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**Air Resources Board**

HAAGEN-SMIT  
LABORATORY  
P.O. Box 8001  
9528 Telstar Avenue  
El Monte, CA  
91734-8001

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Pete Wilson  
Governor

Peter M. Rooney  
Secretary for  
Environmental  
Protection

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

On December 12, 1996, the Air Resources Board (ARB or Board) conducted a public hearing to consider amendments to section 1968.1 of Title 13, California Code of Regulations (CCR), entitled "Malfunction and Diagnostic System Requirements--1994 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines" (OBD II). At the hearing, the Board approved for adoption the proposed modifications to the regulation. The regulation as modified is effective as of September 25, 1997.

Enclosed are copies of the approval by the Office of Administrative Law (OAL) and the text of the OBD II regulation. The text of the OBD II regulation is also available in electronic format on the ARB's world wide web site at <http://www.arb.ca.gov> (search for keyword "obd").

Any questions regarding the regulation may be directed to Allen Lyons, Manager, Advanced Engineering Section, at (626) 575-6833.

Sincerely,

Robert H. Cross, Chief  
Mobile Source Control Division

Enclosures

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

(a) GENERAL REQUIREMENTS

- (1.0) All 1994 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles shall be equipped with a malfunction indicator light (MIL) located on the instrument panel that will automatically inform the vehicle operator in the event of a malfunction of any powertrain components which can affect emissions and which provide input to, or receive output from, the on-board computer(s) or of the malfunction of the on-board computer(s) itself. The MIL shall not be used for any other purpose.
- (1.1) The MIL shall be of sufficient illumination and location to be readily visible under all lighting conditions. The MIL shall illuminate in the engine-run key position before engine cranking to indicate that the MIL is functional and shall, when illuminated, display the phrase "Check Engine" or "Service Engine Soon". The word "Powertrain" may be substituted for "Engine" in the previous phrases. Alternatively, the International Standards Organization (ISO) engine symbol may be substituted for the word "Engine," or for the entire phrase.
- (1.2) All 1994 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles required to have MIL pursuant to (1.0) above shall also be equipped with an on-board diagnostic system capable of identifying the likely area of the malfunction by means of fault codes stored in computer memory. These vehicles shall be equipped with a standardized electrical connector to provide access to the stored fault codes. Specific performance requirements are listed below. A glossary of terms is contained in section (n). Unless otherwise noted, all section references refer to section 1968.1 of Title 13, CCR.
- (1.3) Any reference to vehicles in this regulation shall also include medium-duty vehicles with engines certified on an engine dynamometer.
- (1.4) For Low Emission Vehicles (LEV), the Executive Officer shall revise the emission threshold for a malfunction on any check if the most reliable monitoring method developed requires a higher threshold to prevent significant errors of commission in detecting a malfunction.
- (1.5) For every case in which a malfunction is to be noted when an emission threshold is exceeded (e.g., emissions in excess of 1.5 times the standard), the manufacturer may perform only a functional check (defined in section (n)(16.0)) of a specific component or system if deterioration or failure of such would not cause the vehicle's emissions to exceed the emission threshold.
- (1.6) After the 1998 model year, for Non-LEVs, fulfillment of federal On-Board Diagnostic (OBD) requirements shall be deemed to be an acceptable option for the manufacturer for the purpose of meeting these requirements.
- (1.7) For 1994 and 1995 model years only, illumination of the malfunction indicator light upon

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

- (1.8) Manufacturers may employ alternate statistical MIL illumination and fault code storage protocols to those specified in these requirements, subject to Executive Officer approval based on comparable timeliness in detecting a malfunction and evaluating system performance. For strategies requiring on average between three and six driving cycles for MIL illumination, the manufacturer shall provide data and/or an engineering evaluation which adequately demonstrate that the monitoring system is equally effective and timely in detecting component deterioration. Strategies requiring on average more than six driving cycles for MIL illumination shall not be accepted.
- (1.9) Regarding diagnostic system monitoring conditions and MIL illumination requirements, manufacturers are generally required to define appropriate operating conditions for monitoring, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable Federal Test Procedure (FTP) test. Alternatively, manufacturers may request, subject to Executive Officer approval, use of monitoring conditions encountered during the Unified Cycle (see section (n)). In approval of the request, the Executive Officer shall consider the extent to which use of the cycle provides for more effective monitoring. Upon detection of a malfunction, the MIL is to be illuminated and a fault code stored no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again detected. Until the 1997 model year, diagnostic strategies that illuminate the MIL on the basis of

completing a trip (trip is defined in section (n)(5.0) of these requirements) shall be accepted. The Executive Officer shall accept trip based diagnostic systems until the 1998 model year, provided the manufacturer adequately demonstrates that the diagnostic strategies run with reasonable frequency during normal driving conditions. When a trip criterion is employed, upon detection of a malfunction, the diagnostic system shall store a fault code and the MIL shall be illuminated no later than the end of the next trip if the malfunction is again present.

- (1.10) For other emission control devices not identified or addressed in sections (b)(1) through (b)(12) (e.g., hydrocarbon adsorbers), manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy and fault thresholds prior to introduction on a production vehicle. Executive Officer approval shall be based on the effectiveness of the monitoring strategy, the malfunction criteria utilized, and the monitoring conditions required by the diagnostic.
- (2.0) Manufacturers may request Executive Officer approval to disable a diagnostic system designed to meet the requirements of section (b) at ambient engine starting temperatures below twenty degrees Fahrenheit (low ambient temperature conditions may be determined based on intake air or engine coolant temperature at engine starting), and at elevations above eight thousand feet above sea level provided the manufacturer submits data and/or an engineering evaluation which adequately demonstrate that monitoring would be unreliable when such conditions exist. Notwithstanding, diagnostic system disablement may be requested at other ambient engine starting temperatures if the manufacturer adequately demonstrates with data and/or an engineering evaluation that misdiagnosis would occur due to the impact of such ambient temperatures on the performance of the component itself (e.g., component freezing).
- (2.1) Manufacturers may disable monitoring systems that can be affected by running out of fuel (e.g., misfire detection) when the fuel level is low, provided disablement will not occur when the fuel level is above 15 percent of the nominal capacity of the fuel tank.
- (2.2) For vehicles designed to accommodate the installation of Power Take-Off (PTO) units (defined in section (n)(19.0)), disablement of affected monitoring systems is permitted provided disablement occurs only while the PTO unit is active, and provided the OBD II readiness code (specified in section (e)) is cleared by the on-board computer (i.e., all bits shall be set to "test not complete") while the PTO unit is activated. The code may be restored to its state prior to PTO activation upon PTO de-activation.

## (b) MONITORING REQUIREMENTS

### (1.0) CATALYST MONITORING

#### (1.1) Requirement:

- (1.1.1) The diagnostic system shall monitor the catalyst system for proper performance.
- (1.1.2) Manufacturers are not required to implement these catalyst monitoring requirements on diesel vehicles and engines. Further, manufacturers of spark-ignited lean-burn vehicles and engines may request that the Executive Officer exempt such applications from these catalyst monitoring requirements if it can be demonstrated that a reliable monitoring technology is not available. The Executive Officer shall approve such a request upon determining that all reasonable monitoring technologies have been considered to the extent possible.

#### (1.2) Malfunction Criteria:

- (1.2.1) Low Emission Vehicles (see section (n)(14.0)): The catalyst system shall be considered malfunctioning when its conversion capability decreases to the point that either of the following occurs: 1) Hydrocarbon (HC) emissions exceed the applicable emission threshold specified in section (b)(1.2.2) below, or 2) the average Federal Test Procedure (FTP) Non-Methane Hydrocarbon (NMHC) 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. For low emission vehicle applications, 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 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).
- (1.2.2) TLEV applications shall employ an emission threshold malfunction criterion of 2.0 times the applicable FTP HC standard plus the emissions from a test run with a representative 4000 mile catalyst system (125 hours of operation for medium-duty vehicles with engines certified on an engine dynamometer). The emission threshold criterion for LEV and ULEV applications shall be 2.5 and 3.0 times the applicable FTP HC standard, respectively, plus the emission level with a representative 4000 mile catalyst system. Notwithstanding, beginning with the 1998 model year, manufacturers shall phase in an emission threshold of 1.75 times the applicable FTP HC standard for all categories of low emission vehicles, which shall not include the emission level with a 4000 mile catalyst system. The phase in percentages (based on

the manufacturer's projected sales volume for low emission vehicle applications) shall equal or exceed 20 percent in the 1998 model year, 40 percent in the 1999 model year, 60 percent in the 2000 model year, 80 percent in the 2001 model year, with 100 percent implementation for the 2002 model year. Alternate phase-in schedules that provide for equivalent emission reduction and timeliness overall as defined in section (n)(21.0) shall be accepted. 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.

- (1.2.3) Non-Low Emission Vehicles: The catalyst system shall be considered malfunctioning when its conversion capability decreases to the point that HC emissions increase by more than 1.5 times the standard over an FTP test from a test run with a representative 4000 mile catalyst system.
- (1.2.4) For 1994 and 1995 model year 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).

(1.3) Monitoring Conditions:

- (1.3.1) The manufacturer shall define appropriate operating conditions during which monitoring shall occur, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. However, vehicles utilizing steady state monitoring (as permitted by section (1.2.4) above), may alternatively comply with the monitoring conditions specified in section (1.3.2). The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.
- (1.3.2) If steady state efficiency is being monitored (see section (b) (1.2.4)), the manufacturer shall choose a non-closed throttle, reasonably steady speed condition for monitoring

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

#### (1.4) MIL Illumination and Fault Code Storage:

- (1.4.1) Except as noted below, upon detection of a catalyst malfunction, the MIL shall illuminate and a fault code stored no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present.
- (1.4.2) For steady state catalyst efficiency checks, upon detection of catalyst efficiency below 60 percent, the diagnostic system may perform up to two successive monitoring checks prior to informing the vehicle operator of a malfunction. These monitoring checks need not occur on the same driving cycle, but shall be performed as soon as proper monitoring conditions occur. If catalyst efficiency remains below 60 percent for the three sequential checks, a fault code shall be stored and the MIL shall then be

activated.

- (1.4.3) The diagnostic system shall temporarily disable catalyst monitoring when a malfunction exists which could affect the proper evaluation of catalyst efficiency.
- (1.4.4) The monitoring method for the catalyst(s) shall be capable of detecting when a catalyst trouble code has been cleared (except diagnostic system self-clearing), but the catalyst has not been replaced (e.g., catalyst overtemperature approaches may not be acceptable).

## (2.0) HEATED CATALYST MONITORING

### (2.1) Requirement:

- (2.1.1) The diagnostic system shall monitor all heated catalyst systems for proper heating.
- (2.1.2) The efficiency of heated catalysts shall be monitored in conjunction with the requirements of section (b)(1).

### (2.2) Malfunction Criteria:

- (2.2.1) The catalyst heating system shall be considered malfunctioning when the catalyst does not reach its designated heating temperature within a requisite time period after engine starting. The time period is to be determined by the manufacturer subject to the requirement that the system shall detect a heating system malfunction causing emissions from a vehicle equipped with the heated catalyst system to exceed 1.5 times any of the applicable FTP standards.
  - (2.2.2) Manufacturers using other heating or monitoring strategies may submit an alternate plan for approval by the Executive Officer to monitor heated catalyst systems based on comparable reliability and timeliness to these requirements in detecting a catalyst heating malfunction.
- (2.3) Monitoring Conditions: Manufacturers shall define appropriate operating conditions for monitoring of the catalyst heating system, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.



- (2.4) MIL Illumination and Fault Code Storage: Upon detection of a catalyst heating malfunction, the MIL shall illuminate and a fault code stored no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present.

### (3.0) MISFIRE MONITORING

- (3.1) Requirement: The diagnostic system shall monitor engine misfire and shall identify the specific cylinder experiencing misfire. Manufacturers may request Executive Officer approval to store a general misfire fault code instead of a cylinder specific code under certain operating conditions provided the manufacturer submits data and/or an engineering evaluation which adequately demonstrate that the misfiring cylinder cannot be reliably identified when such conditions occur. If more than one cylinder is misfiring, a separate code shall indicate that multiple cylinders are misfiring (specifying the individual misfiring cylinders under this condition is optional, however, identifying only one misfiring cylinder shall not occur when a multiple misfire code is stored).
- (3.2) Malfunction Criteria: The manufacturer shall specify in the documentation provided for certification (see subsection (g) and (h) infra.) a percentage of misfires out of the total number of firing events necessary for determining a malfunction for each of the conditions listed below.
- (A) The percent misfire evaluated in 200 revolution increments for each engine speed and load condition which would result in catalyst damage. Subject to Executive Officer approval, a longer interval may be employed (but only for determining, on a given driving cycle, the first misfire exceedance in section (3.4.1)(A) below) provided the manufacturer submits data and/or an engineering evaluation which adequately demonstrate that catalyst damage would not occur due to unacceptably high catalyst temperatures before the interval has elapsed. The manufacturer shall submit in the certification documentation catalyst temperature data versus percent misfire over the full range of engine speed and load conditions. The data shall be obtained from a representative cross section of a manufacturer's engine offerings from small to large displacements. Up to three such engine evaluations shall be documented per manufacturer, though a manufacturer may submit more data if desired. An engineering evaluation shall be provided for establishing malfunction criteria for the remainder of engine families in the manufacturer's product line. The Executive Officer shall waive the evaluation requirement each year if, in the judgment of the Executive Officer, technological changes do not affect the previously determined malfunction criteria;
- (B) The percent misfire evaluated in 1000 revolution increments which would cause

emissions from a durability demonstration vehicle to exceed 1.5 times any of the applicable FTP standards if the degree of misfire were present from the beginning of the test. 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. 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.

### (3.3) Monitoring Conditions:

- (3.3.1) Pre-1997 Model Year Vehicles: misfire shall be monitored continuously during, at a minimum, positive torque operating conditions within the range of engine speed and load condition combinations encountered during an FTP test; nonetheless, subject to Executive Officer approval, manufacturers may employ higher misfire percentage malfunction criteria under specific conditions within the range of operating conditions encountered during an FTP test if the manufacturer provides data and/or an engineering evaluation which adequately demonstrate that the detection of lower levels of misfire would not be reliable for the vehicle model in question when such conditions are encountered without making fundamental engine or control unit design modifications. If the manufacturer can so demonstrate that even the detection of higher misfire percentages is not feasible under specific FTP operating conditions, the manufacturer may request Executive Officer approval to disable the monitoring system when such conditions are encountered.
- (3.3.2) 1997 and Later Model Year Vehicles: Manufacturers shall phase in expanded misfire monitoring conditions beginning with the 1997 model year. The phase in percentages (based on the manufacturer's projected sales volume for all vehicles and engines) shall equal or exceed 50 percent in the 1997 through 1999 model years, 75 percent in the 2000 model year, 90 percent in the 2001 model year, with 100 percent implementation for the 2002 model year. Alternate phase-in schedules that provide for equivalent emission reduction and timeliness overall shall be accepted. Small volume manufacturers shall not be required to meet the phase-in percentages;

however, 100 percent implementation of these monitoring conditions shall be required beginning with the 2002 model year. On vehicles meeting these phase-in percentages, except as provided for in section (3.3.3) below, monitoring for misfire shall be continuous from engine starting (see section (n)) and under all positive torque engine speeds and load conditions. Vehicles not meeting the monitoring conditions of this section shall meet the monitoring conditions specified in section (b)(3.3.1) above.

- (3.3.3) As an exception to monitoring misfire during all positive torque operating conditions, manufacturers may disable misfire monitoring in the engine operating region bound by the positive torque line (i.e., engine load with the transmission in neutral), and the two following engine operating points: an engine speed of 3000 rpm with the engine load at the positive torque line, and the redline engine speed (defined in section (n)(18.0)) with the engine's manifold vacuum at four inches of mercury lower than that at the positive torque line. Misfire detection systems unable to detect all misfire patterns under all required conditions shall be evaluated for compliance by the Executive Officer based on, but not limited to, the following factors: the magnitude of the region(s) in which misfire detection is limited, the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events), the frequency with which said region(s) are expected to be encountered in-use, the type of misfire patterns for which misfire detection is troublesome, and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation shall be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders, single cylinder continuous misfire, and paired cylinder (cylinders firing at the same crank angle) continuous misfire. Further, with Executive Officer approval, the manufacturer may disable misfire monitoring or employ higher malfunction criteria when misfire cannot be distinguished from other effects (e.g., rough roads, transmission shifts, etc.) when using the best available monitoring technology. The manufacturer shall present data and/or an engineering evaluation to the Executive Officer to justify the proposed action. Executive Officer approval shall be based on the extent to which monitoring is expected to be disabled in relation to the capabilities of the best available monitoring technologies as applied to other engines. However, through the 2000 model year, any such disablement occurring within the first 5 seconds after engine starting shall not require Executive Officer approval. Additionally, for engines with greater than eight cylinders, the Executive Officer shall waive the requirements of this section provided the manufacturer submits data and/or an engineering evaluation which adequately demonstrates that misfire detection throughout the required operating region cannot be achieved when employing proven monitoring technology (i.e., a technology that provides for compliance with these requirements on other engines) and provided misfire is detected to the fullest extent permitted by the technology, but under no circumstances shall acceptance be granted for misfire

detection systems not meeting the requirements of section (b)(3.3.1) above.

(3.4) MIL Illumination and Fault Code Storage:

(3.4.1) Upon detection of the level of misfire specified in subsection (3.2) (A), the following criteria shall apply for MIL illumination and fault code storage:

(A) A temporary fault code shall be stored and the MIL shall blink once per second during actual misfire conditions no later than after the third exceedance of the specified misfire level when operating in the region bound by the maximum engine speed and load conditions encountered during the FTP cycle and no later than after the first exceedance of the specified misfire level when operating at any other engine speed and load condition during a single driving cycle. While a temporary fault code is stored, the MIL shall blink during every subsequent exceedance during the driving cycle but may remain extinguished when misfire is not present. If the level of misfire is exceeded again (a single exceedance) during the following driving cycle or the next driving cycle in which similar conditions are encountered (as defined in section (3.4.3)) or while a temporary fault code for the level of misfire specified in subsection (3.2)(B) is present, the MIL shall blink as specified above, a fault code shall be stored, and the MIL shall remain continuously illuminated, even if the misfire ceases. The initial temporary code and stored conditions may be erased if misfire is not detected during the following driving cycle and similar conditions have been encountered without an exceedance of the specified misfire level. The code and conditions may also be erased if similar driving conditions are not encountered during 80 driving cycles subsequent to the initial detection of a malfunction.

(B) Notwithstanding, in vehicles which provide fuel shutoff and default fuel control to prevent over fueling during misfire conditions, the MIL need not blink. Instead, the MIL may illuminate continuously in accordance with the requirements for continuous MIL illumination in section (3.4.1)(A) above upon detection of misfire provided that the fuel shutoff and default control shall be activated as soon as misfire is detected. Fuel shutoff and default fuel control may be deactivated only to permit fueling outside of the misfire range.

(3.4.2) Upon detection of the misfire level specified in subsection (3.2) (B), the following criteria shall apply for MIL illumination and fault code storage:

(A) A temporary fault code shall be stored no later than after the fourth exceedance of the specified misfire level during a single driving cycle and the MIL shall be illuminated and a fault code stored no later than the end of the following driving cycle or the next driving cycle in which similar conditions are encountered (as defined in section (3.4.3)) if the level of misfire is again exceeded four times.

The initial temporary code and stored conditions may be erased if misfire is not detected during the following driving cycle and similar conditions have been encountered without an exceedance of the specified misfire level. The code and conditions may also be erased if similar driving conditions are not encountered during 80 driving cycles subsequent to the initial detection of a malfunction.

- (B) Notwithstanding, a temporary fault code shall be stored no later than after the first exceedance of the specified misfire level during a single driving cycle if the exceedance occurs within the first 1000 revolutions from engine start (defined in section (n)(20.0)) during which misfire detection is active. The MIL shall be illuminated and a fault code stored no later than the end of any subsequent driving cycle if misfire is again detected in the first 1000 revolutions. If similar conditions are encountered during a subsequent driving cycle without an exceedance of the specified misfire level, the initial temporary code and stored conditions may be erased. Furthermore, if similar driving conditions are not encountered during 80 driving cycles subsequent to the initial detection of a malfunction, the initial temporary code and stored conditions may be erased.

- (3.4.3) Upon detection of misfire, manufacturers shall store the engine speed, load, and warm-up status (i.e., cold or warmed-up) under which the first misfire event which resulted in the storage of a temporary fault code was detected. A driving cycle shall be considered to have similar conditions if the stored engine speed conditions are encountered within 375 rpm, load conditions within 20 percent, and the same warm-up status is present. With Executive Officer approval, other strategies for determining if similar conditions have been encountered may be employed. Approval shall be based on comparable timeliness and reliability in detecting similar conditions.

### (3.5) MISFIRE MONITORING FOR DIESELS

- (3.5.1) Requirement: Beginning with the 1998 model year, the diagnostic system on a diesel engine shall be capable of detecting the lack of combustion in one or more cylinders. To the extent possible without adding hardware for this specific purpose, the diagnostic system shall also identify the specific cylinder for which combustion cannot be detected. If the lack of combustion is present in more than one cylinder, a separate code shall indicate that multiple cylinders are malfunctioning (specifying the individual malfunctioning cylinders under this condition is optional; however, identifying one malfunctioning cylinder shall not occur when a multiple cylinder code is stored).
- (3.5.2) Malfunction Criteria: A cylinder shall be considered malfunctioning when combustion cannot be detected.
- (3.5.3) Monitoring Conditions: Manufacturers shall define appropriate operating conditions for monitoring, subject to the limitation that the monitoring conditions shall be

encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.

- (3.5.4) MIL Illumination and Fault Code Storage: The MIL shall illuminate and a fault code shall be stored no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present.

#### (4.0) EVAPORATIVE SYSTEM MONITORING

##### (4.1) Requirement:

- (4.1.1) The diagnostic system shall verify air flow from the complete evaporative system. In addition, the diagnostic system shall also monitor the evaporative system for the loss of HC vapor into the atmosphere by performing a pressure or vacuum check of the complete evaporative system.
- (4.1.2) Manufacturers may temporarily disable the evaporative purge system to perform a check.
- (4.1.3) Manufacturers may request Executive Officer approval to abort an evaporative system check under specific conditions (e.g., when the fuel tank level is over 85 percent of nominal tank capacity) if data and/or an engineering evaluation are provided which adequately demonstrate that a reliable check cannot be made when these conditions exist.
- (4.1.4) Subject to Executive Officer approval, other monitoring strategies may be used provided the manufacturer provides a description of the strategy and supporting data showing equivalent monitoring reliability and timeliness in detecting an evaporative system malfunction or leak.
- (4.1.5) Implementation of this requirement is mandatory only for 1996 and later model year vehicles designed to comply with the requirements of Title 13, California Code of Regulations, Section 1976, "Standards and Test Procedures for Motor Vehicle Fuel Evaporative Emissions," for 1995 and subsequent model year vehicles.

##### (4.2) Malfunction Criteria:

- (4.2.1) An evaporative system shall be considered malfunctioning when no air flow from the system can be detected, or when a system leak is detected that is greater than or equal in magnitude to a leak caused by a 0.040 inch diameter orifice in any portion of the evaporative system excluding the tubing and connections between the purge valve

and the intake manifold.

- (4.2.2) Beginning with the 2000 model year, manufacturers shall phase-in diagnostic strategies to detect system leaks greater than or equal in magnitude to a leak caused by a 0.020 inch diameter orifice. The phase-in percentages (based on the manufacturer's projected sales volume for all vehicles) shall equal or exceed 20 percent for the 2000 model year, 40 percent for the 2001 model year, 70 percent for the 2002 model year, and 100 percent implementation for the 2003 model year. Alternate phase-in schedules that provide for equivalent emission reduction and timeliness overall shall be accepted. Small volume manufacturers shall not be subject to the phase-in requirements; however, 100 percent implementation shall be required for the 2003 model year.
- (4.2.3) On vehicles with fuel tank capacity greater than 25 gallons, the Executive Officer shall revise the size of the orifice if the most reliable monitoring method available cannot reliably detect a system leak of the magnitudes indicated above. Further, on vehicles with fuel tank capacity from 18 to 25 gallons, the Executive Officer may allow a larger size orifice (e.g., 0.050 inch diameter rather than 0.040 inch diameter) to be detected at low fuel levels (e.g., less than 50 percent of capacity) through the 1999 model year if the manufacturer demonstrates that it is necessary to avoid false MILs for a particular application due to a unique fuel tank configuration that would require hardware modifications to facilitate reliable monitoring.
- (4.2.4) Upon request by the manufacturer and submission of data and/or engineering evaluation which adequately support the request, the Executive Officer shall revise the orifice size upward to exclude detection of leaks that cannot cause evaporative or running loss emissions to exceed 1.5 times the applicable standards.
- (4.3) Monitoring Conditions: Manufacturers shall define appropriate operating conditions for monitoring, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met. However, monitoring conditions may be further limited with respect to detecting leaks equivalent to a 0.020 inch diameter orifice, subject to Executive Officer approval, on the basis that the monitoring conditions will be reasonably-occurring in-use, and provided that a check for leaks equal or greater in magnitude than a 0.040 inch orifice will continue to be conducted at least once per driving cycle as indicated above. Subject to Executive Officer approval, if performance of the check causes vehicles to exceed applicable emission standards when using the best available technology, manufacturers may perform evaporative system monitoring during a steady-speed condition, as defined in section (b) (1.3.2), between 20 and 50 mph.
- (4.4) MIL Illumination and Fault Code Storage:

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

#### (5.0) SECONDARY AIR SYSTEM MONITORING

- (5.1) Requirement: Any vehicle equipped with any form of secondary air delivery system shall have the diagnostic system monitor the proper functioning of (1) the secondary air delivery system and (2) any air switching valve.
- (5.2) Malfunction Criteria:
  - (5.2.1) The diagnostic system shall indicate secondary air delivery system malfunction when the flow rate falls below the manufacturer's specified low flow limit such that a vehicle would exceed 1.5 times any of the applicable FTP emission standards.
  - (5.2.2) Manufacturers adequately demonstrating that deterioration of the flow distribution system is unlikely may request Executive Officer approval to perform only a functional check of the system. As part of this demonstration, manufacturers shall demonstrate that the materials used for the secondary air system (e.g., air hoses, and tubing) are inherently resistant to corrosion or other deterioration. If a functional check is approved, the diagnostic system shall indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during a check.
- (5.3) Monitoring Conditions: Manufacturers shall define appropriate operating conditions for monitoring of the secondary air system, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.



- (5.4) MIL Illumination and Fault Code Storage: The diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present.

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

##### (6.1) Requirement:

- (6.1.1) The diagnostic system shall monitor air conditioning systems for loss of refrigerants which could harm the stratospheric ozone layer or are reactive in forming atmospheric ozone. Any sensor used for such monitoring shall itself be monitored for proper circuit continuity and proper range of operation. A provision for ensuring that a leak has been corrected before extinguishing the MIL shall be provided.
- (6.1.2) Manufacturers of a model vehicle which will phase out the use of chlorofluorocarbons in its air conditioning systems by the 1996 model-year or which will use federally-approved refrigerants with substantially less atmospheric ozone depleting potential than CFC-12 need not comply with this requirement for that model.
- (6.2) Malfunction Criteria: Manufacturers shall provide a monitoring strategy for approval by the Executive Officer for monitoring a refrigerant leak. The approval shall be based on timeliness and reliability in detecting a leak.
- (6.3) Monitoring Conditions: Manufacturers shall define appropriate operating conditions for monitoring, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.
- (6.4) MIL Illumination and Fault Code Storage: The diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present. The diagnostic system shall not clear a fault code and the MIL shall not turn off unless the leak has been corrected.

#### (7.0) FUEL SYSTEM MONITORING

- (7.1) Requirement: The diagnostic system shall monitor the fuel delivery system for its ability to provide compliance with emission standards. For diesel vehicles and engines, the manufacturer shall monitor the performance of all electronic fuel system components to the extent feasible with respect to the malfunction criteria specified in section (7.2) below.

- (7.2) **Malfunction Criteria:** The manufacturer shall establish malfunction criteria to monitor the fuel delivery system such that a vehicle's emissions would not exceed 1.5 times any of the applicable FTP standards before a fault is detected. If the vehicle is equipped with fuel trim circuitry, the manufacturer shall include as one of the malfunction criteria the condition where the trim circuitry has used up all of the trim adjustment allowed within the manufacturer's selected limit(s). Manufacturers may compensate the criteria limit(s) appropriately for changes in altitude or for temporary introduction of large amounts of purge vapor or for other similar identifiable operating conditions when they occur.
- (7.3) **Monitoring Conditions:** The fuel system shall be monitored continuously for the presence of a malfunction.
- (7.4) **MIL Illumination and Fault Code Storage:**
- (7.4.1) For fuel systems with short-term trim only capability, the diagnostic system shall store a fault code after the fuel system has attained the criteria limit for a manufacturer-defined time interval sufficient to determine a malfunction. If the malfunction criteria limit and time interval are exceeded, the MIL shall be illuminated and a fault code stored no later than the end of the next driving cycle in which the criteria and interval are again exceeded, unless driving conditions similar to those under which the problem was originally detected have been encountered (see section (7.4.3)) without such an exceedance, in which case the initial temporary code and stored conditions may be erased. Furthermore, if similar driving conditions are not encountered during 80 driving cycles subsequent to the initial detection of a malfunction, the initial temporary code and stored conditions may be erased.
- (7.4.2) For fuel systems with long-term fuel trim capability, upon attaining a long-term based malfunction criteria limit independent of, or in combination with, the short-term trim system status, the MIL shall be illuminated and a fault code stored no later than the end of the next driving cycle if the malfunction is again detected. If the malfunction is not detected during the second driving cycle, the MIL shall be illuminated and a fault code stored no later than the next driving cycle in which the malfunction is again detected, unless driving conditions similar to those under which the problem was originally detected have been encountered (see section (7.4.3)) without an indication of a malfunction, in which case the initial temporary code and stored conditions may be erased. Furthermore, if similar driving conditions are not encountered during 80 driving cycles subsequent to the initial detection of a malfunction, the initial temporary code and stored conditions may be erased.
- (7.4.3) Upon detection of a fuel system malfunction, manufacturers shall store the engine speed, load and warm-up status (i.e., cold or warmed-up) under which the malfunction was detected. A driving cycle shall be considered to have similar

conditions if the stored engine speed is encountered within 375 rpm, load conditions within 20 percent, and the same warm-up status is present. With Executive Officer approval, other strategies for determining if similar conditions have been encountered may be employed. Approval shall be based on comparable timeliness and reliability in detecting similar conditions.

## (8.0) OXYGEN SENSOR MONITORING

### (8.1) Requirement:

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

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

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

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

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

### (8.2) Malfunction Criteria:

- (8.2.1) An oxygen sensor shall be considered malfunctioning when the voltage, response rate, or other criteria are exceeded and causes emissions from a vehicle equipped with the sensor(s) to exceed 1.5 times any of the applicable FTP standards, or when the 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).
- (8.2.2) For heated oxygen sensors, the heater circuit shall be considered malfunctioning when the current or voltage drop in the circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Subject to Executive Officer approval, other monitoring strategy malfunction criteria for detection of heater circuit malfunctions may be used provided the manufacturer submits data and/or an engineering evaluation adequately showing monitoring reliability and timeliness to be equivalent to the stated criteria in this paragraph.

(8.3) Monitoring Conditions:

- (8.3.1) For primary oxygen sensor(s) used for fuel control, the response rate and output voltage shall be monitored for malfunction before the end of the first idle period after the vehicle has commenced closed-loop operation, if the necessary checking condition for acceptable oxygen sensor(s) performance has been encountered. The performance of the sensor can only be judged acceptable by one or more of the following means: within any 20 second reasonably steady speed condition as defined in (b) (1.3.2), within any deceleration of 3 seconds or more, or during the first idle period of at least 20 seconds after closed loop operation begins (i.e., not during an acceleration condition); notwithstanding, unacceptable performance can be determined at any time. Other monitoring conditions may be used provided the manufacturer provides a monitoring strategy and supporting data showing equivalent monitoring reliability and timeliness in detecting a malfunctioning sensor compared to the above monitoring conditions and the Executive Officer approves.
- (8.3.2) For secondary oxygen sensors used for catalyst monitoring and/or fuel system trim, the manufacturer shall define appropriate operating conditions for response rate and/or output voltage malfunction monitoring, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.
- (8.3.3) For heated oxygen sensors, the manufacturer shall define appropriate operating conditions for malfunction monitoring of the heater circuit, subject to the limitation that the monitoring conditions shall be encountered at least once during the first

engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.

- (8.4) MIL Illumination and Fault Code Storage: Upon detection of any oxygen sensor malfunction, the diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present.

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

- (8.5.1) For vehicles equipped with universal exhaust gas oxygen sensors (i.e. sensors which provide an output proportional to exhaust gas oxygen concentration), the manufacturer shall define appropriate operating conditions for the diagnostic system to perform a response rate check (the time required to respond to a specific change in fuel/air ratio), subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met. The diagnostic system shall also perform an out-of-range check for which monitoring shall be continuous. For malfunctions, MIL illumination and fault code storage shall be as in (8.4).
- (8.5.2) If a manufacturer utilizes other types of oxygen sensors, the manufacturer shall submit a monitoring plan to the Executive Officer for approval based on equivalent monitoring with conventional sensors.

(9.0) EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITORING

(9.1) Requirement:

- (9.1.1) The diagnostic system shall monitor the EGR system on vehicles so-equipped for low and high flow rate malfunctions.
- (9.1.2) Manufacturers may request Executive Officer approval to temporarily disable the EGR system check under specific conditions provided the manufacturer submits data and/or an engineering evaluation which adequately demonstrate that a reliable check cannot be made when these conditions exist.
- (9.2) Malfunction Criteria: The EGR system shall be considered malfunctioning when one or both of the following occurs: (1) any component of the system fails to perform within manufacturer specifications, or (2) the EGR flow rate exceeds the manufacturer's specified low or high flow limits such that a vehicle would exceed 1.5 times any of the applicable

FTP emission standards.

- (9.3) Monitoring Conditions: Manufacturers shall define appropriate operating conditions for monitoring the EGR system, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.
- (9.4) MIL Illumination and Fault Code Storage: The diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present.

#### (10.0) POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM MONITORING

- (10.1) Requirement: Beginning with the 2002 model year, manufacturers shall phase-in diagnostic strategies to monitor the PCV system on vehicles so-equipped for system integrity. The phase-in percentages (based on the manufacturer's projected sales volume for all vehicles and engines subject to this section) shall equal or exceed 30 percent in the 2002 model year, 60 percent in the 2003 model year, with 100 percent implementation for the 2004 model year. Small volume manufacturers are not required to meet the phase-in percentages; however, 100 percent implementation of these monitoring requirements shall be required beginning with the 2004 model year. Alternate phase-in percentages that provide for equivalent emission reduction and timeliness overall in implementing these requirements shall be accepted.

#### (10.2) Malfunction Criteria:

- (10.2.1) Except as provided below, the PCV system shall be considered malfunctioning when disconnection occurs between either the crankcase and the PCV valve, or between the PCV valve and the intake manifold.
- (10.2.2) If the PCV system is designed such that the PCV valve is fastened directly to the crankcase in a manner which makes it significantly more difficult to remove the valve from the crankcase rather than disconnect the line between the valve and the intake manifold (taking aging effects into consideration), the Executive Officer shall exempt the manufacturer from detection of disconnection between the crankcase and the PCV valve. Subject to Executive Officer approval, system designs that utilize tubing between the valve and the crankcase shall also be exempted from this portion of the monitoring requirement provided the manufacturer submits data and/or engineering evaluation which adequately demonstrate that the connections between the valve and the crankcase are resistant to deterioration or accidental disconnection, are significantly more

difficult to disconnect than the line between the valve and the intake manifold, and are not subject to disconnection per manufacturer's repair procedures for non-PCV system repair work.

(10.2.3) Manufacturers shall not be required to detect disconnections between the PCV valve and the intake manifold if said disconnection (1) causes the vehicle to stall immediately during idle operation; or (2) is unlikely due to a PCV system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses).

(10.3) Monitoring Conditions: Manufacturers shall define appropriate operating conditions for monitoring the PCV system, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. The monitoring system shall operate at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.

(10.4) MIL Illumination and Fault Code Storage: The diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present. The fault code need not specifically identify the PCV system (e.g., a fault code for idle speed control or fuel system monitoring can be stored) if the manufacturer demonstrates that additional monitoring hardware would be necessary to make this identification, and provided the manufacturer's diagnostic and repair procedures for the indicated fault include directions to check the integrity of the PCV system.

## (11.0) THERMOSTAT MONITORING

(11.1) Requirement: Beginning with the 2000 model year, manufacturers shall phase-in diagnostic strategies to monitor the thermostat on vehicles so-equipped for proper operation. The phase-in percentages (based on the manufacturer's projected sales volume for all vehicles and engines) shall equal or exceed 30 percent in the 2000 model year, 60 percent in the 2001 model year, with 100 percent implementation for the 2002 model year. Small volume manufacturers are not required to meet the phase-in percentages; however, 100 percent implementation of these monitoring requirements shall be required beginning with the 2002 model year. Alternate phase-in percentages that provide for equivalent emission reduction and timeliness overall in implementing these requirements shall be accepted.

(11.2) Malfunction Criteria: The thermostat shall be considered malfunctioning if within a manufacturer-specified time interval after starting the engine, (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

temperature within 20 degrees Fahrenheit of the manufacturer's thermostat regulating temperature. Manufacturers shall provide data and/or engineering evaluation to support specified times. Subject to Executive Officer approval, manufacturers may utilize lower temperatures for criterion (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.

(11.3) Monitoring Conditions: Manufacturers shall define appropriate operating conditions for monitoring the thermostat; however, manufacturers may disable monitoring at ambient engine starting temperatures below 20 degrees Fahrenheit.

(11.4) MIL Illumination and Fault Code Storage: The diagnostic system shall store a fault code and the MIL shall illuminate no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again present.

## (12.0) COMPREHENSIVE COMPONENT MONITORING

(12.1) Requirement: The diagnostic system shall monitor for malfunction any electronic powertrain component/system not otherwise described above which 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.

### (12.1.1) Input Components:

(A) The monitoring system shall have the capability of detecting, at a minimum, lack of circuit continuity and out of range values to ensure proper operation of the input device. The determination of out of range values shall include logic evaluation of available information to determine if a component is operating within its normal range (e.g., a low throttle position sensor voltage would not be reasonable at a high engine speed with a high mass airflow sensor reading). To the extent feasible, said logic evaluation shall be "two-sided" (i.e., verify a sensor output is not inappropriately high or low).

(B) Input components may include, but are not limited to, the vehicle speed sensor, crank angle sensor, knock sensor, throttle position sensor, coolant temperature sensor, cam position sensor, fuel composition sensor (e.g. methanol flexible fuel vehicles), transmission electronic components such as sensors, modules, and solenoids which



provide signals to the powertrain control system (see section (b) (12.5)).

- (C) The coolant temperature sensor shall be monitored for achieving a stabilized minimum temperature level which is needed to achieve closed-loop operation (or for diesel applications, the minimum temperature needed for warmed-up fuel control to begin) within a manufacturer-specified time interval after starting the engine. The time interval shall be a function of starting engine coolant temperature and/or a function of intake air temperature and, except as noted below, shall not exceed two minutes for engine start temperatures at or above 50 degrees Fahrenheit and five minutes for engine start temperatures at or above 20 degrees and below 50 degrees Fahrenheit. Manufacturers may suspend or delay the diagnostic if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time). Manufacturers shall provide data to support specified times. The Executive Officer shall allow longer time intervals provided a manufacturer submits data and/or an engineering evaluation which adequately demonstrate that the vehicle requires a longer time to warm up under normal conditions. The Executive Officer shall allow disablement of this check under extremely low ambient temperature conditions (below 20 degrees Fahrenheit) provided a manufacturer submits data and/or an engineering evaluation which adequately demonstrate non-attainment of a stabilized minimum temperature.

(12.1.2) Output Components:

- (A) The diagnostic system shall monitor output components for proper functional response to computer commands.
- (B) Components for which functional monitoring is not feasible shall be monitored, at a minimum, for proper circuit continuity and out of range values, if applicable.
- (C) Output components may include, but are not limited to, the automatic idle speed motor, emission-related electronic only transmission controls, heated fuel preparation systems, the wait-to-start lamp on diesel applications, and a warmup catalyst bypass valve (see section (b) (12.5)).

(12.2) Malfunction Criteria:

- (12.2.1) Input Components: Input components/systems shall be considered malfunctioning when, at a minimum, lack of circuit continuity or manufacturer-specified out-of-range values occur.

(12.2.2) Output Components:

- (A) Output components/systems shall be considered malfunctioning when proper functional

response to computer commands does not occur. Should a functional check for malfunction not be feasible, then an output component/system shall be considered malfunctioning when, at a minimum, lack of circuit continuity or manufacturer-specified out-of-range values occur.

- (B) The idle speed control motor/valve shall be monitored for proper functional response to computer commands. For strategies based on deviation from target idle speed, a fault shall be indicated when the idle speed control system cannot achieve the target idle speed within a manufacturer specified time and engine speed tolerance. In general, the engine speed tolerances shall not exceed 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed. The Executive Officer shall allow larger engine speed tolerances provided a manufacturer submits data and/or an engineering evaluation which adequately demonstrate that the tolerances can be exceeded without a malfunction present.
- (C) Glow plugs shall be monitored for proper functional response to computer commands. The glow plug circuit(s) shall be monitored for proper current and voltage drop. The Executive Officer shall approve other monitoring strategies based on manufacturer's data and/or engineering analysis demonstrating equally reliable and timely indication of malfunctions. Manufacturers shall indicate a malfunction when a single glow plug no longer operates within the manufacturer's specified limits for normal operation. If a manufacturer demonstrates that a single glow plug failure cannot cause a measurable increase in emissions during any reasonable driving condition, the manufacturer shall indicate a malfunction for the minimum number of glow plugs needed to cause an emission increase. Further, to the extent feasible (without adding additional hardware for this purpose), the stored fault code shall identify the specific malfunctioning glow plug(s).

#### (12.3) Monitoring Conditions:

- (12.3.1) Input Components: Input components shall be monitored continuously for proper range of values and circuit continuity. For rationality monitoring (where applicable), manufacturers shall define appropriate operating conditions during which monitoring shall occur, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. Rationality monitoring shall occur at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.

(12.3.2) Output Components: Monitoring for circuit continuity and proper range of values (if applicable) shall be conducted continuously. For functional monitoring, manufacturers shall define appropriate operating conditions during which monitoring shall occur, subject to the limitation that the monitoring conditions shall be encountered at least once during the first engine start portion of the applicable FTP test. However, functional monitoring may be conducted during non-FTP driving conditions, subject to Executive Officer approval, if the manufacturer provides data and/or an engineering evaluation which adequately demonstrate that the component does not normally function, or monitoring is otherwise not feasible, during applicable FTP test driving conditions. Functional monitoring shall occur at least once per driving cycle during which the manufacturer-defined monitoring conditions are met.

(12.4) MIL Illumination and Fault Code Storage:

(12.4.1) Upon detecting a malfunction, the diagnostic system shall store a fault code no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again detected.

(12.4.2) In conjunction with storing a fault code, manufacturers shall illuminate the MIL for malfunctions of components/systems for which either of the following occurs: 1) When malfunctioning, the component or system could cause vehicle emissions to increase by 15 percent or more of the FTP standard, or 2) The component/system is used as part of the diagnostic strategy for any other monitored system or component.

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

(c) ADDITIONAL MIL ILLUMINATION AND FAULT CODE STORAGE PROTOCOL

(1.0) MIL ILLUMINATION For all emission-related components/systems, upon final determination of malfunction, the MIL shall remain continuously illuminated (except that it shall blink as indicated previously for misfire detection). If any malfunctions are identified in addition to misfire, the misfire condition shall take precedence, and the MIL shall blink accordingly. The diagnostic system shall store a fault code for MIL illumination whenever the MIL is illuminated. The diagnostic system shall illuminate the MIL and shall store a

code whenever the powertrain enters a default or "limp home" mode of operation. The diagnostic system shall illuminate the MIL and shall store a code whenever the engine control system fails to enter closed-loop operation (if employed) within a manufacturer specified minimum time interval.

## (2.0) EXTINGUISHING THE MIL

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

(2.2) All Other Malfunctions: Except as noted in section (b) (6.4), for all other faults, the MIL may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction and if no other malfunction has been identified that would independently illuminate the MIL according to the requirements outlined above.

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

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

(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 Society of Automotive Engineers' (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. 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)).

- (f) **STORED ENGINE CONDITIONS** Upon detection of the first malfunction of any component or system, "freeze frame" engine conditions present at the time shall be stored in computer memory. Should a subsequent fuel system or misfire malfunction occur, any previously stored freeze frame conditions shall be replaced by the fuel system or misfire conditions (whichever occurs first). Stored engine conditions shall include, but are not limited to, calculated load value, engine RPM, fuel trim value(s) (if available), fuel pressure (if available), vehicle speed (if available), coolant temperature, intake manifold pressure (if available), closed- or open-loop operation (if available), and the fault code which caused the data to be stored. The manufacturer shall choose the most appropriate set of conditions facilitating effective repairs for freeze frame storage. Only one frame of data is required. Manufacturers may at their discretion choose to store additional frames provided that at least the required frame can be read by a generic scan tool meeting SAE specifications established in SAE Recommended Practices on "OBD II Scan Tool" (J1978), June, 1994, and "E/E Diagnostic Test Modes" (J1979), June, 1994, which are incorporated by reference herein. If approval is granted to use the SAE J1939 communication protocol according to section (k)(5.0), the data shall be accessible using a scan tool meeting the J1939 specifications. If the fault code causing the conditions to be stored is erased in accordance with section (c)(3.0), the stored engine conditions may be cleared as well.

(g) **MONITORING SYSTEM DEMONSTRATION REQUIREMENTS**

- (1.0) **REQUIREMENT** Each year a manufacturer shall provide emission test data obtained from a certification durability vehicle for one engine family that has not been used previously for purposes of this section. 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 NO<sub>x</sub> standard applicable for more than 50,000 miles is established in California, the federal 50,000 to 100,000 mile NO<sub>x</sub> standard shall be used for demonstration purposes.

- (1.1) Flexible fuel vehicles shall perform each demonstration test using 85 percent methanol and 15 percent gasoline, and gasoline only. For vehicles capable of operating on other fuel combinations, the manufacturer shall submit a plan for performing demonstration testing for approval by the Executive Officer on the basis of providing accurate and timely evaluation of the monitored systems.
- (2.0) **APPLICABILITY:** The manufacturer shall perform single-fault testing based on the applicable FTP test cycle with the following components/systems at their malfunction criteria limits as determined by the manufacturer:
  - (2.1) **Oxygen Sensors.** The manufacturer shall conduct the following demonstration tests: The first test involves testing all primary and secondary (if equipped) oxygen sensors used for fuel control simultaneously possessing normal output voltage but response rate deteriorated to the malfunction criteria limit (secondary oxygen sensors for which response rate is not monitored shall be with normal response characteristics). The second test shall include testing with all primary and secondary (if equipped) oxygen sensors used for fuel control simultaneously possessing output voltage at the malfunction criteria limit. Manufacturers shall also conduct a malfunction criteria demonstration test for any other oxygen sensor parameter that can cause vehicle emissions to exceed 1.5 times the applicable standards (e.g., shift in air/fuel ratio at which oxygen sensor switches). When performing additional test(s), all primary and secondary (if equipped) oxygen sensors used for fuel control shall be operating at the malfunction criteria limit for the applicable parameter only. All other primary and secondary oxygen sensor parameters shall be with normal characteristics.
  - (2.2) **EGR System:** The manufacturer shall conduct only one flow rate demonstration test at the low flow limit.
  - (2.3) **Fuel Metering System:**
    - (2.3.1) For vehicles with short-term or long-term fuel trim circuitry, the manufacturer shall conduct one demonstration test at the border of the rich limit and one demonstration test at the border of the lean limit established by the manufacturer for emission compliance.

- (2.3.2) For other systems, the manufacturer shall conduct a demonstration test at the criteria limit(s).
- (2.3.3) For purposes of the demonstration, the fault(s) induced may result in a uniform distribution of fuel and air among the cylinders. Non-uniform distribution of fuel and air used to induce a fault shall not cause an indication of misfire. The manufacturer shall describe the fault(s) induced in the fuel system causing it to operate at the criteria limit(s) for the demonstration test (e.g., restricted or increased flow fuel injectors, an altered output signal airflow meter, etc.). Computer modifications to cause the fuel system to operate at the adaptive limit for malfunction shall be allowed for the demonstration tests if the manufacturer demonstrates that the computer modification produces equivalent test results.
- (2.4) Misfire: The manufacturer shall conduct one FTP demonstration test at the criteria limit specified in (b)(3.2)(B) for malfunction. This demonstration is not required for diesel applications.
- (2.5) Secondary Air System: The manufacturer shall conduct a flow rate demonstration test at the low flow limit, unless only a functional check is permitted according to section (b)(5.2.2).
- (2.6) Catalyst Efficiency:
  - (2.6.1) Non-Low Emission Vehicles: The manufacturer shall conduct a baseline FTP test with a representative 4000 mile catalyst system followed by one FTP demonstration test using a catalyst system deteriorated to its malfunction limit. If a manufacturer is employing a steady state catalyst efficiency check in accordance with section (b) (1.2.4), demonstration of the catalyst monitoring system is not required.
  - (2.6.2) Low Emission Vehicles: The manufacturer shall conduct a catalyst efficiency demonstration using a catalyst system deteriorated to the malfunction criteria.
- (2.7) Heated Catalyst Systems: The manufacturer shall conduct a demonstration test where the designated heating temperature is reached at the time limit for malfunction after engine starting.
- (2.8) Manufacturers may electronically simulate deteriorated components, but may not make any vehicle control unit modifications (unless otherwise excepted above) when performing demonstration tests. All equipment necessary to duplicate the demonstration test must be made available to the ARB upon request.

(3.0) **PRECONDITIONING** The manufacturer shall use the first engine start portion of one applicable FTP cycle (or Unified Cycle, if approved) for preconditioning before each of the above emission tests. If a manufacturer provides data and/or an engineering evaluation which adequately demonstrate that additional preconditioning is necessary to stabilize the emission control system, the Executive Officer shall allow an additional identical preconditioning cycle, or a Federal Highway Fuel Economy Driving Cycle, following a ten-minute (or 20 minutes for medium duty engines certified on an engine dynamometer) hot soak after the initial preconditioning cycle. The manufacturer shall not require the demonstration vehicle to be cold soaked prior to conducting preconditioning cycles in order for the monitoring system demonstration to be successful.

#### (4.0) EVALUATION PROTOCOL

- (4.1) The manufacturer shall set the system or component for which detection is to be demonstrated at the criteria limit(s) prior to conducting the applicable preconditioning cycle(s). (For misfire demonstration, misfire shall be set at its criteria limit as specified pursuant to section (b)(3.2)(B)). If a second preconditioning cycle is permitted in accordance with section (3.0) above, the manufacturer may adjust the demonstrated system or component before conducting the second preconditioning cycle; however, the demonstrated system or component shall not be replaced, modified or adjusted after preconditioning has taken place.
- (4.2) After preconditioning, the vehicle shall be operated over the first engine start portion of the applicable FTP test (or Unified Cycle, if approved) to allow for the initial detection of the malfunction. This driving cycle may be omitted from the evaluation protocol if it is unnecessary. If required by the demonstrated monitoring strategy, a cold soak may be performed prior to conducting this driving cycle.
- (4.3) The vehicle shall then be operated over a full applicable FTP test. If monitoring during the Unified Cycle is approved, a second Unified Cycle may be conducted prior to the FTP test.
- (4.4) For all demonstrations, the MIL shall be illuminated before the hot start portion of the full FTP test (or before the hot start portion of the last Unified Cycle, if applicable) in accordance with requirements of subsection (b):
- (4.4.1) If the MIL does not illuminate when the systems or components are set at their limit(s), the criteria limit or the OBD system is not acceptable.
  - (4.4.2) Except for catalyst efficiency demonstration, if the MIL illuminates and emissions do not exceed 1.5 times any of the applicable FTP emission standards, no further demonstration shall be required.



- (4.4.3) Except for catalyst efficiency demonstration, if the MIL illuminates and emissions exceed 1.5 times any of the applicable FTP emission standards, the vehicle shall be retested with the component's malfunction criteria limit value reset such that vehicle emissions are reduced by no more than 30 percent. Limit value at a minimum includes, in the case of oxygen sensors, response rate and voltage; for EGR systems, EGR flow rate; for secondary air systems, air flow rate; for short-term fuel trim- only systems, time interval at the fuel system range of authority limit; for long-term fuel trim systems, shift in the base fuel calibration; for heated catalyst systems, the time limit between engine starting and attaining the designated heating temperature (if an after-start heating strategy is used); and for misfire, percent misfire. For the OBD system to be approved, the vehicle must then meet the above emission levels when tested with the faulty components. The MIL shall not illuminate during this demonstration.
- (4.4.4) For Non-LEV catalyst efficiency demonstration, if HC emissions do not increase by more than 1.5 times the standard from the baseline FTP test and the MIL is illuminated, no further demonstration shall be required. However, if HC emissions increase by more than 1.5 times the standard from the baseline FTP test and the MIL is illuminated, the vehicle shall be retested with the average FTP HC conversion capability of the catalyst system increased by no more than 10 percent (i.e., 10 percent more engine out hydrocarbons are converted). For the OBD system to be approved, the vehicle must then meet the above emission levels when re-tested. The MIL shall not illuminate during this demonstration.
- (4.4.5) For Low Emission Vehicle catalyst efficiency demonstration, if HC emissions do not exceed the applicable emission threshold specified in section (b)(1.2.2) and the MIL is illuminated, no further demonstration shall be required. However, if HC emissions exceed the threshold and the MIL is illuminated, the vehicle shall be retested with average FTP HC conversion capability of the catalyst system increased by no more than 5 percent (i.e., 5 percent more engine out hydrocarbons 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.
- (4.5) If an OBD system is determined unacceptable by the above criteria, the manufacturer may re-calibrate and re-test the system on the same vehicle. Any affected monitoring systems demonstrated prior to the re-calibration shall be re-verified.
- (4.6) The Executive Officer may approve other demonstration protocols if the manufacturer can adequately show comparable assurance that the malfunction criteria are chosen based on meeting emission requirements and that the timeliness of malfunction detections are within the constraints of the applicable monitoring requirements.

- (h) **CERTIFICATION DOCUMENTATION:** The manufacturer shall submit the following documentation for each engine family at the time of certification. 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:
- (1) A written description of the functional operation of the diagnostic system to be included in section 8 of manufacturers' certification applications.
  - (2) A table providing the following information for each monitored component or system (either computer-sensed or -controlled) of the emission control system:
    - (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
  - (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, shall be used. J1930 is incorporated by reference herein. The information required in the chart under (2) above may instead be included in this flow chart, provided all of the information required in (2) is included.
  - (4) A listing and block diagram of the input parameters used to calculate or determine calculated load values and the input parameters used to calculate or determine fuel trim values.
  - (5) A scale drawing of the MIL and the fuel cap indicator light, if present, which specifies location in the instrument panel, wording, color, and intensity.
  - (6) Emission test data specified in subsection (g).
  - (7) Data supporting the selected degree of misfire which can be tolerated without damaging

the catalyst. 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).

- (8) Data supporting the limit for the time between engine starting and attaining the designated heating temperature for after-start heated catalyst systems.
  - (9) For 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.
  - (12) A description of the modified or deteriorated components used for fault simulation with respect to the demonstration tests specified in section (g).
  - (13) A listing of all electronic powertrain input and output signals.
  - (14) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this section.
- (i) **IN-USE RECALL TESTING PROTOCOL** The manufacturer shall adhere to the following procedures for vehicles subject to in-use recall testing required by the ARB:
- (1) If the MIL illuminates during a test cycle or during a preconditioning cycle, the fault causing the illumination may be identified and repaired following published procedures readily available to the public including the independent service sector.
  - (2) The test may be rerun, and the results from the repaired vehicle may be used for emission reporting purposes.
  - (3) If a vehicle contains a part which is operating outside of design specifications with no MIL illumination, the part shall not be replaced prior to emission testing unless it is determined that the part has been tampered with or abused in such a way that the diagnostic system

cannot reasonably be expected to detect the resulting malfunction.

- (4) Failure of a vehicle, or vehicles on average, to meet applicable emission standards with no illumination of the MIL shall not by itself be grounds for requiring the OBD system to be recalled for recalibration or repair since the OBD system cannot predict precisely when vehicles exceed emission standards.
- (5) A decision to recall the OBD system for recalibration or repair will depend on factors including, but not limited to, level of emissions above applicable standards, presence of identifiable faulty or deteriorated components which affect emissions with no MIL illumination, and systematic erroneous activation of the MIL. 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.
- (6) Regarding catalyst system monitoring, unmonitored catalysts shall be normally aged.
- (j) **CONFIRMATORY TESTING** The ARB may perform confirmatory testing of manufacturers' diagnostic systems for compliance with requirements of this section in accordance with malfunction criteria submitted in the manufacturer's approved certification documentation. The ARB or its designee may install appropriately deteriorated or malfunctioning components in an otherwise properly functioning test vehicle of an engine family represented by the demonstration test vehicle(s) (or simulate a deteriorated or malfunctioning component response) in order to test the fuel system, misfire detection system, oxygen sensor, secondary air system, catalyst efficiency monitoring system, heated catalyst system, and EGR system malfunction criteria for compliance with the applicable emission constraints in this section. Confirmatory testing to verify that malfunction criteria are set for compliance with emission requirements of this section shall be limited to vehicles in engine families derived from the demonstration vehicle(s). Diagnostic systems of a representative sample of vehicles which uniformly fail to meet the requirements of this section may be recalled for correction.

- (k) STANDARDIZATION Standardized access to emission-related fault codes, emission-related powertrain test information (i.e., parameter values) as outlined in subsection (l), emission related diagnostic procedures, and stored freeze frame data shall be incorporated based on the industry specifications referenced in this regulation.
- (1.0) Either SAE Recommended Practice J1850, "Class B Data Communication Network Interface", July, 1995, or ISO 9141-2, "Road vehicles - Diagnostic Systems - CARB Requirements for Interchange of Digital Information," February, 1994, or ISO 14230-4, "Road vehicles - Diagnostic systems - KWP 2000 requirements for Emission-related systems," 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.
- (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), June, 1994, and "E/E Diagnostic Test Modes" (J1979), 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.
- (2.1) Manufacturers shall make readily available at a fair and reasonable price to the automotive repair industry vehicle repair procedures which allow effective emission related diagnosis and repairs to be performed using only the J1978 generic scan tool and commonly available, non-microprocessor based tools. As an alternative to publishing repair procedures using only the J1978 generic scan tool, manufacturers may make available manufacturer-specific commands needed to perform the same emission-related diagnosis and repair procedures (excluding any reprogramming) in a comparable manner as the manufacturer-specific diagnostic scan tool. In addition to these procedures, manufacturers may publish repair procedures referencing the use of manufacturer specific or enhanced equipment. Vehicle manufacturers shall provide for same day availability (e.g., via facsimile transmission) at a fair and reasonable cost of emission-related technical service bulletins less than 20 pages in length.
- (2.2) The J1978 scan tool shall be capable of notifying the user when one or more of the required monitoring systems are not included as part of the OBD system.
- (3.0) J2012 Part C Uniform fault codes based on SAE specifications shall be employed. SAE "Recommended Format and Messages for Diagnostic Trouble Codes" (J2012), October, 1994, is incorporated by reference.

- (4.0) J1962 A standard data link connector in a standard location in each vehicle based on SAE specifications shall be incorporated. 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), January, 1995, is incorporated by reference.
- (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", 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.
- (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 J2008 Draft Technical Report, "Recommended Organization of Service Information", 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.

#### (l) SIGNAL ACCESS

- (1.0) The following signals in addition to the required freeze frame information shall be made available on demand through the serial port on the standardized data link connector: calculated load value, diagnostic trouble codes, engine coolant temperature, fuel control system status (open loop, closed loop, other; 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. 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 in a standardized format. Alternate phase-in percentages that provide for equivalent timeliness overall in implementing these requirements shall be accepted.

- (2.0) The manufacturer shall publish in factory service manuals a normal range for the calculated load value and mass air flow rate (if available) at idle, and at 2500 RPM (no load, in neutral or park). If 2500 RPM is outside of the operating range of the engine, the corresponding data may be omitted. If the total fuel command trim is made up by more than one source (e.g. short-term trim and long-term trim), all fuel trim signals shall be available. The signals shall be provided in standard units based on the incorporated SAE specifications, and actual signals shall be clearly identified separately from default value or limp home signals. Diesel vehicles shall be exempt from this requirement.
- (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 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). Alternative methods shall be approved by the Executive Officer if, in the judgment of the Executive Officer, they provide for equivalent off-board evaluation.
- (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. 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. Alternate phase-in percentages that provide for equivalent timeliness overall in implementing these

requirements shall be accepted.

(m) IMPLEMENTATION SCHEDULE

- (1.0) These OBD II requirements, unless otherwise specified, shall be implemented beginning with the 1994 model year.
- (2.0) The Executive Officer shall grant an extension for compliance with the requirements of these subsections with respect to a specific vehicle model or engine family if the vehicle model or engine family meets previously applicable on-board diagnostic system requirements and a manufacturer demonstrates that it cannot modify a present electronic control system by the 1994 model-year because major design system changes not consistent with the manufacturer's projected changeover schedule would be needed to comply with provisions of these subsections.
- (2.1) The manufacturer which has received an extension from the Executive Officer shall comply with these regulations when modification of the electronic system occurs in accordance with the manufacturer's projected changeover schedule or in the 1996 model year, whichever first occurs.
- (2.2) Any manufacturer requesting an extension shall, no later than October 15, 1991, submit to the Executive Officer an application specifying the period for which the extension is required.
- (3.0) Small volume manufacturers as defined in (n) (13.0) shall meet these requirements by the 1996 model year.
- (4.0) Manufacturers may at their discretion implement a portion of these regulations prior to the required implementation date provided that the system complies with previously applicable on-board diagnostic system requirements.
- (5.0) Diesel vehicles shall meet these requirements by the 1996 model year. Manufacturers may request a delay in the implementation of these requirements for diesel vehicles until 1997, subject to Executive Officer approval, if it is adequately demonstrated that the delay will allow for the development of significantly more effective monitoring systems.
- (5.1) Vehicles and engines certified to run on alternate fuels shall meet these requirements by the 1996 model year. However, manufacturers may request the Executive Officer to waive specific monitoring requirements for which monitoring may not be reliable with respect to the use of alternate fuels until the 2005 model year.
- (5.2) Medium-duty vehicles with engines certified on an engine dynamometer may comply with



these requirements on an engine model year certification basis rather than on a vehicle model basis.

- (6.0) The Executive Officer may waive one or more of the requirements of these subsections with respect to a specific vehicle or engine family for which production commences prior to April 1, 1994, and which is not otherwise exempted from compliance in accordance with sections (2.0) and (2.1) above. In granting a waiver, the Executive Officer shall consider the following factors: the extent to which these requirements are satisfied overall on the vehicle applications in question, the extent to which the resultant diagnostic system design will be more effective than systems developed according to section 1968, Title 13, and a demonstrated good-faith effort to meet these requirements in full by evaluating and considering the best available monitoring technology.
- (6.1) For 1995 and 1996 model year vehicles for which production is to commence subsequent to March 31, 1994, and which are not exempted from compliance in accordance with sections (2.0) and (2.1) above, the Executive Officer, upon receipt of an application from the manufacturer, may certify the vehicles in question even though said vehicles may not comply with one or more of the requirements of these subsections. Such certification is contingent upon the manufacturer meeting the criteria set forth in section (6.0) above. Manufacturers of non-complying systems shall be subject to fines pursuant to section 43016 of the California Health and Safety Code for each deficiency identified, after the second, in a vehicle model. For the third deficiency and every deficiency thereafter identified in a vehicle model, the fines shall be in the amount of \$50 per deficiency per vehicle for non-compliance with any of the monitoring requirements specified in subsections (b)(1) through (b)(11), and \$25 per deficiency per vehicle for non-compliance with any other requirement of section 1968.1. In determining the identified order of deficiencies, deficiencies of subsections (b)(1) through (b)(11) shall be identified first. Total fines per vehicle under this section shall not exceed \$500 per vehicle and shall be payable to the State Treasurer for deposit in the Air Pollution Control Fund. Engine families in receipt of a waiver granted under section (6.0) above shall be exempt from these fines. Further, small volume manufacturers choosing to comply with these requirements in the 1995 model year shall also be exempt from these fines. For 1996 model year vehicles and engines only, failure to properly monitor multiple electronic transmission components shall be considered a single monitoring system deficiency.
- (6.2) Beginning with the 1997 model year and through the 2003 model year, the certification provisions set forth in section (m)(6.1) above shall continue to apply subject to the following limitations: 1) The specified fines shall apply to the third and subsequently identified deficiencies, with the exception that fines shall apply to all monitoring system deficiencies wherein a required monitoring strategy is completely absent from the OBD system, and 2) Manufacturers may not carry over monitoring system deficiencies for more than two model years unless it can be adequately demonstrated that substantial vehicle hardware modifications and additional lead time beyond two years would be necessary to

correct the deficiency, in which case the deficiency may be carried over for three model years.

- (6.3) Beginning with the 2004 model year, the certification provisions set forth in section (m)(6.1) and (m)(6.2) above shall continue to apply subject to the following limitations:
- 1) The specified fines shall apply to the second and subsequently identified deficiencies, and
  - 2) Manufacturers may not carry over monitoring system deficiencies to future model years.

(n) GLOSSARY For purposes of this section:

- (1.0) "Malfunction" means the inability of an emission-related component or system to remain within design specifications. Further, malfunction refers to the deterioration of any of the above components or systems to a degree that would likely cause the emissions of an average certification durability vehicle with the deteriorated components or systems present at the beginning of the applicable certification emission test to exceed by more than 1.5 times any of the emission standards (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 emission standard shall refer only to the useful life standards.
- (2.0) "Secondary air" refers to air introduced into the exhaust system by means of a pump or aspirator valve or other means that is intended to aid in the oxidation of HC and CO contained in the exhaust gas stream.
- (3.0) "Engine misfire" means lack of combustion in the cylinder due to absence of spark, poor fuel metering, poor compression, or any other cause.
- (4.0) Oxygen sensor "response rate" refers to the delay (measured in milliseconds) between a switch of the sensor from lean to rich or vice versa in response to a change in fuel/air ratio above and below stoichiometric.
- (5.0) A "trip" means vehicle operation (following an engine-off period) of duration and driving mode such that all components and systems are monitored at least once by the diagnostic system except catalyst efficiency or evaporative system monitoring when a steady-speed check is used, subject to the limitation that the manufacturer-defined trip monitoring conditions shall all be encountered at least once during the first engine start portion of the applicable FTP cycle.
- (6.0) A "warm-up cycle" means sufficient vehicle operation such that the coolant temperature has risen by at least 40 degrees Fahrenheit from engine starting and reaches a minimum temperature of at least 160 degrees Fahrenheit (140 degrees Fahrenheit for diesel

applications).

- (7.0) A "driving cycle" consists of engine startup, and engine shutoff.
- (8.0) "Continuous monitoring" means sampling at a rate no less than two samples per second. If for engine control purposes, a computer input component is sampled less frequently, the value of the component may instead be evaluated each time sampling occurs.
- (9.0) "Fuel trim" refers to feedback adjustments to the base fuel schedule. Short-term fuel trim refers to dynamic or instantaneous adjustments. Long-term fuel trim refers to much more gradual adjustments to the fuel calibration schedule than short-term trim adjustments. These long term adjustments compensate for vehicle differences and gradual changes that occur over time.
- (10.0) "Base Fuel Schedule" refers to the fuel calibration schedule programmed into the Powertrain Control Module or PROM when manufactured or when updated by some off-board source, prior to any learned on-board correction.
- (11.0) "Calculated load value" refers to an indication of the current airflow divided by peak airflow, where peak airflow is corrected for altitude, if available. This definition provides a unitless number that is not engine specific, and provides the service technician with an indication of the percent engine capacity that is being used (with wide open throttle as 100%).

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

For diesel applications, the calculated load value shall be determined by the ratio of current output torque to maximum output torque at current engine speed.

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

- (13.0) "Small volume manufacturer" shall mean any vehicle manufacturer with sales less than or equal to 3000 new light-duty vehicles and medium-duty vehicles per model year based on the average number of vehicles sold by the manufacturer each model year from 1989 to 1991, except as noted below. For manufacturers certifying for the first time in California, model year sales shall be based on projected California sales. If a manufacturer's average California sales exceeds 3000 units of new light-duty and medium-duty vehicles based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the requirements applicable for larger manufacturers beginning with the fourth model year after the last of the three consecutive model years. If a manufacturer's average California sales falls below 3000 units of new light-duty and medium-duty vehicles based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall be treated as a small volume manufacturer and shall be subject to the requirements for small volume manufacturers beginning with the next model year.
- (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). These vehicle categories are further defined in Title 13, sections 1956.8 and 1960.1.
- (15.0) "Diesel engines" refers to engines using a compression ignition thermodynamic cycle.
- (16.0) "Functional check" for an output component means verification of proper response to a computer command. For an input component, functional check means verification of the input signal being in the range of normal operation, including evaluation of the signal's rationality in comparison to all available information.
- (17.0) "Federal Test Procedure" (FTP) cycle or test refers to, for passenger vehicles, light-duty trucks, and medium-duty vehicles certified on a chassis dynamometer, the driving schedule in Code of Federal Regulations (CFR) 40, Appendix 1, Part 86, section (a) entitled, "EPA Urban Dynamometer Driving Schedule for Light- Duty Vehicles and Light-Duty Trucks." For medium-duty engines certified on an engine dynamometer, FTP cycle or test refers to the engine dynamometer schedule in CFR 40, Appendix 1, Part 86, section (f)(1), entitled, "EPA Engine Dynamometer Schedule for Heavy-Duty Otto-Cycle Engines," or section (f)(2), entitled, "EPA Engine Dynamometer Schedule for Heavy-Duty Diesel Engines."
- (18.0) "Redline engine speed" means the manufacturer recommended maximum engine speed as normally displayed on instrument panel tachometers, or the engine speed at which fuel shutoff occurs.

- (19.0) "Power Take-Off unit" refers to an engine driven output provision for the purposes of powering auxiliary equipment (e.g., a dump-truck bed, aerial bucket, or tow-truck winch).
- (20.0) "Engine Start" is defined as the point at which normal, synchronized spark and fuel control is obtained or when the engine reaches a speed 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission).
- (21.0) An "Alternate or Equivalent Phase-in" is one that achieves equivalent emission reductions by the end of the last year of the scheduled phase-in. The emission reductions shall be calculated by multiplying the percent of vehicles (based on the manufacturer's projected sales volume of all vehicles and engines) meeting the new requirements per year by the number of years implemented prior to and including the last year of the scheduled phase-in and then summing these yearly results to determine a cumulative total (e.g., a three year, 30/60/100 percent scheduled phase-in would be calculated as  $(30\% * 3 \text{ years}) + (60\% * 2 \text{ years}) + (100\% * 1 \text{ year}) = 310$ ). Manufacturers shall be allowed to include vehicles introduced before the first year of the scheduled phase-in (e.g., in the previous example, 10 percent introduced one year before the scheduled phase-in begins would be calculated as  $(10\% * 4 \text{ years})$  and added to the cumulative total). Any alternate phase-in which results in an equal or larger cumulative total by the end of the last year of the scheduled phase-in shall be considered acceptable by the Executive Officer; however, all vehicles shall comply with the respective requirements subject to the phase-in within one model year following the last year of the phase-in schedule.
- (22.0) "Unified Cycle" is defined in "Speed Versus Time Data for California's Unified Driving Cycle", dated December 12, 1996, incorporated by reference.

Note: Authority cited: Sections 39515, 39600, 39601, 43006, 43013, 43018, 43104, and 44036.2, Health and Safety Code; and Sections 27156 and 38395, Vehicle Code. Reference: Sections 39002, 39003, 39667, 43000, 43004, 43006, 43008.6, 43013, 43018, 43100, 43101, 43101.5, 43102, 43104, 43105, 43106, 43204, and 44036.2, Health and Safety Code; and Sections 27156, 38391, and 38395, Vehicle Code.