



Winston H. Hickox
*Secretary for
Environmental
Protection*

Air Resources Board

Alan C. Lloyd, Ph.D.
Chairman

9528 Telstar Avenue • P.O. Box 8001 • El Monte, California 91731 • www.arb.ca.gov



Gray Davis
Governor

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

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

Background

The Board originally adopted section 1968.1 of Title 13, California Code of Regulations on September 14, 1989. The section contains the malfunction detection and diagnostic system requirements known as OBD II. The Board adopted amendments to the regulation in 1991, 1993, 1994, 1996, and most recently in November 1998. These amendments were adopted to address manufacturers' concerns, improve the effectiveness of certain requirements and clarify portions of the regulatory language.

At the December, 1996 hearing, the Board directed the staff to continue to follow manufacturers' progress towards meeting the OBD II requirements, and to report back in two years should modifications to the requirements be deemed appropriate. Such modifications are not necessarily proposed to address technical feasibility issues, but may be deemed appropriate on the basis that they clarify certain areas of the regulation, provide better compliance flexibility, allow for a more cost-effective implementation of the OBD II requirements, conserve developmental resources, or for other similar reasons.

The next update to the Board will be scheduled for later this year. The staff will review manufacturers' progress in meeting OBD II requirements and propose amendments regarding implementation of some monitoring requirements that are already adopted such as thermostat and misfire monitoring. Further, proposals will be discussed for malfunction thresholds for vehicles certified under the LEV II program and monitoring of the catalyst's capability to convert oxides of nitrogen (NOx) emissions.

In order to consider further amendments, ARB staff would also like to review catalyst aging methods with industry and the emission impacts of pressure-based evaporative system monitoring. In addition, with respect to recently adopted emission standards and test procedures (i.e., LEV II standards and air conditioning test cycles/standards), the staff will express its concerns about proper performance of the emission control system while special control strategies (e.g., cold starting and air conditioning) are invoked.

Workshop Information

The staff is scheduling a workshop and requests comments from industry in these areas. The workshop will be held Wednesday, June 30, 1999, from 9:00 A.M. to 5:00 P.M. to discuss these issues and obtain information to further formulate specific proposals prior to the release of the public hearing notice and Staff Report. The workshop will be held at:

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

An electronic version of this notice and supporting regulatory documentation will be available on the ARB's web page at www.arb.ca.gov/msprog/obdprog/obdprog.htm.

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

Manufacturers unable to participate in the workshop or those wishing to supply additional information are encouraged to submit written comments by June 23, 1999. Written comments should be sent to the following address:

Mr. Robert H. Cross, Chief
Mobile Source Control Division
Air Resources Board
P. O. Box 8001
El Monte, CA 91734-2301

Workshop participants wishing to discuss unresolved technical issues or confidential data may schedule individual meetings with staff. Please contact Mr. Allen Lyons, Manager, Advanced Engineering Section, at (626) 575-6833 to schedule an individual meeting time and date.

Sincerely,

Robert H. Cross, Chief
Mobile Source Control Division

Attachment

Attachment

State of California AIR RESOURCES BOARD

Discussion and Proposed Amendments to Title 13 CCR Section 1968.1 “Malfunction and Diagnostic System Requirements--1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines”

Introduction

With implementation of the OBD II requirements now well underway, input from manufacturers, service technicians, and in-use evaluation programs indicate that the program is very effective in finding emission problems and facilitating repairs. Overall, 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 we pledge to continue to work closely with industry in meeting the remaining issues as OBD II is revisited to account for changes resulting from adoption of the Low Emission Vehicle II program in November, 1998. While a few new requirements are outlined below, most are aimed at refining the program, better serving repair technicians, and improving incorporation of OBD II into I/M programs. ARB's current position and proposals regarding the issues to be discussed are summarized below.

Catalyst Monitoring

The current OBD II regulation requires monitoring of the catalyst for malfunctions affecting hydrocarbon conversion efficiency. Manufacturers have successfully certified catalyst monitors to the most stringent current catalyst malfunction threshold of 1.75 times the ULEV HC standard. However, data from OBD II demonstration vehicles show NO_x emissions can be high when HC emissions reach the malfunction threshold. Examination of a cross section of certification data shows that while NO_x emissions are on average about 1.3 times the 100,000 mile standard when NMHC emissions are at the malfunction threshold, a few vehicles exhibited NO_x emissions as high as 2.6 times the NO_x standard at 100,000 miles. At the other end of the spectrum, some vehicles exhibited NO_x emissions at only 0.2 times the standard when at the malfunction threshold for HC. The level of NO_x emissions when the catalyst is at the HC threshold appeared to be independent of the certification category (i.e., TLEV, LEV, ULEV, etc.) or malfunction criteria (i.e., whether the vehicle has an interim malfunction threshold or the threshold is 1.75 times the HC standard) of the vehicle.

With the significant reduction in NO_x emission standards under the LEV II program (the NMOG standards for the LEV and ULEV categories remain unchanged), NO_x emission levels using current HC threshold catalysts would be unacceptably high. Data from a 1999 model year OBD II demonstration vehicle having certification emission levels below the LEV II standards for

the ULEV category show NO_x emissions approximately 2.3 times the LEV II NO_x standards when the catalyst is at its HC malfunction threshold. In order to maximize the NO_x emission reductions associated with the LEV II program, staff is proposing a NO_x-based catalyst monitoring requirement for these vehicles in addition to the HC-based requirement. The staff proposes a malfunction criterion of 1.75 times the NO_x standard or 50 percent conversion efficiency for the monitored portion of the catalyst; the catalyst would be malfunctioning when either condition is exceeded.

Adjustment of current catalyst monitoring strategies will likely be used to establish an HC/NO_x monitoring strategy. The ARB has reviewed data from one source (a European catalyst supplier) that shows a relationship between oxygen storage and NO_x conversion efficiency that is better (more linear) than the relationship between oxygen storage and NMHC emissions. Therefore, the staff believes with proper choice of monitored catalyst volume, precious metal loading, washcoat formulation, and oxygen storage component tailoring, manufacturers should be able to meet a NO_x-based catalyst monitoring threshold.

Other monitoring technologies, such as the use of a NO_x sensor, might also be used to meet the staff's proposed requirement. NO_x sensor technologies have been presented in a number of SAE papers (SAE Reference Numbers 1999-01-1280, 980266, 980170, and 970858). These technologies continue to evolve and may be viable candidates for NO_x catalyst monitoring. Another method for monitoring catalyst efficiency is to evaluate the light off characteristics of the catalyst using a catalyst temperature sensor. This method was discussed in the recently published SAE paper 1999-01-0311, "Closed Loop Temperature Feedback for Controlled Catalyst Lightoff and Diagnostics for ULEV." While the paper focused on HC conversion efficiency and HC-based catalyst monitoring, this method offers similar potential for NO_x efficiency monitoring. Additional data and analysis supplied by the manufacturer showed trends that are similar for NO_x emissions and catalyst light-off characteristics. Addition of a catalyst temperature sensor or a NO_x sensor may also provide manufacturers with secondary benefits such as enhanced fuel control.

The staff proposes that the NO_x efficiency monitoring requirement be phased-in with the introduction of vehicles meeting the LEV II standards (2004-2007). This would provide manufacturers with lead time to make any necessary catalyst system configuration changes and would ensure that adequate monitoring is in place as manufacturers begin to certify high volumes of vehicles to the LEV II NO_x standards. The proposal would not require vehicles that are certified to the LEV II standards prior to the 2004 model year to meet the NO_x monitoring requirement (except for SULEVs receiving a partial ZEV allowance), but manufacturers may wish to do so to avoid reconfiguration of a carry-over package in 2004 and beyond.

The staff proposes to amend sections (b) and (n) of the OBD II regulation as follows:

(b)(1.2.4) LEV II applications (LEV II is defined section (n)(14.0)): Beginning with the 2004 model year on LEV II applications, the catalyst system shall be considered

malfunctioning when its conversion capability decreases to the point that either of the following occurs: 1) hydrocarbon (HC) or oxides of nitrogen (NOx) emissions exceed 1.75 times the applicable FTP emission standard, or 2) the average Federal Test Procedure (FTP) Non-Methane Hydrocarbon (NMHC) or NOx conversion efficiency of the monitored portion of the catalyst system falls below 50 percent. Regarding the first criterion, the malfunction threshold shall be based on the emission standards to which the vehicle is certified. Hydrocarbon emissions shall be multiplied by the certification reactivity adjustment factor for the vehicle. Regarding the second criterion, the efficiency determination shall be based on an FTP test wherein a malfunction is noted when the cumulative NMHC or NOx emissions measured at the outlet of the monitored catalyst(s) are more than 50 percent of the cumulative engine-out emissions measured at the inlet of the catalyst(s). The requirements of section (b)(1.2.1) shall apply to LEV II applications certified prior to the 2004 model year. Notwithstanding, SULEVs receiving a partial ZEV allowance shall comply with these requirements even if introduced prior to 2004.

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

The following changes are proposed for the glossary to incorporate the LEV II emission standards:

- (n)(14.0) "Low Emission Vehicle" refers to a vehicle certified in California as a Transitional Low Emission Vehicle (TLEV), a Low Emission Vehicle (LEV), ~~or~~ an Ultra Low Emission Vehicle (ULEV), or a Super Ultra Low Emission Vehicle (SULEV). These vehicle categories are further defined in Title 13, sections 1956.8, ~~and~~ 1960.1, ~~and~~ 1961 as adopted on [Insert last amended/adopted date]. The LEV II emission standards are contained in Title 13, CCR section 1961.

Catalyst Aging Methods

Manufacturers use varying methods during development to deteriorate catalysts to the threshold necessary for MIL illumination. Manufacturers have indicated they prefer a method that allows them to controllably, progressively, and quickly age catalysts with repeatable results. A number of aging methods have been used with varying degrees of success. These methods include oven aging; aging with misfire on an engine dynamometer, chassis dynamometer, and on the road; aging on an engine dynamometer with cycling of the air/fuel ratio and/or air injection; and poisoning. However, the staff is concerned that some aging methods currently being used by manufacturers may not be representative of real world deterioration and MIL illumination may not be timely for in-use failures. Therefore, the staff is considering setting guidelines regarding acceptable catalyst aging methods. Manufacturers are invited, either at the workshop or in private meetings, to discuss their aging methods and correlation to in-use deterioration. The staff would like to see data from in-use catalyst failures to the extent such data are available.

Demonstration Testing

Some manufacturers have raised issues regarding the demonstration testing requirements in section (g) of the OBD II regulation in light of the recently adopted CAP 2000 certification procedures. Section (g) of the regulation requires a manufacturer to provide OBD II-related emission test data from a certification durability vehicle or, with Executive Officer approval, a representative high mileage vehicle. In practice, the ARB has accepted data from vehicles with a minimum of 75,000 miles. Manufacturers indicate that certification durability vehicles are not readily accessible by their OBD II engineering groups, and that it is difficult to obtain suitable high mileage vehicles for OBD II demonstration purposes prior to emission certification. In addition, new alternative durability programs reduce the number of high mileage vehicles available for OBD II demonstration testing. There is concern by ARB, however, that fewer demonstration vehicles will result from the trend in industry toward consolidation of manufacturers. Consolidation reduces the number of demonstration test vehicles that ARB can select each year although the amount of engine families/test groups remains much the same.

In considering these issues, ARB proposes to increase the number of demonstration vehicles required each year but accept data from vehicles with bench-aged components or accelerated mileage accumulation. The number of demonstration vehicles would depend on the number of test groups a manufacturer plans to certify in a particular model year. Although the staff's proposal would allow the OBD II system to be demonstrated with bench-aged components, manufacturers would remain liable for compliance with OBD II emission thresholds on vehicles in-use. For this reason, the ARB encourages manufacturers to calibrate their OBD thresholds on high mileage vehicles where all the 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 were not used during calibration, a manufacturer would likely need to

allow more margin when determining its malfunction thresholds.

The staff proposes the following changes to section (g) of the regulation:

- (g)(1.0) **REQUIREMENT** Each year a manufacturer shall provide emission test data obtained from a certification durability vehicle or vehicles for one or more test groups engine family that ~~has~~ have not been used previously for purposes of this section. If a test group designated for testing is different than the durability vehicle, the Executive Officer shall permit a manufacturer to satisfy this requirement with data from a representative high mileage vehicle or vehicles or from a vehicle or vehicles equipped with the appropriate bench-aged components. Bench-aged components used to satisfy the requirements of this section shall include the same components/systems and be aged by the same procedures as used for the durability vehicle of a test group designated for OBD II demonstration. For applications certified on engine dynamometers, engines may be used instead of vehicles. The Air Resources Board (ARB) shall determine the test group(s) to be demonstrated. Each manufacturer shall notify the Executive Officer prior to applying for certification of the test groups planned for a particular model year in order to allow selection of the test group(s) to be demonstrated. A manufacturer certifying one to five test groups in a model year shall demonstrate one test group. A manufacturer certifying six to ten test groups in a model year shall demonstrate two test groups. A manufacturer certifying eleven or more test groups in a model year shall demonstrate three test groups. If a manufacturer does not have a certification durability vehicle available which is suitable for the engine family designated for testing, the Executive Officer shall permit a manufacturer to satisfy this requirement with data from a representative high mileage vehicle or vehicles (or a representative high operating-hour engine or engines) acceptable to the Executive Officer to demonstrate that malfunction criteria are based on emission performance. The Air Resources Board (ARB) shall determine the engine family to be demonstrated. Each manufacturer shall notify the Executive Officer prior to applying for certification of the engine families planned for a particular model year in order to allow selection of the engine family to be demonstrated. Demonstration tests shall be conducted on the certification durability vehicle or engine at the end of the required mileage or operating-hour accumulation. For non-LEVs, until a NOx standard applicable for more than 50,000 miles is established in California, the federal 50,000 to 100,000 mile NOx standard shall be used for demonstration purposes.

The staff also proposes the following additional changes to section (g) of the regulation to include the proposed NOx monitoring requirements for catalysts and to obtain better documentation that the monitored catalyst efficiency is greater than 50 percent when a malfunction is determined. Staff proposes that manufacturers report catalyst efficiency values associated with the tailpipe emission values determined from the demonstration vehicle when equipped with deteriorated catalysts. Section (g)(4.4.5) is amended as follows:

(g)(4.4.5) For Low Emission Vehicle catalyst efficiency demonstration, if HC and NOx emissions do not exceed the applicable emission thresholds specified in sections (b)(1.2.2) and (b)(1.2.4), and the MIL is illuminated, no further demonstration shall be required. However, if HC or NOx emissions exceed the threshold and the MIL is illuminated, the vehicle shall be retested with average FTP HC or NOx (whichever is applicable) conversion capability of the catalyst system increased by no more than 5 percent (i.e., 5 percent more engine out hydrocarbons or NOx are converted). For the OBD II system to be approved, the vehicle must then meet the above emission levels when re-tested. The MIL shall not illuminate during this demonstration. Manufacturers shall also report the HC and NOx conversion efficiencies of the monitored portion of the catalyst system. Efficiencies less than 50 percent are not acceptable.

LEV II Malfunction Criteria

In November, 1998, the Air Resources Board adopted the LEV II emission standards for passenger cars, light-duty trucks, and medium-duty vehicles. These standards are applicable to 2004 and subsequent model year vehicles. The adoption of LEV II standards resulted in a number of changes for which there may be OBD II implications. A new light-duty vehicle emission category, super ultra low emission vehicle (SULEV) was created. The useful life emission standards for the SULEV category are 0.010 grams/mile NMOG, 1.0 grams/mile CO and 0.02 grams/mile NOx. Under the LEV II program, the NOx emission standard was also lowered for the LEV and ULEV emission categories from 0.3 grams/mile at 100,000 miles to 0.07 grams/mile at 120,000 miles.

The OBD II regulation specifies malfunction thresholds at 1.5 times the applicable FTP standards for many monitoring requirements including misfire, secondary air system, fuel system, oxygen sensor, and exhaust gas recirculation (EGR). Catalyst monitoring is an exception that specifies thresholds dependent on the hydrocarbon emission standards to which the vehicle is certified. Currently, the most stringent catalyst threshold is 1.75 times the ULEV HC standard. Manufacturers have successfully certified ULEV vehicles with full OBD II compliance for all OBD II monitors. The comprehensive component monitoring requirements do not specify malfunction criteria based on the emission standards. Comprehensive components that provide input to the computer are considered malfunctioning when their input values are not properly within their normal range. Comprehensive components that receive commands from the computer are considered malfunctioning when they do not properly respond to computer commands.

Manufacturers have expressed concerns about malfunction thresholds for low emission vehicles certified to the LEV II standards. Some manufacturers have simply commented that monitoring to 1.5 times the SULEV standards in particular may not be feasible considering the low emission levels. To date the ARB has reviewed very limited data from industry regarding the

feasibility of meeting malfunction thresholds based on 1.5 times the SULEV standards. The ARB has not received data from any one manufacturer demonstrating compliance for all OBD II monitors on a SULEV vehicle. However, the preliminary data from SULEV targeted vehicles are promising. In meetings with industry, one manufacturer was confident it could meet 1.5 times the SULEV standards for the fuel system and oxygen sensor monitor. Another manufacturer will illuminate the MIL for HC-based catalyst malfunctions at 1.75 times the SULEV standard for at least one model. Staff received preliminary data from one manufacturer for EGR monitoring showing that while NO_x emissions exceeded 1.5 times the SULEV standard, it appeared that the EGR malfunction threshold could still be lowered.

As discussed later in this workshop notice, staff proposes to limit misfire detection to 1.0 percent for all applications in order to ensure that such problems are “findable and fixable”. Therefore, misfire monitoring should not be an issue on SULEV applications. Comprehensive components should not be an issue either since their malfunction criteria are not based on emissions. Staff would like to examine SULEV data from other manufacturers as it becomes available.

Given these initial indications that the current monitoring thresholds may be feasible even for SULEVs, the staff is proposing to continue the current malfunction criteria (i.e, generally 1.5 times the applicable FTP standards and 1.75 times the applicable HC and NO_x standards for the catalyst) even for SULEV applications. Furthermore, since SULEV vehicles may qualify for partial ZEV allowances or “partial ZEV credits,” in-use emissions should be maintained at levels as close to the standards as possible to justify the credits. However, since the ARB wants to encourage the development and early introduction of SULEVs, staff proposes to apply the in-use recall threshold of 2.0 times the applicable standards in section (i)(5) of the regulation to vehicles certified to the LEV II emission standards through the 2005 model year.

Section (i)(5) is amended as follows:

- (i)(5) A decision to recall the OBD system for recalibration or repair will depend on factors including, but not limited to, level of emissions above applicable standards, presence of identifiable faulty or deteriorated components which affect emissions with no MIL illumination, and systematic erroneous activation of the MIL. With respect to erroneous activation of the MIL, the manufacturer may request Executive Officer approval to take action apart from a formal recall (e.g., extended warranty or a service campaign) to correct the performance of the diagnostic strategy on in-use vehicles. In considering a manufacturer's request, the Executive Officer shall consider the estimated frequency of false MIL activation in-use, and the expected effectiveness in relation to a formal recall of the manufacturer's proposed corrective action in capturing vehicles in the field. For 1994 through 1997 model years, on-board diagnostic system recall shall not be considered for excessive emissions without MIL illumination (if required) and fault code storage until emissions exceed 2.0 times any of the applicable standards in those instances where the malfunction criterion is based on exceeding 1.5 times (or 1.75 times for LEV catalyst

monitoring) any of the applicable standards. This higher emission threshold for recall shall extend through the 1998 model year for TLEV applications (except for catalyst monitoring, for which the threshold shall extend through the 2003 model year), ~~and through the 2003 model year for all applicable monitoring requirements on LEV and ULEV applications, and through the 2005 model year for all applicable monitoring requirements on LEV II applications.~~

Misfire Monitoring

In the past, manufacturers have expressed concerns about MIL illumination for misfire rates below 1.0 percent. At such low levels, the probability of false MIL illumination increases and misfire levels of 1.0 percent or less may be difficult to diagnose. Accordingly, staff proposes to set a lower limit on the level of misfire that is required to be detected. If the percent misfire causing emissions to exceed 1.5 times any of the applicable FTP standards is less than 1.0 percent, the manufacturer may limit the malfunction criterion for FTP misfire to 1.0 percent.

Section (b)(3.4.2)(B) of the regulation requires a temporary fault code to be stored and subsequent MIL illumination if the misfire level is exceeded within the first 1000 revolutions from engine start. Some manufacturers have requested approval to use a misfire malfunction criterion higher than the one determined in section (b)(3.2)(B) if the misfire occurs only during the first 1000 revolutions (i.e., no misfire during the remainder of the test). They estimated that if misfire occurred at the FTP threshold rate only during the first 1000 revolutions, emissions would be less than the emission threshold when the MIL was illuminated. The manufacturers conducted FTP tests with increased misfire levels during the first 1000 revolutions that demonstrated emissions do not exceed 1.5 times the emission standards. They used equally spaced random misfire to make this determination. Based on this data, the staff approved the request to allow a higher misfire criterion for the first 1000 revolutions.

Subsequent to these early tests, staff obtained additional data from an in-use test program showing excessively high cold start emissions with relatively low misfire rates (and thus no MIL illumination). Considering this data, the original data submitted by the manufacturers appears to be a best case for emission results. Accordingly, staff is concerned that certain patterns and causes of misfire can yield excessive cold start emissions even at low levels of misfire. As a compromise in addressing this situation, the staff proposes adding language to the misfire monitoring requirements to permit higher misfire rates during the first 1000 revolutions only to the point that FTP emissions would exceed 1.0 times any of the FTP standards rather than 1.5 times the FTP standards.

The staff also proposes to delete some of the provisions for establishing misfire criteria for vehicles other than the demonstration vehicle. Prior to December 1994, section (b)(3.2)(B) of the regulation required a manufacturer to use the misfire criterion determined for the durability vehicle on other vehicles having the same number cylinders. The manufacturers and staff expected

misfire monitors would be calibrated according to this requirement. However, in practice, the manufacturers actually calibrated the misfire monitor for each vehicle application even for vehicles having the same number of cylinders. When the regulation was reviewed in December 1994, this requirement was made optional to remove an unnecessary restriction on misfire calibrations. Currently, the staff is unaware of any manufacturers using this provision because the misfire calibration needs to be engine/vehicle specific for robust misfire detection. The staff therefore proposes to delete these provisions.

The staff proposes the following amendments to section (b)(3.2)(B) of the regulation to address the issues discussed above:

(b)(3.2)(B) The percent misfire evaluated in 1000 revolution increments which would cause emissions from a durability demonstration vehicle to exceed 1.5 times any of the applicable FTP standards if the degree of misfire were present from the beginning of the test. A manufacturer may determine a separate percent misfire, only applicable under section (b)(3.4.2)(B), which would cause emissions to exceed 1.0 times any of the applicable FTP standards if the degree of misfire were present only during the first 1000 revolutions after engine start. Subject to Executive Officer approval, a manufacturer may employ other revolution increments if the manufacturer adequately demonstrates that the strategy is equally effective and timely in detecting misfire. For the purpose of establishing the percent misfire, the manufacturer shall conduct the demonstration test(s) with the misfire events occurring at equally spaced complete engine cycle intervals, across randomly selected cylinders throughout each 1000 revolution increment. However, the percent misfire established shall be applicable for any misfire condition (e.g. random, continuous, equally spaced, etc.) for the purpose of identifying a malfunction. If the percent misfire determined under this subsection is less than or equal to 1.0 percent, the manufacturer may set the malfunction criterion to 1.0 percent. This criterion may be used for all vehicles with engines containing the same number of cylinders as the demonstration vehicle. The number of misfires in 1000 revolution increments which was determined for the durability demonstration vehicle malfunction criterion may be used to establish the corresponding percent misfire malfunction criteria for engines with other numbers of cylinders. The malfunction criteria for a manufacturer's product line shall be updated when a new durability demonstration vehicle is tested which indicates more stringent criteria are necessary than previously established to remain within the above emission limit.

Cold Start/Warm-up Strategies

A significant portion of the weighted emissions of an FTP test for low emission vehicles is generated during the first two minutes of the cold start portion of the test. In developing vehicles to meet LEV standards, some manufacturers have utilized a variety of engine calibration

techniques to reduce cold start emissions and accelerate catalyst light-off. These techniques include ignition retard, increased idle speed after engine start, and richer or leaner than stoichiometric air-fuel mixtures. The staff report for the LEV II regulatory item projects that such calibration techniques will be used on all low emission vehicles.

A common strategy that is expected consists of commanding a fixed amount of ignition retard for a specified time during idle after engine start and/or to command increased idle speed. Some manufacturers vary the duration of ignition timing retard depending on the start up conditions. A more sophisticated approach is to use closed-loop idle control in order to maximize any one of the warm-up parameters (ie., idle speed, idle air or ignition timing). For example, a calibration may require attaining a target idle speed window for after start conditions. The computer would then continue to increase the amount of ignition retard and idle air flow to maximize catalyst heating while maintaining idle speed in the target window.

The staff is concerned about the performance and monitoring of such components/strategies used to reduce cold start emissions or accelerate catalyst light off. In particular, there is concern about failure modes that may affect the components when the vehicle is warming up but may not be apparent during stabilized or warmed-up operation. For example, the computer may command an increase in idle speed to accelerate the catalyst light-off during cold start. In general, most manufacturers monitor the idle speed control system only during warmed-up, relatively stable idle operation. However, with the accelerated catalyst light-off strategies, the idle speed control system must function properly during cold conditions in order to achieve the emission standards. If higher idle speed cannot be achieved due to a fault that is present only during cold operation (such as a sticking or slow idle air control valve), catalyst light off will be delayed, and emissions can be excessive with no indication to a driver or repair technician. Therefore, the staff believes that confirmation of the accelerated warm-up conditions is necessary.

The intent of the proposed requirements is to monitor the engine operating conditions such as engine speed, air/fuel ratio, and ignition timing to verify that the commanded conditions were achieved. The regulatory language would thus specify that the emission/engine control system shall be monitored for achieving the required engine operating conditions necessary for accelerated catalyst warm-up. The staff understands that some manufacturers may incorporate exhaust or catalyst temperature sensors into their emission control systems. A manufacturer may develop a diagnostic strategy utilizing such sensors to verify that the conditions to accelerate catalyst light off were achieved or catalyst light off temperature was reached within a specified amount of time.

The staff proposes to add the following sections to the regulation,

(b)(12.1.1)(D) If the emission control system incorporates a specific engine control strategy to accelerate catalyst light off or reduce cold start emissions, the input components used to effect that strategy (e.g., engine speed, mass air flow, etc.) shall be

monitored while the control strategy is active for proper values to ensure proper operation of the control strategy. The components/systems shall be considered malfunctioning if the target operating conditions are not achieved. Manufacturers shall implement these requirements on applications certified to the LEV II emission standards beginning with the 2004 model year. Notwithstanding, SULEVs receiving a partial ZEV allowance shall comply with these requirements even if introduced prior to 2004.

- (b)(12.1.2)(D) If the emission control system incorporates a specific engine control strategy to accelerate catalyst light off or reduce cold start emissions, the output components used to effect that strategy (e.g., ignition timing, idle air control, etc.) shall be monitored for proper response to computer commands while the control strategy is active. The components/systems shall be considered malfunctioning when proper functional response to computer commands does not occur. Manufacturers shall implement these requirements on applications certified to the LEV II emission standards beginning with the 2004 model year. Notwithstanding, SULEVs receiving a partial ZEV allowance shall comply with these requirements even if introduced prior to 2004.

Air Conditioning Engine Control Strategies

In the past, emission standards were based on testing conducted with the air conditioning switched off. On vehicles predominantly equipped with air conditioning, the dynamometer loading was adjusted to account for the higher engine loads caused by air conditioning. Recently, a test procedure and emission standards were adopted for testing with the air conditioning on. Under these new standards, manufacturers may use an alternate emission control strategy for vehicle operation with the air conditioning switched on. While these alternate engine control strategies are permissible, the staff is concerned that a fault in the air conditioning control system or air conditioning system components could cause the vehicle to enter into an “air conditioning-on mode” or control strategy when the air conditioning is not engaged. If these alternate control strategies could measurably increase emissions when a malfunction is present, the system should be monitored for proper computer input and response to computer commands. The staff is concerned that a strategy that increases emissions could be invoked when there is a hardware failure (i.e., the compressor is not running) or an input switch to the computer fails in an “on” position. The staff expects that the input/output components used as part of an air conditioning control strategy should be monitored under the comprehensive component monitoring requirements. Therefore, the staff has no proposed changes to the regulation to address these concerns. However, manufacturers should consider these concerns with respect to the comprehensive component monitoring requirements when utilizing alternate emission control strategies for vehicles operating with the air conditioning on.

Concerns Regarding Pressure Methods for Leak Detection

The OBD II regulation requires manufacturers, beginning in the 2000 model year, to phase-in monitoring for small leaks equal or greater in magnitude than a 0.020 inch diameter orifice. Compliance with the 0.020 inch requirements on all vehicles is scheduled to take place in the 2003 model year. Manufacturers are performing the 0.020 inch diameter leak check of the fuel and evaporative control system using either a vacuum or pressure strategy. Under both of these methods, the pressure inside the system is monitored over an interval of time. If the pressure or vacuum changes toward ambient at a significant rate, a leak is considered to be present.

Between the two methods, pressure-based technologies are generally more reliable in detecting a 0.020 inch leak and have a lower probability of signaling false malfunctions since they have significantly higher signal-to-noise ratios compared to vacuum-based approaches. Therefore, to reliably detect a 0.020 inch diameter leak under reasonable monitoring conditions, vacuum-based technologies must set the malfunction threshold at a level significantly lower than 0.020 inch (maybe as low as 0.015 inch) while the pressure-based technologies can set the threshold at a level closer to 0.020 inch. Therefore, a vacuum-based system may have the secondary effect of detecting leaks smaller than 0.020 inch and could potentially yield slightly higher emission benefits than an equivalent pressure-based system. However, the emission benefits are difficult to quantify.

In evaluating the relative effectiveness of these two methods from an air-quality viewpoint, ARB staff has become aware of an attendant emission concern with use of pressure systems for detecting leaks. Unlike the vacuum-based check where ambient air enters the system when the monitor is operating and a leak is present, a pressure check causes the air-vapor mixture in the evaporative control system to be expelled from the system when any size leak is present. In other words, performing the pressure check causes increased evaporative emissions to be released to the ambient if a leak is present. If there is a leak equivalent to or larger in magnitude than 0.020 inch present, then the leak is identified and fixed. However, if there is a leak smaller than 0.020 inch present, then the pressurized leak check would not identify the leak, but in the process of performing the check, excess evaporative emissions would be generated. Recent data from one manufacturer indicates that such emissions could be as high as one gram per diagnostic event. Staff's experience with leak check diagnostics indicates that the checks in some vehicles are performed several times a day and consequently, ARB is increasingly concerned that each time the leak check diagnostic is performed using a pressure-based method, excess evaporative emissions would be released to the ambient. The cumulative emission impact of this phenomenon would be dependent on factors such as monitoring frequency, the number of vehicles in-use with leak sizes less than 0.020 inch with pressure-based monitors, and the magnitude of emissions from such leaks.

To fully understand the impact of this phenomenon and its effect on the vehicle evaporative emissions, staff would like to discuss this topic at the workshop and would welcome

any input and data that manufacturers and other interested parties can provide in this regard. Specifically, staff requests input on ways to offset the negative effects of pressure-based monitors relative to vacuum-based monitors and whether it would be possible to design a test procedure that could be used to demonstrate equivalent emission impact of a pressure versus vacuum-based monitor design.

Thermostat Monitoring

To date, staff has reviewed the thermostat monitoring strategies for most manufacturers. Some manufacturers have used overly simple approaches in developing thermostat monitors by accumulating data for normal and malfunctioning thermostats under extreme operating conditions (i.e., low ambient temperatures, maximum passenger compartment heating, low engine load, etc.). The resulting fault times, ranging from 15 to 90 minutes, were then based on these extreme operating conditions. Under such extreme operating conditions with a normally functioning thermostat, these long periods may be appropriate for the coolant to achieve the thermostat regulating temperature. However, during normal operating conditions with a malfunctioning thermostat, the coolant will take longer to warm-up, and monitors using coolant temperature as an enable condition may be unnecessarily delayed or disabled. With excessive fault times, MIL illumination will also be delayed, and some malfunctioning thermostats may not be detected. More appropriate monitoring conditions would result in more reasonable fault times and timely MIL illumination. Based on a review of thermostat monitoring strategies for the 2000 model year, staff has concluded that malfunction thresholds should be based on monitoring conditions that cause significant coolant temperature warm-up. If the diagnostic is enabled under conditions that accelerate coolant temperature warm-up, and suspended or disabled during extreme operating conditions with low heat input to the coolant, more reasonable fault times can be used.

In a related issue, the OBD II regulation states in section(b)(11.2) “The thermostat shall be considered malfunctioning if . . . the coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit of the manufacturer’s thermostat regulating temperature.” Staff has found that some manufacturers have incorrectly implemented this requirement. Depending on the location of the engine coolant temperature (ECT) sensor relative to the thermostat, the ECT sensor may read a significantly different value than the regulating temperature at the thermostat. Some manufacturers have based their fault criteria on the coolant temperature at the thermostat without correlating it to the ECT sensor reading. However, the malfunction criteria should be based on the temperature at the ECT sensor when the thermostat is at its regulating temperature because engine control strategies and enable temperatures for diagnostics using coolant temperature are based on the actual ECT sensor reading.

In view of these issues, the staff proposes to modify section(b)(11.2) of regulation as follows:

(b)(11.2) Malfunction Criteria: The thermostat shall be considered malfunctioning if within a manufacturer-specified time interval after starting the engine, either of the following occurs: (a) the coolant temperature does not reach the highest temperature required by the manufacturer to enable other diagnostics; or (b) the coolant temperature does not reach a warmed-up coolant temperature within 20 degrees Fahrenheit of the coolant temperature when the thermostat is at the manufacturer's thermostat regulating temperature. The time interval shall be a function of starting engine coolant temperature and a function of vehicle operating conditions while the monitor is enabled. Manufacturers may suspend or delay the diagnostic if the vehicle is subjected to conditions that could lead to false diagnosis (e.g., extended periods of light load or high load, etc.). Manufacturers shall provide data and/or engineering evaluation to support specified times. Subject to Executive Officer approval, manufacturers may utilize lower temperatures for criteria (b) above if they adequately demonstrate that the fuel, spark timing, and/or other coolant temperature-based modifications to the engine control strategies would not cause an emission increase of 50 or more percent of any of the applicable standards (e.g., 50 degree Fahrenheit emission test, etc.). With Executive Officer approval, manufacturers may omit this monitor provided the manufacturer adequately demonstrates that a malfunctioning thermostat cannot cause a measurable increase in emissions during any reasonable driving condition nor cause any disablement of other monitors.

Transfer Case Monitoring Requirements

Section (b)(12.0) states “The diagnostic system shall monitor for malfunction any electronic powertrain component/system that either provides input to (directly or indirectly), or receives commands from the on-board computer and which: (1) can affect emissions during any reasonable in-use driving condition, or (2) is used as part of the diagnostic strategy for any other monitored system or component.” Manufacturers have been monitoring electronic transmission components, such as shift solenoids and torque converter lock-up clutches, under this requirement of the regulation. Recently in discussions with industry, staff was informed that some transfer cases are electronically controlled by and/or provide input to the on-board computer. From further discussions with industry, staff understands the trend is to use more electronically-controlled transfer cases in future four-wheel or all-wheel drive applications.

Under the current comprehensive component monitoring requirements, most electronically-controlled transfer cases should be monitored. However, most manufacturers currently using electronically-controlled transfer cases do not monitor the transfer case. For some of these manufacturers, the OBD II engineering group is not responsible for transfer case

electronics or integration of the transfer case into the powertrain. As a result, transfer case diagnostic requirements were inadvertently overlooked by most of the industry as well as ARB staff. Transfer case monitoring is a complicated issue to address because of the number of drivetrain designs and control strategies (i.e., all-wheel drive, part-time and full-time four-wheel drive, on demand four-wheel drive, etc.). The staff's primary concern regarding electronically-controlled transfer cases is that the transfer case could fail in a mode that disables other monitors. For example, if the transfer case status (two-wheel or four-wheel drive) or transfer case inputs to the computer are used as enable criteria for any OBD II monitors, the transfer case should be monitored under the comprehensive component monitoring requirements.

The staff recognizes that some transfer case failures could affect emissions; however, staff expects the emission impact to be small. One manufacturer has already presented information showing there is no expected emission impact of four-wheel drive versus two-wheel drive operation for at least one drivetrain design. Furthermore, most manufacturers will use another warning lamp to notify drivers and technicians of transfer case malfunctions. These systems will have non-OBD II diagnostics and associated fault codes. Under the current service information requirements, these fault codes and service information should be available to service technicians and scan tool manufacturers. Considering the complexity and variety of powertrain control strategies and designs, the costliness of these drivetrain repairs, and small emission effects, the staff proposes to require monitoring of electronically-controlled transfer cases only if transfer case information is used as part of an OBD II diagnostic strategy.

The staff proposes the following additions to the OBD II regulation:

- (b)(12.1.1)(E) The diagnostic system shall monitor an electronic transfer case or system if the transfer case or system provides input to the on-board computer and is used as part of the diagnostic strategy for any other monitored system or component.

- (b)(12.1.2)(E) The diagnostic system shall monitor an electronic transfer case or system if the transfer case or system receives commands from the on-board computer and is used as part of the diagnostic strategy for any other monitored system or component.

Fault Codes

Section (a)(1.2) of the regulation states that the OBD II system shall identify “the likely area of the malfunction by means of fault codes stored in computer memory.” Fault codes provide technicians with detailed information necessary to diagnose and repair vehicles in an efficient manner. The standardized fault codes listed in SAE J2012 include a number of fault codes for each component or system. In the fault code listing, there is usually a “general” fault code that indicates a fault with a particular component or system (e.g., P0100 Mass or Volume Air Flow Circuit). There are also additional, more specific, fault codes for the different failure

conditions of the same component/system (e.g., P0102 Mass or Volume Air Flow Circuit Low Input, or P0103 Mass or Volume Air Flow High Input).

In order to facilitate repairs, fault codes should be as specific as possible to identify the nature of the fault. However, some manufacturers only use general fault codes to simply indicate the component or system that is malfunctioning. The repair technician is then required to use the manufacturer's service information or a fault tree to pinpoint the problem. In many cases, the diagnostic system actually detects different root causes (e.g., sensor shorted to ground or battery) for a malfunctioning component/system, yet the manufacturer only uses one fault code to identify all the different malfunctions. In this situation, staff expects manufacturers to store a specific fault code such as "sensor circuit high input" or "sensor circuit low input" rather than a general code such as "sensor circuit malfunction." The staff understands that in some cases the standardized or generic fault codes do not adequately identify the malfunction. In such cases, manufacturers may request additional fault codes to be added to SAE J2012 or use manufacturer-defined fault codes and off-board diagnostic procedures.

It should be noted, however, that staff is concerned with the current use of manufacturer-defined fault codes. These codes are designated with a P1xxx format as opposed to the generic, SAE-defined fault codes of P0xxx. Because these codes are manufacturer-defined, generic scan tools are unable to display the text label that corresponds to the fault code. Thus, technicians are only given the numeric fault code and a message such as "manufacturer-defined fault code". Staff is concerned that some technicians may not have ready access to all manufacturer's service information and are thus, unable to make any use of the fault information provided by a generic scan tool in cases where P1xxx fault codes have been stored. Staff is seeking feedback from industry on suggestions on how to best ensure that the majority of technicians have reasonable means available to identify the fault associated with a P1xxx fault code.

Staff has become aware of another practice, similar to the one described above, for some manufacturers. These manufacturers use limited fault codes to only indicate the malfunctioning component or system. More detailed fault information or analysis, known as symptom bytes, is then provided through a manufacturer-specific scan tool or "dealer" tool. In this situation, the dealer technician is provided with electronic information that is not available through the generic scan tool. If the information is available in the diagnostic system and useful to a dealer technician, the information must be provided to the generic scan tool. The staff proposes the following changes to further clarify the requirements for fault codes:

- (a)(1.2) All 1994 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles required to have a MIL pursuant to (1.0) above shall also be equipped with an on-board diagnostic system capable of identifying the likely area of the malfunction by means of fault codes stored in computer memory. If a monitor required under this regulation is capable of distinguishing between different fault modes or conditions, the manufacturer shall use generic fault codes (see reference in Section (k)(3.0)) that best identify the different fault modes or conditions. If a generic fault

code does not accurately describe a malfunction, the manufacturer may use a manufacturer-specific fault code with Executive Officer approval. These vehicles shall be equipped with a standardized electrical connector to provide access to the stored fault codes. Specific performance requirements are listed below. A glossary of terms is contained in section (n). Unless otherwise noted, all section references refer to section 1968.1 of Title 13, CCR.

Oxygen and Air/Fuel Ratio Sensor Monitoring

Most manufacturers use the rear (secondary) oxygen sensor for fuel control or to “trim” or correct the output from the front (primary) oxygen sensor. The rear sensor can be used to correct the front sensor for aging, poisoning or deterioration resulting in offset or drift. Some manufacturers set limits on the correction by the rear sensor and, when the limits are exceeded, store a fault code and illuminate the MIL. Section (b)(8.1.1) of the regulation requires monitoring of the front oxygen sensor for any parameter that can affect emissions. Therefore, if sensor drift can cause vehicle emissions to exceed 1.5 times any of the applicable standards or if the system has reached the limits of its correction, the sensor should be monitored and considered malfunctioning when these conditions occur. Monitoring of front oxygen sensor correction is currently required under the oxygen sensor monitoring requirements as “any other parameter which can affect emissions.” However, in order to make this requirement more explicit in the regulation, staff is proposing the following changes to the oxygen sensor monitoring requirements:

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

- (b)(8.2.1) An oxygen sensor shall be considered malfunctioning when the voltage, response rate, or other criteria are exceeded and causes emissions from a vehicle equipped with the sensor(s) to exceed 1.5 times any of the applicable FTP standards, or when the sensor output characteristics are no longer sufficient (e.g., lack of sensor switching) for use as a diagnostic system monitoring device (e.g., for catalyst efficiency monitoring). If the vehicle utilizes a strategy of primary oxygen sensor correction by the secondary sensor, the manufacturer shall include as one of the malfunction criteria the condition where the correction exceeds the manufacturer's selected limit(s).

Inspection and Maintenance Program Issues

Full phase-in of OBD II systems on light and medium-duty vehicles was required for the 1996 model year. Currently, inspection and maintenance (I/M) programs are being reviewed and in some instances being restructured to incorporate OBD II system checks as a primary element of the program. There has been considerable discussion among industry and government agencies on the issue of readiness indications for I/M testing. The intent of the readiness indications is to ensure that a vehicle is ready for testing (i.e., all the major monitors have run). As OBD II checks are added to I/M tests, there is concern that a significant portion of vehicles would be rejected for an I/M test because they do not have complete readiness indications for all major monitors. Concern has been expressed about consumer reaction should even small numbers of vehicles with incomplete readiness indications be rejected in an OBD II-based I/M program.

Data from pilot I/M test programs show approximately two percent of test vehicles have incomplete readiness indications. An analysis of the data shows a large portion of the incomplete readiness indications are for the evaporative system monitor. There are a number of reasons why readiness indications may not be set at the time of inspection. If a vehicle with the MIL illuminated was repaired shortly before an I/M test and had fault codes cleared subsequent to the repair, the vehicle may not have been driven sufficiently to exercise all of the major monitors before being taken to the I/M station. In some cases, vehicle operation in extreme ambient conditions will prohibit the monitors from running and setting readiness indications. Also, if a vehicle owner has an uncommon driving pattern, the monitoring conditions may not be frequently encountered. For example, most manufacturers require a cold start to enable the evaporative system monitor. In addition to the cold start requirements, some manufacturers require extended driving of 20 minutes or more. For some consumers, these conditions may be less frequently satisfied resulting in incomplete readiness. Because of these specified conditions, a repair technician may not be able to verify an evaporative system repair until the day after the repair (i.e., until the vehicle soaks and the cold start requirement is met).

Readiness indications are a significant component of the OBD II system. Readiness indications were incorporated into the OBD II requirements to address problems with I/M testing on OBD I vehicles. The readiness indications ensure that the vehicle has been driven sufficiently for the OBD II system to test all the emission control components and determine whether or not a fault is present. Secondly, readiness indications also combat fraud in I/M testing. It was possible with OBD I vehicles to erase fault codes just before a vehicle was subject to the I/M test thus enabling a malfunctioning vehicle to falsely pass an I/M test. If fault codes are erased on an OBD II vehicle, the readiness indications are set to incomplete at the same time. If a fault remains, it will be detected again before all readiness indications are set to complete. Therefore, it is important for all readiness indications to be complete before subjecting a vehicle to an I/M test. The ARB supports adding an OBD II element to the California's I/M program. However, in order for an OBD II-based I/M test to be fully effective in addressing air quality issues and acceptable to consumers, staff believes a mechanism is needed, based on the pilot I/M test data,

for an I/M technician or repair technician to test the evaporative system on a vehicle and set the readiness indication at the time of repair in the service bay.

The staff believes a mechanism similar to SAE J1979 Test Mode \$08 is a practical solution to this issue. Mode \$08 provides a generic format to use an “off-board test device to control the operation of an on-board system, test, or component.” If a technician could initiate or control the evaporative system monitor from an off-board device (i.e., generic OBD II scan tool), the evaporative system could be tested, as needed, at a repair facility or I/M station. Additionally, by executing a monitor in the relatively constrained operating conditions found in a service bay or I/M station (i.e., vehicle at rest and engine idling), a manufacturer could bypass some of the restrictive enable criteria (e.g., a cold start) and/or allow the monitor to be executed under a broader range of temperatures. In areas where extreme operating conditions (e.g., cold ambient temperatures) prevent the monitor from running, the service bay or I/M station could provide an acceptable test environment. The test results could be used to store a fault code and illuminate the MIL if the problem has not been remedied or set readiness indications as appropriate. Some manufacturers currently have such capabilities to control on-board diagnostics with the dealer scan tool. For these “service bay” diagnostics, some manufacturers use their OBD II diagnostic routines, and other manufacturers use different diagnostic routines.

The staff proposes to add a requirement for standardized off-board control of the OBD II evaporative system monitor with a generic OBD II scan tool. The OBD II scan tool should be capable of initiating the 0.020 and 0.040 inch leak detection diagnostics. However, readiness code setting should be based on the test results for the 0.040 inch leak detection diagnostic. If a manufacturer uses an off-board-controlled strategy different than the OBD II strategy, the manufacturer must receive Executive Officer approval of the strategy to ensure that it operates just as reliably in detecting malfunctions.

The staff proposes to add the following section to the regulation:

(k)(7.0) The J1978 generic scan tool shall be capable of requesting the evaporative system monitor to execute through a standardized format. The J1978 scan tool shall be capable of controlling both the 0.020 and 0.040 inch leak detection diagnostics. The on-board computer shall set the readiness indication or bit for the evaporative system monitor (SAE J1979 Mode \$01, PID \$01, Data D, bit 2) when the 0.040 inch leak detection diagnostic reports a passing result. If the on-board computer uses a diagnostic strategy or strategies to satisfy this requirement that are different than those utilized under section (b)(4), the manufacturer must receive Executive Officer approval for the strategy or strategies. Manufacturers shall meet this requirement on all 2003 and newer model year vehicles.

Data from the pilot I/M test programs have also identified a discrepancy among manufacturers in the way they have implemented Mode \$01, PID \$01, Data A, bit 7, of SAE J1979, known as MIL status. This data parameter can be read through a generic scan tool at the

time of an I/M inspection to determine if the MIL is commanded “on” or “off”. In automating I/M inspections as much as possible, this information is electronically transmitted from the vehicle to the I/M off-board device and may be used to pass or fail a vehicle. Some manufacturers have implemented this data parameter such that it reads MIL commanded “on” during the routine bulb check performed at ignition on. This may cause confusion and/or a false failure of a test vehicle at an I/M station. As such, manufacturers need to ensure that this data parameter only indicates MIL commanded “on” when a fault code is stored and MIL illumination is required under section (C) of the regulation. The staff proposes the following modifications to section (a)(1.1) to address this issue:

- (a)(1.1) The MIL shall be of sufficient illumination and location to be readily visible under all lighting conditions. The MIL shall illuminate in the engine-run key position before engine cranking to indicate that the MIL is functional and shall, when illuminated, display the phrase "Check Engine" or "Service Engine Soon". The word "Powertrain" may be substituted for "Engine" in the previous phrases. Alternatively, the International Standards Organization (ISO) engine symbol may be substituted for the word "Engine," or for the entire phrase. During the functional check of the MIL, the MIL status parameter (SAE J1979 Mode \$01, PID \$01, Data A, bit 7) shall report “MIL commanded on” only when a fault code is stored and the MIL illumination is required under section (c) herein.

Staff has received proposals from industry to use the MIL to indicate to vehicle owners the status of the vehicle readiness indications for I/M testing. For example, cycling the ignition switch on and off a specified number of times without starting the engine could prompt the vehicle for a readiness indication. The computer could respond by flashing the MIL in a standardized manner to indicate vehicle readiness. Staff believes such a feature may help to address some of the previously discussed concerns regarding the I/M readiness code. Staff proposes the following modifications to sections (a)(1.0) and (e) to allow use of the MIL to indicate vehicle readiness for I/M testing.

- (a)(1.0) All 1994 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles shall be equipped with a malfunction indicator light (MIL) located on the instrument panel that will automatically inform the vehicle operator in the event of a malfunction of any powertrain components which can affect emissions and which provide input to, or receive output from, the on-board computer(s) or of the malfunction of the on-board computer(s) itself. The MIL shall not be used for any other purpose except as permitted in section (e).
- (e) **READINESS/FUNCTION CODE** The on-board computer shall store a code upon first completing a full diagnostic check (i.e., the minimum number of checks necessary for MIL illumination) of all monitored components and systems (except as noted below) since the computer memory was last cleared (i.e., through the use of a scan tool or battery disconnect). The code shall be stored in the format specified by SAE J1979 or SAE

J1939, whichever applies. Both documents are incorporated by reference in sections (k)(2.0) and (k)(5.0). The diagnostic system check for comprehensive component monitoring and continuous monitoring of misfire and fuel system faults shall be considered complete for purposes of determining the readiness indication if malfunctions are not detected in these areas by the time all other diagnostic system checks are complete. The MIL may be used to indicate system readiness in a standardized format. Subject to Executive Officer approval, if monitoring is disabled for a multiple number of driving cycles due to the continued presence of extreme operating conditions (e.g., cold ambient temperatures, high altitudes, etc), readiness for the subject monitoring system may be set without monitoring having been completed. Executive Officer approval shall be based on the conditions for monitoring system disablement and the number of driving cycles specified without completion of monitoring before readiness is indicated. For evaporative system monitoring, the readiness indication shall be set when a full diagnostic check has been completed with respect to the 0.040 inch orifice malfunction criteria if the monitoring conditions are constrained with respect to detection of a 0.020 inch leak (see sections (b)(4.2.2) and (4.3)).

Pending Fault Codes

In general, the OBD II regulation requires manufacturers to notify vehicle operators after a malfunction has been detected on two consecutive driving cycles by illuminating the MIL and storing a fault code. Section (l)(3.0), however, requires manufacturers to also provide an indication to technicians (via a generic scan tool) upon the first detection of a malfunction. One of the primary reasons for this requirement was to provide technicians with an early indication of a potential malfunction as well as help provide more immediate feedback when a technician attempts to confirm that a repair has been made correctly.

This “one-trip” indication of a potential malfunction is provided to a generic scan tool through the standardized test messages of SAE J1979. Mode \$06 of J1979 was developed to provide an indication for major monitors that only ran once per driving cycle (e.g., catalyst, EGR, etc.) while Mode \$07 was developed for all other monitors that ran continuously (e.g., circuit continuity checks and rationality checks for comprehensive components, etc.). However, the fault indications for these two Modes are displayed to a technician in very different formats. Currently, Mode \$07 results are simply displayed and labeled as a “pending” fault code (identical to the fault code displayed after the fault has been confirmed and the MIL illuminated) if a malfunction has been identified on one driving cycle. If no malfunctions have been identified, the scan tool will indicate to the technician that no “pending” fault codes are present.

Mode \$06 results, however, are displayed in a more cryptic format that is difficult for technicians to decipher or understand without extensive knowledge of the system and access to the manufacturer’s service information. Results in this test mode typically identify a hex label (e.g., TID 01/CID 02) and a decimal result with the corresponding maximum or minimum

allowable decimal value. Technicians are thus unable to determine which system or component the result represents and may be unable to determine if the system has passed or failed. While staff continues to believe the information contained in Mode \$06 is useful information to technicians, staff also recognizes the need to simplify the indication to a technician to indicate the presence of a pending failure. As such, staff is proposing to require manufacturers to also provide an indication of a malfunction (i.e., “pending” fault code) in Mode \$07 for all monitors currently indicating malfunctions only through Mode \$06. In this manner, technicians would consistently be able to verify a repair status by only checking for pending codes rather than have to check pending codes and decipher Mode \$06 results.

Additionally, to help those technicians that do indeed want to make use of the data in Mode \$06, staff is proposing to add language clarifying that manufacturers also need to make available all information necessary to properly decipher the Mode \$06 results. This includes identification of which test results correspond to which monitors and/or systems and conversion functions to translate the decimal test results and limits into useable engineering units. This information should cover all vehicles certified to the requirements of this section and identify which labels and conversion functions are applicable to which vehicles to account for any inconsistencies across a manufacturer’s product line. Staff expects manufacturers to make this information available in their service information (e.g., repair manuals) so that technicians utilizing a generic scan tool could make use of the data. Staff also expects scan tool manufacturers to incorporate this information into their non-generic, or manufacturer-specific, scan tool software to automatically convert these values and hex labels to the appropriate engineering units and text labels.

The staff proposes the following changes to section (l)(3.0) of the regulation:

- (l)(3.0) Oxygen sensor data (including current oxygen sensor output voltages) that will allow diagnosis of malfunctioning oxygen sensors shall be provided through serial data port on the standardized data link. In addition, beginning with the 1996 model year (with full compliance required by the 1997 model year), for all monitored components and systems, except misfire detection, fuel system monitoring, and comprehensive component monitoring, results of the most recent test performed by the vehicle, and the limits to which the system is compared shall be available through the data link. For ~~the~~ all monitored components and systems ~~excepted above~~, a pass/fail indication for the most recent test results shall be available through the data link. Such data shall be transmitted in accordance with SAE J1979 (or SAE J1939, whichever applies). Manufacturers shall report the test results such that properly functioning systems do not indicate a failure (e.g., a test value which is outside of the test limits). Manufacturers shall make available the information necessary to identify the monitored component and diagnostic parameter associated with the test results and the necessary logic (e.g., formulas, conversion factors, etc.) needed to convert the decimal values to the engineering units used by the manufacturer. Alternative methods shall be approved by the Executive Officer if, in the judgment of the Executive Officer, they provide for

equivalent off-board evaluation.

Compliance Assurance Program (CAP 2000) and Certification Documentation

With the LEV II board item, modifications to the certification, assembly-line, and in-use test requirements were adopted. These modifications, known as CAP 2000, provide manufacturers with added control and flexibility in the certification process. The existing certification procedures require 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 depending on the information.

In developing the CAP 2000 requirements, changes to the OBD II approval process and requirements were also negotiated. The changes will allow manufacturers to establish OBD II groups consisting of test groups having similar OBD II systems. The manufacturers will then be required to submit 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 should consider emission standards, OBD II phase-in requirements (i.e., does a representative test group meet 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 an HC adsorber or EGR, that test group should be selected as the representative test group. If one test group does not adequately represent an OBD II group, the manufacturer should select an additional group.

Per the CAP 2000 agreements, essential OBD II information will be required prior to certification, while the remainder of the information may be submitted after certification. The following changes are proposed for section (h) of the regulation:

- (h) **CERTIFICATION DOCUMENTATION:** The manufacturer shall submit the following documentation for each engine family at the time of certification test group at the time specified with each documentation requirement. If any of the items listed below are standardized for all test groups, the manufacturer may submit one copy. The manufacturer may determine OBD II groups subject to Executive Officer approval and submit information based on these groups. An OBD II group consists of test groups belonging to the same durability group and having the same OBD II strategies and similar calibrations. The manufacturer shall select one or more representative test group(s) per OBD II group subject to Executive Officer approval and submit one copy of the information required below per representative test group. At a minimum, the representative test group(s) shall include the most stringent emission standards and OBD II monitoring requirements and cover all the emission control devices within an OBD II group. With Executive Officer approval, one or

more of the documentation requirements specified in this section may be waived or altered if the information required would be redundant or unnecessarily burdensome to generate:

(h)(1.0) The following information shall be submitted before an Executive Order will be issued (i.e., with "Part 1" of the certification application):

- (1.1) A written description of the functional operation of the diagnostic system to be included in Section 8 of manufacturers' certification applications.
- (1.2) A table providing the following information for each monitored component or system (either computer-sensed or -controlled) of the emission control system:
 - (A) corresponding fault code
 - (B) monitoring method or procedure for malfunction detection
 - (C) primary malfunction detection parameter and its type of output signal
 - (D) fault criteria limits used to evaluate output signal of primary parameter
 - (E) other monitored secondary parameters and conditions (in engineering units) necessary for malfunction detection
 - (F) monitoring time length and frequency of checks
 - (G) criteria for storing fault code
 - (H) criteria for illuminating malfunction indicator light
 - (I) criteria used for determining out of range values and input component rationality checks
- (1.3) A logic flowchart describing the general method of detecting malfunctions for each monitored emission-related component or system. To the extent possible, abbreviations in Society of Automotive Engineers' (SAE) J1930 "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms", ~~September, 1995~~ May 1998, shall be used. J1930 is incorporated by reference herein. The information required in the chart under (1.2) above may instead be included in this flow chart, provided all of the information required in (1.2) is included.
- ~~(4) A listing and block diagram of the input parameters used to calculate or determine calculated load values and the input parameters used to calculate or determine fuel trim values.~~
- ~~(5) A scale drawing of the MIL and the fuel cap indicator light, if present, which specifies location in the instrument panel, wording, color, and intensity.~~
- (1.46) Emission test data specified in subsection (g).

- (1.57) Data supporting the selected degree of misfire which can be tolerated without damaging the catalyst. For vehicles designed to meet the expanded misfire monitoring conditions (section (b)(3.3.2) or (b)(3.3.3)), representative data demonstrating the capability of the misfire monitoring system (i.e., probability of detection of misfire events) to detect misfire over the full engine speed and load operating range for selected misfire patterns (i.e., random cylinders, one cylinder out, paired cylinders out).
- (1.68) Data supporting the limit for the time between engine starting and attaining the designated heating temperature for after-start heated catalyst systems.

~~(9) For Low Emission Vehicles, data supporting the criteria used to indicate a malfunction when catalyst deterioration causes emissions to exceed the applicable threshold specified in section (b)(1.2.2):~~

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

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

- ~~(1.7+2) A description of the modified or deteriorated components used for fault simulation with respect to the demonstration tests specified in section (g).~~
- ~~(1.8+3) A listing of all electronic powertrain input and output signals.~~
- ~~(1.9+4) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this section.~~

(h)(2.0) The following information shall be submitted by January 1st of the applicable model year (i.e., with "Part 2" of the certification application):

- (2.1) A listing and block diagram of the input parameters used to calculate or determine calculated load values and the input parameters used to calculate or determine fuel trim values.
- (2.2) A scale drawing of the MIL and the fuel cap indicator light, if present, which specifies location in the instrument panel, wording, color, and intensity.

- (h)(3.0) The following information shall be submitted upon request:
- (3.1) For Low Emission Vehicles, data supporting the criteria used to indicate a malfunction when catalyst deterioration causes emissions to exceed the applicable threshold specified in section (b)(1.2.2).
 - (3.2) For Non-Low Emission Vehicles, data supporting the criteria used to indicate a malfunction when catalyst deterioration leads to a 1.5 times the standard increase in HC emissions. If a steady state catalyst efficiency check is employed in accordance with section (b)(1.2.4), data supporting the criteria used by the diagnostic system for establishing a 60 to 80 percent catalyst efficiency level shall be provided instead.
 - (3.3) Data supporting the criteria used to detect evaporative ~~purge~~ system leaks.
 - (3.4) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this section.

Communication Protocol

Members of the International Standards Organization (ISO) and the Society of Automotive Engineers (SAE) have asked ARB to allow an additional protocol for the required generic OBD II communications. Specifically, they have asked for ARB to adopt the newly created ISO 15765-4 standard for controller area network (CAN) systems. While ARB has been reluctant to add new protocols for generic OBD II communication, especially when they require hardware upgrades to existing scan tools, staff does recognize the need to update the requirements as technology advances.

In exchange for allowing a new protocol, ARB has asked ISO and SAE for several changes to the existing protocols to improve some features for technicians utilizing generic scan tools. For instance, changes have been made to the message structure to allow a faster update rate of multiple data parameters to a generic scan tool to provide technicians with more useful information. Additionally, several changes have been made to simplify implementation for scan tool manufacturers. However, ISO has chosen to continue to provide additional flexibility in their standard by allowing manufacturers to select among two different length identifiers and two different baud rates for communication. While options such as these generally provide vehicle manufacturers with needed flexibility, they also provide numerous permutations of the standardized protocol for scan tool manufacturers to implement and verify in-use. Given ARB's past experience with the problems in implementation of the currently allowed protocols and multiple baud rates, the staff is proposing to eliminate the option of two different baud rates and require a single baud rate of 500 kbps for generic OBD II communications. This should reduce the burden on scan tool manufacturers in implementing the new protocol and result in fewer

issues from differences in interpretation of the protocol standards. Further, because this protocol necessitates hardware upgrades to existing generic scan tools, the staff proposes to only allow the CAN protocol on 2003 and newer model year vehicles.

Section (k)(1.0) and (k)(2.0) are amended as follows to include staff's proposal and update the references to the current versions:

- (k)(1.0) Either SAE Recommended Practice J1850, "Class B Data Communication Network Interface", ~~March, 1998, July, 1995,~~ or ISO 9141-2, "Road vehicles - Diagnostic Systems - CARB Requirements for Interchange of Digital Information," [insert current version date], ~~February, 1994,~~ or ISO 14230-4, "Road vehicles - Diagnostic systems - KWP 2000 requirements for Emission-related systems," [insert current version date], ~~April, 1996,~~ which are incorporated by reference, shall be used as the on-board to off-board network communications protocol. All SAE J1979 emission related messages sent to the J1978 scan tool over a J1850 data link shall use the Cyclic Redundancy Check and the three byte header, and shall not use inter-byte separation or checksums. Beginning with the 2003 model year, manufacturers may use ISO 15765-4 "Road Vehicles - Diagnostic Systems - Diagnostics on CAN - Part 4: Requirements for Emission-Related Systems" [insert draft version date], which is incorporated by reference, as the on-board to off-board network communications protocol, with the exception that manufacturers must utilize a baud rate of 500 kbps for all OBD II functions.
- (k)(2.0) J1978 & J1979 Standardization of the message content (including test modes and test messages) as well as standardization of the downloading protocol for fault codes, parameter values and their units, and freeze frame data are set forth in SAE Recommended Practices on "OBD II Scan Tool" (J1978), ~~February 1998, June, 1994,~~ and "E/E Diagnostic Test Modes" (J1979), ~~September, 1997, July, 1996,~~ which have been incorporated by reference. Fault codes, parameter values, and freeze frame data shall be capable of being downloaded to a generic scan tool meeting these SAE specifications. Vehicles using ISO 15765-4 as the communications protocol under section (k)(1.0) shall use ISO 15031-4 "Road Vehicles - Emission-Related Diagnostic - Communication Between Vehicle and External Equipment - Part 4: External Test Equipment" [insert current version date], and ISO 15031-5 "Road Vehicles - Emission-Related Diagnostics - Communication Between Vehicle and External Test Equipment - Part 5: Emission-Related Diagnostic Services" [insert current version date], which are incorporated by reference, in place of SAE J1978 and SAE J1979 respectively.

Standardized Electronic Format of Service Information (J2008)

Beginning in 2002, manufacturers are required to make their emission-related service information (e.g., repair manuals, technical service bulletins, etc.) available in a standardized

electronic format developed by SAE and known as J2008. While manufacturers have always been required to make their emission-related service information available, ARB adopted this requirement in an attempt to improve the accessibility to manufacturer-specific service information for aftermarket or independent service and repair facilities. By requiring the information in a standardized electronic format, ARB envisioned that there would be fewer technical hurdles to getting the information distributed to those who wanted it and that the cost of providing that information would be reduced compared to common mechanisms currently used (e.g., paper manuals, manufacturer-specific software and hardware platforms, etc.).

Recently, however, several manufacturers have asked the Environmental Protection Agency (EPA) and ARB to consider allowing other options instead of requiring use the J2008 format. Some feel that the software language utilized in J2008 (sgml) is already out-dated and would limit their ability to continually improve the organization and content of their service information. These manufacturers also believe they can satisfy the intent of this requirement by providing information in an extremely accessible and easily readable electronic format via the Internet. In such a system, technicians would be able to access the information via the Internet through a standard browser without any manufacturer-specific software or hardware needed. They believe this would meet ARB's desire for improved access to the information yet still afford the manufacturer considerable flexibility in the authoring language and organization of the information. They also believe this will result in a better end product to the technician by better allowing the manufacturer to incorporate graphics, audio files, video files, animation, or whatever the future may bring to service information and Internet delivery methods.

Staff is inclined to believe that the Internet does provide a better mechanism for distribution of service information to technicians without artificially imposing technical limits on how the information is originally authored and organized. However, the staff is still uncertain as to how well this will be received by independent repair facilities as well as the fee structures that will be established by vehicle manufacturers for access to this information. Additionally, the staff is concerned that alternatives such as this will likely need to meet some minimum set of requirements (e.g., capacity to handle multiple users at one time, ease of use, ease of location of desired information, "per access" fee structures versus monthly "subscription" structures, etc.) to ensure the systems do indeed meet ARB's intent.

At this time, staff does not feel adequately informed to develop those minimum requirements and propose an alternative to J2008. However, EPA is currently in the early stages of an emission-related service information rulemaking. Staff is working with EPA to harmonize the requirements for electronic formatting of service information as much as possible to provide a common solution. In case EPA does adopt new requirements addressing the electronic format of service information that adequately addresses ARB's concerns, the staff proposes to add language to allow manufacturers meeting EPA's electronic formatting requirements to also satisfy the requirements of (k)(6.0) with Executive Officer approval.

Section (k)(6.0) is amended as follows to include staff's proposal and update the reference

to the current version:

- (k)(6.0) J2008 Beginning January 1, 2002, manufacturers shall make available at a fair and reasonable price, all 2002 and newer model year vehicle emission-related diagnosis and repair information provided to the manufacturer's franchised dealers (e.g., service manuals, technical service bulletins, etc.) in the electronic format specified in SAE Recommended Practice J2008 Draft Technical Report, "Recommended "Organization of Service Information" (J2008), October, 1998, November, 1995. The information shall be made available within 30 days of its availability to franchised dealers. Small volume manufacturers shall be exempted indefinitely from the J2008 formatting requirement. Subject to Executive Officer approval, a manufacturer meeting federal emission-related service information requirements may be deemed compliant with the requirements of this section. Executive Officer approval will be based on the effectiveness of the manufacturer's service information format in satisfying the service information requirements of Section 1968.1

Software Calibration Identification Number

Section (l)(1.0) of the regulation requires manufacturers to make the software calibration identification number (CAL ID) available in a standard format to generic scan tools. SAE specifically developed Vehicle Information Types \$03 and \$04 of Mode \$09, J1979 to handle this requirement. There has been some confusion, however, by manufacturers who are not sure as to which electronic control units (ECUs) must support this requirement. Currently, staff believes that all emission-related ECUs, reprogrammable or non-reprogrammable, are required to support this function. However, staff is proposing to modify this requirement to only require ECUs essential to emission controls and/or diagnostics to support this function. Typically, this would be engine control modules (ECMs) and transmission control modules (TCMs), but not encompass other ECUs such as anti-lock brake system (ABS) modules even though they may contain some small portions of emission-related and/or OBD II software. ARB proposes to allow manufacturers to request Executive Officer approval to exclude ECUs from the software calibration identification requirement if they do not perform critical emission or diagnostic functions. In general, however, ECMs and TCMs will not be excluded under this provision.

ARB's intended use for the CAL ID is to improve the robustness of the I/M program. As ARB envisions it, an I/M station would verify that the CAL ID is a valid number for the vehicle identified as the test vehicle. As such, manufacturers will need to make available the information which identifies which CAL IDs are valid for which vehicles. ARB envisions a central database whereby manufacturers would be able to submit updated calibration information as it becomes available. To minimize errors of transcription in this database, staff is seeking comments from industry on how best to achieve this goal.

It should be noted that the electronic transmission of the CAL ID also provides a

mechanism for aftermarket software modifications exempted by the ARB to obtain a unique CAL ID for their products. CAL IDs for exempted modifications would then be added to the central database as valid calibrations for the applicable vehicles. This could help to reduce confusion at an I/M station as to whether a particular aftermarket calibration was valid for the vehicle being inspected.

The staff proposes the following amendments to section (1)(1.0):

- (1)(1.0) The following signals in addition to the required freeze frame information shall be made available on demand through the serial port on the standardized data link connector: calculated load value, diagnostic trouble codes, engine coolant temperature, fuel control system status (open loop, closed loop, other; if equipped with closed loop fuel control), fuel trim (if equipped), fuel pressure (if available), ignition timing advance (if equipped), intake air temperature (if equipped), manifold air pressure (if equipped), air flow rate from mass air flow meter (if equipped), engine RPM, throttle position sensor output value (if equipped), secondary air status (upstream, downstream, or atmosphere; if equipped), and vehicle speed (if equipped). The signals shall be provided in standard units based on the SAE specifications incorporated by reference in this regulation, and actual signals shall be clearly identified separately from default value or limp home signals. Additionally, beginning with a phase-in of 30 percent in the 2000 model year, 60 percent in the 2001 model year, and with full implementation by the 2002 model year, the software calibration identification number shall be made available through the serial port on the standardized data link connector. With Executive Officer approval, a manufacturer may exclude from the software calibration identification requirement electronic control units (ECUs) that do not perform emission or diagnostic-critical functions. The phase-in percentages shall be based on the manufacturer's projected sales volume for all vehicles and engines. Small volume manufacturers shall not be required to meet the phase-in percentages; however, such manufacturers shall achieve 100 percent compliance by the 2002 model year. The software calibration identification number shall be provided to the generic scan tool in a standardized format. Alternate phase-in percentages that provide for equivalent timeliness overall in implementing these requirements shall be accepted. The manufacturer shall make available a listing of engine families/test groups and corresponding valid calibration identification numbers in a standardized format.

Software Calibration Verification Number (CVN)

Section (1)(4.0) requires manufacturers to provide for verification of the software integrity in a standardized format for all emission-related reprogrammable ECUs beginning in the 2000 model year with full implementation by the 2002 model year. This requirement is intended to allow an off-board device such as a generic scan tool to request on-board ECUs to perform a calculation on the memory contents of the ECU and report a numerical value of the results back

to the scan tool. This value could then be compared with a master database or document to confirm that it is a valid 'self-check' result for the specific calibration (as identified through the CAL ID) in that vehicle. In this manner, reprogrammable ECUs that had been inappropriately modified or corrupted could be identified through an I/M check. At the same time, this also provides a mechanism for approved aftermarket software calibrations to be recognized as legally allowed modifications and not be inappropriately rejected at I/M checks.

In order for this to result in a robust verification of software integrity, ARB did not standardize the calculation algorithm that manufacturers will utilize to perform this verification. This allows manufacturers to continually modify the calculation from year to year or product to product to reduce the chance of software modifiers from also manipulating the memory contents to produce the right calculation result with non-exempted software modifications. As such, staff believes some minimum level of complexity and/or sophistication is needed in the calculation algorithms used by vehicle manufacturers to ensure that the memory contents cannot be easily manipulated to produce the correct calculation result. Additionally, staff believes that this is also a reason to require manufacturers to carry out the calculation when a request from an off-board device is received rather than perform the calculation at power-down or power-up conditions and simply store the results of the calculation in a memory location. Methods using the latter format lend themselves to easy manipulation of the stored value in the memory location, effectively defeating the verification process.

In accordance with our requirement, SAE modified J1979 to standardize this function. Specifically, SAE defined Vehicle Information Types \$05 and \$06 of Mode \$09 to provide a mechanism for communicating the results of a CVN calculation to a generic scan tool. SAE has also provided some guidelines in implementing this function including identifying an allowance to only perform the calculation during ignition on, engine off conditions. However, SAE did not develop these standards until more recently so that some manufacturers did not implement systems that meet all of the criteria in the SAE standard.

Additionally, many manufacturers did not fully understand ARB's requirements nor appreciate the complexity involved with implementing such a feature and have thus developed systems that do not meet the intent of the regulation. This includes the use by some manufacturers of relatively straightforward "check-sum" algorithms which are easily manipulated and do not provide the level of robustness that staff was hoping to achieve. At this time, staff proposes to add language to further clarify that the calculation used must meet a minimum level of complexity and receive Executive Officer approval and that the calculation must be carried out at the time of a scan tool request.

The following changes are proposed for section (l)(4.0) of the regulation:

- (l)(4.0) Beginning with a phase-in of 30 percent in the 2000 model year, 60 percent in the 2001 model year, and with full implementation by the 2002 model year, manufacturers shall provide for verification of the on-board computer software integrity in electronically reprogrammable control units through the standardized vehicle data connector in a standardized format ~~to be adopted by SAE based on the SAE specifications incorporated by reference.~~ The phase-in percentages shall be based on the manufacturer's projected sales volume for all vehicles and engines. Small volume manufacturers shall not be required to meet the phase-in percentages; however, such manufacturers shall achieve 100 percent compliance by the 2002 model year. Such verification shall be capable of being used to determine if the emission-related software and/or calibration data are valid and applicable for that vehicle. Such verification shall be performed at the time of a request by an off-board device. Manufacturers shall submit information describing the verification calculation algorithm for evaluation of compliance by the Executive Officer based on incorporating a sufficiently rigorous calculation likely to deter inappropriate modifications of the computer software. Alternate phase-in percentages that provide for equivalent timeliness overall in implementing these requirements shall be accepted.

Updates to Reference Documents

The dates for the following "SAE Recommended Practice" documents referenced in the regulation are updated to the most recent revisions.

- (k)(3.0) J2012 ~~Part C Uniform~~ Appendix C Generic fault codes based on SAE specifications shall be employed. SAE "Recommended Format and Messages for Diagnostic Trouble Codes" (J2012), March, 1999, October, 1994, is incorporated by reference.
- (k)(4.0) J1962 A standard data link connector in a standard location in each vehicle based on SAE specifications shall be incorporated. The location of the connector shall be easily identified by a technician entering the vehicle from the driver's side. Any pins in the standard connector that provide any electrical power shall be properly fused to protect the integrity and usefulness of the diagnostic connector for diagnostic purposes. The SAE Recommended Practice "Diagnostic Connector" (J1962), February, 1998, January, 1995, is incorporated by reference.
- (k)(5.0) With Executive Officer approval, medium-duty vehicles may alternatively employ the communication protocols established in SAE J1939 ~~Committee Draft~~, "Recommended Practice for a Serial Controlled Communications Vehicle Network", insert adopted

date ~~January 1994~~, to satisfy the standardization requirements specified in sections (k)(1) through (k)(4) above. The Executive Officer's decision shall be based on the effectiveness of the SAE J1939 protocol in satisfying the diagnostic information requirements of Section 1968.1 in comparison with the above referenced documents.

Miscellaneous Modifications

The following changes are proposed to make other minor changes, correct clerical errors, reflect the changes resulting from the LEV II program, and reflect the staff's proposals discussed above in the workshop notice.

- (n)(1.0) "Malfunction" means the inability of an emission-related component or system to remain within design specifications. Further, malfunction refers to the deterioration of any of the above components or systems to a degree that would likely cause the emissions of an average certification durability vehicle with the deteriorated components or systems present at the beginning of the applicable certification emission test to exceed ~~by more than~~ 1.5 times any of the emission standards (both with respect to the certification and useful life standards), unless otherwise specified, applicable pursuant to Subchapter 1 (commencing with Section 1900), Chapter 3 of Title 13. Notwithstanding, for catalyst monitoring (section (b)(1.0)), applicable HC or NOx emission standard shall refer only to the useful life standards.
- (n)(12.0) "Medium-duty vehicle" is defined in Title 13, Section 1900 (b)(9) as adopted on [Insert last amended date].
- (n)(14.0) "Low Emission Vehicle" refers to a vehicle certified in California as a Transitional Low Emission Vehicle (TLEV), a Low Emission Vehicle (LEV), ~~or~~ an Ultra Low Emission Vehicle (ULEV), or a Super Ultra Low Emission Vehicle (SULEV). These vehicle categories are further defined in Title 13, sections 1956.8, ~~and 1960.1, and 1961~~ as adopted on [Insert last amended/adopted date]. The LEV II emission standards are contained in Title 13, CCR section 1961.
- (n)(22.0) "Unified Cycle" is defined in "Speed Versus Time Data for California's Unified Driving Cycle", dated December 12, 1996, and incorporated by reference.

OBD II Requirements for Heavy-Duty Vehicles and Engines

On-board diagnostic requirements are currently being developed for heavy duty vehicles by the Environmental Protection Agency (EPA). ARB staff is working with the EPA on its heavy-duty on-board diagnostic system rulemaking. The staff expects to adopt a similar proposal and will harmonize with the federal requirements as much as possible.