Greater catalyst loading	20.38	0	100	20.38	33.03	0	100	33.03
Imp. double layer washcoat & 900 cpi cell density	4.33	0	100	4.33	10.56	0	100	10.56
Engine modifications (f)	10.00	0	100	10.00	10.00	0	100	10.00
Air injection (electric) (g)	50.00	0	0	0	65.00	0	50	32.50
Total incremental cost				$75.98				$158.53

(a) Only the front oxygen sensor in an UEGO type sensor
(b) Air assisted fuel injection requires minor redesign of the idle air control valve at no additional cost and the addition of an adaptor to each injector at a cost of $2 each
(c) Improved cylinder fuel control and retarded spark-timing at start-up constitute software changes only, at no additional cost
(d) Abbreviated engine start-up utilizes a higher speed starter or integral starter/alternator system to achieve quicker engine cranking at start-up.
(e) Catalyst volume on a SULEV is estimated to be 20 percent greater than that on a ULEV I vehicle.
(f) Types of engine modifications may be less uniform throughout the industry and may include items such as an additional spark plug per cylinder, addition of a swirl control velve or other hardware needed to achieve cold combustion stability, improved mixing and fuel injector targeting.
(e) Cost of air injection includes an electric air pump with integrated filter and relay, wiring, air shut-off valve with integral solenoid, check valve, tubing and brackets

Table II-33
Light-Duty Truck (3751 LVW-8500 GVW): Incremental Cost of a SULEV Compared to a ULEV I Vehicle

	4-cylinder				6-cylinder			
Emission Control Technology	**Tech. cost est. (In dollars)**	**Tech.on 2003 MY ULEV I (%)**	**Proj. Tech. on ULEV II (%)**	**Inc. Cost (In dollars)**	**Tech. cost est. (In dollars)**	**Tech. on 2003 MY ULEV I (%)**	**Proj. Tech. on ULEV II (%)**	**Inc. Cost (In dollars)**
Universal exhaust gas oxygen sensor (a)	10.00	50	100	5.00	20.00	50	100	10.00
Air-assisted fuel injection (b)	8.00	25	100	6.00	12.00	50	100	6.00
Heated fuel injectors	12.00	0	0	0	18.00	0	0	0
Individual cylinder fuel control (c)	0	25	100	0	0	25	100	0
Retarded spark timing as start-up (c)	0	0	100	0	0	25	100	0
Abbreviated engine start-up (d)	10.00	0	25	2.50	10.00	0	25	2.50
Low thermal capacity manifold	20.00	25	100	15.00	40.00	25	100	30.00
Close-coupled pipe catalyst(s) (e)	23.00	0	100	23.00	92.50	0	100	92.50
Greater catalyst loading	31.73	0	100	31.73	51.04	0	100	51.04
Imp. double layer washcoat & 900 cpi cell density	6.74	0	100	6.74	10.84	0	100	10.84
Engine modifications (f)	10.00	0	100	10.00	10.00	0	100	10.00
Air injection (electric) (g)	50.00	0	50	25.00	65.00	0	50	32.50
Total incremental cost				**$124.97**				**$245.38**

(a) Only the front oxygen sensor in an UEGO type sensor
(b) Air assisted fuel injection requires minor redesign of the idle air control valve at no additional cost and the addition of an adaptor to each injector at a cost of $2 each
(c) Improved cylinder fuel control and retarded spark-timing at start-up constitute software changes only, at no additional cost
(d) Abbreviated engine start-up utilizes a higher speed starter or integral starter/alternator system to achieve quicker engine cranking at start-up.
(e) Catalyst volume on a SULEV is estimated to be 20 percent greater than that on a ULEV I vehicle.
(f) Types of engine modifications may be less uniform throughout the industry and may include items such as an additional spark plug per cylinder, addition of a swirl control velve or other hardware needed to achieve cold combustion stability, improved mixing and fuel injector targeting.
(g) Cost of air injection includes an electric air pump with integrated filter and relay, wiring, air shut-off valve with integral solenoid, check valve, tubing and brackets

Table II-34
Increased Catalyst Cost Estimates for LEV II Vehicles

		Sales Wtd. Eng. Disp. (liter)	Proj. ULEV I Cat. Vol. (liter)	Proj. ULEV II Cat. Vol. (liter)	Inc. Cat. Vol. Cost (a) (dollars)	Inc. Rh. (b) (grams)	Add. Rh Cost (c) (dollars)	Higher cpi coct (c) (dollars)
Passenger Cars								
ULEV II compared to ULEV I	4-cylinder	2.0	1.5	1.5	0	0.626	13.59	1.80
	6-cylinder	3.2	2.4	2.4	0	1.015	22.02	2.92
	8-cylinder	4.5	4.0	4.0	0	1.686	36.59	4.86
Light-duty trucks (0-8,500 lbs. GVWR)								
ULEV II compared to ULEV I	4-cilinder	2.3	2.3	2.3	0	0.975	21.15	2.81
	6-cylinder	3.7	2.6	3.7	55.50	1.568	34.03	4.52
	8-cylinder	5.4	4.7	5.4	35.10	2.288	49.66	6.59
Medium-Duty Vehicles (8500-10000 GVW)								
ULEV II	8-cylinder	6.1	5.3	6.1	39.65	2.585	42.07	7.44
Passenger Cars								
SULEV compared to ULEV I	4-cylinder	2.0	1.5	1.8	14.78	0.939	20.38	4.33
	6-cylinder	3.2	2.4	2.9	23.94	1.522	33.03	7.01
Light-duty trucks (0-8,500 lbs. GVWR)								
ULEV II compared to ULEV I	4-cilinder	2.3	2.3	2.8	23.00	1.462	31.73	6.74
	6-cylinder	3.7	2.6	4.4	92.50	2.352	51.04	10.84

(a) Catalyst cost is estimated to be approximately $50/liter
(b) Assumes increase in rhodium loading of 12 g/ft^3 for ULEV II and 15 g/ft^3 for SULEV
(c) Cost of rhodium = $675 per troy ounce.
(d) Assumes ULEV II vehicles use 600 cpi cata;ysts and SULEVs use 900 cpi cata;ysts. Cost of 600 cpi catalyst compared to 400 cpi catalyst is 2 $cents/in^3$ in large volumes. Corresponding cost for 900 cpi catalist is 4 $cents/in^3$.

Table II-35
SUPPORT COSTS

(A) Engineering Development Cost of Advanced Vehicle Technology (Research)

Emission Control Technology	Eng. Staff for Tech. Dev.		Eng. Staff Cost (a) (in dollars)	Dev. Vehicle Cost (in dollars)	Addtl. Equipment (in dollars)	Cost/Vehicle (c) (dollars/veh.)
	(Person yrs.)	(Person hrs.)				
Catalyst evaluation	4	8,320	499,200	400,000	0	1.12
Engine modifications	6	12,480	748,800	500,000	0	2.19
Individual cylinder fuel control	4	8,320	499,200	500,000	0	1.87
Heated fuel preparation	3	6,240	374,400	400,000	0	1.47
EHC + HC adsorber eval. (D)	10	20,800	1,248,000	500,000	0	2.81
Low thermal capacity manifold	4	8,320	499,200	400,000	0	1.12
Total						$10.59

(B) Legal and Administrative Costs

	No. Of Staff	Number of years	Staff Cost (in dollars)	Cost/Veh. (c) (dollars/vehicle)
Legal	0	0	0	0
Administrative	0	0	0	0

(a) Development cost includes personnel, overhead and other miscellaneous costs at a total rate of $60/hr.
(b) Prototype development vehicles are estimated to cost $100,000 each.
(c) Cost has been distributed over 100,000 vehicles per year for 8 years.
(d) For advanced engineering work in contrast to vehicle calibration/certification effort.

Table II-36
Passenger Car: Incremental Consumer Cost of a ULEV II Compared to a ULEV I

		4-cylinder (in dollars)	6-cylinder (in dollars)	8-cylinder (in dollars)
Variable costs	Component	25.39	87.44	108.94
	Assembly	0.00	1.00	1.00
	Warranty	0.00	0.08	0.08
	Shipping	0.00	0.13	0.13
Support costs	Research	10.59	10.59	10.59
	Legal	0.00	0.00	0.00
	Administrative	0.00	0.00	0.00
Investment recovery costs	Mach & equipment	0.00	0.00	0.00
	Assembly plant changes	0.00	0.00	0.00
	Vehicle development	0.00	0.00	0.00
Capitol recovery		2.16	5.95	7.24
Dealership costs	Operating costs	1.14	3.16	3.84
	Capitol recovery	0.59	1.63	1.99
Total incremental cost to consumer		**$39.87**	**$109.98**	**$133.81**

Light-Duty Truck (0-8500 lbs. GVWR): Incremental Consumer Cost of a ULEV II Compared to a ULEV I

		4-cylinder (20%) (in dollars)	6-cylinder (59%) (in dollars)	8-cylinder (21%) (in dollars)
Variable costs	Component	35.96	156.54	180.85
	Assembly	0.00	1.00	1.00
	Warranty	0.00	0.08	0.08
	Shipping	0.00	0.13	0.13
Support costs	Research	10.59	10.59	10.59
	Legal	0.00	0.00	0.00
	Administrative	0.00	0.00	0.00
Investment recovery costs	Mach & equipment	0.00	0.00	0.00
	Assembly plant changes	0.00	0.00	0.00
	Vehicle development	0.00	0.00	0.00
Capitol recovery		2.79	10.10	11.56
Dealership costs	Operating costs	1.48	5.38	6.13
	Capitol recovery	0.77	2.77	3.17
Total incremental cost to consumer		**$51.58**	**$186.56**	**$213.50**

MDV (8500-1000 GVW): Incremental Consumer Cost of a ULEV II Compared to a ULEV I

		8-cylinder (in dollars)
Variable costs	Component Assembly Warranty Shipping	109.17 1.00 0.08 0.13
Support costs	Research Legal Administrative	10.59 0.00 0.00
Investment recovery costs	Mach & equipment Assembly plant changes Vehicle development	0.00 0.00 0.00
Capitol recovery		7.26
Dealership costs	Operating costs Capitol recovery	3.85 1.99
Total incremental cost to consumer		**$134.06**

Table II-37

Light-Duty Truck (0-8500 lbs. GVWR): Incremental Consumer Cost of a SULEV Compared to a ULEV I

		4-cylinder (in dollars)	6-cylinder (in dollars)
Variable costs	Component Assembly Warranty Shipping	75.98 0.50 0.00 0.00	158.53 2.00 0.08 0.13
Support costs	Research Legal Administrative	10.59 0.00 0.00	10.59 0.00 0.00
Investment recovery costs	Mach & equipment Assembly plant changes Vehicle development	0.00 0.00 0.00	0.00 0.00 0.00
Capitol recovery		5.22	10.28
Dealership costs	Operating costs Capitol recovery	2.77 1.43	5.45 2.82
Total incremental cost to consumer		**$96.50**	**$189.87**

Light-Duty Truck (0-8500 lbs. GVWR): Incremental Consumer Cost of a SULEV Compared to a ULEV I

		4-cylinder (in dollars)	6-cylinder (in dollars)
Variable costs	Component Assembly Warranty Shipping	124.97 1.50 0.08 0.13	245.38 2.00 0.08 0.13
Support costs	Research Legal Administrative	10.59 0.00 0.00	10.59 0.00 0.00
Investment recovery costs	Mach & equipment Assembly plant changes Vehicle development	0.00 0.00 0.00	0.00 0.00 0.00
Capitol recovery		8.24	15.49
Dealership costs	Operating costs Capitol recovery	4.36 2.26	8.21 4.25
Total incremental cost to consumer		**$152.12**	**$286.13**

Table II-38
Incremental Cost of a LEV II Vehicle Compared to a LEV I Vehicle

Emission Category	LEV I Vehicle Category	New Vehicle Fleet Composition 4-cyl/6-cyl/8-cyl			Composite Incremental Cost (dollars)
		4-cyl	6-cyl	8-cyl	
ULEV	PC	58%	33%	9%	71.46
	L DT1	91%	9%	0%	46.18
	LDT2	4%	85%	11%	184.13
	MDV2	0%	21%	79%	207.85
	MDV3	0%	17%	83%	208.92
	MDV4	0%	0%	100%	134.06
SULEV	PC	63%	37%	0%	131.05
	LDT1	91%	9%	0%	104.90
	LDT2	5%	95%	0%	279.43

Cost-Effectiveness of LEV II Vehicle Compared to ULEV I Vehicles

Emission Category	LEV I Veh Category	Incremental cost to consumer (dollars)	Emission Reduction 120K miles			Cost-effectiveness		Inc. Cost-effectiveness	
			ROG (lbs.)	CO (lbs.)	Nox (lbs.)	ROG+NOx ($/lb.)	ROG+CO/7+NOx ($/lb.)	ROG+NOx ($/lb.)	ROG+CO/7+NOx (lbs.)
ULEV	PC	71.46	0.0	48.4	67.3	1.06	0.96		
	LDT1	46.18	0.0	51.5	69.3	0.67	0.60		
	LDT2	184.13	2.3	171.2	159.7	1.14	1.10		
	MDV2	207.85	10.6	662.4	156.1	1.25	1.14		
	MDV3	208.92	13.3	796.8	244.0	0.81	0.56		
	MDV4	134.06	11.0	78.4	94.3	1.27	1.15		
SULEV	PC	131.05	5.8	205.5	81.6	1.50	1.12	2.96	1.40
	LDT1	104.90	5.9	216.0	83.9	1.17	0.87	2.85	1.33
	LDT2	279.43	7.7	335.7	174.4	1.53	1.32	4.76	2.19

APPENDIX III

Cost-Effectiveness Analysis

Methodology

In reexamining the cost-effectiveness of the Low Emission Vehicle II program to include the impact of the proposed OBD II requirements, the staff bifurcated the lifetime of Low Emission Vehicle II applications into two mileage intervals. The first interval, 0 to 120,000 miles, represents the durability period for Low Emission Vehicle II full useful life emission standards. The second interval, beyond 120,000 miles, represents the period in a vehicle's life when OBD II is expected to have a major impact on the program's emission benefits and costs (the staff extended vehicle lifetime to 230,000 miles when EMFAC2001 assumes only 33 percent of a model year remains in service). Cost-effectiveness was calculated in dollars per pound of reactive organic gas (ROG) and oxides of nitrogen (NOx) reduced relative to a Low Emission Vehicle I application for each mileage interval and then summed to determine the cost-effectiveness for vehicles in each Low Emission Vehicle II emission category (LEV II, ULEV II, Tier 2 Bin 4, Tier 2 Bin 3, and PZEV) and vehicle class (passenger cars, LDT1, LDT2 less than 6,000 lbs. GVW, and LDT2 between 6,000 lbs. and 8,500 lbs. GVW). The resulting cost-effectiveness for each vehicle class was then weighted by its percent fraction of the Low Emission Vehicle II fleet in order to determine the average cost-effectiveness of vehicles meeting Low Emission Vehicle II requirements.

Costs

The incremental costs to the consumer for Low Emission Vehicle II applications compared to Low Emission Vehicle I applications were retained from the original analysis for the Low Emission Vehicle II rulemaking and used for the mileage interval from 0-120,000 miles. The methodology used to determine these costs is described in detail in Appendix II above. Costs considered in that analysis included the manufacturers' hardware costs, variable costs (costs of assembly, shipping, and warranty), support costs (research, legal and administrative), investment recovery (machinery and equipment to manufacturer the parts, assembly plant changes, vehicle development, and costs of capital recovery), and dealer costs (operating costs and costs of capital recovery).

However, the original Low Emission Vehicle II analysis did not include the incremental costs for the cleaner federal Tier 2 vehicles that manufacturers are now required to certify in California. Therefore, the staff used the incremental costs for ULEV II vehicles for Tier 2 Bin 4 vehicles and the incremental costs for SULEV vehicles for Tier 2 Bin 3 vehicles. The staff believes this to be a reasonable approximation, since the emission standards are similar. Furthermore, incremental costs for PZEVs were not included in the original cost analysis for Low Emission Vehicle II, since this emission category was provided as an option to the ZEV requirements. It has since become apparent that manufacturers will choose to certify a significant number of PZEVs in order to meet their ZEV obligations. Therefore, the staff has included an incremental cost for PZEVs of $200, revised downward from the $500 estimate cited in the Staff

Report for the 1999 review of the ZEV program. The revised cost reflects a reevaluation of the likely technology to be used by PZEVs. Confidential data from several manufacturers suggest that PZEVs will use essentially the same technology as SULEVs that are required to meet the same exhaust emission standards. The original warranty costs for PZEVs have also been reduced to reflect the more cost-effective approach manufacturers will likely use to prevent component failures in the 150,000-mile operating interval rather than build less robust components that might fail and whose repair would result in payment of warranty costs. In the Low Emission Vehicle II rulemaking, the staff estimated the incremental cost for SULEVs at $131. The revised cost of $200 for PZEVs also includes costs to the manufacturer for building increased component durability into the emission control components in order to avoid excessive repair costs during the 150,000 mile emission warranty period.

Costs for the vehicle beyond 120,000 miles depend on the repair frequency assumed for each vehicle. For this analysis, the staff assumed that each vehicle (non-PZEV) would undergo two repairs at an average of $260 per repair[59] resulting from component malfunctions detected by the OBD system at the proposed MIL illumination thresholds. For PZEVs, the staff assumed one repair at $275 per repair after the 150,000-mile emission durability and warranty period. Staff developed these average repair costs based on analysis of repair cost data reported from the Smog Check program in California (for OBD II-equipped and non OBD II-equipped vehicles), the Oregon I/M program (OBD II-equipped vehicles only), and a U.S. EPA study on the use of OBD II in I/M programs. A slightly higher repair cost was assumed for PZEVs to reflect the cost for increased durability of the replacement emission control components utilized on PZEVs. For the repair rates, staff analyzed failure rate data from the California Smog Check program and the Oregon I/M program to determine the cumulative number of emission-related repairs the average vehicle would undergo between 120,000 and 230,000 miles. The failure rates were then adjusted to account for the improved durability (and thus, lower failure rate) of vehicles in the Low Emission Vehicle II program. For non-PZEVs, an average failure rate of two emission-related repairs per vehicle was projected between 120,000 and 230,000 miles. For PZEVs (subject to warranty for 150,000 miles), an average rate of a one emission-related repair per vehicle was projected between the 150,000 and 230,000 mile interval.

Emission benefits

Emission benefits for the useful life (120,000 miles) were recalculated using EMFAC2001 for each emission category and vehicle class. The benefits were calculated by summing the pounds per year emissions reduced relative to a Low Emission Vehicle I application for the first nine years of a vehicle's life (according to EMFAC2001, a vehicle travels approximately 125,000 miles in the first nine years).

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[59] Staff estimate for repair costs derived from Oregon I/M program data provided by Gary Beyer, U.S. EPA paper "Evaluation of Onboard Diagnostics for Use in Detecting Malfunctioning and High Emitting Vehicles" (August 2000), and presentation "Smog Operations Applications Unit" (July 2001) and personal communication with Dean Saito, Bureau of Automotive Repair (BAR).

Similarly, emission benefits were calculated for vehicle age ten to nineteen years to account for vehicle mileage between 120,000 miles and 230,000 miles. Emission benefits were determined for both the proposed MIL thresholds and at the higher threshold suggested by industry using EMFAC2001.

To determine emission benefits at the proposed thresholds, vehicle emissions were calculated using EMFAC2001 assuming an effective I/M program. For OBD II-equipped vehicles, the model assumes that OBD II will identify 95 percent of the failures for vehicles in the high to super emission regimes. In EMFAC2001, vehicles remain in the normal and moderate regimes for the useful life (120,000 miles), and then begin to migrate into the high to super regimes. Furthermore, after repair, these vehicles will move evenly to the normal and moderate emission regimes.[60] This is a reasonable assumption, since the MIL will not deactivate unless the vehicle has been properly repaired. The model assumes the MIL thresholds are set at 1.5 times the tailpipe emission standard for all categories (staff is proposing a threshold of 2.5 times the tailpipe emission standard for SULEVs, but this difference has little effect on the overall analysis).

To simulate emission benefits at the higher thresholds suggested by industry, the emission benefits were determined using EMFAC2001 assuming no effective I/M program in place. In this scenario, vehicles migrate into the high to super regimes and remain there. While no vehicle repairs occur in this scenario, it does simulate vehicles remaining in the higher regimes for a longer period of time. Since an effective repair is determined by MIL deactivation (see discussion below on the impact of OBD II on I/M for Low Emission Vehicle applications), setting the threshold at higher levels would cause the MIL to deactivate at the higher emissions thresholds. Accordingly, there would be no assurance of any emission benefits below the emission level where the MIL deactivates (i.e., there is no assurance that vehicles would migrate to the normal and moderate emission regimes). Accordingly, the staff believes this provides a reasonable approximation of the emission benefits of setting the thresholds at the higher levels.

Since the primary improvement in emissions for Low Emission Vehicle I and Low Emission Vehicle II applications is achieved by reducing cold-start emissions, catalyst efficiencies for these vehicles remain high under I/M test conditions when the catalyst is fully warmed up. Therefore, even when failing the emission standard by a factor of two or three, vehicle emissions under I/M test conditions will remain low. To evaluate the potential effectiveness of the current I/M program without OBD II for low-emission vehicles, the staff conducted I/M tests on a limited number of vehicles meeting Low

[60] In EMFAC2001, vehicles in each technology group are categorized into five regimes; normals, moderates, highs, very highs, and supers. As vehicles age (or accumulate mileage), their emissions increase as a result of deterioration; hence, they migrate from normal emitting regimes to higher emitting regimes.

Emission Vehicle I and Low Emission Vehicle II emission standards. The vehicles were also tested over the federal test procedure (FTP), the test procedure used to determine compliance with the certification emission standard. Table A below illustrates the results of this test program.

Table A - I/M and FTP Emission Test Results

Vehicle	Test	HC Meas.	NOx Meas.
LEV I	15 mph	11 ppm	37 ppm
	25 mph	7 ppm	5 ppm
	FTP	0.059 g/mi	0.093 g/mi
ULEV I	15 mph	10 ppm	46 ppm
	25 mph	6 ppm	19 ppm
	FTP	0.031 g/mi	0.049 g/mi
SULEV II	15 mph	2 ppm	0
	25 mph	1 ppm	1 ppm
	FTP	0.008 g/mi	0.012 g/mi
PZEV	15 mph	0	0
	25 mph	0	0
	FTP	0.007 g/mi	0.006 g/mi

While the table represents a limited data set, it illustrates the potential problem for current I/M instrumentation to determine small increases in vehicle emissions at low levels. For example, the LEV I FTP hydrocarbon (HC) emissions are approximately double the FTP HC emissions of the ULEV I vehicle. However, the I/M test indicates only a one-ppm difference in vehicle emissions, well outside the resolution of test instrumentation used in the I/M program. In addition, the FTP NOx emissions of the LEV I vehicle are significantly higher than those of the ULEV I vehicle, while the I/M test measured lower emissions for the LEV I vehicle, directionally opposite to the FTP test results. Since the FTP emissions for the LEV I and ULEV I vehicles are 3 to 6 times the HC emission standard and 2.5 to 5 times the NOx emission standard for SULEVs and PZEVs, the data suggest that, if significant improvements in instrumentation accuracy and/or test methods are not made, without OBD II, the I/M program will have difficulty in identifying these vehicles when they exceed the emission standard by a substantial margin. The staff, therefore, believes it is reasonable to assume that an I/M program without OBD would not be effective in maintaining Low Emission Vehicle I and Low Emission Vehicle II applications close to their certification levels. Accordingly, it is appropriate to attribute the emission benefits of the I/M program beyond 120,000 miles solely to OBD II.

Cost-Effectiveness

Cost-effectiveness was calculated for model years 2003-2020. The emission benefit in pounds year of emissions reduced of a vehicle meeting each of the LEV II emission categories (i.e., LEV II, ULEV II, PZEV) was held constant for all model years.

Therefore, the only variable in the analysis was the percent of vehicles meeting each of the LEV II emission categories for each model year as determined by the fleet implementation schedule in EMFAC2001. The cost-effectiveness for each emission category within the vehicle classes (PC/LDT1, LDT2) was then weighted according to its percentage contribution to the fleet. For example, in model year 2007, EMFAC2001 assumes that 25% of new PCs and LDT1s will meet LEV II emission standards, 15% will meet ULEV II emission standards, 19% will meet Tier 2 Bin 4 emission standards, and 37% will meet the PZEV emission standards (ZEVs were not included in the analysis). The weighted cost-effectiveness for the emission categories were then summed within each vehicle class to determine cost-effectiveness for that vehicle class. In addition, since the model assumes that the PC/LDT1 class will constitute 51% of the light-duty vehicle fleet, the cost-effectiveness of the PC/LDT1 vehicle class was further adjusted by that amount. Summing the weighted cost-effectiveness across the vehicle classes then resulted in the cost-effectiveness for the fleet for each model year. The final cost-effectiveness of $4.57 for staff's proposal was then determined by averaging over model years 2003-2020. The cost-effectiveness of industry's proposal was similarly derived.

APPENDIX IV

Tri-City Database Analysis

The Tri-City database was used as a representative collection of driver habits for the purpose of defining a minimum in-use performance, or monitoring frequency, ratio for OBD II monitoring. The U.S. EPA initiated the Tri-City studies, which involved the random selection of 252 vehicles that were being tested at vehicle Inspection and Maintenance (I/M) facilities in three cities: Baltimore, Atlanta, and Spokane. The vehicles were equipped with data-recording instrumentation that logged time, engine rpm, and vehicle speed. The instrumentation remained on the sampled vehicles and recorded data on a second-by-second basis for 3 to 16 days. However, the database used for the analysis had been condensed into vehicle trip records with relevant parameters needed to determine whether the filtered trip ("f-trip") criteria had been met. Incidentally, eight of the 252 vehicles' records were in a different format and therefore not included in the actual database sent to the ARB, which consisted of driving data for the remaining 244 vehicles.

Using this database, analysis was carried out to derive a ratio of tests per f-trip to represent a frequency that achieved monitoring for 90 percent of vehicle drivers in two-weeks time. The data were investigated and filtered to improve the accuracy of the data analysis. First, driving data from the first and last days of driving for a given test vehicle were excluded from the analysis. These data were viewed as unrepresentative of actual driver data on a per day basis due to the fact that the monitoring equipment for the vehicle was not installed for the full day. Specifically, during the first day, vehicles typically had monitoring equipment installed some time between 10 and 11 AM, thus, vehicle trips occurring on the day of installation but before the equipment was installed were not recorded. Likewise, vehicle trips occurring on the last day of sampling but after the equipment was removed were not recorded nor were they included in the database. For these reasons, it was apparent that including these days would bias the vehicle data in the direction of fewer trips per day. Accordingly, two days were subtracted from the total number of days of data for each vehicle (Figure 1).

Second, if data for a given vehicle did not include at least six days of driving after the first and last days were excluded, this vehicle was excluded from the analysis. Driver habits are generally established on a weekly basis. Specifically, weekday driving establishes commuting driver habits while weekend driving establishes errand and excursion driver habits. If a specific vehicle recorded less than six days of driving data, it is not certain that both weekday and weekend driving habits were established in the database. Therefore, all data used in the analysis were taken from vehicles that recorded at least six valid days of driving. This reduced the number of test vehicles in the analysis from 244 to 186.

To calculate the ratio that corresponded to a two-week time period, the vehicle data were analyzed to determine the number of trips per day that met the "filtered trip", or f-trip, definition (e.g., 10 minutes long, 5 minutes above 25 mph, 30 seconds of idle, etc.)

and, subsequently, determine the average f-trips/day for each vehicle (Figure 2). The mean and standard deviation of this distribution of f-trips/day were found to be 1.79 and 1.11, respectively. Since this distribution was clearly not symmetrical about the mean and tailed to the right (i.e., in the direction of more f-trips/day), a gamma distribution was determined to be the best fit (Figure 3). With the help of a statistician and an iterative process (see Appendix V), the estimated mean and standard deviation of the gamma distribution were calculated to match the distribution of data in the Tri-City database. This yielded an estimated mean of 1.79 and a standard deviation of 0.96.

After the distribution of f-trips/day was determined, the ratio was then derived by determining how often an OBD II monitor would have to operate to ensure that 90 percent of the vehicle population could detect a malfunction within two weeks. Generally, to detect a malfunction and illuminate the MIL, an OBD II monitor has to operate twice. Therefore, if a vehicle is required to illuminate the MIL within two weeks, the OBD II monitor must operate twice within two weeks. To calculate the ratio, it was necessary to estimate the distribution of how often monitors would execute. By then multiplying values from this distribution with values from the distribution of f-trips/day, the minimum ratio that ensures 90 percent of the population will get two decisions in two weeks can be calculated.

To determine the distribution of monitoring frequency, an iterative process was used to model possible distributions. Since vehicle populations that are at or near the minimum frequency would likely have nearly all values between zero and one, a beta distribution was chosen to model the monitoring frequency (Figure 4). Various combinations of assumed means and standard deviations of monitoring frequency were then run through simulations to determine the minimum ratio. For purposes of these simulations, the standard deviations of the monitoring frequency were assumed to be 50 percent of the mean. While both smaller and larger standard deviations were studied, the assumption of 50 percent was selected based on similar standard deviations observed for trips/day and f-trips/day.

For each assumed mean and standard deviation of monitoring frequency, a sample distribution of 100,000 points was generated. Similarly, for the mean and standard deviation of f-trips/day calculated previously, a sample distribution of 100,000 points was also generated. Single values from each distribution were then randomly selected and multiplied together to determine the number of OBD II monitoring events per day for a sample vehicle. If the calculated value was greater than two monitoring events in a 14-day period (i.e., two-weeks), the vehicle was assumed to meet the required monitoring frequency. After doing this for 100,000 simulated "vehicles", the percentage of cars that met the required frequency was determined. This entire process was repeated with various assumed means for the monitoring frequency until a number was generated that yielded 90 percent of the cars as achieving two decisions in two weeks.

From this method, it was calculated that a mean ratio of 0.336 was the minimum ratio necessary to assure 90 percent of the vehicle population would detect a malfunction within two weeks. That is, vehicle populations that have a mean (or average) ratio of 0.336 or higher should result in 90 percent of the vehicles from that population detecting malfunctions within two weeks.

Following similar methodology, a separate ratio was developed for a few monitors (notably, the secondary air system and evaporative system leak detection monitors) that typically operate under more constrained monitoring conditions than other monitors and are much more sensitive to ambient temperature fluctuations. For these monitors, a more heavily filtered trip ("fE-trip") is used for the denominator of the ratio, which would eliminates trips that occur outside of ambient temperatures between 40-95° Fahrenheit and are not "cold-starts". Further, the increased reliance on cold-starts and ambient temperatures places additional uncertainty in the representativeness of the Tri-City data for vehicles operated in California. Accordingly, the ratio was calculated with a more conservative approach by finding the minimum ratio necessary for 50 percent (instead of 90 percent) of the population to detect a malfunction within two weeks. This additional filtering necessitated a separate calculation of the ratio. With these modifications, the minimum mean ratio was calculated to be 0.260.

Sampling

For enforcement testing done by the Executive Officer to determine if vehicles comply with the minimum ratio, a specific test procedure is proposed in the enforcement regulation (section 1968.5). Specifically, the ARB would collect data from a minimum of 30 vehicles to determine if the minimum ratio was met. However, whenever a sample of vehicles is taken from the total population of vehicles, there is some uncertainty as to how accurately the sample vehicles represent the true population of vehicles. Much of this problem is addressed by using very specific procedures to solicit vehicles for inclusion into the sample. However, since the entire vehicle population cannot be sampled, averaged, and compared to the required minimum ratio, the sample of 30 vehicles will be averaged and compared to a "critical" ratio. The critical ratio is a value slightly less than the required minimum ratio and is calculated such that sample means that are lower than the critical ratio provide evidence that the population mean is lower than the required minimum ratio with 90 percent confidence.

For example, for the required minimum ratio of 0.336, a critical ratio of 0.297 was calculated. Thus, a sample of 30 or more vehicles that had an average ratio of less than 0.297 would indicate, with 90 percent confidence, that the actual population of vehicles had an average ratio of less than 0.336. By establishing these critical ratios and using these values for the "trigger" points in enforcement testing, manufacturers would only be found to be noncompliant if there is very strong evidence to support the finding. This process would, however, allow some manufacturers that are actually noncompliant to falsely be determined to be compliant, but overall should provide sufficient separation to identify the majority of OBD II systems that do not comply with the minimum requirements.

To address one other possible scenario, a second failure criterion based on the median ratio of the sampled vehicles is also proposed. This is necessary to avoid a potential situation where the vast majority of a population of vehicles have in-use ratios below the required minimum ratio but a few vehicles have extremely high ratios. In this possible scenario, the few high ratios may cause the average ratio of the sample to exceed the minimum ratio despite the vast majority of vehicles actually monitoring at a frequency below the minimum required ratio. To this end, if a sample of 30 or more vehicles had two-thirds or more of the vehicles with ratios below the minimum required ratio, the population would be determined to be non-compliant. This criterion was also developed such that a sample of 30 or more vehicles that fail this criterion provides evidence that the population mean is lower than the minimum required ratio with 90 percent confidence. Following the example cited above where the required minimum ratio is 0.336, a sample of 30 vehicles where 20 or more of the vehicles had ratios below 0.336 would indicate, with 90 percent confidence, that the actual population of vehicles had an average ratio of less than 0.336.

Figure 1: Tri-City Data: Days of Data per Vehicle
(244 vehicles)

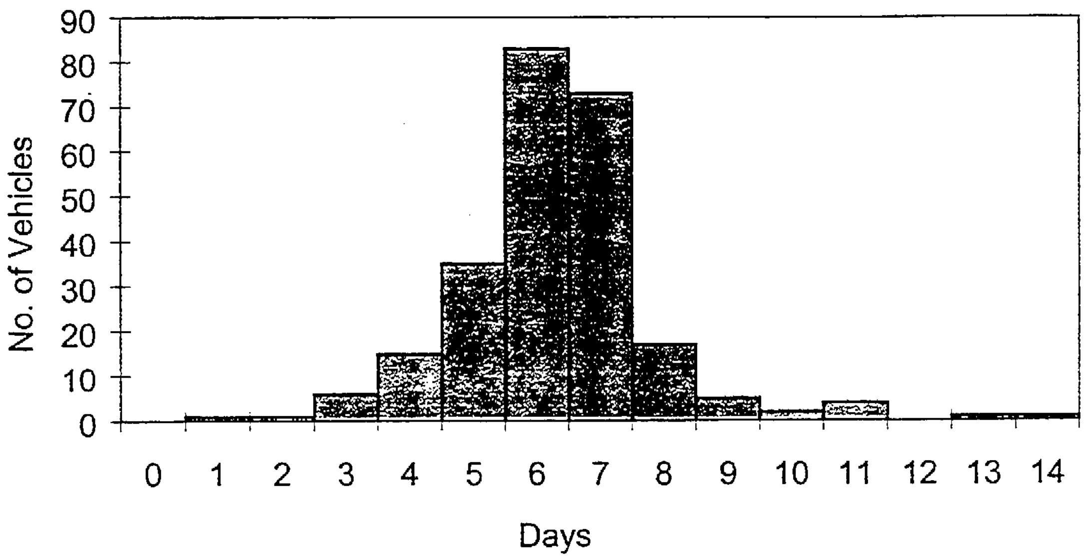


Figure 2: Tri-City Data: f-trips/day
(186 vehicles)

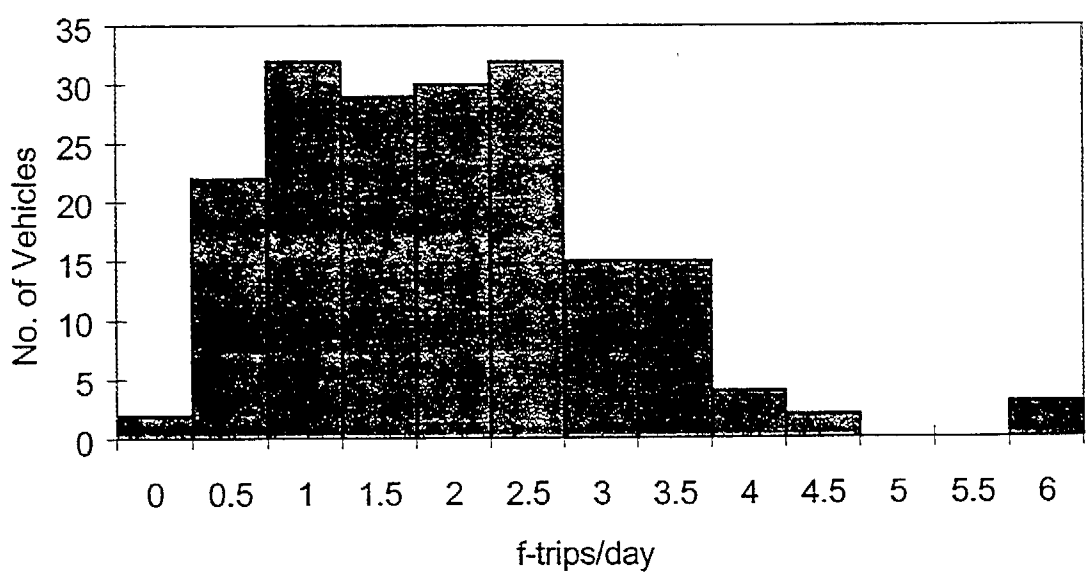


Figure 3: Simulation: Gamma Distribution
(mean = 1.79, SD = 0.96)

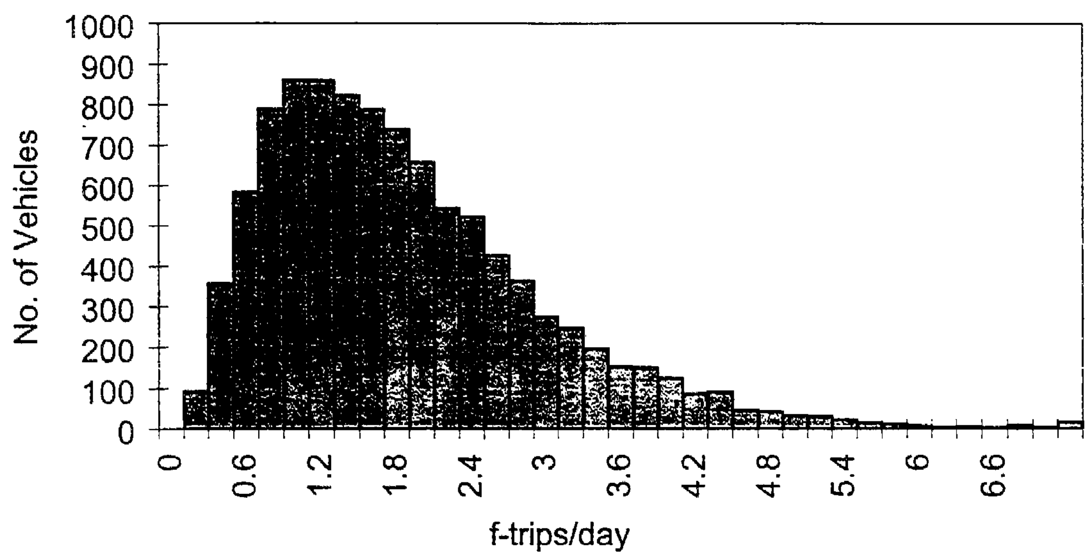
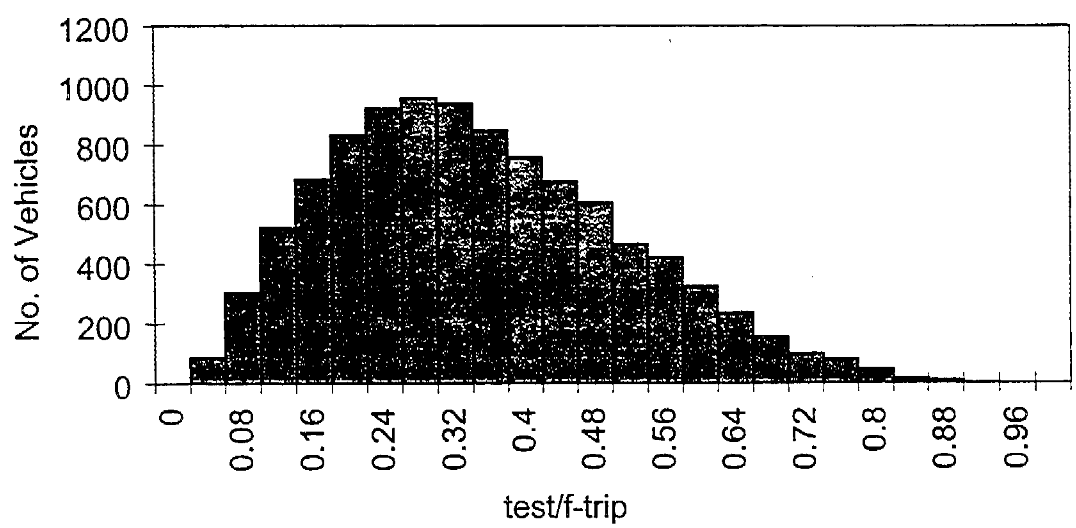


Figure 4: Simulation: Beta Distribution
(mean = 0.330, SD = 0.165)



APPENDIX V

Modeling Vehicle Use and Monitoring Ratios of On-Board Diagnostic Equipment to Assess Adequate Monitoring Frequency

David M. Rocke
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1. Introduction

The purpose of the proposed regulation is to insure that a specified fraction of automobiles on the road have on-board monitoring (OBM) equipment that will signal each particular type of defect within two (or three in some cases) weeks of its occurrence. Since it may require two runs of the OBM to detect a defect, this means that it is required that the specified fraction automobiles in service should have the OBM check for a given defect at least once per week on the average (0.67 times per week in some cases).

This requirement in turn depends on two characteristics of a particular vehicle in use. The first is the number of trips taken per week. This may be total trips, or filtered trips in which the "filter" is designed to count only trips on which the OBM is likely to function (for example, greater running time than 10 minutes). The second is the fraction of trips on which the OBM functions. In this report, I discuss a method of modeling each of these two factors, and then using the constructed models to estimate the fraction of a given sub-fleet of automobiles that will meet the monitoring requirement. In order to make the modeling at all feasible, I will assume that the monitoring ratio and the number of trips taken are statistically independent.

The average monitoring frequency (per week) of a vehicle in use is the product of the average number of trips per week and the monitoring ratio. Since both of these vary from vehicle-in-use to vehicle-in-use, both factors must be considered simultaneously to estimate the fraction of vehicle whose average monitoring frequency is at least once per week.

2. The Distribution of Number of Trips

Inspection of Figures 2, 5a, and 5b and Table 1, in material provide to me by CARB staff, along with an analysis of the data provided to me, show that the normal distribution is not a good model for these data. Two connected attributes of the data confirm this. First, there is a pronounced right-skewness to the data. Second, by definition, no value of the number of trips per day can be negative. Consider, for example, the f-trips/day/vehicle data. The average and the standard deviation given in Table 1 are 1.79 and 1.11, respectively. If the distribution were normal, the probability that (on a randomly selected vehicle) the f-trips per day was less than zero would be more than 5%. Although the 10th percentile is still positive, the 5th percentile is not, and this casts doubt on the use of the normal distribution.

The normal distribution can be used to model data that are inherently positive, so long as 1) the distribution is sufficiently bounded away from zero, and 2) the distribution is symmetric. The trips/day data fail test 2 in all cases, and fail test 1 more strongly for f-trips/day than for trips/day (for which the normal-theory chance of that the variable is negative is just over 1%). In both cases, the preponderance of evidence is that the normal distribution is not an adequate model.

As an alternative, I propose the gamma distribution. Like the normal distribution, there is a gamma distribution for every combination of (positive) mean and variance. Unlike the normal, it can model right-skew data, and all values generated from a gamma distribution, as well as all percentage points, are non-negative. In the Appendix, some basic facts about the gamma distribution are displayed. We can thus fit a gamma distribution to the mean and standard deviation of the trip data, and use this to determine the monitoring ratio distribution in order to meet the required monitoring frequency.

There is one additional complication to be dealt with. The data from the Tri-City database do not record the true average number of trips per day. Instead, they record the number of trips during a sample of days. If we assume that each vehicle i has an unobserved, true number of trips per day ξ_i, then if the vehicle is observed for d_i days, the actual number x_i of trips is also a random variable. As a first approximation, we can model this as Poisson with parameter $\theta = d_i\xi_i$. The trips per day estimate for vehicle i is then x_i / d_i. Although the length of observation d_i is random, it is formally ancillary to the estimation of the mean, and does not affect the mean trips per day. This two-stage process does, however, affect the variance. The variance of x_i / d_i is larger than the variance of ξ_i, and the variance of x_i / d_i depends on d_i. All of this means that we cannot estimate the parameters of the gamma model for the trips-per-day distribution directly from the mean and variance of the individual vehicle trips-per-day. Note that this conceptual model can be used for subsets of the data set in which inadequately observed vehicles are removed or for modified data sets in which trips are filtered.

To investigate this issue, I wrote a simulation program that repeated the following steps for each conceptual vehicle:

1. On input, specify the mean and standard deviation of the gamma distribution, and the mean and variance of the days distribution. Also specify the number of days of observation needed for the sample vehicle to be used.

2. For each vehicle

   (a) Generate the theoretical trips per day ξ for the vehicle from a gamma distribution with the specified mean and standard deviation.

   (b) Generate a random days under observation d from a normal distribution with specified mean and variance. Use the observation only if the number of days meets the threshold.

   (c) Generate an observed number of trips x from a Poisson distribution with parameter $d\xi$.

   (d) Calculate the trips per day $t = x / d$.

3. Compute the mean and standard deviation of the observed trips per day variable *t*.

For the distribution of days, I used a mean of 6.3 and a standard deviation of 1.57, corresponding to the full data set of the Tri-City data base. I used a threshold of 6 days to correspond to the analysis of the Tri-City data base. I then varied the input parameters of the gamma distribution until the simulated mean and variance over 100,000 trials matched the mean and variance of the actual data as given in Table 1 of the Draft Staff Report. This is then an indirect method-of-moments estimate of the gamma parameters. Table 1 of this document gives the estimated gamma parameters to match the two distributions in Table 1 of the Draft Staff Report.

Table 1: Gamma Parameter Estimates by the Indirect Method of Moments

	Observed		Gamma Estimated		
Variable	Mean	SD	Mean	SD	10 th %ile
TPD	6.95	3.11	6.95	2.95	3.54
f-TPD	1.79	1.11	1.79	0.99	0.70
fE-TPD	0.68	0.47	0.68	0.35	0.29

3. Modeling Monitoring Frequency

The remaining factor that determines monitoring frequency is the monitoring ratio: the fraction of trips, f-trips, or fE-trips during which the monitor executes. In this section, I describe how the monitoring ratio and the trips-per-day parameter interact to produce monitoring frequency. Briefly, the average monitoring frequency (executions per week) of a vehicle in use is the product of the monitoring ratio and the average number of trips per week.

We model the distribution across a category of vehicles of the monitoring ratio by a beta distribution (appendix). This is a more appropriate distribution than the normal, because of the fact that the ratio is bounded below by 0 and above by 1, unlike the normal distribution.[1]

To determine the distribution of the monitoring frequency, I ran simulations of 100,000 trials each in which each vehicle in use is assigned a number of trips per day (or f-trips or fE-trips per day) randomly chosen from the appropriate gamma distribution as in the previous section. Then a ratio is chosen from a beta distribution with a mean and standard deviation specified on input. Given a threshold on input (such as one

[1] If the trips are filtered and the total executions of the OBM are recorded, ratios greater than one are possible. Since the concern is with small ratios, and there will be little controversy if the monitoring ratio is near 1, we treat only the case where all ratios are between 0 and 1.

execution per week), the simulation determines the fraction of vehicles in use in which the monitoring frequency exceeds the threshold.

By variation of the beta distribution parameters, we can choose cases in which the predicted mean monitoring frequency matches a pre-specified fraction. In this case, we have varied the beta distribution mean, and assumed that the coefficient of variation is 50%, matching some previous experience. Table 2 shows the results for the four cases we are considering.

Table 2: Monitoring Frequency

Vehicle Activity	Monitoring Frequency	Fraction in Compliance	Beta Mean
Trips/Day	MIL/2 weeks	0.90	0.064
f-Trips/Day	MIL/2 weeks	0.90	0.336
fE-Trips/Day	MIL/2 weeks	0.50	0.260
fE-Trips/Day	MIL/3 weeks	0.50	0.175

4. Vehicle Sampling

Given a sample of vehicles, say 30 in number, a procedure needs to be defined to determine whether the sample of vehicles reasonably corresponds to a population with the desired characteristics. In one plausible method, the manufacturer would be declared out of compliance only if the sampling data were inconsistent with parameter values that would indicate compliance. When we perform this type of hypothesis test with normal assumptions, we usually take the observed variance as if it were the true variance, and then determine whether the mean is too small by comparison. For the beta distributions, we will perform the calculations for the required mean, and for a 50% CV.

The minimum value for the observed mean monitoring ratio from a sample of 30 vehicles, and requiring 90% confidence, is the 10th percentile of the sampling distribution of the mean from a sample of 30 from a beta distribution with mean as given in the fourth column of Table 2, and with a standard deviation half as large. We determined these percentage points by simulation with 100,000 trials. The column in Table 3 labeled "Critical Mesa Ratio " is the minimum mean ratio of a sample of 30 vehicles that is consistent (with 90% confidence) with the true mean ratio being as required in Table 2.

Table 3: Critical Ratios

Vehicle Activity	Monitoring Frequency	Fraction in Compliance	Critical Mean Ratio
Trips/Day	MIL/2 weeks	0.90	0.057
f-Trips/Day	MIL/2 weeks	0.90	0.297
fE-Trips/Day	MIL/2 weeks	0.50	0.230
fE-Trips/Day	MIL/3 weeks	0.50	0.155

In order to avoid an anomalous situation in which the mean ratio criterion is reached by a few large ratios, rather than by the general level, we can also require that the median ratio not be significantly below the required population mean ratio in Table 2. This is achieved (at about the 90% significance level), by requiring that no more than 19 in the 30 vehicles have ratios below the required mean ratio in Table 2. This is a sign test for the median.[2]

[2] If the true median was the number listed in Table 2, then there is a 50% chance that each ratio is below the required number. In a binomial sample with n = 30 and p = 0.5, the chance of 19 or more in 30 being below is 0.1002

Appendix

A. Properties of the Beta Distribution

The beta distribution with parameters (α, β), denoted Beta(α, β) has density

$$f(x) = [B(\alpha, \beta)]^{-1} x^{\alpha-1}(1-x)^{\beta-1}, \quad (A.1)$$

where $B(\alpha, \beta)$ is the beta function. The mean and the variance of such a beta variable X are given by

$$E(X) = \frac{\alpha}{\alpha+\beta} \quad (A.2)$$

$$V(X) = \frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)} \quad (A.3)$$

Beta distributions form a natural and flexible class of distributions on [0,1]. All values generated from a beta distribution are positive and less than 1, and the parameters α and β can be chosen to match any possible mean μ and variance σ^2 as follows:

$$\beta = \frac{\mu(1-\mu)^2 - \sigma^2(1-\mu)}{\sigma^2} \quad (A.4)$$

$$\alpha = \frac{\beta\mu}{1-\mu} \quad (A.5)$$

Since both α and β must be positive, the requirement on a given mean μ and variance σ^2 to be legal values for a beta distribution are

$$\sigma^2 < \mu(1-\mu), \quad (A.6)$$

which can be rewritten in terms of the CV as

$$CV < \sqrt{\frac{1-\mu}{\mu}} \quad (A.7)$$

For example, if the mean is 0.25, the CV must be less than 3. This mathematical constraint should cause no modeling problems. See Johnson, Katz, and Balakrishnan (1995) for further details.

B. Properties of the Gamma Distribution

The gamma distribution with parameters (α, β), denoted Gamma (α, β) has density

$$f(\chi) = [\,\beta^{\alpha}\Gamma(\alpha)]^{-1}\,\chi^{\alpha-1}\,e^{\chi/\beta}, \tag{B.1}$$

where Γ(α, β) is the gamma function. The mean and the variance of such a beta variable X are given by

$$E(X) = \alpha\beta \tag{B.2}$$

$$V(X) = \alpha\beta^2 \tag{B.3}$$

Gamma distributions form a natural and flexible class of distributions on [0, ∞]. All values generated from a gamma distribution are positive, and the parameters α and β can be chosen to match any mean μ and variance σ^2 as follows:

$$\alpha = \frac{\mu^2}{\sigma^2} \tag{B.4}$$

$$\beta = \frac{\mu}{\alpha} \tag{B.5}$$

See Johnson, Kotz, and Balakrishnan (1994) for further details.

C. Properties of the Poisson Distribution

The Poisson distribution with parameter θ, denoted Poisson(θ) has probability function

$$p(x) = \frac{e^{-\theta}\theta^{x}}{x!} \tag{C.1}$$

The mean and the variance of such a Poisson variable X are given by

$$E(X) = \theta \tag{C.2}$$

$$V(X) = \theta \tag{C.3}$$

The Poisson distribution is the simplest model for the occurrence of discrete events in time. See Johnson, Kotz, and Kemp (1992) for further details.

References

Johnson, N. L., Kotz, S., and Balakrishnan, N. (1994) *Continuous Univariate Distributions, Volume 1, Second Edition*, New York: John Wiley and Sons.

Johnson, N. L., Kotz, S., and Balakrishnan, N. (1995) *Continuous Univariate Distributions, Volume 2, Second Edition*, New York: John Wiley and Sons.

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Attachment A

Modifications to Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II), Section 1968.2, Title 13, California Code Regulations

Table of Contents

§1968.2. Malfunction and Diagnostic System Requirements--2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines

(a) PURPOSE

The purpose of this regulation is to establish emission standards and other requirements for onboard diagnostic systems (OBD II systems) that are installed on 2004 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles and engines certified for sale in California. The OBD II systems, through the use of an onboard computer(s), shall monitor emission systems in-use for the actual life of the vehicle and shall be capable of detecting malfunctions of the monitored emission systems, illuminating a malfunction indicator light (MIL) to notify the vehicle operator of detected malfunctions, and storing fault codes identifying the detected malfunctions.

(b) APPLICABILITY

Except as specified elsewhere in this regulation (title 13, CCR section 1968.2), all 2004 and subsequent model-year vehicles, defined as passenger cars, light-duty trucks, and medium-duty vehicles, including medium-duty vehicles with engines certified on an engine dynamometer and medium-duty passenger vehicles, shall be equipped with an OBD II system and shall meet all applicable requirements of this regulation (title 13, CCR section 1968.2).

(c) DEFINITIONS

(1) "Actual life" refers to the entire period that a vehicle is operated on public roads in California up to the time a vehicle is retired from use.

(2) "Alternate phase-in" is a phase-in schedule that achieves equivalent compliance volume by the end of the last year of a scheduled phase-in provided in this regulation. The compliance volume is the number calculated by multiplying the percent of vehicles (based on the manufacturer's projected sales volume of all vehicles) meeting the new requirements per year by the number of years implemented prior to and including the last year of the scheduled phase-in and then summing these yearly results to determine a cumulative total (e.g., a three year, 30/60/100 percent scheduled phase-in would be calculated as (30%*3 years) + (60%*2 years) + (100%*1 year) = 310). On phase-ins scheduled to begin prior to the 2004 model year, manufacturers are allowed to include vehicles introduced before the first year of the scheduled phase-in (e.g., in the previous example, 10 percent introduced one year before the scheduled phase-in begins would be calculated as (10%*4 years) and added to the cumulative total). However, on phase-ins scheduled to begin in 2004 or subsequent model years, manufacturers are only allowed to include vehicles introduced up to one model year before the first year of the scheduled phase-in. The Executive Officer shall consider acceptable any alternate phase-in which results in an equal or larger cumulative total by the end of the last year of the scheduled phase-in; however, all vehicles shall comply with the respective requirements subject to the phase-in within one model year following the last year of the scheduled phase-in.

(3) "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.

(4) "Calculated load value" refers to an indication of the percent engine capacity that is being used and is defined in ISO 15031-5, incorporated by reference (section (f)(1.9)). For diesel applications, the calculated load value is determined by the ratio of current output torque to maximum output torque at current engine speed.

(5) "Confirmed fault code" is defined as the diagnostic trouble code stored when an OBD II system has confirmed that a malfunction exists (e.g., typically on the second driving cycle that the malfunction is detected) in accordance with the requirements of sections (e)[1] and (f)(4.4).

(6) "Continuously," if used in the context of monitoring conditions for circuit continuity, lack of circuit continuity, circuit faults, and out-of-range values, means sampling at a rate no less than two samples per second. If for engine control purposes, a computer input component is sampled less frequently, the signal of the component may instead be evaluated each time sampling occurs.

(7) "Deactivate" means to turn-off, shutdown, desensitize, or otherwise make inoperable through software programming or other means during the actual life of the vehicle.

(8) "Diagnostic or emission critical" electronic powertrain control unit refers to the engine and transmission control unit(s). For the 2005 and subsequent model years, it also includes any other on-board electronic powertrain control unit containing software that has primary control over any of the monitors required by sections (e)(1.0) through (e)(15.0) and (e)(17.0) or has primary control over the diagnostics for more than two of the components required to be monitored by section (e)(16.0).

(9) "Diesel engines" refers to engines using a compression ignition thermodynamic cycle.

(10) "Driving cycle" consists of engine startup and engine shutoff and includes the period of engine off time up to the next engine startup. For vehicles that employ engine shutoff strategies (e.g., engine shutoff at idle), the manufacturer may request Executive Officer approval to use an alternate definition for driving cycle (e.g., key on and key off). Executive Officer approval of the alternate definition shall be based on equivalence to engine startup and engine shutoff signaling the beginning and ending of a single driving event for a conventional vehicle. Engine restarts following an engine shut-off that has been neither commanded by the vehicle operator nor by the engine control strategy but caused by an event such as an engine stall may be considered a new driving cycle or a continuation of the existing driving cycle.

(11) "Engine misfire" means lack of combustion in the cylinder due to absence of spark, poor fuel metering, poor compression, or any other cause. This does not include lack of combustion events in non-active cylinders due to default fuel shut-off or cylinder deactivation strategies.

(12) "Engine start" is defined as the point when the engine reaches a speed 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission). For hybrid vehicles or for

[1] Unless otherwise noted, all section references refer to section 1968.2 of title 13, CCR.

engines employing alternate engine start hardware or strategies (e.g., integrated starter and generators, etc.), the manufacturer may request Executive Officer approval to use an alternate definition for engine start (e.g., ignition key "on"). Executive Officer approval of the alternate definition shall be based on equivalence to an engine start for a conventional vehicle.

(13) "Fault memory" means information pertaining to malfunctions stored in the onboard computer, including fault codes, stored engine conditions, and MIL status.

(14) "Federal Test Procedure (FTP) test" refers to an exhaust emission test conducted according to the test procedures incorporated by reference in title 13, CCR section 1961(d) that is used to determine compliance with the FTP standard to which a vehicle is certified.

(14.1) "FTP cycle". For passenger vehicles, light-duty trucks, and medium-duty vehicles certified on a chassis dynamometer, FTP cycle refers to 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 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."

(14.2) "FTP standard" refers to the certification tailpipe exhaust emission standards (both 50,000 mile and FTP full useful life standards) and test procedures applicable to the class to which the vehicle is certified.

(14.3) "FTP full useful life standard" refers to the FTP standard applicable when the vehicle reaches the end of its full useful life as defined in the certification requirements and test procedures incorporated by reference in title 13, CCR section 1961(d).

(15) "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.

(16) "Functional check" for an output component or system means verification of proper response of the component and system to a computer command.

(17) "Key on, engine off position" refers to a vehicle with the ignition key in the engine run position (not engine crank or accessory position) but with the engine not running.

(18) "Light-duty truck" is defined in title 13, CCR section 1900 (b).

(19) "Low Emission Vehicle I application" refers to a vehicle or engine certified in California to the exhaust emission standards defined in title 13, CCR sections 1956.8(g), 1960.1(g)(1), and 1960.1(h)(1) for any of the following vehicle emission categories: Transitional Low Emission Vehicle (TLEV), Low Emission Vehicle (LEV), Ultra Low Emission Vehicle (ULEV), or Super Ultra Low Emission Vehicle (SULEV). Additionally, vehicles certified to Federal emission standards (bins) in California but categorized in a Low Emission Vehicle I vehicle emission category for purposes of calculating NMOG fleet average in accordance with the certification requirements and test procedures incorporated by reference in title

13, CCR section 1961 (d) are subject to all monitoring requirements applicable to Low Emission Vehicle I applications but shall use the Federal tailpipe emission standard (i.e., the Federal bin) for purposes of determining the malfunction thresholds in section (e).

(19.1) "MDV SULEV vehicles" refer only to medium-duty Low Emission Vehicle I applications certified to the SULEV vehicle emission category.

(19.2) "TLEV vehicles" refer only to Low Emission Vehicle I applications certified to the TLEV vehicle emission category.

(19.3) "LEV vehicles" refer only to Low Emission Vehicle I applications certified to the LEV vehicle emission category.

(19.4) "ULEV vehicles" refer only to Low Emission Vehicle I applications certified to the ULEV vehicle emission category.

(20) "Low Emission Vehicle II application" refers to a vehicle or engine certified in California to the exhaust emission standards defined in title 13, CCR section 1961 for any of the following vehicle emission categories: LEV, ULEV, or SULEV. Additionally, except as provided for in section (e)(18.1.3), vehicles certified to Federal emission standards (bins) in California but categorized in a Low Emission Vehicle II vehicle emission category for purposes of calculating NMOG fleet average in accordance with the certification requirements and test procedures incorporated by reference in title 13, CCR section 1961 (d) are subject to all monitoring requirements applicable to Low Emission Vehicle II applications but shall use the Federal tailpipe emission standard (i.e., the Federal bin) for purposes of determining the malfunction thresholds in section (e).

(20.1) "PC/LDT SULEV II vehicles" refer only to passenger car and light-duty truck Low Emission Vehicle II applications certified to the SULEV vehicle emission category.

(20.2) "MDV SULEV II vehicles" refer only to medium-duty Low Emission Vehicle II applications certified to the SULEV vehicle emission category.

(20.3) "LEV II vehicles" refer only to Low Emission Vehicle II applications certified to the LEV vehicle emission category.

(20.4) "ULEV II vehicles" refer only to Low Emission Vehicle II applications certified to the ULEV vehicle emission category.

(21) "Malfunction" means any deterioration or failure of a component that causes the performance to be outside of the applicable limits in section (e).

(22) "Medium-duty vehicle" is defined in title 13, CCR section 1900 (b).

(22.1) "Medium-duty passenger vehicle" is defined in Title 40, Section 86.1803-01, Code of Federal Regulations.

(23) "Passenger car" is defined in title 13, CCR section 1900 (b).

(24) "Pending fault code" is defined as the diagnostic trouble code stored upon the initial detection of a malfunction (e.g., typically on a single driving cycle) prior to illumination of the MIL in accordance with the requirements of section (e) and (f)(4.4).

(25) "Percentage of misfire" as used in (e)(3.2) means the percentage of misfires out of the total number of firing events for the specified interval.

(26) "Power Take-Off (PTO) unit" refers to an engine driven output provision for the purposes of powering auxiliary equipment (e.g., a dump-truck bed, aerial bucket, or tow-truck winch).

(27) "Rationality fault diagnostic" for an input component means verification of the accuracy of the input signal while in the range of normal operation and when compared to all other available information.

(28) "Redline engine speed" shall be defined by the manufacturer as either the recommended maximum engine speed as normally displayed on instrument panel tachometers or the engine speed at which fuel shutoff occurs.

(29) "Response rate" for oxygen sensors refers to the delay between a switch of the sensor from lean to rich or vice versa in response to a commanded change in air/fuel ratio.

(30) "SC03 emission standards" refers to the certification tailpipe exhaust emission standards for the air conditioning (A/C) test of the Supplemental Federal Test Procedure Off-Cycle Emission Standards specified in title 13, CCR section 1961(a) applicable to the class to which the vehicle is certified.

(31) "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.

(32) "Similar conditions" as used in sections (e)(3) and (e)(6) means engine conditions having an engine speed within 375 rpm, load conditions within 20 percent, and the same warm-up status (i.e., cold or hot) as the engine conditions stored pursuant to (e)(3.4.4) and (e)(6.4.5). The Executive Officer may approve other definitions of similar conditions based on comparable timeliness and reliability.

(33) "Small volume manufacturer" is defined in title 13, CCR section 1900(b). However, for a manufacturer that transitions from a small volume manufacturer to a non-small volume manufacturer, the manufacturer is still considered a small volume manufacturer for the first three model years that it no longer meets the definition in title 13, CCR section 1900(b).

(34) "Unified cycle" is defined in "Speed Versus Time Data for California's Unified Driving Cycle", dated December 12, 1996, incorporated by reference.

(35) "US06 cycle" refers to the driving schedule in CFR 40, Appendix 1, Part 86, section (g) entitled, "EPA US06 Driving Schedule for Light-Duty Vehicles and Light-Duty Trucks."

(36) "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 at least 160 degrees Fahrenheit (140 degrees Fahrenheit for applications with diesel engines).

(d) GENERAL REQUIREMENTS

Section (d) sets forth the general requirements of the OBD II system. Specific performance requirements for components and systems that shall be monitored are set forth in section (e) below.

(1) The OBD II System.

(1.1) If a malfunction is present as specified in section (e), the OBD II system shall detect the malfunction, store a pending or confirmed fault code in the onboard computer's memory, and illuminate the MIL as required.

(1.2) The OBD II system shall be equipped with a standardized data link connector to provide access to the stored fault codes as specified in section (f).

(1.3) The OBD II system shall be designed to operate, without any required scheduled maintenance, for the actual life of the vehicle in which it is installed and may not be programmed or otherwise designed to deactivate based on age and/or mileage of the vehicle during the actual life of the vehicle.

(1.4) Computer-coded engine operating parameters may 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 that are unlikely to require protection. Criteria to be evaluated in making an exemption include current availability of performance chips, high performance capability of the vehicle, and sales volume.

(2) MIL and Fault Code Requirements.

(2.1) MIL Specifications.

(2.1.1) The MIL shall be located on the driver's side instrument panel and be of sufficient illumination and location to be readily visible under all lighting conditions and shall be amber in color when illuminated. The MIL, when illuminated, shall display the phrase "Check Engine" or "Service Engine Soon". The word "Powertrain" may be substituted for "Engine" in the previous phrases. Alternatively, the International Standards Organization (ISO) engine symbol may be substituted for the word "Engine" or for the entire phrase.

(2.1.2) The MIL shall illuminate in the key on, engine off position before engine cranking to indicate that the MIL is functional. For all 2005 and subsequent model year vehicles, the MIL shall continuously illuminate during this functional check for a minimum of 15-20 seconds. During this functional check of the MIL, the data stream value for MIL status shall indicate commanded off (see section (f)(4.2)) unless the MIL has also been commanded on for a detected malfunction. This functional check of the MIL is not required during vehicle operation in the key on, engine off position subsequent to the initial engine cranking of each driving cycle (e.g., due to an engine stall or other non-commanded engine shutoff).

(2.1.3) The MIL shall also illuminate within 10 seconds to inform the vehicle operator whenever the powertrain enters a default or "limp home" mode of operation that can affect emissions or the performance of the OBD II system or in the event of a malfunction of an on-board computer(s) itself that can affect the performance of the OBD II system. If the default or "limp home" mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following driving cycle), the OBD II system may wait and illuminate the MIL only if the default or "limp home" mode of operation is again entered before the end of the next driving cycle in lieu of illuminating the MIL within 10 seconds on the first driving cycle where the default or "limp home" mode of operation is entered.

(2.1.4) At the manufacturer's option, the MIL may be used to indicate readiness status in a standardized format (see section (f)(4.1.3)) in the key on, engine off position.

(2.1.5) A manufacturer may request Executive Officer approval to also use the MIL to indicate which, if any, fault codes are currently stored (e.g., to "blink" the stored codes) in the key on, engine off position. The Executive Officer shall approve the request if the manufacturer demonstrates that the method used to indicate the fault codes will not be activated during a California Inspection and Maintenance test or during routine driver operation.

(2.1.6) The MIL may not be used for any purpose other than specified in this regulation.

(2.2) MIL Illumination and Fault Code Storage Protocol.

(2.2.1) Upon detection of a malfunction, the OBD system shall store a pending fault code within ten seconds indicating the likely area of the malfunction and "freeze frame" engine conditions (as defined in section (f)(4.3)) present at the time the malfunction occurs.

(2.2.2) After storage of a pending fault code, if the identified malfunction is again detected before the end of the next driving cycle in which monitoring occurs, the MIL shall illuminate continuously and a confirmed fault code shall be stored within 10 seconds. If a malfunction is not detected before the end of the next driving cycle in which monitoring occurs (i.e., there is no indication of the malfunction at any time during the driving cycle), the corresponding pending fault code and "freeze frame" conditions set according to section (d)(2.2.1) shall be erased at the end of the driving cycle.

(2.2.3) A manufacturer may request Executive Officer approval to employ alternate statistical MIL illumination and fault code storage protocols to those specified in these requirements. The Executive Officer shall grant approval if the manufacturer provides data and/or engineering evaluation that adequately demonstrate that the alternative protocols can evaluate system performance and detect malfunctions in a manner that is equally effective and timely. Except as otherwise provided in section (e) for evaporative system malfunctions, strategies requiring on average more than six driving cycles for MIL illumination may not be accepted.

(2.2.4) Regarding "freeze frame" conditions, a manufacturer may store "freeze frame" engine conditions in conjunction with storing a confirmed fault code in lieu of a pending fault code as required in sections (d)(2.2.1), (e)(3.4), and (e)(6.4).

(2.3) Extinguishing the MIL.

Except as otherwise provided in sections (e)(3.4.5) and (e)(6.4.6) for misfire and fuel system malfunctions, once the MIL has been illuminated it may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions and the previously detected malfunction is no longer present provided no other malfunction has been detected that would independently illuminate the MIL according to the requirements outlined above.

(2.4) Erasing a confirmed fault code.
The OBD II system may erase a confirmed fault code if the identified malfunction has not been again detected in at least 40 engine warm-up cycles, and the MIL is presently not illuminated for that malfunction.

(3) Monitoring Conditions.
Section (d)(3) sets forth the general monitoring requirements while section (e) sets forth the specific monitoring requirements as well as identifies which of the following general monitoring requirements in section (d)(3) are applicable for each monitored component or system identified in section (e).

(3.1) For all 2004 and subsequent model year vehicles:

(3.1.1) As specifically provided for in section (e), manufacturers shall define monitoring conditions, subject to Executive Officer approval, for detecting malfunctions identified in section (e). The Executive Officer shall approve manufacturer defined monitoring conditions that are determined (based on manufacturer submitted data and/or other engineering documentation) to be: technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false detection of malfunctions), designed to ensure monitoring will occur under conditions which may reasonably be expected to be encountered in normal urban vehicle operation and use, and designed to ensure monitoring will occur during the FTP cycle or Unified cycle.

(3.1.2) Monitoring shall occur at least once per driving cycle in which the monitoring conditions are met.

(3.1.3) Manufacturers may request Executive Officer approval to define monitoring conditions that are not encountered during the FTP cycle or Unified cycle as required in section (d)(3.1.1). In evaluating the manufacturer's request, the Executive Officer shall consider the degree to which the requirement to run during the FTP or Unified cycle restricts in-use monitoring, the technical necessity for defining monitoring conditions that are not encountered during the FTP or Unified cycle, data and/or an engineering evaluation submitted by the manufacturer which adequately demonstrate that the component/system does not normally function, or monitoring is otherwise not feasible, during the FTP or Unified cycle, and, where applicable in section (d)(3.2), the ability of the manufacturer to demonstrate the monitoring conditions will satisfy the minimum acceptable in-use monitor performance ratio requirement as defined in section (d)(3.2).

(3.2) As specifically provided for in section (e), manufacturers shall define monitoring conditions in accordance with the criteria in sections (d)(3.2.1) through (3.2.3). The requirements of section (d)(3.2) shall be phased in as follows: 50 percent of all 2005 model year vehicles, 75 percent of all 2006 model year vehicles, and 100 percent of all 2007 and subsequent model year vehicles. Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) with the exception that 100 percent of 2007 and subsequent model year vehicles shall comply with the requirements.

(3.2.1) Manufacturers shall define monitoring conditions that, in addition to meeting the criteria in section (d)(3.1), ensure that the monitor yields an in-use performance ratio (as defined in section (d)(4)) that meets or exceeds the minimum acceptable in-use monitor performance ratio on in-use vehicles. For purposes of this regulation, the minimum acceptable in-use monitor performance ratio is:

(A) 0.260 for secondary air system monitors and other cold start related monitors utilizing a denominator incremented in accordance with section (d)(4.3.2)(E);

(B) For evaporative system monitors:

(i) 0.260 for monitors designed to detect malfunctions identified in section (e)(4.2.2)(C) (i.e., 0.020 inch leak detection); and

(ii) 0.520 for monitors designed to detect malfunctions identified in section (e)(4.2.2)(A) and (B) (i.e., purge flow and 0.040 inch leak detection); and

(C) 0.336 for catalyst, oxygen sensor, EGR, VVT system, and all other monitors specifically required in section (e) to meet the monitoring condition requirements of section (d)(3.2).

(3.2.2) In addition to meeting the requirements of section (d)(3.2.1), manufacturers shall implement software algorithms in the OBD II system to individually track and report in-use performance of the monitors in the standardized format specified in section (d)(5) for each of the following component monitors:

a. Catalyst (section (e)(1.3) or, where applicable, (e)(1.5.3))
b. Oxygen sensor (section (e)(7.3.1)(A))
c. Evaporative system (section (e)(4.3.2))
d. EGR system (section (e)(8.3.1)) and VVT system (section (e)(13.3))
e. Secondary air system (section (e)(5.3.2)(B))

The OBD II system is not required to track and report in-use performance for monitors other than those specifically identified above.

(3.2.3) Manufacturers may not use the calculated ratio (or any element thereof) or any other indication of monitor frequency as a monitoring condition for any monitor (e.g., using a low ratio to enable more frequent monitoring through diagnostic executive priority or modification of other monitoring conditions, or using a high ratio to enable less frequent monitoring).

(4) In-Use Monitor Performance Ratio Definition

(4.1) For monitors required to meet the minimum in-use monitor performance ratio in section (d)(3.2.1), the ratio shall be calculated in accordance with the following specifications for the numerator, denominator, and ratio.

(4.2) Numerator Specifications

(4.2.1) Definition: The numerator is defined as a measure of the number of times a vehicle has been operated such that all monitoring conditions necessary for a specific monitor to detect a malfunction have been encountered.

(4.2.2) Specifications for incrementing:

(A) Except as provided for in section (d)(4.2.2)(F), the numerator, when incremented, shall be incremented by an integer of one. The numerator may not be incremented more than once per driving cycle.

(B) The numerator for a specific monitor shall be incremented within ten seconds if and only if the following criteria are satisfied on a single driving cycle:

(i) Every monitoring condition necessary for the monitor of the specific component to detect a malfunction and store a pending fault code has been satisfied, including enable criteria, presence or absence of related fault codes, sufficient length of monitoring time, and diagnostic executive priority assignments (e.g., diagnostic "A" must execute prior to diagnostic "B", etc.). For the purpose of incrementing the numerator, satisfying all the monitoring conditions necessary for a monitor to determine the component is passing may not, by itself, be sufficient to meet this criteria;

(ii) For monitors that require multiple stages or events in a single driving cycle to detect a malfunction, every monitoring condition necessary for all events to have completed must be satisfied;

(iii) For monitors that require intrusive operation of components to detect a malfunction, a manufacturer shall request Executive Officer approval of the strategy used to determine that, had a malfunction been present, the monitor would have detected the malfunction. Executive Officer approval of the request shall be based on the equivalence of the strategy to actual intrusive operation and the ability of the strategy to accurately determine if every monitoring condition necessary for the intrusive event to occur was satisfied.

(iv) In addition to the requirements of section (d)(4.2.2)(B)(i) through (iii) above, the secondary air system monitor numerator(s) shall be incremented if and only if the criteria in section (B) above have been satisfied during normal operation of the secondary air system for vehicles that require monitoring during normal operation (sections (e)(5.2.2) through (5.2.4)). Monitoring during intrusive operation of the secondary air system later in the same driving cycle solely for the purpose of monitoring may not, by itself, be sufficient to meet this criteria.

(C) For monitors that can generate results in a "gray zone" or "non-detection zone" (i.e., results that indicate neither a passing system nor a malfunctioning system) or in a "non-decision zone" (e.g., monitors that increment and decrement counters until a pass or fail threshold is reached), the manufacturer shall submit a plan for appropriate incrementing of the numerator to the Executive Officer for review and approval. In general, the Executive Officer shall not approve plans that allow the numerator to be incremented when the monitor indicates a result in the "non-detection zone" or prior to the monitor reaching a decision. In reviewing the plan for approval, the Executive Officer shall consider data and/or engineering evaluation submitted by the manufacturer demonstrating the expected frequency of results in the "non-detection zone" and the ability of the monitor to accurately determine if a monitor would have detected a malfunction instead of a result in the "non-detection zone" had an actual malfunction been present.

(D) For monitors that run or complete during engine off operation, the numerator shall be incremented within 10 seconds of engine start on the subsequent driving cycle.

(E) Manufacturers utilizing alternate statistical MIL illumination protocols as allowed in section (d)(2.2.3) for any of the monitors requiring a numerator shall submit a plan for appropriate incrementing of the numerator to the Executive Officer for review and approval. Executive Officer approval of the plan shall be conditioned upon the manufacturer providing supporting data and/or engineering evaluation for the proposed plan, the equivalence of the incrementing in the manufacturer's plan to the incrementing specified in section (d)(4.2.2) for monitors using the standard MIL illumination protocol, and the overall equivalence of the manufacturer's plan in determining that the minimum acceptable in-use performance ratio in section (d)(3.2.1) is satisfied.

(4.3) Denominator Specifications

(4.3.1) Definition: The denominator is defined as a measure of the number of times a vehicle has been operated as defined in (d)(4.3.2).

(4.3.2) Specifications for incrementing:

(A) The denominator, when incremented, shall be incremented by an integer of one. The denominator may not be incremented more than once per driving cycle.

(B) The denominator for each monitor shall be incremented within ten seconds if and only if the following criteria are satisfied on a single driving cycle:

(i) Cumulative time since engine start is greater than or equal to 600 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit;

(ii) Cumulative vehicle operation at or above 25 miles per hour occurs for greater than or equal to 300 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit;

(iii) Continuous vehicle operation at idle (i.e., accelerator pedal released by driver and vehicle speed less than or equal to one mile per hour) for greater than or equal to 30 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit;

(C) In addition to the requirements of section (d)(4.3.2)(B) above, the secondary air system monitor denominator(s) shall be incremented if and only if commanded "on" operation of the secondary air system occurs for a time greater than or equal to ten seconds. For purposes of determining this commanded "on" time, the OBD II system may not include time during intrusive operation of the secondary air system solely for the purposes of monitoring;

(D) In addition to the requirements of section (d)(4.3.2)(B) above, the evaporative system monitor denominator(s) shall be incremented if and only if:

(i) Cumulative time since engine start is greater than or equal to 600 seconds while at an ambient temperature of greater than or equal to

40 degrees Fahrenheit but less than or equal to 95 degrees Fahrenheit;

(ii) Engine cold start occurs with engine coolant temperature at engine start greater than or equal to 40 degrees Fahrenheit but less than or equal to 95 degrees Fahrenheit and less than or equal to 12 degrees Fahrenheit higher than ambient temperature at engine start.

(E) In addition to the requirements of section (d)(4.3.2)(B) above, the denominator(s) for the following monitors shall be incremented if and only if the component or strategy is commanded "on" for a time greater than or equal to ten seconds:

(i) Heated catalyst (section (e)(2))

(ii) Cold Start Emission Reduction Strategy (section (e)(11))

(iii) Components or systems that operate only at engine start-up (e.g., glow plugs, intake air heaters, etc.) and are subject to monitoring under "other emission control or source devices" (section (e)(17)) or comprehensive component output components (section (e)(16))

For purposes of determining this commanded "on" time, the OBD II system may not include time during intrusive operation of any of the components or strategies later in the same driving cycle solely for the purposes of monitoring.

(F) In addition to the requirements of section (d)(4.3.2)(B) above, the denominator(s) for the following monitors of output components (except those operated only at engine start-up and subject to the requirements of the previous section (d)(4.3.2)(E)) shall be incremented if and only if the component is commanded to function (e.g., commanded "on", "open", "closed", "locked", etc.) on two or more occasions during the driving cycle or for a time greater than or equal to ten seconds, whichever occurs first:

(i) Air conditioning system (section (e)(12))

(ii) "Other emission control or source device" (section (e)(17))

(iii) Comprehensive component output component (section (e)(16)) (e.g., turbocharger waste-gates, variable length manifold runners, torque converter clutch lock-up solenoids, etc.)

(G) For hybrid vehicles, vehicles that employ alternate engine start hardware or strategies (e.g., integrated starter and generators), or alternate fuel vehicles (e.g., dedicated, bi-fuel, or dual-fuel applications), the manufacturer may request Executive Officer approval to use alternate criteria to the criteria in section (d)(4.3.2)(B) above for incrementing the denominator. In general, the Executive Officer shall not approve alternate criteria for vehicles that only employ engine shut off at or near idle/vehicle stop conditions. Executive Officer approval of the alternate criteria shall be based on the equivalence of the alternate criteria to determine the amount of vehicle operation relative to the measure of conventional vehicle operation in accordance with the criteria in section (d)(4.3.2)(B) above.

(4.4) Ratio Specifications

(4.4.1) Definition: The ratio is defined as the numerator divided by the denominator.

(4.5) Disablement of Numerators and Denominators

(4.5.1) Within ten seconds of a malfunction that disables a monitor required to meet the monitoring conditions in section (d)(3.2.1) being detected (i.e., a pending or confirmed code is stored), the OBD II system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the malfunction is no longer detected (i.e., the pending code is erased through self-clearing or through a scan tool command), incrementing of all corresponding numerators and denominators shall resume within ten seconds.

(4.5.2) Within ten seconds of the start of a PTO (see section (c)) operation that disables a monitor required to meet the monitoring conditions in section (d)(3.2.1), the OBD II system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the PTO operation ends, incrementing of all corresponding numerators and denominators shall resume within ten seconds.

(4.5.3) The OBD II system shall disable further incrementing of all numerators and denominators within ten seconds if a malfunction of any component used to determine if the criteria in sections (d)(4.3.2)(B) through (D) are satisfied (i.e., vehicle speed, ambient temperature, elevation, idle operation, engine cold start, or time of operation) has been detected and the corresponding pending fault code has been stored. Incrementing of all numerators and denominators shall resume within ten seconds when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command).

(5) Standardized tracking and reporting of monitor performance

(5.1) For monitors required to track and report in-use monitor performance in section (d)(3.2.2), the performance data shall be tracked and reported in accordance with the specifications in sections (d)(4), (d)(5), and (f)(5). The OBD II system shall separately report an in-use monitor performance numerator and denominator for each of the following components: catalyst bank 1, catalyst bank 2, primary oxygen sensor bank 1, primary oxygen sensor bank 2, evaporative 0.020 inch leak detection system, EGR/VVT system, and secondary air system. The OBD II system shall also report a general denominator and an ignition cycle counter in the standardized format specified in sections (d)(5.5), (d)(5.6) and (f)(5).

(5.2) Numerator

(5.2.1) The OBD II system shall report a separate numerator for each of the components listed in section (d)(5.1).

(5.2.2) For specific components or systems that have multiple monitors that are required to be reported under section (e) (e.g., oxygen sensor bank 1 may have multiple monitors for sensor response or other sensor characteristics), the OBD II system shall separately track numerators and denominators for each of the specific monitors and report only the corresponding numerator and denominator for the specific monitor that has the lowest numerical ratio. If two or more specific monitors have identical ratios, the corresponding numerator and denominator for the specific monitor that has the highest denominator shall be reported for the specific component.

(5.2.3) The numerator(s) shall be reported in accordance with the specifications in section (f)(5.2.1).

(5.3) Denominator

(5.3.1) The OBD II system shall report a separate denominator for each of the components listed in section (d)(5.1).

(5.3.2) The denominator(s) shall be reported in accordance with the specifications in section (f)(5.2.1).

(5.4) Ratio

(5.4.1) For purposes of determining which corresponding numerator and denominator to report as required in section (d)(5.2.2), the ratio shall be calculated in accordance with the specifications in section (f)(5.2.2).

(5.5) Ignition cycle counter

(5.5.1) Definition:

(A) The ignition cycle counter is defined as a counter that indicates the number of ignition cycles a vehicle has experienced as defined in section (d)(5.5.2)(B).

(B) The ignition cycle counter shall be reported in accordance with the specifications in section (f)(5.2.1).

(5.5.2) Specifications for incrementing:

(A) The ignition cycle counter, when incremented, shall be incremented by an integer of one. The ignition cycle counter may not be incremented more than once per driving cycle.

(B) The ignition cycle counter shall be incremented within ten seconds if and only if the vehicle meets the engine start definition (see section (c)) for at least one second.

(C) The OBD II system shall disable further incrementing of the ignition cycle counter within ten seconds if a malfunction of any component used to determine if the criteria in section (d)(5.5.2)(B) are satisfied (i.e., engine speed or time of operation) has been detected and the corresponding pending fault code has been stored. The ignition cycle counter may not be disabled from incrementing for any other condition. Incrementing of the ignition cycle counter shall resume within ten seconds when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command).

(5.6) General Denominator

(5.6.1) Definition:

(A) The general denominator is defined as a measure of the number of times a vehicle has been operated as defined in section (d)(5.6.2)(B).

(B) The general denominator shall be reported in accordance with the specifications in section (f)(5.2.1).

(5.6.2) Specifications for incrementing:

(A) The general denominator, when incremented, shall be incremented by an integer of one. The general denominator may not be incremented more than once per driving cycle.

(B) The general denominator shall be incremented within ten seconds if and only if the criteria identified in section (d)(4.3.2)(B) are satisfied on a single driving cycle.

(C) The OBD II system shall disable further incrementing of the general denominator within ten seconds if a malfunction of any component used to determine if the criteria in section (d)(4.3.2)(B) are satisfied (i.e., vehicle speed, ambient temperature, elevation, idle operation, or time of operation) has been detected and the corresponding pending fault code has been stored. The general denominator may not be disabled from incrementing for any other condition (e.g., the disablement criteria in sections (d)(4.5.1) and (d)(4.5.2) may not disable the general denominator). Incrementing of the general denominator shall resume within ten seconds when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command).

(6) Enforcement Testing

(6.1) The procedures used to assure compliance with the requirements of title 13, CCR section 1968.2 are set forth in title 13, CCR section 1968.5.

(6.2) Consistent with the requirements of title 13, CCR section 1968.5(b)(4)(A) for enforcement OBD II emission testing, the manufacturer shall retain all test equipment (e.g., malfunction simulators, deteriorated "threshold" components, etc.) necessary to determine the malfunction criteria in section (e) for major monitors subject to OBD II emission testing as defined in title 13, CCR section 1968.5. To meet the requirements of this section, the manufacturers shall only be required to retain test equipment necessary to duplicate "threshold" testing performed by the manufacturer. This test equipment shall include, but is not limited to, aged "threshold" catalyst systems and computer equipment used to simulate misfire, oxygen sensor, fuel system, VVT system, and cold start reduction strategy system faults. This equipment shall be retained by the manufacturer until vehicles certified with the equipment exceed the applicable full useful life age (e.g., 10 years for vehicles certified to a full useful life of 10 years and 100,000 miles).

(e) MONITORING REQUIREMENTS

(1) CATALYST MONITORING

(1.1) Requirement: The OBD II system shall monitor the catalyst system for proper conversion capability.

(1.2) Malfunction Criteria:

(1.2.1) Low Emission Vehicle I applications: The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that either of the following occurs:

(A) Non-Methane Organic Gas (NMOG) emissions exceed 1.75 times the FTP full useful life standards to which the vehicle has been certified with NMOG emissions multiplied by the certification reactivity adjustment factor for the vehicle;

(B) The average FTP test Non-Methane Hydrocarbon (NMHC) conversion efficiency of the monitored portion of the catalyst system falls below 50 percent (i.e., the cumulative NMHC emissions measured at the outlet of the monitored catalyst(s) are more than 50 percent of the cumulative engine-out emissions measured at the inlet of the catalyst(s)). With Executive Officer approval, manufacturers may use a conversion efficiency malfunction criteria of less than 50 percent if the catalyst system is designed such that the monitored portion of the catalyst system must be replaced along with an adjacent portion of the catalyst system sufficient to ensure that the total portion replaced will meet the 50 percent conversion efficiency criteria. Executive Officer approval shall be based on data and/or engineering evaluation demonstrating the conversion efficiency of the monitored portion and the total portion designed to be replaced, and the likelihood of the catalyst system design to ensure replacement of the monitored and adjacent portions of the catalyst system.

(1.2.2) Low Emission Vehicle II applications:

(A) 2004 model year vehicles.

(i) All LEV II, ULEV II, and MDV SULEV II vehicles shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1).

(ii) All PC/LDT SULEV II vehicles shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1) except the malfunction criterion in paragraph (e)(1.2.1)(A) shall be 2.5 times the applicable FTP full useful life NMOG standard.

(B) Except as provided below in section (e)(1.2.4), for 2005 and 2006 model years, the OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that any of the following occurs:

(i) For LEV II, ULEV II, and MDV SULEV II vehicles.

a. NMOG emissions exceed the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(A).

b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).

c. Oxides of nitrogen (NOx) emissions exceed 3.5 times the FTP full useful life NOx standard to which the vehicle has been certified.

(ii) PC/LDT SULEV II vehicles shall use the same malfunction criteria as 2005 and 2006 model year LEV II, ULEV II, and MDV SULEV II vehicles (section (e)(1.2.2)(B)(i)) except the malfunction criteria in paragraph a. shall be 2.5 times the applicable FTP full useful life NMOG standard.

(C) Except as provided below in section (e)(1.2.5), for 2007 and subsequent model years, the OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that any of the following occurs.

(i) For LEV II, ULEV II, and MDV SULEV II vehicles.

a. NMOG emissions exceed the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(A).

b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).

c. NOx emissions exceed 1.75 times the FTP full useful life NOx standard to which the vehicle has been certified.

(ii) For PC/LDT SULEV II vehicles.

a. NMOG emissions exceed 2.5 times the applicable FTP full useful life NMOG standard to which the vehicle has been certified.
b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).
c. NOx emissions exceed 2.5 times the applicable FTP full useful life NOx standard to which the vehicle has been certified.

(1.2.3) Non-Low Emission Vehicle I or II applications: The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that NMHC emissions increase by more than 1.5 times the applicable FTP full useful life standards over an FTP test performed with a representative 4000 mile catalyst system.

(1.2.4) In lieu of using the malfunction criteria in section (e)(1.2.2)(B) for all 2005 and 2006 model year Low Emission Vehicle II applications, a manufacturer may phase-in the malfunction criteria only on Low Emission Vehicle II applications such that at least 30% of all 2005 model year vehicles and 60% of all 2006 model year vehicles use the malfunction criteria. For 2005 and 2006 model year Low Emission Vehicle II applications not included in the phase-in, the malfunction criteria in section (e)(1.2.2)(A) shall be used.

(1.2.5) In lieu of using the malfunction criteria in section (e)(1.2.2)(C) for all 2007 model year Low Emission Vehicle II applications, for the 2007 model year only, a manufacturer may continue to use the malfunction criteria in section (e)(1.2.2)(B) for any Low Emission Vehicle II applications previously certified in the 2005 or 2006 model year to the malfunction criteria in section (e)(1.2.2.)(B) and carried over to the 2007 model year.

(1.2.6) For purposes of determining the catalyst system malfunction criteria in sections (e)(1.2.1), (1.2.2)(A), and (1.2.3), the malfunction criteria shall be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the vehicle's full useful life.

(1.2.7) For purposes of determining the catalyst system malfunction criteria in sections (e)(1.2.2)(B) and (C):

(A) The manufacturer shall use a catalyst system deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning operating conditions.

(B) Except as provided below in section (e)(1.2.7)(C), the malfunction criteria shall be established by using a catalyst system with all monitored and unmonitored (downstream of the sensor utilized for catalyst monitoring) catalysts simultaneously deteriorated to the malfunction criteria.

(C) For vehicles using fuel shutoff to prevent over-fueling during misfire conditions (see section (e)(3.4.1)(D)), the malfunction criteria shall be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the vehicle's full useful life.

(1.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(1.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(1.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(1.4) MIL Illumination and Fault Code Storage:

(1.4.1) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

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

(1.5) CATALYST MONITORING FOR DIESELS

(1.5.1) Requirement: On all 2004 and subsequent model year diesel passenger cars, light-duty trucks, and medium-duty passenger vehicles (see section (c)) and all 2005 and subsequent model year medium-duty vehicles, the OBD II system shall monitor the catalyst system for proper conversion capability.

(1.5.2) Malfunction Criteria:

(A) For 2004 and subsequent model year diesel passenger cars, light-duty trucks, and medium-duty passenger vehicles:

(i) Except as provided below, the OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that emissions exceed 1.5 times the applicable FTP full useful life NMHC, NOx, or PM standard.

(ii) For the 2004 through 2009 model year, a manufacturer may request to be exempted from the requirements for NMHC conversion catalyst system monitoring. The Executive Officer shall approve the request if the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NMHC conversion efficiency of the system is less than 30 percent (i.e., the cumulative NMHC emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NMHC emissions measured at the inlet of the catalyst(s)).

(iii) For the 2004 through 2009 model year, a manufacturer may request to be exempted from the requirements for NOx conversion catalyst system monitoring. The Executive Officer shall approve the request if the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NOx conversion efficiency of the system is less than 30 percent (i.e., the cumulative NOx emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NOx emissions measured at the inlet of the catalyst(s)).

(iv) For vehicles not exempted from NMHC conversion efficiency monitoring under the provisions of section (e)(1.5.2)(A)(ii), if no failure or deterioration of the catalyst system NMHC conversion capability could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of NMHC conversion capability.

(v) For vehicles not exempted from NOx conversion efficiency monitoring under the provisions of section (e)(1.5.2)(A)(iii), if no failure or deterioration of the catalyst system NOx conversion capability could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of NOx conversion capability.

(B) For 2005 and 2006 model year diesel medium-duty vehicles (except medium-duty passenger vehicles):

(i) Except as provided below, the OBD II system shall detect a NOx conversion catalyst system malfunction when the catalyst system's conversion capability decreases to the point that emissions exceed 1.5 times the applicable FTP full useful life NOx or PM standard (or, if applicable, NMHC+NOx standard).

(ii) A manufacturer may request to be exempted from the requirements for NOx conversion catalyst system monitoring. The Executive Officer shall approve the request if the manufacturer has demonstrated, through data and/or engineering evaluation, that no failure or deterioration of the system will cause emissions to exceed the emission threshold specified in section (e)(1.5.2)(B)(i).

(iii) Monitoring of the NMHC conversion catalyst system performance is not required.

(C) For 2007 and subsequent model year diesel medium-duty vehicles (except medium-duty passenger vehicles):

(i) Except as provided below, the OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that emissions exceed 1.5 times the applicable FTP full useful life NMHC, NOx, or PM standard (or, if applicable, NMHC+NOx standard).

(ii) For the 2007 through 2009 model year, a manufacturer may request to be exempted from the requirements for NMHC conversion catalyst system monitoring. The Executive Officer shall approve the request if the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NMHC conversion efficiency of the system is less than 30 percent (i.e., the cumulative NMHC emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NMHC emissions measured at the inlet of the catalyst(s)).

(iii) For the 2007 through 2009 model year, a manufacturer may request to be exempted from the requirements for NOx conversion catalyst system monitoring. The Executive Officer shall approve the request if the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NOx conversion efficiency of the system is less than 30 percent (i.e., the cumulative NOx emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NOx emissions measured at the inlet of the catalyst(s)).

(iv) For vehicles not exempted from NMHC conversion efficiency monitoring under the provisions of section (e)(1.5.2)(C)(ii), if no failure or deterioration of the catalyst system NMHC conversion capability could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of NMHC conversion capability.

(v) For vehicles not exempted from NOx conversion efficiency monitoring under the provisions of section (e)(1.5.2)(C)(iii), if no failure or deterioration of the catalyst system NOx conversion capability could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of NOx conversion capability.

(1.5.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(1.5.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(1.5.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(1.5.4) MIL Illumination and Fault Code Storage:

(A) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

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

(2) HEATED CATALYST MONITORING

(2.1) Requirement:

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

(2.1.2) The efficiency of heated catalysts shall be monitored in conjunction with the requirements of section (e)(1).

(2.2) Malfunction Criteria:

(2.2.1) The OBD II system shall detect a catalyst heating system malfunction when the catalyst does not reach its designated heating temperature within a requisite time period after engine starting. The manufacturer shall determine the requisite time period, but the time period may not exceed the time that would cause emissions from a vehicle equipped with the heated catalyst system to exceed 1.75 times any of the applicable FTP full useful life standards.

(2.2.2) Manufacturers may use other monitoring strategies for the heated catalyst but must submit the alternate plan to the Executive Officer for approval.

The Executive Officer shall approve alternate strategies for monitoring heated catalyst systems based on comparable reliability and timeliness to these requirements in detecting a catalyst heating malfunction.

(2.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(2.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(2.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(3) MISFIRE MONITORING

(3.1) Requirement:

(3.1.1) The OBD II system shall monitor the engine for misfire causing catalyst damage and misfire causing excess emissions.

(3.1.2) The OBD II system shall identify the specific cylinder that is experiencing misfire. Manufacturers may request Executive Officer approval to store a general misfire fault code instead of a cylinder specific fault code under certain operating conditions provided the manufacturer submits data and/or an engineering evaluation that adequately demonstrate that the misfiring cylinder cannot be reliably identified when the conditions occur.

(3.1.3) If more than one cylinder is misfiring, a separate fault code shall be stored indicating that multiple cylinders are misfiring except as allowed below. When identifying multiple cylinder misfire, the manufacturer is not required to also identify each of the misfiring cylinders individually through separate fault codes. For 2005 and subsequent model year vehicles, if more than 90 percent of the detected misfires occur in a single cylinder, the manufacturer may elect to store the appropriate fault code indicating the specific misfiring cylinder in lieu of the multiple cylinder misfire fault code. If, however, two or more cylinders individually have more than 10 percent of the total number of detected misfires, a multiple cylinder fault code must be stored.

(3.2) Malfunction Criteria: The OBD II system shall detect a misfire malfunction pursuant to the following:

(3.2.1) Misfire causing catalyst damage:

(A) Manufacturers shall determine the percentage of misfire evaluated in 200 revolution increments for each engine speed and load condition that would result in a temperature that causes catalyst damage. The manufacturer shall submit documentation to support this percentage of misfire as required in section (h)(2.5). For every engine speed and load condition that this percentage of misfire is determined to be lower than five percent, the manufacturer may set the malfunction criteria at five percent.

(B) Subject to Executive Officer approval, a manufacturer may employ a longer interval than 200 revolutions but only for determining, on a given driving cycle, the first misfire exceedance as provided in section (e)(3.4.1)(A) below. Executive Officer approval shall be conditioned upon the manufacturer submitting data and/or an engineering evaluation that adequately demonstrate that catalyst damage would not occur due to unacceptably high catalyst temperatures before the interval has elapsed.

(C) A misfire malfunction shall be detected if the percentage of misfire established in section (e)(3.2.1)(A) is exceeded.

(D) For purposes of establishing the temperature at which catalyst damage occurs as required in section (e)(3.2.1)(A), on 2005 and subsequent model year vehicles manufacturers may not define catalyst damage at a temperature more severe than what the catalyst system could be operated at for ten consecutive hours and still meet the applicable FTP full useful life standards.

(3.2.2) Misfire causing emissions to exceed 1.5 times the FTP standards:

(A) Manufacturers shall determine the percentage of misfire evaluated in 1000 revolution increments that would cause emissions from an emission durability demonstration vehicle to exceed 1.5 times any of the applicable FTP standards if the percentage of misfire were present from the beginning of the test. To establish this percentage of misfire, the manufacturer shall utilize misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent.

(B) Subject to Executive Officer approval, a manufacturer may employ other revolution increments if the manufacturer can adequately demonstrate that the strategy would be equally effective and timely in detecting misfire.

(C) A malfunction shall be detected if the percentage of misfire established in section (3.2.2)(A) is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous, etc.).

(3.3) Monitoring Conditions:

(3.3.1) Manufacturers shall continuously monitor for misfire under the following conditions:

(A) From no later than the end of the second crankshaft revolution after engine start,

(B) During the rise time and settling time for engine speed to reach the desired idle engine speed at engine start-up (i.e., "flare-up" and "flare-down"), and

(C) Under all positive torque engine speeds and load conditions except within the following range: the engine operating region bound by the positive torque line (i.e., engine load with the transmission in neutral), and the two following engine operating points: an engine speed of 3000 rpm with the engine load at the positive torque line, and the redline engine speed (defined in section (c)) with the engine's manifold vacuum at four inches of mercury lower than that at the positive torque line.

(3.3.2) If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions as required in section (e)(3.3.1) above, the manufacturer may request Executive Officer approval to accept the monitoring system. In evaluating the manufacturer's request, the Executive Officer shall consider the following factors: the magnitude of the region(s) in which misfire detection is limited, the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events), the frequency with which said region(s) are expected to be encountered in-use, the type of misfire patterns for which misfire detection is troublesome, and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation shall be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders, single cylinder continuous misfire, and paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(3.3.3) A manufacturer may request Executive Officer approval of a monitoring system that has reduced misfire detection capability during the portion of the first 1000 revolutions after engine start that a cold start emission reduction strategy that reduces engine torque (e.g., spark retard strategies) is active. The Executive Officer shall approve the request if the manufacturer demonstrates that the probability of detection is greater than or equal to 75 percent during the worst case condition (i.e., lowest generated torque) for a vehicle operated continuously at idle (park/neutral idle) on a cold start between 50-86 degrees Fahrenheit and that the technology cannot reliably detect a higher percentage of the misfire events during the conditions.

(3.3.4) A manufacturer may request Executive Officer approval to disable misfire monitoring or employ an alternate malfunction criterion when misfire cannot be distinguished from other effects.

(A) Upon the manufacturer presenting documentation that demonstrates the disablement interval or period of use of an alternate malfunction criterion is limited only to that necessary for avoiding false detection, the Executive Officer shall approve the disablement or use of the alternate malfunction criterion for conditions involving:

(i) rough road,

(ii) fuel cut,

(iii) gear changes for manual transmission vehicles,

(iv) traction control or other vehicle stability control activation such as anti-lock braking or other engine torque modifications to enhance vehicle stability,

(v) off-board control or intrusive activation of vehicle components or diagnostics during service or assembly plant testing,

(vi) portions of intrusive evaporative system or EGR diagnostics that can significantly affect engine stability (i.e., while the purge valve is open during the vacuum pull-down of a evaporative system leak check but not while the purge valve is closed and the evaporative system is sealed or while an EGR diagnostic causes the EGR valve to be intrusively cycled on and off during positive torque conditions), or

(vii) engine speed, load, or torque transients due to throttle movements more rapid than occurs over the US06 cycle for the worst case vehicle within each test group.

(B) Additionally, the Executive Officer will approve a manufacturer's request in accordance with sections (e)(18.3) through (18.5) to disable misfire monitoring when fuel level is 15 percent or less of the nominal capacity of the fuel tank, when PTO units are active, or while engine coolant temperature is below 20 degrees Fahrenheit. The Executive Officer will approve a request to continue disablement on engine starts when engine coolant temperature is below 20 degrees Fahrenheit at engine start until engine coolant temperature exceeds 70 degrees Fahrenheit.

(C) In general, for 2005 and subsequent model year vehicles, the Executive Officer shall not approve disablement for conditions involving normal air conditioning compressor cycling from on-to-off or off-to-on, automatic transmission gear shifts (except for shifts occurring during wide open throttle operation), transitions from idle to off-idle, normal engine speed or load changes that occur during the engine speed rise time and settling time (i.e., "flare-up" and "flare-down") immediately after engine starting without any vehicle operator-induced actions (e.g., throttle stabs), or excess acceleration (except for acceleration rates that exceed the maximum acceleration rate obtainable at wide open throttle while the vehicle is in gear due to abnormal conditions such as slipping of a clutch).

(D) The Executive Officer may approve misfire monitoring disablement or use of an alternate malfunction criterion for any other condition on a case by case basis if the manufacturer can demonstrate that the request is based on an unusual or unforeseen circumstance and that it is applying the best available computer and monitoring technology.

(3.3.5) For engines with more than eight cylinders that cannot meet the requirements of section (e)(3.3.1), a manufacturer may request Executive Officer approval to use alternative misfire monitoring conditions. The Executive Officer shall approve the request upon the manufacturer submitting data and/or an engineering evaluation which adequately demonstrates that misfire detection throughout the required operating region cannot be achieved when employing proven monitoring technology (i.e., a technology that provides for compliance with these requirements on other engines) and provided misfire is detected to the fullest extent permitted by the technology. However, the Executive Officer may not grant the request if the misfire detection system is unable to monitor during all positive torque operating conditions encountered during an FTP cycle.

(3.4) MIL Illumination and Fault Code Storage:

(3.4.1) Misfire causing catalyst damage. Upon detection of the level of misfire specified in section (e)(3.2.1) above, the following criteria shall apply for MIL illumination and fault code storage:

(A) Pending fault codes

(i) A pending fault code and freeze frame conditions shall be stored immediately if, during a single driving cycle, the specified misfire level is exceeded three times when operating in the positive torque region encountered during an FTP cycle or is exceeded on a single occasion when operating at any other engine speed and load condition in the positive torque region defined in section (e)(3.3.1).

(ii) Immediately after a pending fault code is stored as specified in section (e)(3.4.1)(A)(i) above, the MIL shall blink once per second at all times while misfire is occurring during the driving cycle.

a. The MIL may be extinguished during those times when misfire is not occurring during the driving cycle.
b. If, at the time a misfire malfunction occurs, the MIL is already illuminated for a malfunction other than misfire, the MIL shall blink as previously specified in section (e)(3.4.1)(A)(ii) while misfire is occurring. If misfiring ceases, the MIL shall stop blinking but remain illuminated as required by the other malfunction.

(B) Confirmed fault codes

a. If a pending fault code for exceeding the misfire level set forth in section (e)(3.2.1) is stored, the OBD II system shall immediately store a confirmed fault code if the percentage of misfire specified in section (e)(3.2.1) is again exceeded one or more times during either: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered.

(ii) If a pending fault code for exceeding the misfire level set forth in section (e)(3.2.2) is stored from a previous drive cycle, the OBD II system shall immediately store a confirmed fault code if the percentage of misfire specified in section (e)(3.2.1) is exceeded one or more times regardless of the conditions encountered.

(iii) Upon storage of a confirmed fault code, the MIL shall blink as specified in subparagraph (e)(3.4.1)(A)(ii) above as long as misfiring is occurring and the MIL shall remain continuously illuminated, even if the misfiring ceases.

(C) Erasure of pending fault codes

Pending fault codes and stored freeze frame conditions shall be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without any exceedance of the specified misfire levels. The pending code and stored freeze frame conditions may also be erased if similar driving conditions are not encountered during the next 80 driving cycles subsequent to the initial detection of a malfunction.

(D) Exemptions for vehicles with fuel shutoff and default fuel control.

Notwithstanding sections (e)(3.4.1)(A) and (B) above, in vehicles that provide for fuel shutoff and default fuel control to prevent over fueling during catalyst damage misfire conditions, the MIL need not blink. Instead, the MIL may illuminate continuously in accordance with the requirements for continuous MIL illumination in sections (e)(3.4.1)(B)(iii) above upon detection of misfire, provided that the fuel shutoff and default control are 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. Manufacturers may also periodically, but not more than once every 30 seconds, deactivate fuel shutoff and default fuel control to determine if the specified catalyst damage misfire level is still being exceeded. Normal fueling and fuel control may be resumed if the specified catalyst damage misfire level is no longer being exceeded.

(E) Manufacturers may request Executive Officer approval of strategies that steadily illuminate the MIL in lieu of blinking the MIL during extreme catalyst damage misfire conditions (i.e., catalyst damage misfire occurring at all engine speeds and loads). Executive Officer approval shall be granted if the manufacturer employs the strategy only when catalyst damage misfire levels cannot be avoided during reasonable driving conditions and the manufacturer demonstrates that the strategy will encourage operation of the vehicle in conditions that will minimize catalyst damage (e.g., at low engine speeds and loads).

(3.4.2) Misfire causing emissions to exceed 1.5 times the FTP standards. Upon detection of the misfire level specified in section (e)(3.2.2), the following criteria shall apply for MIL illumination and fault code storage:

(A) Misfire within the first 1000 revolutions after engine start.

(i) A pending fault code and freeze frame conditions shall be stored no later than after the first exceedance of the specified misfire level during a single driving cycle if the exceedance occurs within the first 1000 revolutions after engine start (defined in section (c)) during which misfire detection is active.

(ii) If a pending fault code is stored, the OBD II system shall illuminate the MIL and store a confirmed fault code within ten seconds if an exceedance of the specified misfire level is again detected in the first 1000 revolutions during any subsequent driving cycle, regardless of the conditions encountered during the driving cycle.

(iii) The pending fault code and stored freeze frame conditions shall be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without an exceedance of the specified percentage of misfire. The pending code and stored freeze frame conditions may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following the initial detection of the malfunction.

(B) Exceedances after the first 1000 revolutions after engine start.

(i) A pending fault code and freeze frame conditions shall be stored no later than after the fourth exceedance of the percentage of misfire specified in section (e)(3.2.2) during a single driving cycle.

(ii) If a pending fault code is stored, the OBD II system shall illuminate the MIL and store a confirmed fault code within ten seconds if the percentage of misfire specified in section (e)(3.2.2) is again exceeded four times during: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered.

(iii) The pending fault code and stored freeze frame conditions may be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without an exceedance of the specified percentage of misfire. The pending code and stored freeze frame conditions may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following initial detection of the malfunction.

(3.4.3) If freeze frame conditions are stored for a malfunction other than misfire or fuel system malfunction (see section (e)(6)) when a pending fault code is stored as specified in section (e)(3.4) above, the stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction.

(3.4.4) Storage of misfire conditions for similar conditions determination. Upon detection of misfire under sections (e)(3.4.1) or (3.4.2), manufacturers shall store the following engine conditions: engine speed, load, and warm-up status of the first misfire event that resulted in the storage of the pending fault code.

(3.4.5) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

(3.5) MISFIRE MONITORING FOR DIESELS

(3.5.1) Requirement:

(A) The OBD II system on a diesel engine shall be capable of detecting misfire occurring continuously in one or more cylinders. To the extent possible without adding hardware for this specific purpose, the OBD II system shall also identify the specific continuously misfiring cylinder.

(B) If more than one cylinder is continuously misfiring, a separate fault code shall be stored indicating that multiple cylinders are misfiring. When identifying multiple cylinder misfire, the manufacturer is not required to also identify each of the continuously misfiring cylinders individually through separate fault codes.

(3.5.2) Malfunction Criteria: The OBD II system shall detect a misfire malfunction when one or more cylinders are continuously misfiring.

(3.5.3) Monitoring Conditions: The OBD II system shall monitor for misfire during engine idle conditions. A manufacturer shall submit monitoring conditions to the Executive Officer for approval. The Executive Officer shall approve manufacturer defined monitoring conditions that are determined (based on manufacturer submitted data and/or other engineering documentation) to be: (i) technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false detection of malfunctions), (ii) require no more than 1000 cumulative engine revolutions, and (iii) do not require any single continuous idle operation of more than 15 seconds to make a determination that a malfunction is present (e.g., a decision can be made with data gathered during several idle operations of 15 seconds or less). For 2004 model year vehicles only, a manufacturer may comply with the monitoring conditions for diesel misfire monitoring in title 13, CCR section 1968.1 in lieu of meeting the monitoring conditions in section (e)(3.5.3).

(3.5.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(4) EVAPORATIVE SYSTEM MONITORING

(4.1) Requirement: The OBD II system shall verify purge flow from the evaporative system and shall monitor the complete evaporative system, excluding the tubing and connections between the purge valve and the intake manifold, for vapor leaks to the atmosphere. Individual components of the evaporative system (e.g. valves, sensors, etc.) shall be monitored in accordance with the comprehensive components requirements in section (e)(16) (e.g., for circuit continuity, out of range values, rationality, proper functional response, etc.).

(4.2) Malfunction Criteria:

(4.2.1) For purposes of section (e)(4), an orifice shall be defined as an O'Keefe Controls Co. precision metal "Type B" orifice with NPT connections with a diameter of the specified dimension (e.g., part number B-20-SS for a stainless steel 0.020 inch diameter orifice).

(4.2.2) The OBD II system shall detect an evaporative system malfunction when any of the following conditions exist:

(A) No purge flow from the evaporative system to the engine can be detected by the OBD II system;

(B) The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.040 inch diameter orifice; and

(C) The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.020 inch diameter orifice.

(4.2.3) On vehicles with fuel tank capacity greater than 25.0 gallons, a manufacturer may request the Executive Officer to revise the orifice size in sections (e)(4.2.2)(B) and/or (C) if the most reliable monitoring method available cannot reliably detect a system leak of the magnitudes specified. The Executive Officer shall approve the request upon finding that the manufacturer has provided adequate data and/or engineering analysis to support the request.

(4.2.4) Upon request by the manufacturer and submission of data and/or engineering evaluation which adequately support the request, the Executive Officer shall revise the orifice size in sections (e)(4.2.2)(B) and/or (C) upward to exclude detection of leaks that cannot cause evaporative or running loss emissions to exceed 1.5 times the applicable standards.

(4.2.5) A manufacturer may request Executive Officer approval to revise the orifice size in section (e)(4.2.2)(B) to a 0.090 inch diameter orifice. The Executive Officer shall approve the request upon the manufacturer submitting data and/or engineering analysis and the Executive Officer finding that:

(A) the monitoring strategy for detecting orifices specified in section (e)(4.2.2)(C) meets the monitoring conditions requirements of section (e)(4.3.2); and

(B) the monitoring strategy for detecting 0.090 inch diameter orifices substantially exceeds the monitoring conditions requirements of section (e)(4.3.1) for monitoring strategies designed to detect orifices specified in section (e)(4.2.2)(B).

(4.2.6) For the 2004 and 2005 model years only, manufacturers that use separate monitors to identify leaks (as specified in (e)(4.2.2.)(B) or (C)) in different portions of the complete evaporative system (e.g., separate monitors for the fuel tank to canister portion and for the canister to purge valve portion of the system) may request Executive Officer approval to revise the malfunction criteria in sections (e)(4.2.2)(B) and (C) to identify a malfunction when the separately monitored portion of the evaporative system (e.g., the fuel tank to canister portion) has a leak (or leaks) that is greater than or equal to the specified size in lieu of when the complete evaporative system has a leak (or leaks) that is greater than or equal to the specified size. The Executive Officer shall approve the request upon finding that the manufacturer utilized the same monitoring strategy (e.g., monitoring portions of the complete system with separate monitors) on vehicles prior to the 2004 model year and that the monitoring strategy provides further isolation of the malfunction for repair technicians by utilizing separate fault codes for each monitored portion of the evaporative system.

(4.3) Monitoring Conditions:

(4.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(4.2.2)(A) and (B) (i.e., purge flow and 0.040 inch leak detection) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(4.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(4.2.2)(C) (i.e., 0.020 inch leak detection) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(4.2.2)(C) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(4.3.3) Manufacturers may disable or abort an evaporative system monitor when the fuel tank level is over 85 percent of nominal tank capacity or during a refueling event.

(4.3.4) Manufacturers may request Executive Officer approval to execute the evaporative system monitor only on driving cycles determined by the manufacturer to be cold starts if the condition is needed to ensure reliable monitoring. The Executive Officer may not approve criteria that exclude engine starts from being considered as cold starts solely on the basis that ambient temperature exceeds (i.e., indicates a higher temperature than) engine coolant temperature at engine start. The Executive Officer shall approve the request upon finding that data and/or an engineering evaluation submitted by the manufacturer adequately demonstrate that a reliable check can only be made on driving cycles when the cold start criteria are satisfied.

(4.3.5) Manufacturers may temporarily disable the evaporative purge system to perform an evaporative system leak check.

(4.4) MIL Illumination and Fault Code Storage:

(4.4.1) Except as provided below for fuel cap leaks and alternate statistical MIL illumination protocols, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(4.4.2) If the OBD II system is capable of discerning that a system leak is being caused by a missing or improperly secured fuel cap:

(A) The manufacturer is not required to illuminate the MIL or store a fault code if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The alternative indicator shall conform to the requirements outlined in section (d)(2.1.1) for location and illumination.

(B) If the vehicle is not equipped with an alternative indicator and the MIL illuminates, the MIL may be extinguished and the corresponding fault codes erased once the OBD II system has verified that the fuel cap has been securely fastened and the MIL has not been illuminated for any other type of malfunction.

(C) The Executive Officer may approve other strategies that provide equivalent assurance that a vehicle operator will be promptly notified of a missing or improperly secured fuel cap and that corrective action will be undertaken.

(4.4.3) Notwithstanding section (d)(2.2.3), manufacturers may request Executive Officer approval to use alternative statistical MIL illumination and fault code storage protocols that require up to twelve driving cycles on average for monitoring strategies designed to detect malfunctions specified by section (e)(4.2.2)(C). Executive Officer approval shall be granted in accordance with the bases identified in section (d)(2.2.3) and if the manufacturer submits data and/or an engineering analysis adequately demonstrating that the most reliable monitoring method available cannot reliably detect a malfunction of the specified size without the additional driving cycles and that the monitoring system will still meet the monitoring conditions requirements specified in sections (d)(3.1) and (3.2).

(5) SECONDARY AIR SYSTEM MONITORING

(5.1) Requirement: The OBD II system on vehicles equipped with any form of secondary air delivery system shall monitor the proper functioning of the secondary air delivery system including all air switching valve(s). The individual electronic components (e.g., actuators, valves, sensors, etc.) in the secondary air system shall be monitored in accordance with the comprehensive component requirements in section (e)(16).

(5.2) Malfunction Criteria:

(5.2.1) For purposes of section (e)(5), "air flow" is defined as the air flow delivered by the secondary air system to the exhaust system. For vehicles using secondary air systems with multiple air flow paths/distribution points, the air flow to each bank (i.e., a group of cylinders that share a common exhaust manifold, catalyst, and control sensor) shall be monitored in accordance with the malfunction criteria in sections (e)(5.2.3) and (5.2.4).

(5.2.2) For all Low Emission Vehicle I applications:

(A) Except as provided in sections (e)(5.2.2)(B) and (e)(5.2.4), the OBD II system shall detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(B) Manufacturers may request Executive Officer approval to detect a malfunction when no detectable amount of air flow is delivered in lieu of the malfunction criteria in section (e)(5.2.2)(A). The Executive Office shall grant approval upon determining that deterioration of the secondary air system is unlikely based on data and/or engineering evaluation submitted by the manufacturer demonstrating that the materials used for the secondary air system (e.g., air hoses, tubing, valves, connectors, etc.) are inherently resistant to disconnection, corrosion, or other deterioration.

(5.2.3) For all Low Emission Vehicle II applications:

(A) For 2004 and 2005 model year vehicles, manufacturers shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(5.2.2).

(B) For 2006 and subsequent model year vehicles, except as provided in sections (e)(5.2.3)(C) and (e)(5.2.4), the OBD II system shall detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow during normal operation that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards. For purposes of sections (e)(5.2) and (5.3), "normal operation" shall be defined as the condition when the secondary air system is activated during catalyst and/or engine warm-up following engine start and may not include the condition when the secondary air system is intrusively turned on solely for the purpose of monitoring.

(C) For 2006 and 2007 model year vehicles only, a manufacturer may request Executive Officer approval to detect a malfunction when no detectable amount of air flow is delivered during normal operation in lieu of the malfunction criteria in section (e)(5.2.3)(B) (e.g., 1.5 times the standard) during normal operation. Executive Officer approval shall be granted if the manufacturer submits data and/or engineering analysis adequately demonstrating that the monitoring system is capable of detecting malfunctions prior to a decrease from the manufacturer's specified air flow that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards during an intrusive operation of the secondary air system later in the same driving cycle.

(5.2.4) For vehicles in which no deterioration or failure of the secondary air system would result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when no detectable amount of air flow is delivered. For vehicles subject to the malfunction criteria in section (e)(5.2.3)(B), this monitoring for no detectable amount of air flow shall occur during normal operation of the secondary air system.

(5.3) Monitoring Conditions:

(5.3.1) For all Low Emission Vehicle I applications: Manufacturers shall define the monitoring conditions in accordance with section (d)(3.1).

(5.3.2) For all Low Emission Vehicle II applications:

(A) For 2004 and 2005 model year vehicles, manufacturers shall define the monitoring conditions in accordance with section (d)(3.1).

(B) For 2006 and subsequent model year vehicles, manufacturers shall define the monitoring conditions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(5.2) during normal operation of the secondary air system shall be tracked separately but reported as a single set of values as specified in sections (d)(4.2.2)(C) and (d)(5.2.2).

(5.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(6) FUEL SYSTEM MONITORING

(6.1) Requirement:

(6.1.1) For all vehicles except vehicles with diesel engines, the OBD II system shall monitor the fuel delivery system to determine its ability to provide compliance with emission standards.

(6.1.2) For vehicles with diesel engines, the manufacturer shall monitor the performance of all electronic fuel system components to the extent feasible with respect to the malfunction criteria specified in section (e)(6.2) below.

(6.2) Malfunction Criteria:

(6.2.1) The OBD II system shall detect a malfunction of the fuel delivery system (including feedback control based on a secondary oxygen sensor) when the fuel delivery system is unable to maintain a vehicle's emissions at or below 1.5 times any of the applicable FTP standards.

(6.2.2) Except as provided for in section (e)(6.2.3) below, if the vehicle is equipped with adaptive feedback control, the OBD II system shall detect a malfunction when the adaptive feedback control has used up all of the adjustment allowed by the manufacturer.

(6.2.3) If the vehicle is equipped with feedback control that is based on a secondary oxygen (or equivalent) sensor, the OBD II system is not required to detect a malfunction of the fuel system solely when the feedback control based on a secondary oxygen sensor has used up all of the adjustment allowed by the manufacturer. However, if a failure or deterioration results in vehicle emissions that exceed the malfunction criteria in section (e)(6.2.1), the OBD II system is required to detect a malfunction.

(6.2.4) The OBD II system shall detect a malfunction whenever the fuel control system fails to enter closed-loop operation (if employed) within a manufacturer specified time interval.

(6.2.5) Manufacturers may adjust the criteria and/or limit(s) to compensate for changes in altitude, for temporary introduction of large amounts of purge vapor, or for other similar identifiable operating conditions when they occur.

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

(6.4) MIL Illumination and Fault Code Storage:

(6.4.1) A pending fault code and freeze frame conditions shall be stored immediately upon the fuel system exceeding the malfunction criteria established pursuant to section (e)(6.2).

(6.4.2) Except as provided below, if a pending fault code is stored, the OBD II system shall immediately illuminate the MIL and store a confirmed fault code if a malfunction is again detected during either of the following two events: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to those that occurred when the pending fault code was stored are encountered.

(6.4.3) The pending fault code and stored freeze frame conditions may be erased at the end of the next driving cycle in which similar conditions have been encountered without an exceedance of the specified fuel system malfunction criteria. The pending code and stored freeze frame conditions may also be erased if similar conditions are not encountered during the 80 driving cycles immediately after the initial detection of a malfunction for which the pending code was set.

(6.4.4) If freeze frame conditions are stored for a malfunction other than misfire (see section (e)(3)) or fuel system malfunction when a pending fault code is stored as specified in section (e)(6.4.1) above, the stored freeze frame information shall be replaced with freeze frame information regarding the fuel system malfunction.

(6.4.5) Storage of fuel system conditions for determining similar conditions of operation. Upon detection of a fuel system malfunction under section (e)(6.2), manufacturers shall store the engine speed, load, and warm-up status of the first fuel system malfunction that resulted in the storage of the pending fault code.

(6.4.6) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without a malfunction of the fuel system.

(7) OXYGEN SENSOR MONITORING

(7.1) Requirement:

(7.1.1) The OBD II 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. Both the lean-to-rich and rich-to-lean response rates shall be monitored.

(7.1.2) The OBD II system shall also monitor all secondary oxygen sensors (those used for fuel trim control or as a monitoring device) for proper output voltage, activity, and/or response rate.

(7.1.3) For vehicles equipped with heated oxygen sensors, the OBD II system shall monitor the heater for proper performance.

(7.1.4) For other types of sensors (e.g., wide range or universal lambda sensors, etc.), the manufacturer shall submit a monitoring plan to the Executive Officer for approval. The Executive Officer shall approve the request upon finding that the manufacturer has submitted data and an engineering evaluation that demonstrate that the monitoring plan is as reliable and effective as the monitoring plan required for conventional sensors under section (e)(7).

(7.2) Malfunction Criteria:

(7.2.1) Primary Sensors:

(A) The OBD II system shall detect a malfunction prior to any failure or deterioration of the oxygen sensor voltage, response rate, amplitude, or other characteristic(s) (including drift or bias corrected for by secondary sensors) that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(B) The OBD II system shall detect malfunctions of the oxygen sensor caused by a lack of circuit continuity or out of range values.

(C) The OBD II system shall detect a malfunction of the oxygen sensor when a sensor failure or deterioration causes the fuel system to stop using that sensor as a feedback input (e.g., causes default or open loop operation).

(D) The OBD II system shall detect a malfunction of the oxygen sensor when the sensor output voltage, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD II system monitoring device (e.g., for catalyst monitoring).

(7.2.2) Secondary Sensors:

(A) The OBD II system shall detect a malfunction prior to any failure or deterioration of the oxygen sensor voltage, response rate, amplitude, or other characteristic(s) that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(B) The OBD II system shall detect malfunctions of the oxygen sensor caused by a lack of circuit continuity.

(C) The OBD II system shall detect a malfunction of the oxygen sensor when the sensor output voltage, amplitude, activity, or other characteristics are no longer sufficient for use as a OBD II system monitoring device (e.g., for catalyst monitoring).

(D) The OBD II system shall detect malfunctions of the oxygen sensor caused by out of range values.

(7.2.3) Sensor Heaters:

(A) The OBD II system shall detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Subject to Executive Officer approval, other malfunction criteria for heater performance malfunctions may be used provided the manufacturer submits data and/or an engineering evaluation adequately showing monitoring reliability and timeliness to be equivalent to the stated criteria in section (e)(7.2.3)(A).

(B) The OBD II system shall detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground), etc.).

(7.3) Monitoring Conditions:

(7.3.1) Primary Sensors

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(7.2.1)(A) and (D) (e.g., proper response rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (e)(7.2.1)(A) and (D) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(B) Except as provided in section (e)(7.3.1)(C), monitoring for malfunctions identified in sections (e)(7.2.1)(B) and (C) (i.e., circuit continuity, out-of-range, and open-loop malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

(ii) Conducted continuously for all 2006 and subsequent model year Low Emission Vehicle II applications.

(C) A manufacturer may request Executive Officer approval to disable continuous oxygen sensor monitoring when an oxygen sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon the manufacturer submitting test data and/or documentation that demonstrates a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(7.3.2) Secondary Sensors

(A) Manufacturers shall define monitoring conditions for malfunctions identified in sections (e)(7.2.2)(A), (B), and (C) (e.g., proper sensor activity) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Except as provided in section (e)(7.3.2)(C), monitoring for malfunctions identified in section (e)(7.2.2)(D) (i.e., out-of-range malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

(ii) Conducted continuously for all 2006 and subsequent model year Low Emission Vehicle II applications.

(C) A manufacturer may request Executive Officer approval to disable continuous oxygen sensor monitoring when an oxygen sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon the manufacturer submitting test data and/or documentation that demonstrates a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(7.3.3) Sensor Heaters

(A) Manufacturers shall define monitoring conditions for malfunctions identified in section (e) (8.2.3)(A) (e.g., sensor heater performance) in accordance sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Monitoring for malfunctions identified in section (e)(7.2.3)(B) (e.g., circuit malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for 2004 and 2005 model year vehicles;

(ii) Conducted continuously for all 2006 and subsequent model year vehicles.

(7.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(8) EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITORING

(8.1) Requirement: The OBD II system shall monitor the EGR system on vehicles so-equipped for low and high flow rate malfunctions. The individual electronic components (e.g., actuators, valves, sensors, etc.) that are used in the EGR system shall be monitored in accordance with the comprehensive component requirements in section (e)(16).

(8.2) Malfunction Criteria:

(8.2.1) The OBD II system shall detect a malfunction of the EGR system prior to an increase or decrease from the manufacturer's specified EGR flow rate that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(8.2.2) For vehicles in which no failure or deterioration of the EGR system could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of EGR flow.

(8.3) Monitoring Conditions:

(8.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(8.2) (e.g., flow rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(8.2.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(8.3.2) Manufacturers may request Executive Officer approval to temporarily disable the EGR system check under specific conditions (e.g., when freezing may affect performance of the system). The Executive Officer shall approve the request provided the manufacturer submits data and/or an engineering evaluation which adequately demonstrate that a reliable check cannot be made when these conditions exist.

(8.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(9) POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM MONITORING

(9.1) Requirement:

(9.1.1) On all 2004 and subsequent model year vehicles, manufacturers shall monitor the PCV system on vehicles so-equipped for system integrity. A manufacturer may use an alternate phase-in schedule in lieu of meeting the requirements of section (e)(9) on all 2004 model year vehicles if the alternate phase-in schedule provides for equivalent compliance volume (as defined in section (c)) to the phase-in schedule specified in title 13, CCR section 1968.1(b)(10.1). Vehicles not required to be equipped with PCV systems shall be exempt from monitoring of the PCV system.

(9.1.2) For vehicles with diesel engines, the manufacturer shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production vehicle. Executive Officer approval shall be based on the effectiveness of the monitoring strategy to monitor the performance of the PCV system to the extent feasible with respect to the malfunction criteria in section (e)(9.2) below and the monitoring conditions required by the diagnostic.

(9.2) Malfunction Criteria:

(9.2.1) For the purposes of section (e)(9), "PCV system" is defined as any form of crankcase ventilation system, regardless of whether it utilizes positive pressure. "PCV valve" is defined as any form of valve or orifice used to restrict or control crankcase vapor flow. Further, any additional external PCV system tubing or hoses used to equalize crankcase pressure or to provide a ventilation path between various areas of the engine (e.g., crankcase and valve cover) are considered part of the PCV system "between the crankcase and the PCV valve" and subject to the malfunction criteria in section (e)(9.2.2) below.

(9.2.2) Except as provided below, the OBD II system shall detect a malfunction of the PCV system when a disconnection of the system occurs between either the crankcase and the PCV valve, or between the PCV valve and the intake manifold.

(9.2.3) If the PCV system is designed such that the PCV valve is fastened directly to the crankcase in a manner which makes it significantly more difficult to remove the valve from the crankcase rather than disconnect the line between the valve and the intake manifold (taking aging effects into consideration), the Executive Officer shall exempt the manufacturer from detection of disconnection between the crankcase and the PCV valve.

(9.2.4) Subject to Executive Officer approval, system designs that utilize tubing between the valve and the crankcase shall also be exempted from the portion of the monitoring requirement for detection of disconnection between the crankcase and the PCV valve. The manufacturer shall file a request and submit data and/or engineering evaluation in support of the request. The Executive Officer shall approve the request upon finding that the connections between the valve and the crankcase are: (i) resistant to deterioration or accidental disconnection, (ii) significantly more difficult to disconnect than the line between the valve and the intake manifold, and (iii) not subject to disconnection per manufacturer's repair procedures for non-PCV system repair work.

(9.2.5) Manufacturers are not required to detect disconnections between the PCV valve and the intake manifold if said disconnection (1) causes the vehicle to stall immediately during idle operation; or (2) is unlikely to occur due to a PCV system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses).

(9.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(9.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(9.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2). The stored fault code need not specifically identify the PCV system (e.g., a fault code for idle speed control or fuel system monitoring can be stored) if the manufacturer demonstrates that additional monitoring hardware would be necessary to make this identification, and provided the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the PCV system.

(10) ENGINE COOLING SYSTEM MONITORING

(10.1) Requirement:

(10.1.1) The OBD II system shall monitor the thermostat on vehicles so-equipped for proper operation.

(10.1.2) The OBD II system shall monitor the engine coolant temperature (ECT) sensor for circuit continuity, out-of-range values, and rationality faults.

(10.2) Malfunction Criteria:

(10.2.1) Thermostat

(A) The OBD II system shall detect a thermostat malfunction if, within an Executive Officer approved time interval after starting the engine, either of the following two conditions occur:

(i) The coolant temperature does not reach the highest temperature required by the OBD II system to enable other diagnostics;

(ii) The coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit of the manufacturer's nominal thermostat regulating temperature. Subject to Executive Officer approval, a manufacturer may utilize lower temperatures for this criterion if it can adequately demonstrate that the fuel, spark timing, and/or other coolant temperature-based modifications to the engine control strategies would not cause an emission increase of 50 or more percent of any of the applicable standards (e.g., 50 degree Fahrenheit emission test, etc.).

(B) Executive Officer approval of the time interval after engine start shall be granted based on data and/or engineering evaluation submitted by the manufacturer to support specified times.

(C) With Executive Officer approval, a manufacturer may use alternate malfunction criteria and/or monitoring conditions (see section (e)(10.3)) that are a function of temperature at engine start on vehicles that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. Executive Officer approval shall be based on the manufacturer submitting data that demonstrates that a properly operating system does not reach the specified temperatures, that the monitor is capable of meeting the specified malfunction criteria at engine start temperatures greater than 50°F, and that the overall effectiveness of the monitor is comparable to a monitor meeting these thermostat monitoring requirements at lower temperatures.

(D) With Executive Officer approval, manufacturers may omit this monitor. Executive Officer approval shall be granted if the manufacturer adequately demonstrates that a malfunctioning thermostat cannot cause a measurable increase in emissions during any reasonable driving condition nor cause any disablement of other monitors.

(10.2.2) ECT Sensor

(A) Circuit Continuity. The OBD II system shall detect a malfunction when a lack of circuit continuity or out-of-range values occur.

(B) Time to Reach Closed-Loop Enable Temperature.

(i) The OBD II system shall detect a malfunction if the ECT sensor does not achieve the stabilized minimum temperature which is needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature) within an Executive Officer approved time interval after starting the engine. For diesel applications, the minimum temperature needed for warmed-up fuel control to begin shall be used instead of the closed-loop enable temperature.

(ii) The time interval shall be a function of starting ECT and/or a function of intake air temperature and, except as provided below in section (e)(10.2.2)(B)(iii), may not exceed:

a. two minutes for engine start temperatures at or above 50 degrees Fahrenheit and five minutes for engine start temperatures at or above 20 degrees Fahrenheit and below 50 degrees Fahrenheit for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

b. two minutes for engine start temperatures up to 15 degrees Fahrenheit below the closed-loop enable temperature and five minutes for engine start temperatures between 15 and 35 degrees Fahrenheit below the closed-loop enable temperature for all 2006 and subsequent model year Low Emission Vehicle II applications.

(iii) Executive Officer approval of the time interval shall be based on data and/or engineering evaluation submitted by the manufacturer to support specified times. The Executive Officer shall allow longer time intervals provided a manufacturer submits data and/or an engineering evaluation which adequately demonstrate that the vehicle requires a longer time to warm up under normal conditions.

(iv) The Executive Officer shall exempt manufacturers from the requirement of section (e)(10.2.2)(B) if the manufacturer does not utilize ECT to enable closed loop fuel control.

(C) Stuck in Range Below the Highest Minimum Enable Temperature. The OBD II system shall detect a malfunction if the ECT sensor indicates a fixed temperature below the highest minimum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be greater than 140 degrees Fahrenheit to enable a diagnostic must detect malfunctions that cause the ECT sensor to indicate a fixed temperature below 140 degrees Fahrenheit).

Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (e)(10.2.1) or (e)(10.2.2)(B) will detect ECT sensor malfunctions as defined in section (e)(10.2.2)(C).

(D) Stuck in Range Above the Lowest Maximum Enable Temperature.

(i) The OBD II system shall detect a malfunction if the ECT sensor indicates a fixed temperature above the lowest maximum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be less than 90 degrees Fahrenheit at engine start to enable a diagnostic must detect malfunctions that cause the ECT sensor to indicate a fixed temperature above 90 degrees Fahrenheit).

(ii) Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (e)(10.2.1), (e)(10.2.2)(B), (e)(10.2.2)(C) (i.e., ECT sensor or thermostat malfunctions) will detect ECT sensor malfunctions as defined in section (e)(10.2.2)(D) or in which the MIL will be illuminated under the requirements of section (d)(2.1.3) for default mode operation (e.g., overtemperature protection strategies).

(iii) For Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications only, manufacturers are also exempted from the requirements of section (e)(10.2.2)(D) for vehicles that have a temperature gauge (not a warning light) on the instrument panel and utilize the same ECT sensor for input to the OBD II system and the temperature gauge.

(iv) For 2006 and subsequent model year Low Emission Vehicle II applications, manufacturers are also exempted from the requirements of section (e)(10.2.2)(D) for temperature regions where the temperature gauge indicates a temperature in the red zone (engine overheating zone) for vehicles that have a temperature gauge (not a warning light) on the instrument panel and utilize the same ECT sensor for input to the OBD II system and the temperature gauge.

(10.3) Monitoring Conditions:

(10.3.1) Thermostat

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(10.2.1)(A) in accordance with section (d)(3.1). Additionally, except as provided for in sections (e)(10.3.1)(B) and (C), monitoring for malfunctions identified in section (e)(10.2.1)(A) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in section (e)(10.2.1)(A).

(B) Manufacturers may disable thermostat monitoring at ambient starting temperatures below 20 degrees Fahrenheit.

(C) Manufacturers may request Executive Officer approval to suspend or disable thermostat monitoring if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 percent of the warm-up time, hot restart conditions, etc.). In general, the Executive Officer shall not approve disablement of the monitor on engine starts where the ECT at engine start is more than 35 degrees Fahrenheit lower than the thermostat malfunction threshold temperature determined under section (e)(10.2.1)(A). The Executive Officer shall approve the request upon finding that the manufacturer has provided adequate data and/or engineering analysis to support the request.

(10.3.2) ECT Sensor

(A) Monitoring for malfunctions identified in section (e)(10.2.2)(A) (i.e., circuit continuity and out of range) shall be conducted continuously.

(B) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(10.2.2)(B) in accordance with section (d)(3.1). Additionally, except as provided for in section (e)(10.3.2)(D), monitoring for malfunctions identified in section (e)(10.2.2)(B) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates a temperature lower than the closed loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out of range low temperature and less than the closed loop enable temperature).

(C) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(10.2.2)(C) and (D) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(D) Manufacturers may suspend or delay the time to reach closed loop enable temperature diagnostic if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time).

(10.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(11) COLD START EMISSION REDUCTION STRATEGY MONITORING

(11.1) Requirement: If a vehicle incorporates a specific engine control strategy to reduce cold start emissions, the OBD II system shall monitor the key control or feedback parameters (e.g., engine speed, mass air flow, ignition timing, etc.), other than secondary air, while the control strategy is active to ensure proper operation of the control strategy. Secondary air systems shall be monitored under the provisions of section (e)(5). The requirements of section (e)(11) shall be phased in as follows: 30 percent of all 2006 model year vehicles, 60 percent of all 2007 model year vehicles, and 100 percent of all 2008 and subsequent model year vehicles.

(11.2) Malfunction Criteria:

(11.2.1) The OBD II system shall detect a malfunction prior to any failure or deterioration of the individual components associated with the cold start emission reduction control strategy that would cause a vehicle's emissions to exceed 1.5 times the applicable FTP standards. Manufacturers shall:

(A) Establish the malfunction criteria based on data from on one or more representative vehicle(s).

(B) Provide an engineering evaluation for establishing the malfunction criteria for the remainder of the manufacturer's product line. The Executive

Officer shall waive the evaluation requirement each year if, in the judgement of the Executive Officer, technological changes do not affect the previously determined malfunction criteria.

(11.2.2) For components where no failure or deterioration the component used for the cold start emission reduction strategy could result in a vehicle's emissions exceeding 1.5 times the applicable standards, the individual component shall be monitored for proper functional response in accordance with the malfunction criteria in section (e)(16.2) while the control strategy is active.

(11.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(11.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(11.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(12) AIR CONDITIONING (A/C) SYSTEM COMPONENT MONITORING

(12.1) Requirement: If a vehicle incorporates an engine control strategy that alters off-idle fuel and/or spark control when the A/C system is on, the OBD II system shall monitor all electronic air conditioning system components for malfunctions that cause the system to fail to invoke the alternate control while the A/C system is on or cause the system to invoke the alternate control while the A/C system is off. The requirements of section (e)(12) shall be phased in as follows: 30 percent of all 2006 model year vehicles, 60 percent of all 2007 model year vehicles, and 100 percent of all 2008 and subsequent model year vehicles.

(12.2) Malfunction Criteria:

(12.2.1) The OBD II system shall detect a malfunction prior to any failure or deterioration of a component of the air conditioning system that would cause a vehicle's emissions to exceed 1.5 times any of the appropriate applicable emission standards or would effectively disable any other monitored system or component covered by this regulation. For malfunctions that result in the alternate control being erroneously invoked while the A/C system is off, the appropriate emission standards shall be the FTP standards. For malfunctions that result in the alternate control failing to be invoked while the A/C system is on, the appropriate emission standards shall be the SC03 emission standards.

(12.2.2) If no single component failure or deterioration causes emissions to exceed 1.5 times any of the appropriate applicable emission standards as defined above in section (e)(12.2.1) nor effectively disables any other monitored system or component, manufacturers are not required to monitor any air conditioning system component for purposes of section (e)(12).

(12.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(12.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(12.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(13) VARIABLE VALVE TIMING AND/OR CONTROL (VVT) SYSTEM MONITORING

(13.1) Requirement: On all 2005 and subsequent model year Low Emission Vehicle II applications, the OBD II system shall monitor the VVT system on vehicles so-equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors, etc.) that are used in the VVT system shall be monitored in accordance with the comprehensive components requirements in section (e)(16). VVT systems on Low Emission Vehicle I applications and 2004 model year Low Emission Vehicle II applications shall be monitored in accordance with the comprehensive components requirements in section (e)(16).

(13.2) Malfunction Criteria:

(13.2.1) Target Error. The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(13.2.2) Slow Response. The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a time that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(13.2.3) For vehicles in which no failure or deterioration of the VVT system could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the VVT system shall be monitored for proper functional response in accordance with the malfunction criteria in section (e)(16.2).

(13.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for VVT system malfunctions identified in section (e)(13.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). Additionally, manufacturers shall track and report VVT system monitor performance under section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(13.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(13.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(14) DIRECT OZONE REDUCTION (DOR) SYSTEM MONITORING

(14.1) Requirement:

(14.1.1) The OBD II system shall monitor the DOR system on vehicles so-equipped for malfunctions that reduce the ozone reduction performance of the system.

(14.1.2) For 2003, 2004, and 2005 model year vehicles subject to the malfunction criteria of section (e)(14.2.1) below, manufacturers may request to be exempted from DOR system monitoring. The Executive Officer shall approve the exemption upon the manufacturer:

(A) Agreeing that the DOR system receive only 50 percent of the NMOG credit assigned to the DOR system as calculated under Air Resources Board (ARB) Manufacturers Advisory Correspondence (MAC) No. 99-06, December 20, 1999, which is hereby incorporated by reference herein.

(B) Identifying the DOR system component(s) as an emission control device on both the underhood emission control label and a separate label as specified below. The DOR system shall be included in the list of emission control devices on the underhood emission control label and be identified as a "DOR system" or other equivalent term from SAE J1930 "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms", incorporated by reference. A separate label shall be located on or near the DOR system component(s) in a location that is visible to repair technicians prior to the removal of any parts necessary to replace the DOR system component(s) and shall identify the components as a "DOR system" or other equivalent SAE J1930 term.

(14.2) Malfunction Criteria:

(14.2.1) For vehicles in which the NMOG credit assigned to the DOR system, as calculated in accordance with ARB MAC No. 99-06, is less than or equal to 50 percent of the applicable FTP NMOG standard, the OBD II system shall detect a malfunction when the DOR system has no detectable amount of ozone reduction.

(14.2.2) For vehicles in which the NMOG credit assigned to the DOR system, as calculated in accordance with ARB MAC No. 99-06, is greater than 50 percent of the applicable FTP NMOG standard, the OBD II system shall detect a malfunction when the ozone reduction performance of the DOR system deteriorates to a point where the difference between the NMOG credit assigned to the properly operating DOR system and the NMOG credit calculated for a DOR system performing at the level of the malfunctioning system exceeds 50 percent of the applicable FTP NMOG standard.

(14.2.3) For vehicles equipped with a DOR system, the manufacturer may modify any of the applicable NMOG malfunction criteria in sections (e)(1)-(3), (e)(5)-(8), (e)(11)-(e)(13), and (e)(17) by adding the NMOG credit received by the DOR system to the required NMOG malfunction criteria (e.g., a malfunction criteria of 1.5 x NMOG standard would be modified to (1.5 x NMOG standard) + DOR system NMOG credit).

(14.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(14.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(14.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(15) PARTICULATE MATTER (PM) TRAP MONITORING

(15.1) Requirement: On all 2004 and subsequent model year diesel passenger cars, light-duty trucks, and medium-duty passenger vehicles (see section (c)) and all 2005 and subsequent model year medium-duty vehicles, manufacturers shall monitor the PM trap on vehicles so-equipped for proper performance.

(15.2) Malfunction Criteria:

(15.2.1) For 2004 and subsequent model year diesel passenger cars, light-duty trucks, and medium-duty passenger vehicles, the OBD II system shall detect a malfunction prior to a decrease in the capability of the PM trap that would cause a vehicle's emissions to exceed 1.5 times the applicable standards.

(15.2.2) For 2005 and 2006 model year diesel medium-duty vehicles (except medium-duty passenger vehicles), the OBD II system shall detect a malfunction of the PM trap when catastrophic failure occurs. The Executive Officer shall exempt vehicles from this PM trap monitoring requirement if the manufacturer can demonstrate with data and/or engineering evaluation that catastrophic failure of the PM trap will not cause emissions to exceed 1.5 times the applicable standards.

(15.2.3) For 2007 and subsequent model year diesel medium-duty vehicles, the OBD II system shall detect a malfunction prior to a decrease in the capability of the PM trap that would cause a vehicle's emissions to exceed 1.5 times the applicable standards.

(15.2.4) For vehicles subject to the malfunction criteria in sections (e)(15.2.1) or (15.2.3) above, if no failure or deterioration of the PM trap could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when catastrophic failure of the PM trap occurs.

(15.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(15.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(15.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(16) COMPREHENSIVE COMPONENT MONITORING

(16.1) Requirement:

(16.1.1) Except as provided in section (e)(16.1.3) and (e)(17), the OBD II system shall monitor for malfunction any electronic powertrain component/system not otherwise described in sections (e)(1) through (e)(15) that either provides input to (directly or indirectly) or receives commands from the on-board computer(s), and: (1) can affect emissions during any reasonable in-use driving condition, or (2) is used as part of the diagnostic strategy for any other monitored system or component.

(A) Input Components: Input components required to be monitored may include the vehicle speed sensor, crank angle sensor, knock sensor, throttle position sensor, cam position sensor, fuel composition sensor (e.g. flexible fuel vehicles), transmission electronic components such as sensors, modules, and solenoids which provide signals to the powertrain control system.

(B) Output Components/Systems: Output components/systems required to be monitored may include the idle speed control system, automatic transmission solenoids or controls, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, the wait-to-start lamp on diesel applications, and a warm-up catalyst bypass valve.

(16.1.2) For purposes of criteria (1) in section (e)(16.1.1) above, the manufacturer shall determine whether a powertrain input or output component/system can affect emissions. If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system cannot affect emissions, the Executive Officer shall require the manufacturer to provide emission data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an emission effect. Emission data may be requested for any reasonable driving condition.

(16.1.3) Manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with an electronic transfer case only if the transfer case component or system is used as part of the diagnostic strategy for any other monitored system or component.

(16.2) Malfunction Criteria:

(16.2.1) Input Components:

(A) The OBD II system shall detect malfunctions of input components caused by a lack of circuit continuity, out of range values, and, where feasible, rationality faults. To the extent feasible, the rationality fault diagnostics shall verify that a sensor output is neither inappropriately high nor inappropriately low (e.g., "two-sided" diagnostics). Rationality faults shall be separately detected and store different fault codes than the respective lack of circuit continuity and out of range diagnostics. Additionally, input component lack of circuit continuity and out of range faults shall be separately detected and store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit, etc.). Manufacturers are not required to store separate fault codes for lack of circuit continuity faults that cannot be distinguished from other out-of-range circuit faults.

(16.2.2) Output Components/Systems:

(A) The OBD II system shall detect a malfunction of an output component/system when proper functional response of the component and system to computer commands does not occur. If a functional check is not feasible, the OBD II system shall detect malfunctions of output components/systems caused by a lack of circuit continuity or circuit fault (e.g., short to ground or high voltage). For output component lack of circuit continuity faults and circuit faults, manufacturers are not required to store different fault codes for each distinct malfunction (e.g., open circuit, shorted low, etc.). Manufacturers are not required to activate an output component/system when it would not normally be active exclusively for the purposes of performing functional monitoring of output components/systems as required in section (e)(16).

(B) The idle speed control system shall be monitored for proper functional response to computer commands. For strategies based on deviation from target idle speed, a malfunction shall be detected when either of the following conditions occur:

(i) The idle speed control system cannot achieve the target idle speed within 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed. The Executive Officer shall allow larger engine speed tolerances provided a manufacturer submits data and/or an engineering evaluation which adequately demonstrate that the tolerances can be exceeded without a malfunction being present.

(ii) The idle speed control system cannot achieve the target idle speed within the smallest engine speed tolerance range required by the OBD II system to enable any other monitors.

(C) Glow plugs shall be monitored for proper functional response to computer commands. The glow plug circuit(s) shall be monitored for proper current and voltage drop. The Executive Officer shall approve other monitoring strategies based on manufacturer's data and/or engineering analysis demonstrating equally reliable and timely detection of malfunctions. Manufacturers shall detect a malfunction when a single glow plug no longer operates within the manufacturer's specified limits for normal operation. If a manufacturer demonstrates that a single glow plug failure cannot cause a measurable increase in emissions during any reasonable driving condition, the manufacturer shall detect a malfunction for the minimum number of glow plugs needed to cause an emission increase. Further, to the extent feasible on existing engine designs (without adding additional hardware for this purpose) and on all new design engines, the stored fault code shall identify the specific malfunctioning glow plug(s).

(16.3) Monitoring Conditions:

(16.3.1) Input Components:

(A) Input components shall be monitored continuously for proper range of values and circuit continuity.

(B) For rationality monitoring (where applicable):

(i) For 2004 model year vehicles, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with section (d)(3.1)..

(ii) For 2005 and subsequent model year vehicles, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that rationality monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(16.3.2) Output Components/Systems:

(A) Monitoring for circuit continuity and circuit faults shall be conducted continuously.

(B) Except as provided in section (e)(16.3.2)(C), for functional monitoring, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(C) For the idle speed control system, manufacturers shall define the monitoring conditions for functional monitoring in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that functional monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(16.4) MIL Illumination and Fault Code Storage:

(16.4.1) Except as provided in section (e)(16.4.2) below, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(16.4.2) Exceptions to general requirements for MIL illumination. MIL illumination is not required in conjunction with storing a confirmed fault code if the component or system, when malfunctioning, could not cause vehicle emissions to increase by 15 percent or more of the FTP standard and is not used as part of the diagnostic strategy for any other monitored system or component.

(17) OTHER EMISSION CONTROL OR SOURCE SYSTEM MONITORING

(17.1) Requirement: For other emission control or source systems that are: (1) not identified or addressed in sections (e)(1) through (e)(16) (e.g., hydrocarbon traps, NOx storage devices, fuel-fired passenger compartment heaters, etc.), or (2) identified or addressed in section (e)(16) but not corrected or compensated for by the adaptive fuel control system (e.g., swirl control valves), manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production vehicle. Executive Officer approval shall be based on the effectiveness of the monitoring strategy, the malfunction criteria utilized, the monitoring conditions required by the diagnostic, and, if applicable, the determination that the requirements of section (e)(17.3) below are satisfied.

(17.2) For purposes of section (e)(17), emission source systems are components or devices that emit pollutants subject to vehicle evaporative and exhaust emission standards (e.g., NMOG, CO, NOx, PM, etc.) and include non-electronic components and non-powertrain components (e.g., fuel-fired passenger compartment heaters, on-board reformers, etc.).

(17.3) Except as provided below in this paragraph, for 2005 and subsequent model year vehicles that utilize emission control systems that alter intake air flow or cylinder charge characteristics by actuating valve(s), flap(s), etc. in the intake air delivery system (e.g., swirl control valve systems), the monitoring strategy shall, at a minimum, monitor the shaft to which all valves in one exhaust bank are physically attached for proper functional response. For non-metal shafts or segmented shafts, the monitor shall verify all shaft segments for proper functional response (e.g., by verifying the segment or portion of the shaft furthest from the actuator properly functions). For systems that have more than one shaft to operate valves in multiple exhaust banks, manufacturers are not required to add more than one set of detection hardware (e.g., sensor, switch, etc.) per exhaust bank to meet this requirement. Vehicles utilizing these emission control systems designed and certified for 2004 or earlier model year vehicles and carried over to the 2005 or subsequent model year shall be not be required to meet the provisions of section (e)(17.3) until the vehicle, engine, or intake air delivery system are redesigned.

(18) EXCEPTIONS TO MONITORING REQUIREMENTS

(18.1) Except as provided in sections (e)(18.1.1) through (18.1.3) below, upon request of a manufacturer or upon the best engineering judgment of the ARB, the Executive Officer may revise the emission threshold for a malfunction on any check on a Low Emission Vehicle I application or Low Emission Vehicle II application if the most reliable monitoring method developed requires a higher threshold to prevent significant errors of commission in detecting a malfunction.

(18.1.1) For PC/LDT SULEV II vehicles, the Executive Officer shall approve a malfunction criteria of 2.5 times the applicable FTP standards in lieu of 1.5 wherever required in section (e).

(18.1.2) For 2004 model year PC/LDT SULEV II vehicles only, the Executive Officer shall approve monitors with thresholds that exceed 2.5 times the applicable FTP standard if the manufacturer demonstrates that a higher threshold is needed given the state of development of the vehicle and that the malfunction criteria and monitoring approach and technology (e.g., fuel system limits, percent misfire, monitored catalyst volume, etc.) are at least as stringent as comparable ULEV (not ULEV II) vehicles.

(18.1.3) For vehicles certified to Federal Bin 3 or Bin 4 emission standards, manufacturers shall utilize the ULEV II vehicle NMOG and CO malfunction criteria (e.g., 1.5 times the Bin 3 or Bin 4 NMOG and CO standards) and the PC/LDT SULEV II vehicle NOx malfunction criteria (e.g., 2.5 times the Bin 3 or Bin 4 NOx standards).

(18.2) Whenever the requirements in section (e) of this regulation require a manufacturer to meet a specific phase-in schedule (e.g., (e)(11) cold start emission reduction strategy monitoring requires 30 percent in 2006 model year, 60 percent in 2007 model year, and 100 percent in 2008 model year):

(18.2.1) The phase-in percentages shall be based on the manufacturer's projected sales volume for all vehicles subject to the requirements of title 13, CCR section 1968.2 unless specifically stated otherwise in section (e).

(18.2.2) Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) except as specifically noted for the phase in of in-use monitor performance ratio monitoring conditions in section (d)(3.2).

(18.2.3) Small volume manufacturers are required to meet the requirement on all vehicles by the final year of the phase-in in lieu of meeting the specific phase-in requirements for each model year (e.g., in the example in section (e)(18.2), small volume manufacturers are required to meet 100% in the 2008 model year for cold start emission reduction strategy monitoring, but not 30% in the 2006 model year or 60% in the 2007 model year).

(18.3) Manufacturers may request Executive Officer approval to disable an OBD II system monitor at ambient engine starting temperatures below twenty degrees Fahrenheit (20°F) (low ambient temperature conditions may be determined based on intake air or engine coolant temperature at engine starting) or at elevations above 8000 feet above sea level. The Executive

Officer shall approve the request upon the manufacturer providing data and/or an engineering evaluation that demonstrates that monitoring during the conditions would be unreliable. A manufacturer may further request, and the Executive Officer shall approve, that an OBD II system monitor be disabled at other ambient engine starting temperatures upon the manufacturer demonstrating with data and/or an engineering evaluation that misdiagnosis would occur at the ambient temperatures because of its effect on the component itself (e.g., component freezing).

(18.4) Manufacturers may request Executive Officer approval to disable monitoring systems that can be affected by low fuel level or running out of fuel (e.g., misfire detection) when the fuel level is 15 percent or less of the nominal capacity of the fuel tank. The Executive Officer shall approve the request upon the manufacturer submitting data and/or an engineering evaluation that adequately demonstrates that monitoring at the fuel levels would be unreliable.

(18.5) Manufacturers may disable monitoring systems that can be affected by vehicle battery or system voltage levels when the battery or system voltage is below 11.0 Volts. Manufacturers may request Executive Officer approval to utilize a voltage threshold higher than 11.0 Volts to disable system monitoring. The Executive Officer shall approve the request if the manufacturer submits data and/or an engineering evaluation that adequately demonstrates that monitoring at the voltages would be unreliable, that operation of a vehicle below the disablement criteria for extended periods of time is unlikely, and that the OBD II system monitors the battery or system voltage.

(18.6) A manufacturer may disable affected monitoring systems in vehicles designed to accommodate the installation of Power Take-Off (PTO) units (as defined in section (c)), provided disablement occurs only while the PTO unit is active, and the OBD II readiness status is cleared by the on-board computer (i.e., all monitors set to indicate "not complete") while the PTO unit is activated (See section (f)(4.1) below). If the disablement occurs, the readiness status may be restored to its state prior to PTO activation when the disablement ends.

(18.7) For 2004 model year vehicles certified to run on alternate fuels, manufacturers may request the Executive Officer to waive specific monitoring requirements in section (e) for which monitoring may not be reliable with respect to the use of alternate fuels. The Executive Officer shall grant the request provided the manufacturer adequately demonstrates that the use of the alternate fuel could cause false illumination of the MIL even when using the best available monitoring technologies.

(f) STANDARDIZATION REQUIREMENTS

(1) Reference Documents:
The following Society of Automotive Engineers (SAE) and International Organization of Standards (ISO) documents are incorporated by reference into this regulation:

(1.1) "SAE J1930" refers to: SAE J1930 "Electrical/Electronic Systems Diagnostic

Terms, Definitions, Abbreviations, and Acronyms", May 1998.

(1.2) "SAE J1962" refers to: SAE J1962 "Diagnostic Connector", February 1998.

(1.3) "SAE J1978" refers to: SAE J1978 "OBD Scan Tool", February 1998.

(1.4) "SAE J1979" refers to: SAE J1979 "Emission-related Diagnostic Services", September 1997.

(1.5) "SAE J1850" refers to: SAE J1850 "Class B Data Communications Network Interface", May 2001.

(1.6) "SAE J2012" refers to: SAE J2012 "Diagnostic Trouble Code Definitions", March 1999.

(1.7) "ISO 9141-2" refers to: ISO 9141-2:1994 "Road Vehicles-Diagnostic Systems-CARB Requirements for Interchange of Digital Information", February 1994.

(1.8) "ISO 14230-4" refers to: ISO 14230-4:2000 "Road Vehicles-Diagnostic Systems-KWP 2000 Requirements for Emission-related Systems", June 2000.

(1.9) "ISO 15031-5" refers to: ISO 15031-5:2001 "Road Vehicles- Communication Between Vehicle and External Test Equipment for Emissions-related Diagnostics-Part 5: Emissions-related Diagnostic Services", December 2001.

(1.10) "ISO 15765-4" refers to: ISO 15765-4:2001 "Road Vehicles-Diagnostics on Controller Area Network (CAN) - Part 4: Requirements for emission-related systems", December 2001.

(2) Diagnostic Connector:
A standard data link connector conforming to SAE J1962 specifications (except as specified in section (f)(2.3)) shall be incorporated in each vehicle.

(2.1) The connector shall be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the center console (or the vehicle centerline if the vehicle does not have a center console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position. The connector may not be located on or in the center console (i.e., neither on the horizontal faces near the floor-mounted gear selector, parking brake lever, or cup-holders nor on the vertical faces near the car stereo, climate system, or navigation system controls). The location of the connector shall be capable of being easily identified by a "crouched" technician entering the vehicle from the driver's side.

(2.2) If the connector is covered, the cover must be removable by hand without the use of any tools and be labeled to aid technicians in identifying the location of the connector. Access to the diagnostic connector may not require opening or the removal of any storage accessory (e.g., ashtray, coinbox, etc.). The label shall be submitted to the Executive Officer for review and approval, at or before the time the manufacturer submits its certification application. The Executive Officer shall approve the label if it clearly identifies that the connector is located behind the cover and is consistent with language and/or symbols commonly used in the automotive industry.

(2.3) Any pins in the connector that provide electrical power shall be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes and may not exceed 18.0 Volts DC regardless of the nominal vehicle system or battery voltage (e.g., 12V, 24V, 42V, etc.).

(2.4) For 2004 model year vehicles only, a manufacturer may comply with the diagnostic connector requirements in title 13, CCR section 1968.1 in lieu of meeting the requirements of section (f)(2).

(3) Communications to a Scan Tool:
Manufacturers shall use one of the following standardized protocols for communication of all required emission related messages from on-board to off-board network communications to a scan tool meeting SAE J1978 specifications:

(3.1) SAE J1850. All required emission related messages using this protocol shall use the Cyclic Redundancy Check and the three byte header, may not use inter-byte separation or checksums, and may not require a minimum delay of 100 ms between SAE J1978 scan tool requests. This protocol may not be used on any 2008 or subsequent model year vehicle.

(3.2) ISO 9141-2. This protocol may not be used on any 2007 or subsequent model year vehicle.

(3.3) ISO 14230-4. This protocol may not be used on any 2008 or subsequent model year vehicle.

(3.4) ISO 15765-4. This protocol shall be allowed on any 2003 and subsequent model year vehicle and required on all 2008 and subsequent model year vehicles. All required emission-related messages using this protocol shall use a 500 kbps baud rate.

(4) Required Emission Related Functions:
The following standardized functions shall be implemented in accordance with the specifications in SAE J1979 to allow for access to the required information by a scan tool meeting SAE J1978 specifications:

(4.1) Readiness Status: In accordance with SAE J1979 specifications, the OBD II system shall indicate "complete" or "not complete" for each of the installed monitored components and systems identified in section (e)(1) through (e)(8) since the fault memory was last cleared. All components or systems that are monitored continuously shall always indicate "complete". Those components or systems that are not subject to continuous monitoring shall immediately indicate "complete" upon the respective diagnostic(s) being fully executed and determining that the component or system is not malfunctioning. A component or system shall also indicate "complete" if after the requisite number of decisions necessary for determining MIL status have been fully executed, the monitor indicates a malfunction for the component or system. The status for each of the monitored components or systems shall indicate "not complete" whenever fault memory has been cleared or erased by a means other than that allowed in section (d)(2). Normal vehicle shut down (i.e., key off, engine off) may not cause the status to indicate "not complete".

(4.1.1) Subject to Executive Officer approval, if monitoring is disabled for a multiple number of driving cycles due to the continued presence of extreme operating conditions (e.g., cold ambient temperatures, high altitudes, etc), readiness status for the subject monitoring system may be set to indicate "complete" without monitoring having been completed.

Executive Officer approval shall be based on the conditions for monitoring system disablement and the number of driving cycles specified without completion of monitoring before readiness is indicated as "complete".

(4.1.2) For the evaporative system monitor, the readiness status shall be set in accordance with section (f)(4.1) when both the functional check of the purge valve and the 0.020 inch leak detection monitor indicate that they are complete. For vehicles with both 0.040 inch and 0.020 inch leak detection monitors, the readiness status may be set when both the functional check of the purge valve and the 0.040 inch leak detection monitor indicate that they are complete.

(4.1.3) If the manufacturer elects to additionally indicate readiness status through the MIL in the key on, engine off position as provided for in section (d)(2.5), the readiness status shall be indicated in the following manner: If the readiness status for all monitored components or systems is "complete", the MIL shall remain continuously illuminated in the key on, engine off position for at least 15-20 seconds. If the readiness status for one or more of the monitored components or systems is "not complete", after 15-20 seconds of operation in the key on, engine off position with the MIL illuminated continuously, the MIL shall blink once per second for 5-10 seconds. The data stream value for MIL status (section (f)(4.2)) shall indicate "commanded off" during this sequence unless the MIL has also been "commanded on" for a detected fault.

(4.2) Data Stream: The following signals shall be made available on demand through the standardized data link connector in accordance with SAE J1979 specifications. The actual signal value shall always be used instead of a default or limp home value.

(4.2.1) For all vehicles: calculated load value, number of stored confirmed fault codes, engine coolant temperature, engine speed, absolute throttle position (if equipped with a throttle), vehicle speed, and MIL status (i.e., commanded-on or commanded-off).

(4.2.2) For all vehicles so equipped: fuel control system status (e.g., open loop, closed loop, etc.), fuel trim, fuel pressure, ignition timing advance, intake air temperature, manifold air pressure, air flow rate from mass air flow sensor, secondary air status (upstream, downstream, or atmosphere), oxygen sensor output, air/fuel ratio sensor output.

(4.2.3) For all 2005 and subsequent model year vehicles using the ISO 15765-4 protocol for the standardized functions required in section (f), the following signals shall also be made available: absolute load, fuel level (if used to enable or disable any other diagnostics), relative throttle position (if equipped with a throttle), barometric pressure (directly measured or estimated), engine control module system voltage, commanded equivalence ratio, catalyst temperature (if directly measured or estimated for purposes of enabling the catalyst monitor(s)), monitor status (i.e., disabled for the rest of this driving cycle, complete this driving cycle, or not complete this driving cycle) since last engine shut-off for each monitor used for readiness status, time elapsed since engine start, distance traveled while MIL activated, distance traveled since fault memory last cleared, and number of warm-up cycles since fault memory last cleared.

(4.2.4) For all 2005 and subsequent model year vehicles so equipped and using the ISO 15765-4 protocol for the standardized functions required in section (f): ambient air temperature, evaporative system vapor pressure, commanded purge valve duty cycle/position, commanded EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), redundant absolute throttle position (for electronic throttle or other systems that utilize two or more sensors), absolute pedal position, redundant absolute pedal position, and commanded throttle motor position.

(4.3) Freeze Frame.

(4.3.1) "Freeze frame" information required to be stored pursuant to section (d)(2.2.1) shall be made available on demand through the standardized data link connector in accordance with SAE J1979 specifications.

(4.3.2) "Freeze frame" conditions must include the fault code which caused the data to be stored and all of the signals required in section (f)(4.2) except: number of stored confirmed fault codes, oxygen sensor output, air/fuel ratio sensor output, catalyst temperature, evaporative system vapor pressure, MIL status, monitor status since last engine shut off, distance traveled while MIL activated, distance traveled since fault memory last cleared, and number of warm-up cycles since fault memory last cleared.

(4.3.3) Only one frame of data is required to be recorded. Manufacturers may choose to store additional frames provided that at least the required frame can be read by a scan tool meeting SAE J1978 specifications.

(4.3.4) For 2004 model year vehicles only, a manufacturer may choose to store freeze frame conditions in accordance with title 13, CCR section 1968.1(f) in lieu of the requirements of sections (f)(4.3.1) through (f)(4.3.3) above.

(4.4) Fault Codes

(4.4.1) For all monitored components and systems, stored pending and confirmed fault codes shall be made available through the diagnostic connector in accordance with SAE J1979 specifications. Standardized fault codes conforming to SAE J2012 shall be employed.

(4.4.2) The stored fault code shall, to the fullest extent possible, pinpoint the likely cause of the malfunction. Manufacturers shall use separate fault codes for every diagnostic where the diagnostic and repair procedure or likely cause of the failure is different. In general, rationality and functional diagnostics shall use different fault codes than the respective circuit continuity diagnostics. Additionally, input component circuit continuity diagnostics shall use different fault codes for distinct malfunctions (e.g., out-of-range low, out-of-range high, open circuit, etc.).

(4.4.3) Manufacturers shall use appropriate SAE-defined fault codes of J2012 (e.g., P0xxx, P2xxx) whenever possible. With Executive Officer approval, manufacturers may use manufacturer-defined fault codes in accordance with SAE J2012 specifications (e.g., P1xxx). Factors to be considered by the Executive Officer for approval shall include the lack of available SAE-defined fault codes, uniqueness of the diagnostic or monitored component, expected future usage of the diagnostic or component, and estimated usefulness in providing additional diagnostic and repair information to service technicians. Manufacturer-defined fault codes shall be used consistently (i.e., the same fault code may not be used to represent two different failure modes) across a manufacturer's entire product line.

(4.4.4) A fault code (pending and/or confirmed, as required in sections (d) and (e)) shall be stored and available to an SAE J1978 scan tool within 10 seconds after a diagnostic has determined that a malfunction has occurred.

(4.4.5) Pending fault codes:

(A) On all 2005 and subsequent model year vehicles, pending fault codes for all components and systems (including continuously and non-continuously monitored components) shall be made available through the diagnostic connector in accordance with SAE J1979 specifications (e.g., Mode $07).

(B) On all 2005 and subsequent model year vehicles, a pending fault code(s) shall be stored and available through the diagnostic connector for all currently malfunctioning monitored component(s) or system(s), regardless of the MIL illumination status or confirmed fault code status (e.g., even after a pending fault has matured to a confirmed fault code and the MIL is illuminated, a pending fault code shall be stored and available if the most recent monitoring event indicates the component is malfunctioning).

(C) Manufacturers using alternate statistical protocols for MIL illumination as allowed in section (d)(2.2.3) shall submit to the Executive Officer a protocol for setting pending fault codes. The Executive Officer shall approve the proposed protocol upon finding that, overall, it is equivalent to the requirements in sections (f)(4.4.5)(A) and (B) and that it effectively provides service technicians with a quick and accurate indication of a pending failure.

(4.5) Test Results

(4.5.1) For all monitored components and systems identified in section (e)(1) through (e)(8) except misfire detection and fuel system monitoring, results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems shall be stored and available through the data link in accordance with SAE J1979 specifications.

(4.5.2) The test results shall be reported such that properly functioning components and systems (e.g., "passing" systems) do not store test values outside of the established test limits.

(4.5.3) The test results shall be stored until updated by a more recent valid test result or the fault memory of the OBD II system computer is cleared. Upon fault memory being cleared, test results reported for monitors that have not yet completed since the last time the fault memory was cleared shall report values that do not indicate a failure (i.e., a test value which is outside of the test limits).

(4.5.4) Additionally, for vehicles using ISO 15765-4 (see section (f)(3.4)) as the communication protocol:

(A) The test results and limits shall be made available in the standardized format specified in ISO 15031-5 for the ISO 15765-4 protocol.

(B) Test limits shall include both minimum and maximum acceptable values and shall be reported for all monitored components and systems identified in sections (e)(1) through (e)(8), except fuel system monitoring. The test limits shall be defined so that a test result equal to either test limit is a "passing" value, not a "failing" value.

(C) For 2005 and subsequent model year vehicles, misfire monitoring test results shall be calculated and reported in the standardized format specified in ISO 15031-5.

(D) Monitors that have not yet completed since the last time the fault memory was cleared shall report values of zero for the test result and test limits.

(E) All test results and test limits shall always be reported and the test results shall be stored until updated by a more recent valid test result or the fault memory of the OBD II system computer is cleared.

(F) The OBD II system shall store and report unique test results for each separate diagnostic (e.g., an OBD II system with individual evaporative system diagnostics for 0.040 inch and 0.020 inch leaks shall separately report 0.040 inch and 0.020 inch test results).

(4.6) Software Calibration Identification: On all vehicles, a software calibration identification number (CAL ID) for the diagnostic or emission critical powertrain control unit(s) shall be made available through the standardized data link connector in accordance with the SAE J1979 specifications. A unique CAL ID shall be used for every emission-related calibration and/or software set having at least one bit of different data from any other emission-related calibration and/or software set. Control units coded with multiple emission or diagnostic calibrations and/or software sets shall indicate a unique CAL ID for each variant in a manner that enables an off-board device to determine which variant is being used by the vehicle.

(4.7) Software Calibration Verification Number

(4.7.1) All 2005[2] and subsequent model year vehicles shall use an algorithm to calculate a calibration verification number (CVN) that verifies the on-board computer software integrity in diagnostic or emission critical electronically reprogrammable powertrain control units. The CVN shall be made available through the standardized data link connector in accordance with the SAE J1979 specifications. The CVN shall be capable of being used to determine if the emission-related software and/or calibration data are valid and applicable for that vehicle and CAL ID.

(4.7.2) Manufacturers shall request Executive Officer approval of the algorithm used to calculate the CVN. Executive Officer approval of the algorithm shall be based on the complexity of the algorithm and the difficulty in achieving the same CVN with modified calibration values.

(4.7.3) The CVN shall be calculated at least once per driving cycle and stored until the CVN is subsequently updated. Except for immediately after a reprogramming event or a non-volatile memory clear, the stored value shall be made available through the data link connector to a generic scan tool in accordance with SAE J1979 specifications. The stored CVN value may not be erased when fault memory is erased by a generic scan tool in

2 The requirements of section (f)(4.7) shall supercede the requirements set forth in title 13, CCR section 1968.1(l)(4.0).

accordance with SAE J1979 specifications or during normal vehicle shut down (i.e., key off, engine off).

(4.7.4) For purposes of Inspection and Maintenance (I/M) testing, manufacturers shall make the CVN and CAL ID combination information available in a standardized electronic format that allows for off-board verification that the CVN is valid and appropriate for a specific vehicle and CAL ID.

(4.8) Vehicle Identification Number: All 2005 and subsequent model year vehicles shall have the vehicle identification number (VIN) available in a standardized format through the standardized data link connector in accordance with SAE J1979 specifications. Only one electronic control unit per vehicle shall report the VIN to an SAE J1978 scan tool.

(5) In-use Performance Ratio Tracking Requirements

(5.1) For each monitor required in section (e) to separately report an in-use performance ratio, manufacturers shall implement software algorithms to report a numerator and denominator in the standardized format specified below and in accordance with the ISO 15031-5 specifications.

(5.2) Numerical Value Specifications:

(5.2.1) For the numerator, denominator, general denominator, and ignition cycle counter:

(A) Each number shall have a minimum value of zero and a maximum value of 65,535 with a resolution of one.

(B) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event, etc.) and may not be reset to zero under any other circumstances including when a scan tool command to clear fault codes is received.

(C) If either the numerator or denominator for a specific component reaches the maximum value of 65,535 ± 2, both numbers shall be divided by two before either is incremented again to avoid overflow problems.

(D) If the ignition cycle counter reaches the maximum value of 65,535 ± 2, the ignition cycle counter shall rollover and increment to zero on the next ignition cycle to avoid overflow problems.

(E) If the general denominator reaches the maximum value of 65,535 ± 2, the general denominator shall rollover and increment to zero on the next driving cycle that meets the general denominator definition to avoid overflow problems.

(F) If a vehicle is not equipped with a component (e.g., oxygen sensor bank 2, secondary air system), the corresponding numerator and denominator for that specific component shall always be reported as zero.

(5.2.2) For the ratio:

(A) The ratio shall have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122.

(B) A ratio for a specific component shall be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.

(C) A ratio for a specific component shall be considered to be the maximum value of 7.99527 if the corresponding denominator is zero or if the actual value of the numerator divided by the denominator exceeds the maximum value of 7.99527.

(6) Service Information:

(6.1) Motor vehicle manufacturers shall provide the aftermarket service and repair industry emission-related service information for all 1994 and subsequent model year vehicles equipped with OBD II systems as set forth in sections (f)(6.3) through (6.8). The requirements of section (f)(6) shall supersede the service information requirements set forth in title 13, CCR section 1968.1.

(6.2) The Executive Officer shall waive the requirements of sections (f)(6.3) through (6.8) if the ARB or U.S. EPA adopt a service information regulation or rule that is in effect and operative and requires motor vehicle manufacturers to provide emission-related service information:

(A) of comparable or greater scope than required under these provisions;

(B) in an easily accessible format and in a timeframe that is equivalent to or exceeds the timeframes set forth below; and

(C) at fair and reasonable cost.

(6.3) For all 1994 and subsequent model year vehicles equipped with an OBD II system, 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 SAE J1978 generic scan tool and commonly available, non-microprocessor based tools.

(6.4) As an alternative to publishing repair procedures required under section (f)(6.3), a manufacturer may publish repair procedures referencing the use of manufacturer-specific or enhanced equipment provided the manufacturer makes available to the aftermarket scan tool industry the information needed to manufacture scan tools to perform the same emission-related diagnosis and repair procedures (excluding any reprogramming) in a comparable manner as the manufacturer-specific diagnostic scan tool.

(6.5) For all 1996 and subsequent model year vehicles, manufacturers shall make available:

(A) Information to utilize the test results reported as required in section (f)(4.5) (or title 13, CCR section 1968.1 (l)(3.0) for 1996 through 2002 model year vehicles). The information must include a description of the test and test result, associated fault codes with the test result, and scaling, units, and conversion factors necessary to convert the results to engineering units.

(B) A generic description of each of the diagnostics used to meet the requirements of this regulation. The generic description must include a text description of how the diagnostic is performed, typical enable conditions, typical malfunction thresholds, typical monitoring time, fault codes associated with the diagnostic, and test results (section (f)(4.5)) associated with the diagnostic. Vehicles that have diagnostics not adequately represented by the typical values identified above shall be specifically identified along with the appropriate typical values.

(C) Information necessary to execute each of the diagnostics used to meet the requirements of sections (e)(1) through (e)(8). The information must either include a description of sample driving patterns designed to be operated in-use or a written description of the conditions the vehicle needs to operate in to execute each of the diagnostics necessary to change the readiness status from not complete to complete for all monitors. The information shall be able to be used to exercise all necessary monitors in a single driving cycle as well as be able to be used to exercise the monitors to individually change the readiness status for each specific monitor from "not complete" to "complete".

(7) Exceptions to Standardization Requirements.
For medium-duty vehicles equipped with engines certified on an engine dynamometer, a manufacturer may request Executive Officer approval to use an alternate diagnostic connector, communication protocol, and emission-related message structure and format in lieu of the standardization requirements in sections (f)(2) and (4) that refer to J1962, J1978, and J1979 as well as the identified protocols in section (f)(3). The Executive Officer shall approve the request upon determination that:

(A) The ARB has adopted an on-board diagnostic regulation for heavy-duty vehicles; and
(B) The alternate diagnostic connector, communication protocol, and emission-related message format and structure requested by the manufacturer meets the standardization requirements in the on-board diagnostic regulation for heavy-duty vehicles.

(g) MONITORING SYSTEM DEMONSTRATION REQUIREMENTS FOR CERTIFICATION

(1) General.

(1.1) Certification requires that manufacturers submit emission test data from one or more durability demonstration test vehicles (test vehicles). For applications certified on engine dynamometers, engines may be used instead of vehicles.

(1.2) The Executive Officer may approve other demonstration protocols if the manufacturer can provide comparable assurance that the malfunction criteria are chosen based on meeting emission requirements and that the timeliness of malfunction detection is within the constraints of the applicable monitoring requirements.

(1.3) For flexible fuel vehicles capable of operating on more than one fuel or fuel combinations, the manufacturer shall submit a plan for providing emission test data to the Executive Officer for approval. The Executive Officer shall approve the plan if it is determined to be representative of expected in-use fuel or fuel combinations and provides accurate and timely evaluation of the monitored systems.

(2) Selection of Test Vehicles:

(2.1.1) Prior to submitting any applications for certification for a model year, a manufacturer shall notify the Executive Officer of the test groups planned for that model year. The Executive Officer will then select the test group(s) that the manufacturer shall use as demonstration test vehicles to provide emission test data.

(2.1.2) A manufacturer certifying one to five test groups in a model year shall provide emission test data from a test vehicle from one test group. A manufacturer certifying six to ten test groups in a model year shall provide emission test data from test vehicles from two test groups. A manufacturer certifying eleven or more test groups in a model year shall provide emission test data from test vehicles from three test groups. The Executive Officer may waive the requirement for submittal of data from one or more of the test groups if data has been previously submitted for all of the test groups.

(2.1.3) For the test vehicle(s), a manufacturer shall use a certification emission durability test vehicle(s), a representative high mileage vehicle(s), or a vehicle(s) aged to the end of the full useful life using an ARB-approved alternative durability procedure (ADP).

(3) Required Testing:
Except as provided below, the manufacturer shall perform single-fault testing based on the applicable FTP test with the following components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the requirements of section (e):

(3.1) Oxygen Sensors:

(3.1.1) The manufacturer shall perform a test with all primary oxygen sensors used for fuel control simultaneously possessing a response rate deteriorated to the malfunction criteria limit. Manufacturers shall also perform a 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, decreased amplitude, etc.). When performing additional test(s), all primary and secondary (if applicable) 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.

(3.1.2) For vehicles utilizing sensors other than oxygen sensors for primary fuel control (e.g., linear air-fuel ratio sensors, universal sensors, etc.), the manufacturer shall submit, for Executive Officer approval, a demonstration test plan for performing testing of all of the sensor parameters that can cause vehicle emissions to exceed 1.5 times the applicable standards. The Executive Officer shall approve the plan if it is determined that it will provide data that will assure proper performance of the diagnostics of the sensors, consistent with the intent of section (g).

(3.2) EGR System: The manufacturer shall perform a test at the low flow limit.

(3.3) VVT System: For 2005 and subsequent model year Low Emission II applications, the manufacturer shall perform a test at each target error limit and slow response limit calibrated to the malfunction criteria (e.g., 1.5 times the FTP standard) in sections (e)(13.2.1) and (13.2.2). In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.4) Fuel System:

(3.4.1) For vehicles with adaptive feedback based on the primary fuel control sensor(s), the manufacturer shall perform a test with the adaptive feedback based on the primary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer in section (e)(6.2.1) to detect a malfunction before emissions exceed 1.5 times the applicable standards.

(3.4.2) For vehicles with feedback based on a secondary fuel control sensor(s) and subject to the malfunction criteria in section (e)(6.2.1), the manufacturer shall perform a test with the feedback based on the secondary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer in section (e)(6.2.1) to detect a malfunction before emissions exceed 1.5 times the applicable standards.

(3.4.3) For other fuel metering or control systems, the manufacturer shall perform a test at the criteria limit(s).

(3.4.4) For purposes of fuel system testing, 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 may not cause misfire. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.5) Misfire: The manufacturer shall perform a test at the malfunction criteria limit specified in section (e)(3.2.2). The testing is not required for diesel applications.

(3.6) Secondary Air System: The manufacturer shall perform a test at the low flow limit. Manufacturers performing only a functional check in accordance with the provisions of section (e)(5.2.2)(B) or (e)(5.2.4) shall perform a test at the functional check flow malfunction criteria.

(3.7) Catalyst System: The manufacturer shall perform a test using a catalyst system deteriorated to the malfunction criteria using methods established by the manufacturer in accordance with section (e)(1.2.6). For diesel vehicles, the manufacturer shall perform a test using a catalyst system deteriorated to the malfunction criteria in sections (e)(1.5.2)(A)(i), (B)(i), or (C)(i). For diesel vehicles with catalyst systems not subject to the malfunction criteria in section (e)(1.5.2)(A)(i), (B)(i), or (C)(i), manufacturers are not required to perform a catalyst demonstration test.

(3.8) Heated Catalyst Systems: The manufacturer shall perform a test at the malfunction criteria limit established by the manufacturer in section (e)(2.2).

(3.9) PM Trap: The manufacturer shall perform a test using a PM trap(s) deteriorated to the malfunction criteria in sections (e)(15.2.1) or (15.2.3). For diesel vehicles with a PM trap(s) not subject to the malfunction criteria in section (e)(15.2.1) or (15.2.3), manufacturers are not required to perform a PM trap(s) demonstration test.

(3.10) Other systems: The manufacturer shall conduct demonstration tests for all other emission control components designed and calibrated to a malfunction criteria of 1.5 times any of the applicable emission standards (e.g., hydrocarbon traps, adsorbers, etc.) under the provisions of section (e)(17).

(3.11) The manufacturer may electronically simulate deteriorated components but may not make any vehicle control unit modifications (unless otherwise excepted above) when performing demonstration tests. All equipment necessary to duplicate the demonstration test must be made available to the ARB upon request.

(4) Testing Protocol:

(4.1) Preconditioning: The manufacturer shall use an applicable FTP cycle (or Unified Cycle, if approved) for preconditioning test vehicles prior to conducting each of the above emission tests. If a manufacturer provides data and/or an engineering evaluation that adequately demonstrates that additional preconditioning is necessary to stabilize the emission control system, the Executive Officer shall allow the manufacturer to perform a single additional preconditioning cycle, identical to the initial preconditioning cycle, or a Federal Highway Fuel Economy Driving Cycle, following a ten minute (20 minutes for medium duty engines certified on an engine dynamometer) hot soak after the initial preconditioning cycle. The manufacturer may not require the test vehicle to be cold soaked prior to conducting preconditioning cycles in order for the monitoring system testing to be successful.

(4.2) Test Sequence:

(4.2.1) The manufacturer shall set the system or component on the test vehicle for which detection is to be tested at the criteria limit(s) prior to conducting the applicable preconditioning cycle(s). If a second preconditioning cycle is permitted in accordance with section (g)(4.1) above, the manufacturer may adjust the system or component to be tested before conducting the second preconditioning cycle. The manufacturer may not replace, modify, or adjust the system or component after the last preconditioning cycle has taken place.

(4.2.2) After preconditioning, the test vehicle shall be operated over the applicable FTP cycle (or Unified Cycle, if approved) to allow for the initial detection of the tested system or component malfunction. This driving cycle may be omitted from the testing protocol if it is unnecessary. If required by the designated monitoring strategy, a cold soak may be performed prior to conducting this driving cycle.

(4.2.3) The test vehicle shall then be operated over the cold start and hot start exhaust tests of the applicable FTP test. If monitoring during the Unified Cycle is approved, a second Unified Cycle may be conducted prior to the FTP test.

(4.3) A manufacturer required to test more than one test vehicle (section (g)(2.1.2)) may utilize internal calibration sign-off test procedures (e.g., forced cool downs, less frequently calibrated emission analyzers, etc.) instead of official FTP test procedures to obtain the emission test data required in section (g) for all but one of the required test vehicles. The manufacturer may elect this option if the data from the alternative test procedure are representative of official FTP emission test results. Manufacturers using this option are still responsible for meeting the malfunction criteria specified in section (e) when emission tests are performed in accordance with official FTP test procedures.

(5) Evaluation Protocol:

(5.1.1) For all tests conducted under section (g), the MIL shall be illuminated upon detection of the tested system or component malfunction before the hot start exhaust test of the complete FTP test (or before the hot start portion of the last Unified Cycle, if applicable) in accordance with requirements of section (e).

(5.1.2) For all tests conducted under section (g), manufacturers may use Non-Methane Hydrocarbon (NMHC) emission results in lieu of Non-Methane Organic Gas (NMOG) emission results for comparison to the applicable FTP standards or malfunction criteria (e.g., 1.5 times the FTP standards). If NMHC emission results are used in lieu of NMOG, the emission result shall be multiplied by 1.04 to generate an equivalent NMOG result before comparison to the applicable FTP standards.

(5.1.3) If the MIL illuminates prior to emissions exceeding the applicable malfunction criteria specified in section (e), no further demonstration is required. With respect to the misfire monitor demonstration test, if a manufacturer has elected to use the minimum misfire malfunction criteria of one percent as allowed in section (e)(3.2.2)(A), no further demonstration is required if the MIL illuminates with misfire implanted at the malfunction criteria limit.

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

(A) Except for testing of the catalyst system, if the MIL first illuminates after emissions exceed the applicable malfunction criteria specified in section (e), the test vehicle shall be retested with the tested system or component adjusted so that the MIL will illuminate before emissions exceed the applicable malfunction criteria specified in section (e). If the component cannot be adjusted to meet this criterion because a default fuel or emission control strategy is used when a malfunction is detected (e.g., open loop fuel control used after an O2 sensor malfunction is determined, etc.), the test vehicle shall be retested with the component adjusted to the worst acceptable limit (i.e., the applicable monitor indicates the component is performing at or slightly better than the malfunction criteria). For the OBD II system to be approved, the MIL must not illuminate during this test and the vehicle emissions must be below the applicable malfunction criteria specified in section (e).

(B) In testing the catalyst system, if the MIL first illuminates after emissions exceed the applicable emission threshold(s) specified in section (e), the tested vehicle shall be retested with a less deriorated catalyst system (i.e., more of the applicable engine out pollutants are converted). For the OBD II system to be approved, testing shall be continued until either of the following conditions are satisfied:

(i) The MIL is illuminated and emissions do not exceed the thresholds specified in section (e); or

(ii) The manufacturer demonstrates that the MIL illuminates within acceptable upper and lower limits of the threshold specified in section (e) for MIL illumination. The manufacturer shall demonstrate acceptable limits by continuing testing until the test results show:

a. The MIL is illuminated and emissions exceed the thresholds specified in section (e) by 10 percent or less of the applicable standard (e.g., emissions are less than 1.85 times the applicable standard for a malfunction criterion of 1.75 times the standard); and

b. The MIL is not illuminated and emissions are below the thresholds specified in section (e) by no more than 20 percent of the standard (e.g., emissions are between 1.55 and 1.75 times the applicable standard for a malfunction criterion of 1.75 times the standard).

(5.1.5) If an OBD II system is determined unacceptable by the above criteria, the manufacturer may recalibrate and retest the system on the same test vehicle. In such a case, the manufacturer must confirm, by retesting, that all systems and components that were tested prior to recalibration and are affected by the recalibration function properly under the OBD II system as recalibrated.

(6) Confirmatory Testing:

(6.1) The ARB may perform confirmatory testing to verify the emission test data submitted by the manufacturer under the requirements of section (g) complies with the requirements of section (g) and the malfunction criteria identified in section (e). This confirmatory testing is limited to vehicles in the OBD II group represented by the demonstration vehicle(s).

(6.2) The ARB or its designee may install appropriately deteriorated or malfunctioning components in an otherwise properly functioning test vehicle of a test group represented by the demonstration test vehicle(s) (or simulate a deteriorated or malfunctioning component) in order to test any of the components or systems required to be tested in section (g). Upon request by the Executive Officer, the manufacturer shall make available a vehicle and all test equipment (e.g., malfunction simulators, deteriorated components, etc.) necessary to duplicate the manufacturer's testing. The Executive Officer shall make the request within six months of reviewing and approving the demonstration test vehicle data submitted by the manufacturer for the specific test group.

(6.3) Vehicles with OBD II systems represented by the demonstration vehicle(s) may be recalled for corrective action if a representative sample of vehicles uniformly fails to meet the requirements of section (g).

(h) CERTIFICATION DOCUMENTATION

(1) When submitting an application for certification of a test group, the manufacturer shall submit the following documentation. If any of the items listed below are standardized for all of a manufacturer's test groups, the manufacturer may, for each model year, submit one set of documents covering the standardized items for all of its test groups.

(1.1) For the required documentation not standardized across all test groups, the manufacturer may propose to the Executive Officer that documentation covering a specified combination of test groups be used. These combinations shall be known as "OBD II groups". Executive Officer approval shall be granted for those groupings that include test groups using the same OBD II strategies and similar calibrations. If approved by the Executive Officer, the manufacturer may submit one set of documentation from one or more representative test group(s) that are a part of the OBD II group. The Executive Officer shall determine whether a selected test group(s) is representative of the OBD II group as a whole. To be approved as representative, the test group(s) must possess the most stringent emission standards and OBD II monitoring requirements and cover all of the emission control devices within the OBD II group.

(1.2) With Executive Officer approval, one or more of the documentation requirements of section (h) may be waived or modified if the information required would be redundant or unnecessarily burdensome to generate.

(1.3) To the extent possible, the certification documentation shall use SAE J1930 terms, abbreviations, and acronyms.

(2) The following information shall be submitted as "Part 1" of the certification application. Except as provided below for demonstration data, the Executive Officer will not issue an Executive Order certifying the covered vehicles without the information having been provided. The information must include:

(2.1) A description of the functional operation of the OBD II system including a complete written description for each monitoring strategy that outlines every step in the decision making process of the monitor. Algorithms, diagrams, samples of data, and/or other graphical representations of the monitoring strategy shall be included where necessary to adequately describe the information.

(2.2) A table, in the standardized format detailed in Attachment A of ARB Mail-Out #95-20, May 22, 1995, incorporated by reference.

(2.2.1) The table must include the following information for each monitored component or system (either computer-sensed or -controlled) of the emission control system:

(A) corresponding fault code
(B) monitoring method or procedure for malfunction detection
(C) primary malfunction detection parameter and its type of output signal
(D) fault criteria limits used to evaluate output signal of primary parameter
(E) other monitored secondary parameters and conditions (in engineering units) necessary for malfunction detection
(F) monitoring time length and frequency of checks
(G) criteria for storing fault code
(H) criteria for illuminating malfunction indicator light
(I) criteria used for determining out of range values and input component rationality checks

(2.2.2) Wherever possible, the table shall use the following engineering units:

(A) Degrees Celsius (°C) for all temperature criteria
(B) KiloPascals (KPa) for all pressure criteria related to manifold or atmospheric pressure
(C) Grams (g) for all intake air mass criteria
(D) Pascals (Pa) for all pressure criteria related to evaporative system vapor pressure
(E) Miles per hour (mph) for all vehicle speed criteria
(F) Relative percent (%) for all relative throttle position criteria (as defined in ISO 15031-5)
(G) Voltage (V) for all absolute throttle position criteria (as defined inISO 15031-5)

(H) Per crankshaft revolution (/rev) for all changes per ignition event based criteria (e.g., g/rev instead of g/stroke or g/firing)
(I) Per second (/sec) for all changes per time based criteria (e.g., g/sec)
(J) Percent of nominal tank volume (%) for all fuel tank level criteria

(2.3) A logic flowchart describing the step by step evaluation of the enable criteria and malfunction criteria for each monitored emission-related component or system.

(2.4) Emission test data, a description of the testing sequence (e.g., the number and types of preconditioning cycles), approximate time (in seconds) of MIL illumination during the test, fault code(s) and freeze frame information stored at the time of detection, corresponding SAE J1979 test results (e.g. Mode $06) stored during the test, and a description of the modified or deteriorated components used for fault simulation with respect to the demonstration tests specified in section (g). The Executive Officer may approve conditional certification of a test group prior to the submittal of this data for ARB review and approval. Factors to be considered by the Executive Officer in approving the late submission of information identified in section (h)(2.4) shall include the reason for the delay in the data collection, the length of time until data will be available, and the demonstrated previous success of the manufacturer in submitting the data prior to certification.

(2.5) Data supporting the misfire monitor, including:

(2.5.1) The established percentage of misfire that can be tolerated without damaging the catalyst over the full range of engine speed and load conditions.

(2.5.2) Data demonstrating the probability of detection of misfire events of the misfire monitoring system over the full engine speed and load operating range for the following misfire patterns: random cylinders misfiring at the malfunction criteria established in section (e)(3.2.2), one cylinder continuously misfiring, and paired cylinders continuously misfiring.

(2.5.3) Data identifying all disablement of misfire monitoring that occurs during the FTP and US06 cycles. For every disablement that occurs during the cycles, the data should identify: when the disablement occurred relative to the driver's trace, the number of engine revolutions that each disablement was present for, and which disable condition documented in the certification application caused the disablement.

(2.5.4) Manufacturers are not required to use the durability demonstration vehicle to collect the misfire data for sections (h)(2.5.1) though (2.5.3).

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

(2.7) A listing of all electronic powertrain input and output signals (including those not monitored by the OBD II system) that identifies which signals are monitored by the OBD II system.

(2.8) A written description of all parameters and conditions necessary to begin closed loop operation.

(2.9) A summary table identifying every test group and each of the OBD II phase-in requirements that apply to each test group.

(2.10) A written identification of the communication protocol utilized by each test group for communication with an SAE J1978 scan tool.
(2.11) A pictorial representation or written description of the diagnostic connector location including any covers or labels.
(2.12) A written description of the method used by the manufacturer to meet the requirements of section (e)(9) for PCV system monitoring including diagrams or pictures of valve and/or hose connections.
(2.13) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this regulation.

(3) "Part 2". The following information shall be submitted by January 1st of the applicable model year:
(3.1) 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.
(3.2) 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.

(4) "Part 3". The following information shall be submitted upon request of the Executive Officer:
(4.1) Data supporting the criteria used to detect a malfunction when catalyst deterioration causes emissions to exceed the applicable malfunction criteria specified in section (e).
(4.2) Data supporting the criteria used to detect evaporative system leaks.
(4.3) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this regulation.

(i) DEFICIENCIES

(1) For 2004 and subsequent model year vehicles, the Executive Officer, upon receipt of an application from the manufacturer, may certify vehicles even though said vehicles may not comply with one or more of the requirements of title 13, CCR section 1968.2. In granting the certification, the Executive Officer shall consider the following factors: the extent to which the requirements of section 1968.2 are satisfied overall based on a review of the vehicle applications in question, the relative performance of the resultant OBD II system compared to systems fully compliant with the requirements of title 13, CCR section 1968.2, and a demonstrated good-faith effort on the part of the manufacturer to: (1) meet the requirements in full by evaluating and considering the best available monitoring technology; and (2) come into compliance as expeditiously as possible. The Executive Officer may not grant certification to a vehicle in which the reported noncompliance for which a deficiency is sought would be subject to ordered recall pursuant to section 1968.5 (c)(3)(A).

(2) Manufacturers of non-complying systems are subject to fines pursuant to section 43016 of the California Health and Safety Code. The specified fines apply to the third and subsequently identified deficiencies, with the exception that fines shall apply to all monitoring system deficiencies wherein a required monitoring strategy is completely absent from the OBD system.

(3) The fines are in the amount of $50 per deficiency per vehicle for non-compliance with any of the monitoring requirements specified in sections (e)(1) through

(e)(8), (e)(11), (e)(13) through (e)(15), and (e)(17), and $25 per deficiency per vehicle for non-compliance with any other requirement of section 1968.2. In determining the identified order of deficiencies, deficiencies subject to a $50 fine are identified first. Total fines per vehicle under section (i) may not exceed $500 per vehicle and are payable to the State Treasurer for deposit in the Air Pollution Control Fund.

(4) Manufacturers must re-apply for Executive Officer approval of a deficiency each model year. In considering the request to carry-over a deficiency, the Executive Officer shall consider the factors identified in section (i)(1) including the manufacturer's progress towards correcting the deficiency. The Executive Officer may not allow manufacturers to carry over monitoring system deficiencies for more than two model years unless it can be adequately demonstrated that substantial vehicle hardware modifications and additional lead time beyond two years would be necessary to correct the deficiency, in which case the Executive Officer shall allow the deficiency to be carried over for three model years.

(5) Except as allowed in section (i)(6), deficiencies may not be retroactively granted after certification.

(6) Request for retroactive deficiencies

(6.1) Manufacturers may request that the Executive Officer grant a deficiency and amend a vehicle's certification to conform to the granting of the deficiencies during the first 120 days after commencement of normal production for each aspect of the monitoring system: (a) identified by the manufacturer (during testing required by section (j)(2) or any other testing) to be functioning different than the certified system or otherwise not meeting the requirements of any aspect of section 1968.2; and (b) reported to the Executive Officer. If the Executive Officer grants the deficiencies and amended certification, their approval would be retroactive to the start of production.

(6.2) Executive Officer approval of the request for a retroactive deficiency shall be granted provided that the conditions necessary for a pre-certification deficiency determination are satisfied (see section (i)(1)) and the manufacturer could not have reasonably anticipated the identified problem before commencement of production.

(6.3) In granting the amended certification, the Executive Officer shall include any approved post-production deficiencies together with all previously approved deficiencies in computing fines in accordance with section (i)(2).

(7) Any OBD II system installed on a production vehicle that fails to conform with the certified OBD II system for that vehicle or otherwise fails to meet the requirements of section 1968.2 and has not been granted a deficiency pursuant to the provisions of section (i)(1) through (i)(6) are considered non-compliant. The vehicles are subject to enforcement pursuant to applicable provisions of the Health and Safety Code and title 13, CCR section 1968.5.

(j) PRODUCTION VEHICLE EVALUATION TESTING

(1) Verification of Standardized Requirements

(1.1) Requirement: For 2005 and subsequent model year vehicles, manufacturers shall perform testing to verify that all vehicles using ISO 15765-4 as the OBD II system communication protocol (see section (f)(3.4)) meet the requirements of section (f)(3) and (f)(4) relevant to proper communication of required emission-related messages to an SAE J1978 scan tool.

(1.2) Selection of Test Vehicles: Manufacturers shall perform this testing every model year on one production vehicle from every unique calibration within 30 days of the start of production for that calibration. Manufacturers may request Executive Officer approval to group multiple calibrations together and test one representative calibration per group. The Executive Officer shall approve the request upon finding that the software designed to comply with the standardization requirements of section (f) in the representative calibration vehicle is identical (e.g., communication protocol message timing, number of supported data stream parameters, etc.) to all others in the group and that any differences in the calibrations are not relevant with respect to meeting the criteria in section (j)(1.4).

(1.3) Test Equipment: For the testing required in section (j)(1), manufacturers shall utilize an off-board device to conduct the testing. Prior to conducting testing, manufacturers are required to request and receive Executive Officer approval of the off-board device that the manufacturer will use to perform the testing. The Executive Officer shall approve the request upon the manufacturer submitting data, specifications, and/or engineering analysis that demonstrate that the off-board device will verify vehicles will be able to perform all of the required functions in section (j)(1.4) with any other off-board device designed and built in accordance with the SAE J1978 generic scan tool specifications.

(1.4) Required Testing:

(1.4.1) The testing shall verify that the vehicle can properly establish communications between all emission-related on-board computers and any SAE J1978 scan tool designed to adhere strictly to the communication protocols allowed in section (f)(3);

(1.4.2) The testing shall further verify that the vehicle can properly communicate to any SAE J1978 scan tool:

(A) The current readiness status from all on-board computers required to support readiness status in accordance with ISO 15031-5 and section (f)(4.1) while the engine is running;

(B) The MIL command status while the MIL is commanded off and while the MIL is commanded on in accordance with ISO 15031-5 and section (f)(4.2) while the engine is running and in accordance with ISO 15031-5 and sections (d)(2.5) and (f)(4.1.3) during the MIL functional check while the engine is off;

(C) All data stream parameters required in section (f)(4.2) in accordance with ISO 15031-5 including the identification of each data stream parameter as supported in ISO 15031-5 (e.g., Mode $01, PID $00);

(D) The CAL ID, CVN, and VIN (if applicable) in accordance with ISO 15031-5 and sections (f)(4.6) through (4.8);

(E) An emission-related fault code (both confirmed and pending) in accordance with ISO 15031-5 (including correctly indicating the number of stored fault codes (e.g., Mode $01, PID $01, Data A)) and section (f)(4.4);

(1.4.3) The testing shall also verify that the vehicle can properly respond to any SAE J1978 scan tool request to clear emission-related fault codes and reset readiness status.

(1.5) Reporting of Results:

(1.5.1) The manufacturer shall notify the Executive Officer within 30 days of identifying any vehicle that does not meet the requirements of section (j)(1.4). The manufacturer shall submit a written report of the problem(s) identified and propose corrective action (if any) to remedy the problem(s) to the Executive Officer for approval. Factors to be considered by the Executive Officer in approving the proposed corrective action shall include the severity of the problem(s), the ability of the vehicle to be tested in an I/M program, the ability of service technicians to access the required diagnostic information, the impact on equipment and tool manufacturers, and the amount of time prior to implementation of the proposed corrective action.

(1.5.2) Upon request of the Executive Officer, a manufacturer shall submit a report of the results of any testing conducted pursuant to section (j)(1) to the Executive Officer for review.

(1.5.3) In accordance with section (i)(6), manufacturers may request Executive Officer approval for a retroactive deficiency to be granted for items identified during this testing.

(2) Verification of Monitoring Requirements

(2.1) Within the first four months after production begins, manufacturers shall conduct a complete evaluation of the OBD II system of one production vehicle per test group selected for monitoring system demonstration in section (g) and submit the results of the evaluation to the Executive Officer.

(2.2) Evaluation requirements:

(2.2.1) The evaluation shall demonstrate the ability of the OBD II system on the selected production vehicle to detect a malfunction, illuminate the MIL, and store a confirmed fault code when a malfunction is present and the monitoring conditions have been satisfied for each individual diagnostic required by title 13, CCR section 1968.2.

(2.2.2) The evaluation shall verify that malfunctions detected by non-MIL illuminating diagnostics of components used to enable any other OBD II system diagnostic (e.g., fuel level sensor) will not inhibit the ability of other OBD II system diagnostics to properly detect malfunctions.

(2.2.3) On vehicles so equipped, the evaluation shall verify that the software used to track the numerator and denominator for purposes of determining in-use monitoring frequency correctly increments as required in section (d)(4).

(2.2.4) Malfunctions may be mechanically implanted or electronically simulated but internal on-board computer hardware or software changes may not be used to simulate malfunctions. Emission testing to confirm that the malfunction is detected before the appropriate emission standards are exceeded is not required.

(2.2.5) Manufacturers shall submit a proposed test plan for Executive Officer approval prior to evaluation testing being performed. The test plan shall identify the method used to induce a malfunction in each diagnostic. If the

Executive Officer determines that the requirements of section (j)(2) are satisfied, the proposed test plan shall be approved.

(2.2.6) Subject to Executive Officer approval, manufacturers may omit demonstration of specific diagnostics. The Executive Officer shall approve a manufacturer's request if the demonstration cannot be reasonably performed without causing physical damage to the vehicle (e.g., on-board computer internal circuit faults).

(2.2.7) For this evaluation, manufacturers are not required to demonstrate diagnostics that were previously demonstrated prior to certification as required in section (g).

(2.3) Manufacturers shall submit a report of the results of all testing conducted pursuant to section (j)(2) to the Executive Officer for review. This report shall identify the method used to induce a malfunction in each diagnostic, the MIL illumination status, and the confirmed fault code(s) stored.

(2.4) In accordance with section (i)(6), manufacturers may request Executive Officer approval for a retroactive deficiency to be granted for items identified during this testing.

(3) Verification and Reporting of In-use Monitoring Performance

(3.1) Manufacturers are required to collect and report in-use monitoring performance data representative of every test group certified by the manufacturer and equipped with in-use monitoring performance tracking software in accordance with section (d)(4) to the ARB within six months after the start of production.

(3.2) For each test group, the data must include all of the in-use performance tracking data reported through SAE J1979 (i.e., all numerators, denominators, and the ignition cycle counter), the date the data was collected, the vehicle VIN, and the ECM software calibration identification number.

(3.3) Manufacturers shall submit a plan to the Executive Officer for review and approval of the sampling method, number of vehicles to be sampled, time line to collect the data, and reporting format. The Executive Officer shall approve the plan if it provides for effective collection of data from a representative sample of vehicles that, at a minimum, is thirty vehicles, will likely result in the collection and submittal of data within the required six month time frame, will generate data that is representative of California drivers and temperatures, and does not, by design, exclude or include specific vehicles in an attempt to collect data only from vehicles with the highest in-use performance ratios.

(3.4) Upon request of the manufacturer, the Executive Officer may for good cause extend the six month time requirement set forth in section (j)(3.1) up to a maximum of twelve months. In granting additional time, the Executive Officer shall consider, among other things, information submitted by the manufacturer to justify the delay, sales volume of the test group, and the sampling mechanism utilized by the manufacturer to procure vehicles. If an extension beyond six months is granted, the manufacturer shall additionally be required to submit an interim report within six months for data collected up to the time of the interim report.

NOTE: Authority cited: Sections 39600, 39601, 43000.5, 43013, 43018, 43100, 43101, 43104, 43105, 43105.5, and 43106, Health and Safety Code. Reference: Sections 39002, 39003, 39010-39060, 39515, 39600-39601, 43000, 43000.5, 43004, 43006, 43013, 43016, 43018, 43100, 43101, 43102, 43104, 43105,43105.5, 43106, 43150-43156, 43204, 43211, and 43212, Health and Safety Code.

Attachment B

Enforcement of Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines, Section 1968.5, Title 13, California Code of Regulations

§ 1968.5. Enforcement of Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines.

(a) **General**

(1) Applicability.

(A) These procedures shall be used to assure compliance with the requirements of title 13, California Code of Regulations (CCR) section 1968.2 for all 2004 and subsequent model year vehicles equipped with OBD II systems that have been certified for sale in California.

(B) Vehicles manufactured prior to the 2004 model year are covered by the general enforcement and penalty provisions of the Health and Safety Code, and the specific provisions of title 13, CCR sections 1968.1 and 2111 through 2149.

(2) Purpose.

The purpose of this section is to establish the enforcement protocol that shall be used by the ARB to assure that vehicles certified for sale in California are equipped with OBD II systems that properly function and meet the purposes and requirements of title 13, CCR section 1968.2.

(3) Definitions.

The definitions applicable to these rules include those set forth in Health and Safety Code section 39010 et seq. and at title 13, CCR sections 1900(b) and 1968.2(b), which are incorporated by reference herein. The following definitions are specifically applicable to section 1968.5 and take precedence over any contrary definitions.

(A) "Days", when computing any period of time, unless otherwise noted, mean calendar days, but the Executive Officer when considering any request for extension of time shall consider the days that a manufacturer is open for business.

(B) "Executive Officer" means the Executive Officer of the Air Resources Board or his or her authorized representative.

(C) "Influenced OBD II-Related Recall" means an inspection, repair, adjustment, or modification program initiated and conducted by a manufacturer as a result of enforcement testing conducted by the ARB for the purpose of correcting any nonconforming OBD II system for which direct notification of vehicle or engine owners is necessary.

(D) "Major Monitor" means those monitors covered by the requirements set forth in title 13, CCR section 1968.2(e)(1.0) through (e)(8.0), (e)(11.0) through (e)(15.0), and (e)(17.0).

(E) "Motor Vehicle Class" means a group or set of vehicles or engines subject to enforcement testing that have been determined by the Executive Officer to share common or similar hardware, software, OBD II monitoring strategy, or emission control strategy.

(F) "Motor Vehicle Manufacturer" means the manufacturer granted certification to sell motor vehicles in the State of California.

(G) "Nonconforming OBD II System" means an OBD II system on a production vehicle that has been determined not to comply with the requirements of title 13, CCR section 1968.2. For purposes of section 1968.5, a motor vehicle class shall be considered nonconforming irrespective of whether vehicles in the motor vehicle class, on average, meet applicable tailpipe or evaporative emission standards.

(H) "OBD II Emission Testing" refers to testing conducted to determine compliance with the malfunction criteria in title 13, CCR section 1968.2(e) that are based on a multiple of a tailpipe emission standard (e.g., 1.5 times the applicable FTP emission standards).

(I) "OBD II Ratio Testing" refers to testing conducted to determine compliance with the required in-use monitor performance ratio in title 13, CCR section 1968.2(d)(3.2.1).

(J) "Ordered OBD II-Related Recall" means an inspection, repair, adjustment, or modification program required by the ARB to be conducted by the manufacturer to correct any nonconforming OBD II system for which direct notification of vehicle owners is necessary.

(K) "Quarterly Reports" refer to the following calendar periods: January 1 – March 31; April 1 – June 30; July 1 – September 30; October 1 – December 31.

(L) "Test Sample Group" means a group of production vehicles in a designated motor vehicle class that are equipped with OBD II systems and are selected and tested as part of the ARB enforcement testing program set forth in section (b).

(M) "Voluntary OBD II-Related Recall" means an inspection, repair, adjustment, or modification program voluntarily initiated and conducted by a manufacturer to correct any nonconforming OBD II system for which direct notification of vehicle owners is necessary.

(b) **Testing Procedures**

(1) Purpose.

To assure that OBD II systems on production motor vehicles and engines comply with the requirements of title 13, CCR section 1968.2, the ARB may periodically evaluate vehicles and engines from a motor vehicle class.

(2) Preliminary Testing and Evaluation.

(A) As part of his or her evaluation of vehicles to determine compliance with the requirements of title 13, CCR section 1968.2, the Executive Officer may routinely conduct testing on any production vehicles that have been sold and operated in California.

(B) Based upon such testing or any other information, including data from California or other State Inspection and Maintenance (I&M) stations, warranty information reports, and field information reports, the Executive Officer may conduct enforcement testing pursuant to sections (b)(3) though (5) below.

(3) Vehicle Selection for Enforcement Testing.
(A) Determining the Motor Vehicle Class.
(i) Upon deciding to conduct enforcement testing, the Executive Officer shall determine the motor vehicle class to be tested. In determining the scope of the motor vehicle class to be tested, the Executive Officer shall consider the similarities and differences in the OBD II systems of potentially affected vehicles. Among other things, the Executive Officer shall consider whether vehicles share similar computer hardware and software, calibrations, or OBD II monitoring and emission control strategies.
(ii) The default motor vehicle class is the test group or OBD II group used by the manufacturer to certify the vehicles to be tested. However, upon concluding that a subgroup of vehicles differs from other vehicles in the identified test group or OBD II group and that a reasonable basis exists to believe that the differences may directly impact the type of testing that will be performed, the Executive Officer may determine that a subgroup of the test group or OBD II group is the appropriate motor vehicle class for testing.
(iii) Similarly, upon concluding that vehicles from several OBD II groups share such common characteristics that a reasonable basis exists to believe that results of enforcement testing may be applicable to a motor vehicle class larger than a specific test group or OBD II group, the Executive Officer may determine that the appropriate motor vehicle class includes more than one test group or OBD II group.
(iv) The Executive Officer may not conduct testing of a motor vehicle class whose vehicles, on average, exceed the defined full useful life of the motor vehicle class. For purposes of the determination of this average, the Executive Officer shall use the accrual rates appropriate for vehicles in the motor vehicle class as defined in Section 7.1, "Accrual Rates", EMFAC2000 Technical Support Documentation, incorporated by reference.
(B) Size of Test Sample Group.
After determining the motor vehicle class to be tested, the Executive Officer shall determine the appropriate number of vehicles to include in the test sample group for enforcement testing in accordance with the following guidelines:
(i) For OBD II emission testing, the Executive Officer shall follow the procedures regarding sample size established in title 13, CCR section 2137 (e.g., using a sample size of at least 10 vehicles).
(ii) For OBD II ratio testing, the Executive Officer shall collect data from a test sample group of at least 30 vehicles.
(iii) In determining compliance with any other requirements of title 13, CCR section 1968.2 (e.g., diagnostic connector location, communication protocol standards, MIL illumination protocol, evaporative system diagnostics, etc.), the Executive Officer shall

determine the number of vehicles to be included in the test sample group based upon the nature of the noncompliance and the scope of the motor vehicle class. The test sample group could be as few as two test vehicles.

(C) Protocol for Procuring Vehicles for Test Sample Group

(i) For OBD II emission testing, the Executive Officer shall follow the same procurement policies used by the Executive Officer in accordance with title 13, CCR section 2137 to procure vehicles for in-use testing of vehicles for compliance with exhaust emission standards, with the exception that the Executive Officer shall modify the selection process (if necessary) to ensure proper selection of vehicles in accord with section (b)(3)(D)(i) below in lieu of the criteria in title 13, CCR section 2137.

(ii) For OBD II ratio testing, the Executive Officer shall follow the same procurement policies used by the Executive Officer in accordance with title 13, CCR section 2137 to procure vehicles for in-use testing of vehicles for compliance with exhaust emission standards, with the exception that the Executive Officer shall modify the selection process (if necessary) to ensure proper selection of vehicles in accord with section (b)(3)(D)(ii) below in lieu of the criteria in title 13, CCR section 2137.

(iii) For all other testing, the Executive Officer shall determine the appropriate procurement policy to be used in procuring vehicles for the test sample group based upon the nature of the noncompliance and the scope of the motor vehicle class. If the Executive Officer concludes that a reasonable basis exists to believe that a vehicle operator's driving or maintenance habits would not substantially impact test results to determine noncompliance, he or she may procure vehicle(s) by any means that assures effective collection and testing of vehicles (e.g., rental car agencies, fleet vehicles, etc.). In all cases, however, the selection process must ensure proper selection of vehicles in accord with section (b)(3)(D)(iii) below.

(D) Vehicles to be included in a Test Sample Group.

(i) In selecting vehicles to be included in a test sample group for enforcement OBD II emission testing, the Executive Officer shall include only vehicles that:

a. Are certified to the requirements of title 13, CCR section 1968.2 and California exhaust emission standards.
b. Are registered for operation in California.
c. Have an odometer reading and age that are less than the certified full useful life mileage and age for the subject vehicles.
d. Have no reasonably apparent evidence of tampering or being equipped with add-on or modified parts that would cause the OBD II system not to comply with the requirements of title 13, CCR section 1968.2.

e. Have no reasonably apparent indication of abuse (e.g., racing, overloading, misfueling) neglect, improper maintenance, or other factors that would cause the OBD II system not to comply with the requirements of title 13, CCR section 1968.2 or would have a permanent effect on exhaust emission performance.
f. Have no reasonably apparent detected or known malfunction(s) that would affect the performance of the OBD II system and are unrelated to the monitor or system being evaluated. At its discretion, the ARB may elect to repair a vehicle with a detected or known malfunction and then include the vehicle in the test sample group.
g. Have no reasonably apparent evidence of a major repair to the engine or major repair of the vehicle resulting from a collision.
h. Have no reasonably apparent indication of a problem that might jeopardize the safety of laboratory personnel.

(ii) In selecting vehicles to be included in a test sample group for enforcement OBD II ratio testing, the Executive Officer shall include only vehicles that:
a. Are certified to the requirements of title 13, CCR section 1968.2.
b. Have collected sufficient vehicle operation data for the monitor to be tested. Specifically, the denominator, as defined in title 13, CCR section 1968.2(d)(4.3), for the monitor to be tested must have a value equal to or greater than:
1. 150 for evaporative system monitors, secondary air system monitors, and monitors utilizing a denominator incremented in accordance with title 13, CCR sections 1968.2(d)(4.3.2)(E) or (F) (e.g., cold start monitors, air conditioning system monitors, etc.), or
2. 300 for catalyst, oxygen sensor, EGR, VVT, and all other component monitors.
c. Have no reasonably apparent evidence of tampering or being equipped with add-on or modified parts that would cause the OBD II system not to comply with the requirements of title 13, CCR section 1968.2.

(iii) In selecting vehicles to be included in a test sample group for enforcement testing of any other requirement of title 13, CCR section 1968.2 (not covered by sections (b)(3)(D)(i) or (ii) above), the Executive Officer shall include only vehicles that:
a. Are certified to the requirements of title 13, CCR section 1968.2.
b. Have no reasonably apparent evidence of tampering or being equipped with add-on or modified parts that would cause the OBD II system not to comply with the requirements of title 13, CCR section 1968.2.
c. Have no reasonably apparent detected or known malfunction(s) that would affect the performance of the OBD II system and are unrelated to the monitor or system being evaluated. At its

discretion, the ARB may elect to repair a vehicle with a detected or known malfunction and then include the vehicle in the test sample group.

(4) Enforcement Testing Procedures

(A) Prior to conducting any testing under section (b)(4), the Executive Officer may replace components monitored by the OBD II system with components that are sufficiently deteriorated or simulated to cause malfunctions that exceed the malfunction criteria established pursuant to title 13, CCR section 1968.2(e) in a properly operating system. The Executive Officer may not use components deteriorated or simulated to represent failure modes that are solely caused by vehicle operator action(s) beyond the vehicle manufacturer's control and that could not have been foreseen to occur (e.g., the use of leaded gasoline in an unleaded vehicle, etc.). Upon request by the Executive Officer, the manufacturer shall make available all test equipment (e.g., malfunction simulators, deteriorated "threshold" components, etc.) necessary to duplicate testing done by the manufacturer to determine the malfunction criteria used for major monitors subject to OBD II emission testing.

(B) OBD II Emission Testing: After the test sample group has been selected and procured, the Executive Officer may perform one or more of the following tests:

(i) Emission testing in accordance with the test procedures used by the Executive Officer for in-use testing of compliance with exhaust emission standards in accordance with title 13, CCR sections 2138 and 2139.

(ii) On-road or dynamometer testing with the vehicle being driven in a manner that reasonably ensures that all of the monitoring conditions disclosed in the manufacturer's certification application for the tested monitor are encountered.

(C) OBD II Ratio Testing:

(i) For OBD II ratio testing of monitors required to meet the in-use monitor performance ratio and to track and report ratio data pursuant to title 13, CCR section 1968.2(d)(3.2), after the test sample group has been selected and procured, the Executive Officer shall download the data from monitors required to track and report such data.

(ii) For OBD II ratio testing of monitors required to meet the in-use monitor performance ratio but not required to track and report ratio data pursuant to title 13, CCR section 1968.2(d)(3.2), after the test sample group has been selected and procured, the Executive Officer shall collect data by installing instrumentation or data-logging equipment on the vehicles. After installation of the equipment, the vehicles shall be returned to the vehicle owner/operator to continue to operate the vehicle until the minimum denominator criteria (see section (b)(3)(D)(ii)b.) is satisfied. The

Executive Officer shall then calculate the ratio from the data collected in a manner that will allow the Executive Officer to effectively determine the in-use monitor performance ratio in accordance with the requirements of title 13, CCR section 1968.2(d)(3.2).

(D) Testing for compliance with any other requirement of title 13, CCR section 1968.2: After the test sample group has been selected and procured, the Executive Officer may perform one or more of the following tests:

(i) Emission testing on the applicable FTP cycle or other applicable emission test cycle used for measuring exhaust or evaporative emissions.

(ii) On-road or dynamometer testing with the vehicle being driven in a manner that reasonably ensures that all of the monitoring conditions disclosed in the manufacturer's certification application for the tested monitor are encountered.

(iii) Any other testing determined to be necessary by the Executive Officer. This may include, but is not limited to, the use of special test equipment to verify compliance with standardization requirements.

(5) Additional Testing.

(A) Based upon testing of the motor vehicle class in section (b)(4) above and after review of all evidence available at the conclusion of such testing, the Executive Officer may elect to conduct further testing of a subgroup of vehicles from the motor vehicle class if the Executive Officer has determined that:

(i) a subgroup of tested vehicles differs sufficiently enough from other vehicles in the tested motor vehicle class, and

(ii) a reasonable basis exists to believe that the identified differences may indicate that the subgroup may be nonconforming whereas the tested motor vehicle class as a whole is not.

(B) Hereinafter all references to motor vehicle class shall be applicable to the subgroup meeting the conditions of section (b)(5)(A) above.

(C) In any testing of a subgroup of vehicles under section (b)(5), the Executive Officer shall follow the vehicle selection and testing procedures set forth in sections (b)(3) and (4) above.

(6) Finding of Nonconformance after Enforcement Testing.

After conducting enforcement testing pursuant to section (b)(4) above, the Executive Officer shall make a finding of nonconformance of the OBD II system in the identified motor vehicle class if:

(A) OBD II Emission Testing: the results of the OBD II emission tests indicate that 50 percent or more of the vehicles in the test sample do not properly illuminate the MIL when the emission malfunction criteria defined in title 13, CCR section 1968.2(e) are exceeded.

(B) OBD II Ratio Testing:

(i) For 2004, 2005, and 2006 model year vehicles, the data collected from the vehicles in the test sample indicate either that the average in-use monitor performance ratio for one or more of the monitors in the test sample group is less than 0.100 or that 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than 0.100 for the same monitor.

(ii) For 2007 and subsequent model year vehicles, the data collected from the vehicles in the test sample indicate either that 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than the required minimum ratio defined in title 13, CCR section 1968.2(d)(3.2.1) for the same monitor or that the average in-use monitor performance ratio for one or more of the monitors in the motor vehicle class is less than the required minimum ratio defined in title 13, CCR section 1968.2(d)(3.2.1) as defined by determining the average in-use monitor performance ratio for one or more of the monitors in the test sample group is less than:

a. 0.230 for secondary air system monitors and other cold start related monitors utilizing a denominator incremented in accordance with title 13, CCR section 1968.2(d)(4.3.2)(E) (e.g., cold start strategy monitors, etc.);

b. For evaporative system monitors:

1. 0.230 for monitors designed to detect malfunctions identified in title 13, CCR section 1968.2(e)(4.2.2)(C) (i.e., 0.020 inch leak detection);
2. 0.460 for monitors designed to detect malfunctions identified in title 13, CCR section 1968.2(e)(4.2.2)(A) and (B) (i.e., purge flow and 0.040 inch leak detection);

c. 0.297 for catalyst, oxygen sensor, EGR, VVT system, and all other monitors specifically required in section title 13, CCR section 1968.2(e) to meet the monitoring condition requirements of title 13, CCR section 1968.2(d)(3.2).

(C) All Other OBD II Testing:

(i) The results of the testing indicate that at least 30 percent of the vehicles in the test sample do not comply with the same requirement of title 13, CCR section 1968.2.

(ii) If the finding of nonconformance under paragraph (b)(6)(C)(i) above concerns vehicles that do not comply with the requirements of title 13, CCR section 1968.2(d)(4) or (5) (e.g., numerators or denominators are not properly being incremented), it shall be presumed that the nonconformance would result in an OBD II ratio enforcement test result that would be subject to an ordered recall in accord with the criterion in section (c)(3)(A)(i). The manufacturer may rebut such a presumption by presenting evidence in accord with section (b)(7)(C)(iii) below that demonstrates to the satisfaction of the Executive Officer that the identified nonconformance would not result in an ordered recall under section (c)(3)(A)(i).

(7) Executive Officer Notification to the Manufacturer Regarding Determination of Nonconformance

(A) Upon making the determination of nonconformance in section (b)(6) above, the Executive Officer shall notify the manufacturer in writing.

(B) The Executive Officer shall include in the notice:

(i) all relevant information, including supporting test data, that the Executive Officer relied upon in making his or her determination,

(ii) a provision allowing the manufacturer no less than 90 days from the date of issuance of the notice to provide the Executive Officer with any information contesting the findings set forth in the notice, and

(iii) a statement that if a final determination is made that the motor vehicle class is equipped with a nonconforming OBD II system, the manufacturer may be subject to appropriate remedial action, including recall and monetary penalties.

(C) Within the time period set by the Executive Officer in section (b)(7)(B)(ii), the manufacturer may provide the Executive Officer with any test results, data, or other information that may rebut or mitigate the results of the ARB testing.

(i) If the manufacturer elects to conduct additional testing of vehicles or engines, the manufacturer shall notify the Executive Officer before conducting such testing so that the Executive Officer may have the opportunity to review the testing protocol of the manufacturer, and witness the testing of vehicles.

(ii) If the manufacturer objects to the size of the test sample group or the method used to procure vehicles in the test sample group used by the Executive Officer pursuant to section (b)(3)(B)(iii) or (b)(3)(C)(iii), the manufacturer shall set forth what it considers to be the appropriate size and procurement method and the reasons therefore.

(iii) If the manufacturer elects to present evidence to overcome the presumption of nonconformance in section (b)(6)(C)(ii) above, the manufacturer shall demonstrate that the vehicles comply with in-use monitor performance ratio requirements of title 13, CCR section 1968.2(d)(3.2) by following one of the following procedures:

a. Presenting evidence in accord with the procurement and testing requirements of sections (b)(3) and (4).

b. Requesting Executive Officer approval to use an alternate procedure to demonstrate compliance. The Executive Officer shall approve the alternate procedure if the manufacturer demonstrates that it would provide an equivalent level of proof that vehicles operated in California do comply with the in-use monitor performance ratio.

(D) After receipt of any information submitted by the manufacturer pursuant to section (b)(7)(C) above, the Executive Officer shall consider all information submitted by the manufacturer and may conduct any additional testing that he or she believes is necessary.

(E) Final Determination:

(i) Within 60 days after completing any additional testing that the Executive Officer deemed necessary under section (b)(7)(D) above, the Executive Officer shall notify the manufacturer of his or her final determination regarding the finding of nonconformity of the OBD II system in the motor vehicle class. The determination shall be made after considering all of the information collected and received, including all information that has been received from the manufacturer.

(ii) The notice must include a description of each test group(s), OBD II group(s), or subgroups thereof, that has been determined to have a nonconforming OBD II system and set forth the factual bases for the determination.

(F) Extensions: The Executive Officer may for good cause extend the time requirements set forth in section (b)(7). In granting additional time to a manufacturer, the Executive Officer shall consider, among other things, any documentation submitted by the manufacturer regarding the time that it reasonably believes is necessary to conduct its own testing, why such information could not have been more expeditiously presented, and what effect any delay caused by granting the extension may have on effective enforcement and the health and welfare of the State.

(c) **Remedial Action**

(1) General.

(A) Upon being notified by the Executive Officer, pursuant to section (b)(7)(E), that a motor vehicle class is equipped with a nonconforming OBD II system, the manufacturer may, within 45 days from the date of service of such notification, elect to conduct an influenced recall of all vehicles within the motor vehicle class for the purpose of correcting the nonconforming OBD II systems. Upon such an election, the manufacturer shall follow the procedures set forth in sections (c)(2) and (d) below.

(B) If a manufacturer does not elect to conduct an influenced recall under section (c)(1)(A) above, the Executive Officer may order the manufacturer to undertake appropriate remedial action, up to and including the recall and repair of the nonconforming OBD II systems.

(2) Voluntary and Influenced OBD II-Related Recalls.

(A) If a manufacturer initiates a voluntary OBD II-related recall campaign, the manufacturer shall notify the Executive Officer of the recall at least 45 days before owner notification is to begin. The manufacturer shall also submit a voluntary recall plan for approval, as prescribed under section (d)(1) below.

(B) If a manufacturer initiates an influenced OBD II-related recall pursuant to section (c)(1)(A), the manufacturer shall submit a recall plan for approval, as prescribed under section (d)(1) below.

(C) A voluntary or influenced OBD II-related recall plan submitted under sections (c)(2)(A) and (B) above shall be approved by the Executive Officer pursuant to section (d)(1)(B) below.

(3) Ordered Remedial Action.

(A) The Executive Officer shall order the recall and repair of all vehicles and engines in a motor vehicle class that have been determined to be equipped with a nonconforming OBD II system if enforcement testing conducted pursuant to section (b) above indicates that:

(i) For 2007 and subsequent model year vehicles, the average in-use monitor performance ratio for one or more of the major monitors in the test sample group is less than or equal to 33.0 percent of the applicable required minimum ratio established in title 13, CCR section 1968.2(d)(3.2.1) (e.g., if the required ratio is 0.336, less than or equal to a ratio of 0.111) or 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than or equal to 33.0 percent of the applicable required minimum ratio established in title 13, CCR section 1968.2(d)(3.2.1) for the same major monitor. For 2004, 2005, and 2006 model year vehicles, the Executive Officer shall determine the remedial action for nonconformances regarding the in-use monitor performance ratio in accordance with section (c)(3)(B) below.

(ii) When the vehicle is tested on-road and driven so as to reasonably encounter all monitoring conditions disclosed in the manufacturer's certification application, a major monitor (other than the monitors for misfire causing catalyst damage and the evaporative system) is unable to detect and illuminate the MIL for a malfunction of the monitored component/system prior to emissions exceeding the malfunction criteria of title 13, CCR section 1968.2(e) by an additional amount equal to 1.5 times the applicable FTP standard (e.g., if the malfunction criteria is 1.5 times the applicable FTP standard, recall would be required when emissions exceed 3.0 times the applicable FTP standard). For purposes of the emission exceedance determination, carbon monoxide (CO) emissions are not considered.

(iii) The monitor for misfire causing catalyst damage is unable to properly detect and illuminate the MIL for misfire rates that are more than 20 percentage points greater than the misfire rates disclosed by the manufacturer in its certification application as causing catalyst damage (e.g., if the disclosed misfire rate is 12 percent, recall would be required if the misfire rate is greater than 32 percent without proper detection).

(iv) When the vehicle is tested on-road and driven so as to reasonably encounter all monitoring conditions disclosed in the manufacturer's certification application, the evaporative system monitor is unable to detect and illuminate the MIL for a cumulative leak or leaks in the evaporative system equivalent to that caused by an orifice with a diameter of at least 1.5 times the diameter of the required orifice in title 13, CCR section 1968.2(e)(4.2.2)(C).

(v) When the vehicle is tested on-road and driven so as to reasonably encounter all monitoring conditions disclosed in the manufacturer's certification application, the OBD II system cannot detect and illuminate the MIL for a malfunction of a non-major monitor component that effectively disables a major monitor and the major monitor, by being disabled, meets the criteria for recall identified in sections (c)(3)(A)(ii) or (iv) above (e.g. is unable to detect and illuminate the MIL for malfunctions that cause FTP emissions to exceed the malfunction criteria by an additional amount equal to or greater than 1.5 times the applicable FTP standard).

(vi) The motor vehicle class cannot be tested so as to obtain valid test results in accordance with the procedures of the California Inspection & Maintenance (I/M) program applicable at the time of vehicle certification due to the nonconforming OBD II system. If the I/M test procedures have been amended within two years prior to the time of certification, the motor vehicle manufacturer may elect to use the preceding procedures.

(B) If the Executive Officer has determined that a motor vehicle class is equipped with a nonconforming OBD II system and the nonconformance does not fall within the provisions of section (c)(3)(A) above, he or she may require the manufacturer to undertake remedial action up to and including recall of the affected motor vehicle class. In making his or her findings regarding remedial action, the Executive Officer shall consider the capability of the OBD II system to properly function. This determination shall be based upon consideration of all relevant circumstances including, but not limited to, those set forth below.

(i) Whether the manufacturer identified and informed the ARB about the nonconformance(s) or whether the ARB identified the nonconformance(s) prior to being informed by manufacturer.

(ii) The number of nonconformances.

(iii) If the identified nonconformance(s) is with a major monitor(s), the nature and extent of the nonconformance(s), including:

a. the degree to which the in-use monitor performance ratio(s) is below the required ratio(s) specified in title 13, CCR section 1968.2 (d)(3.2.1), and
b. the amount of the emission exceedance(s) over the established malfunction criteria set forth in title 13, CCR section 1968.2(e) before a malfunction is detected and the MIL is illuminated.

(iv) If the identified nonconformance(s) is with a non-major monitor the nature and extent of the nonconformance(s), including:
a. the degree to which the in-use monitor performance ratio(s) (where applicable) is below the required ratio(s) specified in title 13, CCR section 1968.2 (d)(3.2.1),
b. the degree to which the monitored component must be malfunctioning or exceed the established malfunction criteria set forth in title 13, CCR section 1968.2(e) before a malfunction is detected and the MIL is illuminated, and
c. the effect that the nonconformance(s) has on the operation of a major monitor(s).

(v) The impact of the nonconformance on vehicle owners (e.g., cost of future repairs, driveability, etc.) and the ability of the service and repair industry to make effective repairs (e.g., difficulty in accessing fault information, diagnosing the root cause of a failure, etc.).

(vi) The degree to which the identified nonconformance(s) complicates, interferes with, disrupts, or hampers a service technicians ability to follow California I/M testing protocol when performing a California I/M inspection.

(vii) The failure of the data link connector of the motor vehicle class to meet the requirements of title 13, CCR section 1968.2(f)(2).

(viii) The failure of the PCV system in a motor vehicle class to comply with the requirements of title 13, CCR section 1968.2(e)(9).

(ix) The failure of the cooling system monitor in a motor vehicle class to properly verify that the cooling system reaches the highest enable temperature used for any other monitor when the vehicle is operated in the monitoring conditions disclosed in the manufacturer's certification application, or failure to comply with any requirement in title 13, CCR section 1968.2(e)(10).

(x) The estimated frequency that a monitor detects a malfunction and illuminates the MIL when no component malfunction is present (i.e., false MILs).

(xi) The estimated frequency that a monitor fails to detect a malfunction and illuminate the MIL when the monitoring conditions, as set forth in the manufacturer's approved certification application, have been satisfied and a faulty or deteriorated monitored component is present (i.e., false passes).

(xii) Whether the manufacturer submitted false, inaccurate, or incomplete documentation regarding the identified nonconformance at the time of certification and the extent to which the false, inaccurate, or incomplete documentation was material to the granting of certification.

(4) Assessment of Monetary Penalties.
The Executive Officer may seek penalties pursuant to the applicable provisions of the Health and Safety Code for violations of the requirements of title 13, CCR section 1968.2 or for production vehicles otherwise failing

to be equipped with OBD II systems that have been certified by the ARB. In determining the penalty amounts that the ARB may seek, the Executive Officer shall consider all relevant circumstances including, but not limited to, mitigation factors and the factors set forth below:

(A) Whether the manufacturer self-reported the nonconformity or the ARB discovered the nonconformity independent of the manufacturer.

(B) The nature and degree of the nonconformity and whether the manufacturer should reasonably have discovered the nonconformity and taken corrective action by voluntary recall or running changes during the production year.

(C) The economic benefits, if any, gained by the manufacturer from not complying with the provisions of title 13, CCR section 1968.2.

(D) The manufacturer's history of compliance with the OBD II requirements.

(E) The preventative efforts taken by the manufacturer to avoid noncompliance, including any programs followed by the manufacturer to ensure compliance.

(F) The manufacturer's efforts to correct the nonconformity once it was identified.

(G) The innovative nature and magnitude of effort, including the cost of any other proposed remedial action, necessary to correct the nonconformity.

(H) The cooperation of the manufacturer during the course of the investigation and any action taken by the manufacturer, including the nature, extent, and time of response of any action taken to mitigate the violation.

(I) The deterrent effect of the penalty.

(J) Whether the manufacturer has failed to provide complete and accurate information required to be submitted at the time of certification pursuant to title 13, CCR section 1968.2(h).

(K) The nature and degree that OBD II systems on production vehicles differ from the systems that have been certified by the ARB.

(5) Notice to Manufacturer.

(A) The Executive Officer shall immediately notify the manufacturer upon the Executive Officer determining the type of remedial action to be taken.

(B) For remedial actions other than the assessment of monetary penalties, the notice must:

(i) specifically set forth the remedial action that is being ordered,

(ii) include a description of the test group(s), OBD II group(s), or subgroup(s) thereof, that has been determined to have a nonconforming OBD II system,

(iii) set forth the factual bases for the determination, and

(iv) designate a date at least 45 days from the date of receipt of such notice by which the manufacturer shall submit a plan, pursuant to section (d)(1) below, outlining the remedial action to be undertaken consistent with the Executive Officer's order. Except as provided in paragraph (c)(6)(B) below, all plans shall be submitted to the Chief, Mobile Source Operations Division, 9528 Telstar Avenue, El Monte, California 91731, within the time limit specified in the notice. The Executive Officer may grant the manufacturer an extension of time for good cause.

(C) For cases in which the ARB elects to seek monetary penalties pursuant to authority granted under the Health and Safety Code, the Executive Officer shall issue a notice to the manufacturer that he or she will be filing a complaint in the appropriate administrative or civil court forum seeking penalties against the manufacturer for violations of title 13, CCR section 1968.2. The notice must include a description of the test group(s), OBD II group(s), or subgroup(s) thereof, that have been determined to have a nonconforming OBD II system and set forth the factual bases for the determination.

(6) Availability of Public Hearing to Contest Remedial Actions Other than Monetary Penalty Assessments.

(A) Within 45 days from the date of receipt of the notice that is required under section (c)(4) above, the manufacturer may request a public hearing pursuant to the procedures set forth in title 17, CCR section 60055, et seq., to contest the findings of nonconformity, the necessity for, or the scope of any ordered remedial action.

(B) If a manufacturer requests a public hearing pursuant to section (c)(6)(A) above and if the Executive Officer's determination of nonconformity is confirmed at the hearing, the manufacturer shall submit the required remedial action plan in accordance with section (d)(1) below within 30 days after receipt of the Board's decision.

(d) **Requirements for Implementing Remedial Actions**

(1) Remedial Action Plans.

(A) A manufacturer initiating a remedial action campaign (voluntary, influenced, or ordered) shall develop a remedial action plan that contains the following information, unless otherwise specified:

(i) A description of each test group, OBD II group, or subgroup thereof covered by the remedial action, including the number of vehicles or engines, the engine families, test groups, or subgroups within the identified class(es), the make(s), model(s), and model years of the covered vehicles and engines, and such other information as may be required to identify the covered vehicles or engines.

(ii) A description of the nonconforming OBD II system and, in the case of a recall (whether voluntary, influenced, or ordered), the specific modifications, alterations, repairs, adjustments, or other changes to correct the nonconforming OBD II system, including data and/or engineering evaluation supporting the specific corrections.

(iii) A description of the method and schedule that the manufacturer will use to determine the names and addresses of vehicle or engine owners and to notify them of the remedial action.

(iv) A copy of all instructions that the manufacturer will use to notify service facilities about the required remedial action and the specific corrections, if any, that will be required to be made to the nonconforming OBD II systems.

(v) A description of the procedure to be followed by vehicle or engine owners to obtain remedial action for the nonconforming OBD II system. This must include the date, on or after which the owner can have required remedial action performed, the time reasonably necessary to perform the labor to remedy the nonconformity, and the designation of facilities at which the nonconformity can be remedied.

(vi) If some or all of the nonconforming OBD II systems are to be remedied by persons other than dealers or authorized warranty agents of the manufacturer, a description of such class of service agents and what steps, including a copy of all instructions mailed to such service agents, the manufacturer will take to assure that such agents are prepared and equipped to perform the proposed remedial action.

(vii) A copy of the letter of notification to be sent to vehicle or engine owners.

(viii) A proposed schedule for implementing the remedial action, including identified increments of progress towards full implementation.

(ix) A description of the method that the manufacturer will use to assure that an adequate supply of parts will be available to initiate the remedial action campaign on the date set by the manufacturer and that an adequate supply of parts will continue to be available throughout the campaign.

(x) A description and test data of the emission impact, if any, that the proposed remedial action may cause to a representative vehicle or engine from the motor vehicle class to be remedied.

(xi) A description of the impact, if any, and supporting data and/or engineering evaluation, that the proposed remedial action will have on fuel economy, driveability, performance, and safety of the motor vehicle class covered by the remedial action.

(xii) Any other information, reports, or data which the Executive Officer may reasonably determine to be necessary to evaluate the remedial action plan.

(B) Approval and Implementation of Remedial Action Plans.

(i) If the Executive Officer finds that the remedial action plan is designed effectively to address the required remedial action and complies with the provisions in section (d)(1)(A) above, he or she shall notify the manufacturer in writing within 30 days of receipt of the plan that the plan has been approved.

(ii) The Executive Officer shall approve a voluntary, influenced, or ordered remedial action plan if the plan contains the information specified in section (d)(1)(A) above and is designed to notify the vehicle or engine owner and implement the remedial action in an expeditious manner.

(iii) In disapproving an ordered remedial action plan, the Executive Officer shall notify the manufacturer in writing of the disapproval and the reasons for the determination. The manufacturer shall resubmit a revised remedial action plan that fully addresses the reasons for the Executive Officer's disapproval within 10 days of receipt of the disapproval notice.

(iv) Upon receipt of the approval notice from the Executive Officer, the manufacturer shall, within 45 days of receipt of the notice, begin to notify vehicle or engine owners and implement the remedial action campaign.

(v) If the Executive Officer disapproves a voluntary or influenced remedial action plan, the manufacturer shall either accept the proposed modifications to the plan as suggested by the Executive Officer or be subject to an Executive Officer order that the manufacturer undertake appropriate remedial action pursuant to section (c)(1)(B) above.

(2) Eligibility for Remedial Action.

(A) The manufacturer may not condition a vehicle or engine owner's eligibility for remedial action required under section 1968.5 on the proper maintenance or use of the vehicle or engine.

(B) Subject to Executive Officer approval, the manufacturer may not be obligated to perform the remedial action on a vehicle which has been modified or altered such that the remedial action cannot be performed without additional cost.

(3) Label Indicating that Recall Repairs Have Been Performed.

(A) If the required remedial action involves recall of a test group(s), OBD II group(s), or subgroup(s) thereof, the manufacturer shall require those who perform inspections and/or recall repairs to affix a label to each vehicle or engine that has been inspected and/or repaired.

(B) The label must be placed in a location approved by the Executive Officer and must be fabricated of a material suitable for such location in which it is installed and which is not readily removable.

(C) The label must contain the remedial action campaign number and a code designating the facility at which the remedial action or inspection to determine the need for remedial action was performed.

(4) Proof of Performance of Remedial Action Certificate.

If the required remedial action involves a recall, the manufacturer shall provide, through its service agents, to owners of vehicles or engines that have had the remedial action performed a certificate that confirms that the vehicle has been recalled and that required inspection and/or repairs have been performed. The certificate must be in a format prescribed by the Executive Officer.

(5) Notice to Owners.

(A) The manufacturer shall notify owners of vehicles or engines in the motor vehicle class covered by the remedial order. The notice must be made by first-class mail or by such other means as approved by the Executive Officer. When necessary, the Executive Officer may require the use of certified mail to assure effective notification.

(B) The manufacturer shall use all reasonable means necessary to locate vehicle or engine owners, including motor vehicle registration lists available from the California Department of Motor Vehicles and commercial sources such as R.L. Polk & Co.

(C) The notice must contain the following:

(i) A statement: "The California Air Resources Board has determined that your vehicle (is or may be) equipped with an improperly functioning on-board emission-related diagnostic system that violates established standards and regulations that were adopted to protect your health and welfare from the dangers of air pollution."

(ii) A statement that "the (name of motor vehicle manufacturer) will, at its expense, be taking the following remedial action (describe) to redress the problems that have been identified with the improperly functioning emission control system."

(iii) A statement that eligibility for remedial action may not be denied solely on the basis that the vehicle or engine owner used parts not manufactured by the original equipment vehicle manufacturer, or had repairs performed by outlets other than the vehicle or engine manufacturer's franchised dealers.

(iv) Instructions to the vehicle or engine owners on how to obtain remedial action, including instructions on whom to contact (i.e., a description of the facilities where the vehicles or engines should be taken for the remedial action), the first date that a vehicle or engine may be brought in for remedial action, and the time that it will reasonably take to correct the nonconformity.

(v) The statement: "In order to assure your full protection under the emission warranty provisions, it is recommended that you have the required remedial action performed on your (vehicle or engine) (at the time and date indicated or, in the case of recall, as soon as possible). Failure to do so could be determined as lack of proper maintenance of your (vehicle or engine)."

(vi) A telephone number for vehicle and engine owners to call to report difficulty in obtaining remedial action.

(vii) A card to be used by a vehicle or engine owner in the event the vehicle or engine to be recalled has been sold. Such card should be addressed to the manufacturer, have postage paid, and shall provide a space in which the owner may indicate the name and address of the person to whom the vehicle or engine was sold or transferred.

(viii) If the remedial action involves recall, the notice must also provide:

a. A clear description of the components that will be affected by the remedial action and a general statement of the measures to be taken to correct the nonconformity.

b. A statement that such nonconformity, if not corrected, may cause the vehicle or engine to fail an emission inspection or I/M smog check test.

c. A statement describing the adverse effects, if any, of an uncorrected nonconforming OBD II system on the performance, fuel economy, or durability of the vehicle or engine.

d. A statement that after remedial action has been taken, the manufacturer will have the service facility issue a certificate showing that a vehicle has been corrected under the recall program, and that such a certificate will be required to be provided to the Department of Motor Vehicles as a condition for vehicle registration.

(D) A notice sent pursuant to this section or any other communication sent to vehicle or engine owners or dealers may not contain any statement, expressed or implied, that the OBD II system is compliant or that the OBD II system will not degrade air quality.

(E) The Executive Officer shall inform the manufacturer of any other requirements pertaining to the notification under section (d)(5) which the Executive Officer has determined as reasonable and necessary to assure the effectiveness of the recall campaign.

(6) Record Keeping and Reporting Requirements.

(A) The manufacturer shall maintain sufficient records to enable the Executive Officer to conduct an analysis of the adequacy of the remedial action.

(B) Unless otherwise specified by the Executive Officer, the manufacturer shall report on the progress of the remedial action campaign by submitting reports for eight consecutive quarters commencing with the quarter immediately after the recall campaign begins. The reports shall be submitted no later than 25 days after the close of each calendar quarter to: Chief, Mobile Source Operations Division, 9528 Telstar Avenue, El Monte, California 91731. For each test group within the motor vehicle class subject to the emission recall campaign, the quarterly report must contain the following:

(i) The remedial action campaign number designated by the manufacturer and a brief description of the nature of the campaign.

(ii) The date owner notifications began and date completed.

(iii) The number of vehicles or engines involved in the remedial action campaign.

(iv) The number of vehicles or engines known or estimated to be equipped with the nonconforming OBD II system and an explanation of the means by which this number was determined.

(v) The number of vehicles or engines inspected during the reporting period and during the campaign since its inception.

(vi) The number of vehicles or engines receiving remedial action during the reporting period and during the campaign since its inception.

(vii) The number of vehicles or engines determined to be unavailable for inspection or remedial action, during the most recent reporting period and during the campaign since its inception, due to exportation, theft, scrapping, or other reasons (specify).

(viii) The number of vehicles or engines, during the most recent reporting period and during the campaign since its inception, determined to be ineligible for remedial action under section (d)(1)(B).

(ix) A list, using the following data elements and designated positions, indicating all vehicles or engines subject to recall that the manufacturer has not been informed of being corrected as of the end of the reporting period. The list must be supplied in a standardized computer format to be specified by the Executive Officer. The date elements must be written in "ASCII" code with a comma separating each element. For example: XTY32A7,1234,E-9456,1234,08-25-91,A. The add/delete flag (see below) should reflect changes in the quarterly updates. The Executive Officer may change the frequency of this submittal depending on the needs of enforcement.

Data Elements	Positions
• File Code (designated by DMV)	1
• License Plate Number	2-8
• Last three VIN positions	9-11
• Recall ID Number	12-17
• Mfg. ID Number (Mfg. Occupational License Number)	18-22
• Recall Start Date (mmddyyyy)	23-30
• Add or Delete Flag (A/D)	31
• Complete VIN if personalized license plate (File Code "L" or "S")	32-48

(x) A copy of any service bulletins issued during the reporting period by the manufacturer to franchised dealerships or other service agents that relate to the nonconforming OBD II system and the remedial action and have not previously been reported to the Executive Officer.

(xi) A copy of all communications transmitted to vehicle or engine owners that relate to the nonconforming OBD II systems and the required remedial action and have not been previously reported to the Executive Officer.

(C) If the manufacturer determines that any of the information submitted to the Executive Officer pursuant to section (d) has changed or is incorrect, the manufacturer shall submit the revised information, with an explanation.

(D) The manufacturers shall maintain in a form suitable for inspection, such as computer information, storage devices, or card files, and shall make available to the Executive Officer or his or her authorized representative upon request, the names and addresses of vehicle or engine owners:

(i) To whom notification was sent;

(ii) Whose vehicles or engines were repaired or inspected under the recall campaign;

(iii) Whose vehicles or engines were determined not to be eligible for remedial action because the vehicles or engines were modified, altered, or unavailable due to exportation, theft, scrapping, or other reason specified in the answer to sections (d)(8)(B)(vii) and (viii).

(E) The information gathered by the manufacturer to compile the reports required by these procedures must be retained for no less than one year beyond the useful life of the vehicles or engines and must be made available to authorized personnel of the ARB upon request.

(F) The filing of any report under the provisions of these procedures must not affect the manufacturer's responsibility to file reports or applications, obtain approval, or give notice under any other provisions of law.

(e) **Penalties for Failing to Comply with the Requirements of Section (d).** In addition to the penalties that may be assessed by the Executive Officer pursuant to section (c) because of a manufacturer's failure to comply with the requirements of title 13, CCR section 1968.2, a manufacturer may be subject to penalties for failing to comply with the requirements of section (d).

NOTE: Authority cited: Sections 39600, 39601, 43000.5, 43013, 43016, 43018, 43100, 43101, 43104, 43105, 43105.5, 43106, 43154, 43211, and 43212 Health and Safety Code. Reference: Sections 39002, 39003, 39010-39060, 39600-39601, 39515, 43000, 43000.5, 43004, 43006, 43013, 43016, 43018, 43100, 43101, 43102, 43104, 43105, 43105.5, 43106, 43150-43156, 43204, 43211, and 43212 Health and Safety Code.