State of California
AIR RESOURCES BOARD

**DRAFT PRELIMINARY STAFF REPORT:**
**INITIAL STATEMENT OF REASONS**

# Technical Status and Revisions to Malfunction and Diagnostic System Requirements for 2003 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II)

| | |
|---|---|
| Date of Release: | June 14, 2001 |
| Scheduled for Public Workshop: | July 18, 2001 |

Mobile Source Control Division
9528 Telstar Avenue
El Monte, California 91731
www.arb.ca.gov

This document has been reviewed by the staff of the California Air Resources Board. Publication does not signify that the contents necessarily reflect the views and policies for the Air Resources Board.

Table of Contents

I. INTRODUCTION ..... 1
II. BACKGROUND INFORMATION ..... 1
What Problem is Addressed by OBD II Systems? ..... 1
How Do OBD II Systems Help to Solve the Problem? ..... 2
What Does the OBD II Regulation Require? ..... 3
OBD II and Inspection and Maintenance ..... 4
III. TECHNICAL STATUS AND PROPOSED MONITORING SYSTEM AMENDMENTS ... 5
A. CATALYST MONITORING ..... 6
B. MISFIRE MONITORING ..... 8
C. EVAPORATIVE SYSTEM MONITORING ..... 9
D. SECONDARY AIR SYSTEM MONITORING ..... 10
E. OXYGEN SENSOR MONITORING ..... 12
F. ENGINE COOLING SYSTEM MONITORING ..... 13
G. COLD START EMISSION REDUCTION STRATEGY MONITORING ..... 15
H. AIR CONDITIONING SYSTEM COMPONENT MONITORING ..... 16
I. VARIABLE VALVE TIMING CONTROL SYSTEM ..... 17
J. DIRECT OZONE REDUCTION MONITORING ..... 18
K. PASSENGER CAR AND LIGHT-DUTY TRUCK SULEV THRESHOLDS ..... 20
L. CATALYST AND PARTICULATE MATTER TRAP MONITORING FOR DIESELS ..... 21
IV. REVISIONS TO STANDARDIZATION REQUIREMENTS ..... 23
A. Phase-in of Controller Area Network (CAN) communication protocol ..... 23
B. Readiness status ..... 24
C. Use of manufacturer-specific fault codes ..... 25
D. Access to additional data through a generic scan tool ..... 26
E. Reporting of pending fault codes ..... 26
F. Software Calibration Identification Number (CAL ID) and Calibration Verification Number (CVN) ..... 27
G. Vehicle Identification Number (VIN) ..... 27
H. Service Information ..... 28
V. REVISIONS TO DEMONSTRATION TESTING REQUIREMENTS ..... 28
VI. REVISIONS TO CERTIFICATION APPLICATION REQUIREMENTS ..... 29
VII. PRODUCTION VEHICLE EVALUATION AND VERIFICATION TESTING ..... 30
A. Verification of Standardized Requirements ..... 30
B. Verification of Monitoring Requirements ..... 31
C. Verification and Reporting of In-use Monitoring Performance ..... 32
VIII. DEFICIENCIES ..... 33
IX. A STANDARDIZED METHOD TO MEASURE REAL WORLD MONITORING PERFORMANCE ..... 34
A. Detailed description of software counters to track real world performance ..... 35
B. Number of monitoring events (“numerator”) ..... 36
C. Number of driving events (“denominator”) ..... 37
D. Minimum acceptable frequency (“ratio”) ..... 38
E. Compliance testing sampling procedure ..... 40
X. PROPOSED ADOPTION OF ENFORCEMENT PROVISIONS SPECIFIC TO OBD II SYSTEMS ..... 40

A. Overview..... 40
B. Applicability ..... 41
C. In-Use Testing Procedures..... 41
D. Remedial Action ..... 42
E. Notice to Manufacturer of Remedial Order and Availability of Public Hearing. ..... 45
F. Requirements for Implementing Remedial Action..... 45
G. Penalties for Failing to Comply with the Requirements of Section 1968.5(d). ..... 45

## I. 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 allowing states to perform OBD II checks for these newer cars 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. 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 amendments are aimed at refining the program, better serving repair technicians, and improving incorporation of OBD II into I/M programs. Additionally, some of the amendments are in response to improperly designed OBD II systems discovered in the field by 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 amendments 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 amendments 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.

## II. BACKGROUND INFORMATION

<u>What Problem is Addressed by OBD II Systems?</u>

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 program can range from about 0.6-0.9% for two to three-year-old vehicles to about 10.6% for ten-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% of all light-duty passenger cars on the road in California will have accumulated more than 100,000 miles, 50% will have more than 125,000 miles, and 41% will have more than 150,000 miles.[3] This reflects a significant increase even from 1995 when only 44% of all light-duty passenger cars had accumulated more than 100,000 miles, 27% had more than 125,000 miles, and 17% had more than 150,000 miles.[4] Additionally, in 2001, 34% of all light-duty passenger car miles traveled will be by cars with more than 150,000 miles on the odometer, an increase from only 10% 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.

---

[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

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

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 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 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 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 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 monitors 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 monitors 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.

[6] Due to the overwhelming time and cost resources that would be required to evaluate the additive emission impacts from multiple components that are partially deteriorated, the regulation only requires detection of any single component failure which can affect emissions.

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 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

[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.

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.

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 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 revisions to the current California Smog Check program, which is administered by BAR. The intentions of this joint effort are 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 AMENDMENTS

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, 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

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

required rewriting and restructuring of the current regulation, which resulted in the following proposed monitoring requirements and amendments.

## 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)). While the OBD II regulation requires catalyst system monitoring, only hydrocarbon conversion efficiency is currently required to be monitored. Recently, the staff has analyzed emission data from OBD II demonstration vehicles with deteriorated catalysts (i.e., catalysts that are detected by the OBD II system as malfunctioning), and found that for Low Emission Vehicle I applications, HC and NOx conversion performances degraded at about equal rates. While the absence of a monitoring requirement related to NOx emissions seems to work reasonably well for Low Emission Vehicle I applications, it does not seem appropriate for Low Emission Vehicle II applications. This is because while the HC emission standards for Low Emission Vehicle I and II applications are the same, NOx emission standards for Low Emission Vehicle II applications are approximately one-fourth the levels for Low Emission Vehicle I applications.

In order to protect against high in-use emissions and to maintain the emission benefits of the Low Emission Vehicle II program, staff is proposing a requirement to monitor NOx conversion efficiency of the catalyst. This requirement would apply only to vehicles certified to Low Emission Vehicle II standards, beginning with 2005 and 2006 model years, which would have an interim threshold of 3.5 times the FTP full useful life standard. For 2007 and subsequent model years, the final threshold for LEV II, ULEV II and medium-duty SULEV II vehicles would be 1.75 times the FTP full useful life standard, while the final threshold for passenger car and light-duty truck SULEV vehicles would be 2.5 times the FTP full useful life standard.

Manufacturers would likely use modifications of their current catalyst monitoring methods to satisfy this requirement. Manufacturers currently use the catalyst's oxygen storage capacity to evaluate HC conversion efficiency, where a malfunction is indicated when oxygen storage (i.e., HC conversion efficiency) decreases to the point where HC emissions generally exceed 1.75 times the standard. Staff has reviewed data showing that oxygen storage capacity can also be used to evaluate NOx conversion efficiency. Manufacturers would likely modify their current oxygen storage methods in determining the new oxygen storage threshold, which would be based on the criterion pollutant, HC or NOx, that exceeds the OBD II emissions threshold first.

Catalyst Aging

As discussed above, manufacturers use oxygen storage capacity as a measure of catalyst performance/conversion efficiency. In order to determine the proper OBD II catalyst threshold (i.e., the acceptable level of oxygen storage capacity), manufacturers progressively deteriorate or "age" catalysts to the point where emissions exceed 1.75 times the standard. Excessive temperature resulting from engine misfire is recognized by industry as the predominant failure mode of catalysts. Accordingly, the two most common methods of catalyst aging are oven aging and misfire aging, 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. If the unmonitored catalyst is not protected by the monitored catalyst and is deteriorated beyond its normal limits, emission levels will likely exceed the level 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 for the catalyst monitor. Under the proposed requirements, manufacturers would 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 amendments would further require that the catalyst system be aged as a whole (i.e., manufacturers would simultaneously age the entire system) for 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 use the current process of aging the monitored catalyst to the malfunction criteria and the unmonitored catalysts to the end of the useful life. This is due to the fact that the catalyst system will not be subjected to extreme temperatures, so it would likely age with the closest monitored catalyst experiencing most of the deterioration.

## B. MISFIRE MONITORING

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 OBD II regulation, the ARB has granted manufacturers more evaluation time in determining whether misfire is present to ensure that misfires are sufficiently repeatable so that technicians are better able to remedy them. Given these improvements, it is no longer necessary to permit many of the disablements to misfire detection systems that were previously allowed due to concerns about the reliability of the systems to correctly identify misfire.

The proposed regulation would be more specific regarding allowable disablements. This would help ensure that all manufacturers are developing misfire detection systems that have uniformly high levels of capability, and would minimize the time staff must spend to determine when misfire systems are really active. This has been a concern in the past, when numerous overlapping disablements 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 of allowed disablements would also reduce development time for misfire monitoring systems since the time spent discussing allowable disablements with staff would be minimized.

In general, the amendments 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 would no longer be allowed to disable misfire detection during engine speed changes that tax their engine computer’s ability to keep up with the calculation requirements. Manufacturers would still be required to list all disablements in their certification applications for review by 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 as determined by the ARB staff prior to granting certification.

Other revisions being proposed include developing a better definition of when a single cylinder or multiple cylinder misfire code is set, setting floors of 1 percent and 5 percent for detecting emission-related and catalyst damage misfires, establishing a more specific means of determining the temperature at which catalyst damage occurs, permitting a reduced threshold for probability of detection for misfire when a cold start emission reduction strategy that causes engine torque to be significantly reduced is operative, increasing specificity concerning default fuel control strategies, and others.

## C. EVAPORATIVE SYSTEM MONITORING

### 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.

Staff is willing to provide greater specificity as requested and therefore proposes the use of a square-edge orifice as 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 below, 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 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 in approximately two weeks time for the majority of drivers. Thus, alternate strategies that may not fit the conventional definition a two consecutive driving cycle monitor but nonetheless, provide for timely and reliable monitoring, would be allowed.

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 a 0.040 inch leak, 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, the 0.020 inch leak detection requirement was adopted 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 0.040 inch monitoring requirement was retained.

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 in such a way that monitoring can now occur more frequently. In addition, some manufacturers have developed innovative approaches that are less costly than previous systems, but 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 specifically. In fact, some manufacturers have indicated that detecting leaks in the 0.090 inch range would occur more rapidly than detecting 0.040 inch leaks. In other words, by allowing manufacturers to perform a 0.090 inch monitor instead of a 0.040 inch monitor, large leaks in the evaporative control system caused by conditions such as a loose or missing gas cap, as well as split or disconnected vacuum lines, would be detected more quickly. 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, staff is proposing greater flexibility for manufacturers in detecting evaporative system leaks for larger hole sizes, as long as their 0.020 inch leak detection capability is robust and the overall evaporative system monitor meets minimum monitoring frequency requirements discussed later in section IX.

## 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 monitor 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 robust and 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 emission 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 robust 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, since ARB engineers are not experts in secondary air designs and materials. Furthermore, secondary air system designs are fairly complex and diverse (e.g., designs utilize various materials, valves, and other components), and the systems are subjected to rigorous environments. These factors create additional uncertainty regarding the durability of these systems, which may result in staff approving non-durable 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 that many manufacturers execute their diagnostics during vehicle warm-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, staff proposes to require all vehicles to indicate a secondary air system fault 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.

To provide manufacturers with sufficient lead-time to comply with the new requirements, a phase-in is proposed beginning with the 2005 model year for Low Emission Vehicle II applications. Accordingly, for the 2005 and 2006 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 be required to incorporate an additional airflow diagnostic that is correlated to emissions during an intrusive operation later in the same drive cycle. By 2007 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 1percent 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 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. Hence, staff is proposing to require continuous monitoring of

the primary and secondary oxygen sensors' circuit continuity and out-of-range values for malfunctions. In addition, continuous monitoring for any malfunction of the 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) will be required. For heated oxygen sensors, continuous monitoring will also be required for all circuit continuity faults of the heater circuit. 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 will help to pinpoint the oxygen sensor as the malfunctioning component if a circuit problem is occurring.

## 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 fixed at a low or high reading, many diagnostics would not be enabled.

Currently, the OBD II regulation includes separate monitoring requirements for 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 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 determine when the coolant temperature is taking too long to reach the closed-loop enable temperature, the OBD II 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 OBD II 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.

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 OBD II regulation was first adopted. Therefore, the current maximum allowable warm-up time thresholds may be too lenient.

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.

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. In order to clarify the various engine cooling system requirements, staff is consolidating them into one section of the OBD II regulation under the "engine cooling system" diagnostic heading. Many of the requirements themselves are not new. The most significant modification to the engine cooling system diagnostic requirements involves the time-to-closed-loop monitor.

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 2005 and subsequent model year vehicles certified to Low Emission Vehicle II standards.

Concerning the thermostat monitor in vehicles with inordinately large interiors to be heated, 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.

## 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 control strategies to reduce these cold start 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 hot 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% 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 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 enough 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 some other malfunction, a fault would need to be indicated. 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. This requirement would apply to 2005 and subsequent model year 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. 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 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.

Amendments are being proposed to require manufacturers using alternate engine control strategies to monitor when either type of malfunction mentioned above

occurs. 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.

Similar to other requirements in the regulation, 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.

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. VARIABLE VALVE TIMING CONTROL SYSTEM

Many of today's vehicles utilize variable valve timing primarily to optimize engine performance. Variable valve timing 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, 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 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, staff is proposing specific requirements for monitoring variable valve timing 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 deviates from the commanded valve timing such that 1.5 times the applicable FTP emission standard would be exceeded.

## 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 amendments follow the requirements 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 component has deteriorated to a level that correlates to a malfunction that causes tailpipe emissions to exceed 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 amendments would allow manufacturers to use the direct ozone reduction system to offset tailpipe HC emissions for two 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 amendments would only allow manufacturers to use 50% 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 amendments 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 were too low. After considering these comments, the staff is proposing thresholds of 2.5 times the standards (2.5 threshold) for SULEVs, 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 emission and OBD 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 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 threshold of 1.5 times the 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 allow manufacturers to have 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. Staff will monitor the industry's progress in meeting these challenges and revise the thresholds as necessary.

## 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 the increasingly more 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) 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, there is some recent indication 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 amendments 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 amendments 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 monitoring amendments would require monitoring of reduction catalysts for proper conversion capability. Monitoring of oxidation catalysts, 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 amendments 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. And, 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 simply be required to perform a functional monitor 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 amendments for PM trap monitoring would require monitoring of the PM trap for proper performance. The malfunction threshold for a PM trap, however, would not be based on a specific emission level. Rather, manufacturers would simply 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 of the PM trap would not cause emissions to exceed 1.5 times applicable standards.

For 2004 and subsequent model year light-duty vehicles and 2007 and subsequent model year medium-duty vehicles, the proposed amendments for PM trap monitoring would require monitoring of the PM trap for proper performance. Manufacturers would be required to indicate a PM trap malfunction when the capability of the PM trap system 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 simply be required to perform a functional monitor and indicate a malfunction when no PM trap capability could be detected.

## 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 in 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 amendments 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 amendments would allow the use of a fifth protocol known as 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 proposed amendments would phase 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 proposed amendments would also eliminate a provision that currently exists for manufacturers to use an alternate protocol known as SAE J1939. 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 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, however, all of the medium-duty vehicles certified to OBD II requirements have used one of the other four allowable protocols, and the provision for J1939 has not been used or even requested by any manufacturer. 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. The elimination of this provision will ensure that all of the I/M stations in California are not required to purchase additional equipment solely to be able to inspect some medium-duty vehicles that may exist in the future.

Upon hearing of the proposed amendments to eliminate J1939, one manufacturer (that currently uses one of the other allowable protocols) has, however, recently indicated that it has future plans to use J1939 in a medium-duty application certified to the OBD II requirements. The benefits of standardization across the industry to technicians, consumers, and I/M inspectors, however, outweigh the continuation of this provision solely to accommodate the future plans of one manufacturer.

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 lieu of traditional tailpipe emission tests in state I/M programs. The readiness status of several major emission control related 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 the on-board computer has been recently cleared (e.g., by a technician clearing fault codes or disconnecting the battery). Many drivers or technicians have tried to avoid "failure" designations by disconnecting the battery and clearing the computer memory prior to inspection, so that any pre-existing fault codes are erased and the malfunction indicator light (MIL) is extinguished. Readiness flags were developed to prevent this type of fraudulent testing. 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), so these drivers may 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.

To address these issues, several amendments have been added to the regulation to help technicians determine if the memory had recently been cleared, either after repairs or fraudulently. Beginning with 2005 model year vehicles, 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 will be able to determine if unset readiness codes or an extinguished MIL are due to recent clearing of the memory. Amendments 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 the conditions necessary to set all the readiness flags to 'complete' are currently present. Using this information, technicians should be able to more easily exercise the various monitors on the vehicle prior to sending the customer back to an I/M inspection.

The revised OBD II-I/M program has raised issues regarding the effect on consumers due to 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, staff is proposing an optional requirement allowing manufacturers to communicate 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 amendment. 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 all emission-related fault codes to be reported in a standardized format and be 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 amendments 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 things like 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.[9] 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 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 exactly 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 amendments define 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. And, lastly, the amendments would provide further clarification to two existing parameters (engine load and throttle position) to ensure consistent use by all manufacturers. To provide a smooth transition, the proposed amendments would require manufacturers 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. When the OBD II system determines that an emission-related malfunction does exist, the MIL is illuminated and a fault code is stored

[9] 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.

in the on-board computer identifying the failing component or system. To help service technicians in verifying repairs and diagnosing intermittent problems, a “pending” fault code is stored in the on-board computer upon initial detection of a malfunction. 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.

Presently, manufacturers are allowed to use two different formats to identify “pending” malfunctions, but this has led to unnecessary confusion and difficulty for repair technicians. The proposed amendments would require manufacturers to report all “pending” malfunctions in the form of a “pending” fault code. 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. 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. 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, proposed amendments 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 ARB is in the process of adopting a stand-alone service information regulation in a separate rulemaking that will identify, in a single regulation, all of the service information requirements that manufacturers must meet. Proposed amendments to the OBD II regulation would clarify that the service information regulation will supercede the redundant service information requirements currently 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 required from 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. However, to minimize the testing burden this places on manufacturers who are required to test more than one vehicle per year, the proposed amendments 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 when the official FTP test procedures are followed but 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 proposed amendments would allow manufacturers to submit data from vehicles aged to high mileage with an approved ADP process. It should be noted, however, that even though the amendments 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 APPLICATION REQUIREMENTS

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

The proposed amendments 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. However, when selecting the representative test group, the manufacturer will need to consider 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 proposed amendments would also require only essential OBD II information 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.

## 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" 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, amendments are proposed to require manufacturers 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 proposed amendments, 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. 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 being tested to the same level of stringency, the proposed amendments would require the ARB to work with the vehicle manufacturers and OBD II scan tool manufacturers to develop a common piece of hardware and software which could be used by all vehicle manufacturers at the end of the assembly line. 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. Since all manufacturers would be held responsible to the results of the testing with this equipment, the proposed amendments for verification testing would not be implemented until this "gold standard" equipment is finalized and available to all manufacturers.

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 a custom designed tool 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, amendments are proposed that would require manufacturers to perform a thorough level of validation testing on one to three actual production vehicles per model year. 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 within 90 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, any problem discovered during this self-testing by the manufacturer should be evaluated for qualifying as a deficiency, whereas problems discovered later by the ARB staff during in-use testing would become non-compliance issues.

C. Verification and Reporting of In-use Monitoring Performance

One of the newly proposed amendments requires manufacturers to 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 amendments are discussed in more detail in section IX. Essentially, these amendments 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 amendments to measure in-use monitoring frequency, amendments are being proposed that would require manufacturers to collect this in-use data during the first six months after production begins. This would provide the ARB with early indication that the system is performing adequately. Manufacturers would be required to submit a data collection plan that would effectively collect a small sample of in-use monitoring frequency data representative of every test group certified by the manufacturer. Since the number of cars in a test group varies greatly from model to model and manufacturer to manufacturer (e.g., a relatively low number of Ferraris exist compared to high volume sellers such as full size pick-ups), the requirements would not set a definitive number of vehicles that need to be sampled. Instead, they would require the manufacturer to submit a plan for review and approval by the Executive Officer. This would also 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.

It is important to note, however, that the data collected in this program may not necessarily meet the requirements that the ARB would be required to follow when collecting data under the in-use test procedures identified in the proposed enforcement procedures in Title 13, CCR, 1968.5. This data 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. 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 amendments 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 to be met to qualify for a deficiency. For one, manufacturers are required to demonstrate that a good-faith effort was made to comply with the requirements in full. Additionally, there are limitations on how many model years a manufacturer may "carry-over" the deficiency before it has to be corrected. Moreover, manufacturers are subject to fines for every vehicle built with more than two deficiencies.

As can be expected, the deficiency provisions were used most often in the early model years of OBD II implementation. As such, the current requirements allow two "free" deficiencies through 2003 before dropping to one "free" deficiency thereafter. 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.

The proposed amendments would continue indefinitely the existing provisions for two "free" deficiencies before the vehicles are subject to fines. The existing fine structure, qualifications for a deficiency, and limitations on carry-over would continue to apply.

The regulatory language regarding deficiencies has been modified 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 in-use testing.

The regulatory language has also been modified to clarify that carry-over of deficiencies is not 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 are only allowed to carry-over deficiencies when the situation warrants the additional time.

Lastly, the proposed amendments would explicitly prohibit the Executive Officer's authority to grant a deficiency in some situations. As discussed in more detail in section X. below, 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 amendments 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

In designing OBD II monitors, manufacturers must define enable conditions such that, when the conditions are met, the monitor will execute and make a judgment as to whether the component or system is malfunctioning. Manufacturers must design these enable conditions such 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. Additionally, 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 light of a recent enforcement case involving Toyota and excessively restrictive enable conditions required to execute their evaporative system monitor, the benefits of explicitly stating such requirements have become apparent.

The proposed amendments would require all manufacturers 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 a minimum acceptable frequency of monitor operation. The amendments would 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 both 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 frequency of monitor operation relative to vehicle operation can be determined.

The proposed amendments would establish a minimum acceptable frequency that roughly correlates to a two week time period. Thus, a monitor that can illuminate the MIL in less than two weeks of driving when a malfunction occurs would meet the minimum frequency requirement. As stated above, 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 have been unsuccessful, however, these amendments would likely make it easier for the ARB to identify their problematic monitors.

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 will be selected, how many vehicles will be selected, how the data will be gathered, and what criteria will be 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.

A. <u>Detailed description of software counters to track real world performance</u>

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:

$$\text{Real World Performance (Ratio)} = \frac{\text{Number of Monitoring Events (Numerator)}}{\text{Number of Driving Events (Denominator)}}$$

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 routine service or maintenance has been performed.

Further, the numerator and denominator will 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). 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 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 (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 is currently working with industry and SAE to develop standards for storing and reporting the data to a generic scan tool. This will also help ensure that all manufacturers report the data in an identical manner and thus help facilitate data collection in the field.

B. 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 will 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 (not “passing” systems), and thus, the real world ability of the monitors to detect malfunctions (i.e., reach a “fail” decision) is the parameter that needs to be measured.

It is imperative that manufacturers implement the numerators correctly to ensure a reliable measure for determining real world performance. “Overcounting” will falsely indicate the monitor is executing more often than it really is, while undercounting will 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.

C. Number of driving events (“denominator”)

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 each time the vehicle is operated.

While 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, a complete consensus has not yet been reached. 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 will 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 20º Fahrenheit, etc.), when most monitors are legitimately disabled or have little chance of completing.

Industry, on the other hand, has suggested the use of a definition that “filters out” these particular driving events. Thus, industry proposes 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 20-100º Fahrenheit, and altitude less than 8000 feet. Additionally, industry proposes 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.

The primary criticisms of industry's proposal are the added complexity for the "filtered" denominator calculation and the relatively unknown effect this "filtering" will have on the total number of vehicle trips. At this point, it is unknown what percentage of total vehicle trips this "filtered" denominator would not count as valid trips. Data analysis previously done for the U.S. EPA indicates that, at a minimum, this "filtered" denominator would eliminate over 50% of the total vehicle trips based on the total length of the trip alone,[10] and that the additional criteria regarding vehicle speed and idle would only serve to further eliminate more trips. While it is not imperative that every vehicle trip be counted in the denominator, it is important to know what portion of the total trips is being excluded for purposes of establishing the minimum acceptable frequency. Not knowing the number of trips that occur in two weeks based on the "filtered" denominator definition makes it extremely hard to establish a minimum acceptable frequency that loosely correlates to a malfunction indication in two weeks.

At this time, the proposed amendments would require manufacturers 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 well the "filtered" denominator works in the real world. This would also provide valuable information needed to "fine-tune" the minimum acceptable performance level (or ratio) to closely agree with the design target of a malfunction indication in two weeks for the majority of the people.

D. Minimum acceptable frequency ("ratio")

Determining how frequent is "frequent enough" is a difficult task that requires consideration of several different factors, including, but not limited to, the technical capability of OBD II systems, the severity of the malfunction, the consequences of delayed detection and repair of the malfunction, and expected driver habits. The proposed amendments would attempt to simplify this task by specifying a minimum acceptable frequency in a quantifiable format. In establishing the appropriate value for the minimum acceptable frequency, the factors listed above were considered as well as the estimated monitoring frequency of typical current monitors, estimated consumer response/reaction in responding to detected malfunctions, and expected consumer driving patterns and habits.

Taking these factors into account, the proposed minimum acceptable frequency would be set to roughly ensure that monitors would be capable of detecting

[10] Over 58% of vehicle trips are shorter than 10 minutes as reported in "Travel Trip Characteristics Analysis", Sierra Research, September 29, 1994.

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 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.) and maximize the chance for monitors to execute. As such, the proposed amendments would define a minimum frequency that approximately equates to a malfunction detection within two weeks for 90% of the population. By structuring the requirements around "90% of the population" instead of 100%, manufacturers would not be held liable for vehicles operated in an extremely unique or rare manner, and the ARB would not have to accept a minimum frequency that represents the absolute worst case.

Until both industry and the ARB reach a consensus on the definition to be used for the denominator, the exact minimum acceptable frequency cannot be defined. For illustration purposes, however, the ratio can be estimated based on the currently proposed definitions. For example, with the ARB's proposal of "key-starts" as the denominator, a minimum acceptable frequency could be calculated as follows. From real world driving data that has been collected for the U.S. EPA or ARB in the past, vehicles, on average, are started approximately 6.94 times per day. Thus, in a two week period, an average vehicle would have about 97.2 starts. However, if you want to account for 90% of the population, the numbers change fairly dramatically. For instance, 90% of the vehicles averaged 2.1 or more starts per day, which equates to only 29.4 starts per two weeks. As most monitors require a malfunction to be detected twice before the MIL is illuminated, a monitor would only need to run two times out of 97.2 starts (2.1% of the time) for an average car, but would have to run two times out of 29.4 starts (6.8% of the time) to cover 90% of the vehicles. Therefore, a denominator defined as "ignition cycles" would dictate a minimum acceptable frequency of something like 6.8%.

A "filtered" denominator as industry has proposed, however, would dictate a different numeric value for the minimum acceptable frequency. Using the same data but only filtering out vehicle trips shorter than 10 minutes, an average vehicle gets 2.89 "filtered" trips per day for a total of 40.46 in two weeks. Accounting for 90% of the vehicles, the number drops to 0.88 "filtered" trips per day for a total of 12.32 in two weeks. Using the same method as above, this would correspond to a frequency of 4.9% for an average car and a minimum acceptable frequency of 16.2% to cover 90% of the cars. These numbers do not, however, account for the additional filtering that industry has proposed including ambient temperature, altitude, average vehicle speed, idle time, etc. Thus, it is expected that these additional criteria will further eliminate some trips and, directionally, result in much higher minimum acceptable frequencies.

Once the definition of this "filtered" denominator is finalized, the ARB and industry will need to analyze the existing data to try and determine the appropriate minimum acceptable frequency. Staff is seeking comments and proposals from industry

on methodology and data analysis to better determine this minimum acceptable frequency.

E. Compliance testing sampling procedure

The last part of this real world monitoring performance proposal includes amendments that would define a test procedure to be followed using this newly adopted methodology. As all vehicles would be required to store both numerators and denominators, the test procedure would be necessary primarily to ensure an adequate number of vehicles are sampled to make an accurate decision as to whether the tested vehicles meet the minimum acceptable frequency.

The proposed test procedure would also establish guidelines for the ARB to follow when determining appropriate sample size and selecting vehicles to be included in the test program (e.g., excluding non-California certified vehicles and vehicles that have not accumulated a sufficient amount of data to be considered representative). The current proposal would require ARB to collect data from 20 vehicles for the first phase of testing. If the vehicles, on average, were below the minimum acceptable frequency, the ARB would proceed to the second phase of testing. In the second phase, ARB would be required to collect data from an additional 40 vehicles. If less than 90% of the vehicles exceeded the minimum acceptable frequency, the ARB would pursue remedial action. Manufacturers would, however, have the option to collect additional data to rebut the ARB's findings. The manufacturer would be required to submit a plan to the ARB for review and approval of the intended data collection program prior to initiating the additional data collection. The ARB would then consider both the manufacturer's data and the previously collected data in deciding whether or not to pursue remedial action.

## X. PROPOSED ADOPTION OF ENFORCEMENT PROVISIONS SPECIFIC TO OBD II SYSTEMS

A. Overview

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 authority to adopt enforcement and test procedures.[11] 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 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.

[11] Health and Safety Code, sections 43102, 43104, and 43105.

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 in Title 13, CCR, Section 2, Articles 2.0 through 2.4, do not adequately address the unique issues involved in enforcing the OBD II regulation. This fact became readily apparent in a recent administrative enforcement action, when the administrative law judge incorrectly concluded, in the opinion of the ARB staff, that the ARB must show in an action to recall non-compliant OBD II systems that the non-compliance causes an emissions exceedance of the entire fleet on average. Specific OBD II enforcement provisions are necessary to better address and identify the special circumstances involved in in-use testing and remedial orders to correct any identified deficiencies. The staff believes that this will provide manufacturers with better notice of their rights and responsibilities and assure a more full and fair administrative process.

B. Applicability

The proposed enforcement procedures would be applicable to all 2003 and subsequent model year vehicles equipped with OBD II monitoring systems that have been certified for sale in California. Most, if not all, of the requirements for that model year have been carried-over from the requirements set forth in section 1968.1, and manufacturers have been on notice of all of those provisions since at least December 1996. 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, would be ordered for noncompliance. For the most part, the proposed enforcement protocol only seeks to clarify existing Board authority to enforce the OBD II regulation; accordingly, additional lead-time after these enforcement provisions become effective would not appear to be warranted.

C. In-Use Testing Procedures

The proposed in-use test procedures would assure that OBD II systems on production motor vehicles and engines conform with motor vehicles and engines certified by the ARB and comply with the requirements of section 1968.2. To this end, the ARB is proposing that it periodically evaluate test sample groups of vehicles and engines from a motor vehicle class determined by the Executive Officer to be equipped with sufficiently similar OBD II systems.

The Executive Officer would also initially determine the appropriate number of vehicles to test within the motor vehicle class (i.e., the size of the test sample group). The exact size of the test sample group would depend on the scope of the motor vehicle class and the nature of the OBD II non-compliance issue to be tested.

After the vehicle test sample group has been selected, the ARB would conduct one or more different tests. To determine the frequencies of operation of non-continuous major monitors, in-use testing would entail the ARB staff attaching a scan

tool to download information indicating the ratio for each monitor (i.e., the number of times a monitor ran compared to the defined number of trips the vehicle has made). To test whether a vehicle's MIL has illuminated prior to the established emission threshold criterion being exceeded, the ARB would replace components monitored by the OBD II system with components sufficiently deteriorated or simulated to cause malfunctions that exceed the malfunction criteria. The ARB or its designated representative would then operate the vehicle, as appropriate, on a dynamometer over the applicable FTP, or would conduct on-road testing. When tested, the vehicles would be driven in a manner that would reasonably assure that all of the monitoring conditions disclosed in the manufacturer's certification application for the tested monitor are encountered.

If testing indicates that the OBD II system of a motor vehicle class is suspected of being non-compliant, the Executive Officer would be required to provide the manufacturer with a preliminary notice of the test results. The proposed regulation would require that such notice include all relevant supporting information regarding the Executive Officer's determination of appropriate test sample size and all test data 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. The Executive Officer would consider all information submitted by the manufacturer in ultimately determining whether an OBD II system is nonconforming. Upon consideration of the information submitted by the manufacturer, the Executive Officer may decide whether additional in-use testing is necessary. In such a case, the Executive Officer would request that the manufacturer provide a reasonable number of vehicles for testing. The Executive Officer's request would not exceed the number of vehicles the manufacturer has itself identified as the appropriate sample size. The regulations would establish a presumption that a motor vehicle class is nonconforming if a manufacturer fails to provide the requested vehicles. Placing the responsibility for vehicle procurement on the manufacturer is both necessary and appropriate since the manufacturer has the greatest access to its vehicles.

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

D. Remedial Action

If the Executive Officer determines that a manufacturer is in noncompliance, the proposed enforcement regulations would provide the Executive Officer with authority to order progressive forms of remedial action scaled to the level of noncompliance. The regulations would set forth a detailed set of factors that the Executive Officer would consider in determining the appropriate remedy. Possible remedies would range from

penalties similar to those that exist under the present deficiency program in the OBD II regulation (Title 13, CCR, section 1968(m)(6.0)) to recall of the affected motor vehicle class.

After notification of noncompliance from the Executive Officer, a manufacturer would have 30 days to elect to conduct a voluntary 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, including recall and monetary penalties.

The proposed regulation would clarify that in ordering a recall of a nonconforming OBD II system, the ARB would not need to demonstrate that the nonconforming system directly causes a present, quantifiable increase in the tailpipe or evaporative emissions of the entire affected motor vehicle class. The recall of an effectively nonfunctional monitor is necessary because it defeats the purposes and objectives of the OBD program. It has been the long-standing position of the ARB that it is necessary to 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.[12] As stated, it is beyond dispute that as motor vehicles age and accumulate high mileage, emission control systems deteriorate and increasingly malfunction, causing emissions from motor vehicles to increase.[13] 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 do occur. To minimize potential emission increases in future years, it is imperative that the identified nonfunctional OBD II systems be recalled and repaired at the time noncompliance of the systems is discovered. No one knows how well emission control systems of different manufacturers will work 10 to 15 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.

Staff is proposing regulation (specifically section 1968.5(c)(3)(A)) that would mandate the recall of the most serious nonconforming OBD II systems. Under 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 vehicle's be certified with OBD II systems that monitor all major emission-related components so that malfunctions may be quickly detected and

---

[12] Refer to ARB Manufacturers Advisory Correspondence No. 87-06 (July 1, 1987).

[13] California Department of Consumer Affairs, Bureau of Automotive Repairs, Executive Summary, 2000/01.

repaired.[14] The regulations were developed to provide assurance that late-model in-use vehicles retain their emission control capabilities near certification levels 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 regulations. 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 concluded that systems that operate below these levels are basically nonfunctional and need to be repaired or replaced.

By specifying minimum performance levels, below which a system would be considered nonfunctioning and in need of recall, the ARB 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 manufacturer 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 to be functional.

In addition to being subject to mandatory recall, the Executive Officer may assess the manufacturer monetary penalties pursuant to the authority granted by the Health and Safety Code.[15] In assessing 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)(3)(C).

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 the nonconformity, including, but not limited to, the factors specifically set forth in sections 1968.5(c)(3)(B) and (C). 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, with little or no penalty assessment. In cases where the problems with the nonconforming OBD II system may be more

---

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

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

significant, a greater form of remedial action might be appropriate and may include remedies such as extended warranties or service campaigns to help mitigate the potential problems caused by the nonconforming OBD II system. In such cases, greater monetary penalties may also be warranted. In the most serious cases, where the Executive Officer determines that the OBD II system, taken as a whole, is largely nonfunctional, the Executive Officer would have authority to order the recall of the nonconforming systems as well as assess monetary penalties. Again, in determining monetary penalty assessments, the Executive Officer would be required to consider various factors, including, but not limited to, those set forth in section 1968.5(c)(3)(C).

E. 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. 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 action.

F. 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 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. The new regulation is proposed for several reasons. First, the OBD II enforcement provisions are considered, in many ways, unique, and for purposes of clarity should be self-contained. The existing provisions pertain to just recalls, and primarily focus on general failures of emission-related parts and general violations of the ARB tailpipe and evaporative emission regulations. A self-contained OBD enforcement section is necessary to specifically address all forms of remedial action to correct nonconforming OBD II systems and to specifically identify the technically unique issues that arise in the OBD II context.

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

Staff is proposing 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 Health and Safety Code section 43105 and would subject the non-compliant 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.