Attachment A

Title 13, California Code Regulations, Section 1971.1, On-Board Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines (HD OBD)

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§1971.1. On-Board Diagnostic System Requirements--2010 and Subsequent Model-Year Heavy-Duty Engines

(a) PURPOSE

The purpose of this regulation is to establish emission standards and other requirements for onboard diagnostic systems (OBD systems) that are installed on 2010 and subsequent model-year engines certified for sale in heavy-duty applications in California. The OBD systems, through the use of an onboard computer(s), shall monitor emission systems in-use for the actual life of the engine and shall be capable of detecting malfunctions of the monitored emission systems, illuminating a malfunction indicator light (MIL) to notify the vehicle operator of detected malfunctions, and storing fault codes identifying the detected malfunctions.

(b) APPLICABILITY

Except as specified in section (d)(7) and elsewhere in this regulation (title 13, CCR section 1971.1), all 2010 and subsequent model-year heavy-duty engines shall be equipped with an OBD system and shall meet all applicable requirements of this regulation (title 13, CCR section 1971.1).[1]

(c) DEFINITIONS

"*Active fault code*," for purposes of engines using Society of Automotive Engineers (SAE) J1939, refers to the diagnostic trouble code stored when an OBD system has confirmed that a malfunction exists (e.g., typically on the second driving cycle that the malfunction is detected) in accordance with the requirements of sections (d)(2), (e), (g), and (h)(4.4).

"*Actual life*" refers to the entire period that an engine is operated on public roads in California up to the time an engine is retired from use.

"*Applicable standards*" refers to the specific exhaust emission standards or family emission limits (FEL), including the Federal Test Procedure (FTP) and Supplemental Emission Test (SET) standards, to which the engine is certified.

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

"*Auxiliary Emission Control Device (AECD)*" refers to any approved AECD (as defined by 40 Code of Federal Regulations (CFR) 86.082-2).

"*Calculated load value*" refers to the percent of engine capacity being used and is defined in SAE J1979 "E/E Diagnostic Test Modes – Equivalent to ISO/DIS 15031-5:April 30, 2002," April 2002 (SAE J1979), incorporated by reference (section (h)(1.4)). For diesel applications, the calculated load value is determined by the ratio of current engine output torque to maximum engine output torque at current engine speed as defined by parameter definition 5.2.1.7 of SAE J1939-71.

"*Confirmed fault code*," for purposes of engines using International Standards Organization (ISO) 15765-4, is defined as the diagnostic trouble code stored when an OBD system has confirmed that a malfunction exists (e.g., typically on the second driving cycle that the malfunction is detected) in accordance with the requirements of sections (d)(2), (f),(g), and (h)(4.4).

[1] Unless otherwise noted, all section references refer to section 1971.1 of title 13, CCR.

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

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

"*Diagnostic or emission critical*" electronic control unit refers to the engine and any other on-board electronic powertrain control unit containing software that has primary control over any of the monitors required by sections (e)(1) through (f)(8), (g)(1) through (g)(3), and (g)(5) or has primary control over the diagnostics for more than two of the components required to be monitored by section (g)(4).

"*Diesel engine*" refers to an engine using a compression ignition thermodynamic cycle.

"*Driving cycle*" is defined as a trip that meets any of the four conditions below:

(a) Begins with engine start and ends with engine shutoff;

(b) Begins with engine start and ends after four hours of continuous engine-on operation;

(c) Begins at the end of the previous four hours of continuous engine-on operation and ends after four hours of continuous engine-on operation; or

(d) Begins at the end of the previous four hours of continuous engine-on operation and ends with engine shutoff.

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For monitors that run during engine-off conditions, the period of engine-off time following engine shutoff and up to the next engine start may be considered part of the driving cycle for conditions (a) and (d). For vehicles that employ engine shutoff strategies that do not require the vehicle operator to restart the engine to continue driving (e.g., hybrid bus with engine shutoff at idle), the manufacturer may request Executive Officer approval to use an alternate definition for driving cycle (e.g., key on and key off). Executive Officer approval of the alternate definition shall be based on equivalence to engine startup and engine shutoff signaling the beginning and ending of a single driving event for a conventional vehicle. Engine restarts following an engine shut-off that has been neither commanded by the vehicle operator nor by the engine control strategy but caused by an event such as an engine stall may be considered a new driving cycle or a continuation of the existing driving cycle. For engines that are not likely to be routinely operated for long continuous periods of time, a manufacturer may also request Executive Officer approval to use an alternate definition for driving cycle (e.g., solely based on engine start and engine shutoff without regard to four hours of continuous engine-on time). Executive Officer approval of the alternate definition shall be based on manufacturer-submitted data and/or information demonstrating the typical usage, operating habits, and/or driving patterns of these vehicles.

"*Engine family*" means a grouping of vehicles or engines in a manufacturer's product line determined in accordance with 40 CFR 86.098-24.

"*Engine rating*" means a unique combination of displacement, rated power, calibration (fuel, emission, and engine control), AECDs, and other engine and emission control components within an engine family.

"*OBD parent rating*" means the specific engine rating selected according to section (d)(7.1.1) or (d)(7.2.2)(B) for compliance with section 1971.1.

"*OBD child rating*" means an engine rating (other than the OBD parent rating) within the engine family containing the OBD parent rating selected according to section (d)(7.1.1) or an engine rating within the OBD group(s) defined according to section (d)(7.2.1) and subject to section (d)(7.2.3).

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

"*Engine start*" is defined as the point when the engine reaches a speed 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission). For hybrid vehicles or for engines employing alternate engine start hardware or strategies (e.g., integrated starter and generators.), the manufacturer may request Executive Officer approval to use an alternate definition for engine start (e.g., ignition key "on"). Executive Officer approval of the alternate definition shall be based on equivalence to an engine start for a conventional vehicle.

"*Family Emission Limit (FEL)*" refers to the exhaust emission levels to which an engine family is certified under the averaging, banking, and trading program incorporated by reference in title 13, CCR section 1956.8.

Deleted: "*European Stationary Cycle (ESC)*" refers to the driving schedule defined as the "supplemental steady state emission test" in 40 CFR 86.1360-2007.¶

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

"*Federal Test Procedure (FTP) test*" refers to an exhaust emission test conducted according to the test procedures incorporated by reference in title 13, CCR section 1956.8(b) and (d) that is used to determine compliance with the FTP standard to which an engine is certified.

"*FTP cycle*". For engines certified on an engine dynamometer, FTP cycle refers to the engine dynamometer schedule in 40 CFR appendix 1 of 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."

"*FTP standard*" refers to the certification exhaust emission standards and test procedures applicable to the FTP cycle incorporated by reference in title 13, CCR sections 1956.8(b) and (d) to which the engine is certified.

"*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.

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

"*Gasoline engine*" refers to an Otto-cycle engine or an alternate-fueled engine.

"*Heavy-duty engine*" means an engine that is used to propel a heavy-duty vehicle.

"*Heavy-duty vehicle*" means any motor vehicle having a manufacturer's gross vehicle weight rating (GVWR) greater than 14,000 pounds.

"*Ignition Cycle*" means a driving cycle that begins with engine start, meets the engine start definition for at least two seconds plus or minus one second, and ends with engine shutoff.

"*Keep-alive memory (KAM)*," for the purposes of this regulation, is defined as a type of memory that retains its contents as long as power is provided to the on-board control unit. KAM is not erased upon shutting off the engine but may be erased if power to the on-board control unit is interrupted (e.g., vehicle battery disconnected, fuse to control unit removed). In some cases, portions of KAM may be erased with a scan tool command to reset KAM.

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

"*Malfunction*" means any deterioration or failure of a component that causes the performance to be outside of the applicable limits in sections (e) through (g).

"*Not-To-Exceed (NTE) control area*" refers to the bounded region of the engine's torque and speed map, as defined in 40 CFR 86.1370-2007, where emissions must not exceed a specific emission cap for a given pollutant under the NTE requirement.

"*Manufacturer-specific NOx NTE carve-out area*" refers to regions within the NTE control area for NOx where the manufacturer has limited NTE testing as allowed by 40 CFR 86.1370-2001(b)(7).

"*Manufacturer-specific PM NTE carve-out area*" refers to regions within the NTE control area for PM where the manufacturer has limited NTE testing as allowed by 40 CFR 86.1370-2001(b)(7).

"*NTE deficiency*" refers to regions or conditions within the NTE control area for NOx or PM where the manufacturer has received a deficiency as allowed by 40 CFR 86.007-11(a)(4)(iv).

"*Non-volatile random access memory (NVRAM)*," for the purposes of this regulation, is defined as a type of memory that retains its contents even when power to the on-board control unit is interrupted (e.g., vehicle battery disconnected, fuse to control unit removed). NVRAM is typically made non-volatile either by use of a back-up battery within the control unit or through the use of an electrically erasable and programmable read-only memory (EEPROM) chip.

"*OBD group*" refers to a combination of engines, engine families, or engine ratings that use the same OBD strategies and similar calibrations. A manufacturer is required to submit a grouping plan for Executive Officer review and approval detailing the OBD groups and the engine families and engine ratings within each group for a model year.

"*Pending fault code*" is defined as the diagnostic trouble code stored upon the initial detection of a malfunction (e.g., typically on a single driving cycle) prior to illumination of the MIL in accordance with the requirements of sections (d)(2), (e) through (g), and (h)(4.4).

"*Permanent fault code*" is defined as a confirmed or active fault code that is currently commanding the MIL on and is stored in NVRAM as specified in sections (d)(2) and (h)(4.4).

"*Percentage of misfire*" as used in sections (e)(2) and (f)(2) means the percentage of misfires out of the total number of firing events for the specified interval.

"*Power Take-Off (PTO) unit*" refers to an engine driven output provision for the purposes of powering auxiliary equipment (e.g., a dump-truck bed, aerial bucket, or tow-truck winch).

"*Previously active fault code*," for purposes of engines using SAE J1939, is defined as the diagnostic trouble code stored when an OBD system has confirmed that a malfunction no longer exists (e.g., after the third consecutive driving cycle in which the corresponding monitor runs and the malfunction is not detected), extinguishes the MIL, and erases the corresponding active fault code in accordance with the requirements of sections (d)(2), (e), (g), and (h)(4.4).

"*Rationality fault diagnostic*" for an input component means verification of the accuracy of the input signal while in the range of normal operation and when compared to all other available information.

"*Redline engine speed*" shall be defined by the manufacturer as either the recommended maximum engine speed as normally displayed on instrument panel tachometers or the engine speed at which fuel shutoff occurs.

"*Response rate*" for exhaust gas sensors refers to the delay between a change in sensor output in response to a commanded change in the sensed exhaust gas parameter. Specifically, the response rate is the delay from the time when the exhaust gas sensor is exposed to an increase/decrease of the exhaust gas parameter to the time when the exhaust gas sensor indicates the increase/decrease of the sensed parameter (e.g., for an oxygen sensor, response rate is the delay from the time when the sensor is exposed to a change in exhaust gas from richer/leaner than stoichiometric to leaner/richer than stoichiometric to the time when the sensor indicates the lean/rich condition; for a NOx sensor, response rate is the delay from the time when the sensor is exposed to an increase/decrease in NOx concentration to the time when the sensor indicates the increased/decreased NOx concentration).

"*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.

"*Similar conditions*" as used in sections (e)(2), (f)(1), and (f)(2) means engine conditions having an engine speed within 375 rpm, load conditions within 20 percent, and the same warm-up status (i.e., cold or hot) as the engine conditions stored pursuant to (e)(2.4.2)(C), (f)(1.4.5), and (f)(2.4.4). The Executive Officer may approve other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine operation.

"*Start of production*" is the time when the manufacturer has produced two percent of the projected volume for the engine or vehicle, whichever is being evaluated in accordance with section (l).

"Supplemental Emission Test (SET) cycle" refers to the driving schedule defined as the "supplemental steady state emission test" in 40 CFR 86.1360-2007.

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"SET standard" refers to the certification exhaust emission standards and test procedures applicable to the SET cycle incorporated by reference in title 13, CCR sections 1956.8(b) and (d) to which the engine is certified

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"*Warm-up cycle*" means sufficient vehicle operation such that the coolant temperature has risen by at least 40 degrees Fahrenheit from engine start and reaches a minimum temperature of at least 160 degrees Fahrenheit (140 degrees Fahrenheit for applications with diesel engines).

"*Weighted sales number*" means a manufacturer's projected sales number for engines to be used in California heavy-duty vehicles multiplied by a weight class factor. Sales numbers for engines for heavy-duty vehicles less than 19,499 pounds GVWR shall be multiplied by 1.0. Sales numbers for engines for heavy-duty vehicles from 19,500 to 33,000 pounds shall be multiplied by 1.68. Sales numbers for engines for heavy-duty vehicles greater than 33,000 pounds and urban buses shall be multiplied by 3.95.

(d) GENERAL REQUIREMENTS

Section (d) sets forth the general requirements of the OBD system. Specific performance requirements for components and systems that shall be monitored are set forth in sections (e) through (g) below. The OBD system is required to detect all malfunctions specified in sections (e) through (g). However, the OBD system is not required to use a unique monitor to detect each malfunction specified.

(1) **The OBD System.**

(1.1) If a malfunction is present as specified in sections (e) through (g), the OBD system shall detect the malfunction, store a pending, confirmed, active, or previously active fault code in the onboard computer's memory, and illuminate the MIL as required.

(1.2) The OBD system shall be equipped with a standardized data link connector to provide access to the stored fault codes as specified in section (h).

(1.3) The OBD system shall be designed to operate, without any required scheduled maintenance, for the actual life of the engine in which it is installed and may not be programmed or otherwise designed to deactivate based on age and/or mileage of the vehicle during the actual life of the engine. This section is not intended to alter existing law and enforcement practice regarding a manufacturer's liability for an engine beyond its useful life, except where an engine has been programmed or otherwise designed so that an OBD system deactivates based on age and/or mileage of the engine.

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

(2) **MIL and Fault Code Requirements.**

(2.1) MIL Specifications.

(2.1.1) The MIL shall be located on the driver's side instrument panel and be of sufficient illumination and location to be readily visible under all lighting conditions and shall be amber in color when illuminated. The MIL, when illuminated, shall display the International Standards Organization (ISO) engine symbol. There shall be only one MIL used to indicate all faults detected by the OBD system on a single vehicle.

(2.1.2) The MIL shall illuminate in the key on, engine off position before engine cranking to indicate that the MIL is functional. The MIL shall continuously illuminate during this functional check for a minimum of 15-20 seconds. During this functional check of the MIL, the data stream value for MIL

status shall indicate commanded off (see section (h)(4.2)) unless the MIL has also been commanded on for a detected malfunction. This functional check of the MIL is not required during vehicle operation in the key on, engine off position subsequent to the initial engine cranking of an ignition cycle (e.g., due to an engine stall or other non-commanded engine shutoff).

(2.1.3) At the manufacturer's option, the MIL may be used to indicate readiness status in a standardized format (see section (h)(4.1.3)) in the key on, engine off position.

(2.1.4) A manufacturer may request Executive Officer approval to also use the MIL to indicate which, if any, fault codes are currently stored (e.g., to "blink" the stored codes). The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated that the method used to indicate the fault codes will not be unintentionally activated during a California inspection test or during routine driver operation.

(2.1.5) The MIL may not be used for any purpose other than specified in this regulation.

(2.2) MIL Illumination and Fault Code Storage Protocol.

(2.2.1) For vehicles using the ISO 15765-4 protocol for the standardized functions required in section (h):

(A) Upon detection of a malfunction, the OBD system shall store a pending fault code within 10 seconds indicating the likely area of the malfunction.

(B) After storage of a pending fault code, if the identified malfunction is again detected before the end of the next driving cycle in which monitoring occurs, the OBD system shall illuminate the MIL continuously, keep the pending fault code stored, and store a confirmed fault code within 10 seconds. If a malfunction is not detected before the end of the next driving cycle in which monitoring occurs (i.e., there is no indication of the malfunction at any time during the driving cycle), the corresponding pending fault code set according to section (d)(2.2.1)(A) shall be erased at the end of the driving cycle.

(C) A manufacturer may request Executive Officer approval to employ alternate statistical MIL illumination and fault code storage protocols to those specified in these requirements. The Executive Officer shall grant approval upon determining that the manufacturer has provided data and/or engineering evaluation that demonstrate that the alternative protocols can evaluate system performance and detect malfunctions in a manner that is equally effective and timely. Strategies requiring on average more than six driving cycles for MIL illumination may not be accepted.

(D) The OBD system shall store and erase "freeze frame" conditions (as defined in section (h)(4.3)) present at the time a malfunction is detected. The storage and erasure of freeze frame conditions shall be done in conjunction with the storage and erasure of either pending or confirmed fault codes as required elsewhere in section (d)(2.2).

(E) The OBD system shall illuminate the MIL and store a confirmed fault code within 10 seconds to inform the vehicle operator whenever the engine

enters a default or “limp home” mode of operation that can affect emissions or the performance of the OBD system or in the event of a malfunction of an on-board computer(s) itself that can affect the performance of the OBD system. If the default or “limp home” mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following ignition cycle), the OBD system may wait and illuminate the MIL and store the confirmed fault code only if the default or “limp home” mode of operation is again entered before the end of the next ignition cycle in lieu of illuminating the MIL within 10 seconds on the first driving cycle where the default or “limp home” mode of operation is entered.

(F) Before the end of an ignition cycle, the OBD system shall store confirmed fault codes that are currently causing the MIL to be illuminated in NVRAM as permanent fault codes (as defined in section (h)(4.4.1)(F)).

(2.2.2) For vehicles using the SAE J1939 protocol for the standardized functions required in section (h):

(A) Upon detection of a malfunction, the OBD system shall store a pending fault code within 10 seconds indicating the likely area of the malfunction.

(B) After storage of a pending fault code, if the identified malfunction is again detected before the end of the next driving cycle in which monitoring occurs, the OBD system shall illuminate the MIL continuously, erase the pending fault code, and store an active fault code within 10 seconds. If a malfunction is not detected before the end of the next driving cycle in which monitoring occurs (i.e., there is no indication of the malfunction at any time during the driving cycle), the corresponding pending fault code set according to section (d)(2.2.2)(A) shall be erased at the end of the driving cycle.

(C) A manufacturer may request Executive Officer approval to employ alternate statistical MIL illumination and fault code storage protocols to those specified in these requirements. The Executive Officer shall grant approval upon determining that the manufacturer has provided data and/or engineering evaluation that demonstrate that the alternative protocols can evaluate system performance and detect malfunctions in a manner that is equally effective and timely. Strategies requiring on average more than six driving cycles for MIL illumination may not be accepted.

(D) Storage and erasure of freeze frame conditions.

(i) The OBD system shall store and erase “freeze frame” conditions (as defined in section (h)(4.3)) present at the time a malfunction is detected.

(ii) The OBD system shall store freeze frame conditions in conjunction with the storage of a pending fault code.

(iii) If the pending fault code is erased in the next driving cycle in which monitoring occurs and a malfunction is not detected (as described under section (d)(2.2.2)(B)), the OBD system may erase the corresponding freeze frame conditions.

(iv) If the pending fault code matures to an active fault code (as described under section (d)(2.2.2)(B)), the OBD system shall either retain the

currently stored freeze frame conditions or replace the stored freeze frame conditions with freeze frame conditions regarding the active fault code. The OBD system shall erase the freeze frame information in conjunction with the erasure of the previously active fault code (as described under section (d)(2.3.2)(C)).

(E) The OBD system shall illuminate the MIL and store an active fault code within 10 seconds to inform the vehicle operator whenever the engine enters a default or “limp home” mode of operation that can affect emissions or the performance of the OBD system or in the event of a malfunction of an on-board computer(s) itself that can affect the performance of the OBD system. If the default or “limp home” mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following ignition cycle), the OBD system may wait and illuminate the MIL only if the default or “limp home” mode of operation is again entered before the end of the next ignition cycle in lieu of illuminating the MIL within 10 seconds on the first driving cycle where the default or “limp home” mode of operation is entered.

(F) Before the end of an ignition cycle, the OBD system shall store active fault codes that are currently causing the MIL to be illuminated in NVRAM as permanent fault codes (as defined in section (h)(4.4.2)(F)).

(2.3) MIL Extinguishing and Fault Code Erasure Protocol.

(2.3.1) For vehicles using the ISO 15765-4 protocol for the standardized functions required in section (h):

(A) Extinguishing the MIL. Except as otherwise provided in sections (f)(1.4.6), (f)(2.4.5), and (f)(7.4.2) for fuel system, misfire, and evaporative system malfunctions, once the MIL has been illuminated, it may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions and the previously detected malfunction is no longer present provided no other malfunction has been detected that would independently illuminate the MIL according to the requirements outlined above.

(B) Erasing a confirmed fault code. The OBD system may erase a confirmed fault code if the identified malfunction has not been again detected in at least 40 engine warm-up cycles and the MIL is presently not illuminated for that malfunction.

(C) Erasing a permanent fault code. The OBD system shall erase a permanent fault code only if either of the following conditions occur:

(i) The OBD system itself determines that the malfunction that caused the confirmed fault code to be stored is no longer present and is not commanding the MIL on, concurrent with the requirements of section (d)(2.3.1)(A), or

(ii) Subsequent to a clearing of the fault information in the on-board computer (i.e., through the use of a scan tool or battery disconnect), the diagnostic for the malfunction that caused the permanent fault code to be stored has fully executed (i.e., has executed the minimum number of checks necessary for MIL illumination) and determined the malfunction is no longer present.

(2.3.2) For vehicles using the SAE J1939 protocol for the standardized functions required in section (h):

(A) Extinguishing the MIL. Except as otherwise provided in sections (e)(2.4.2)(D) and (e)(6.4.2) for misfire malfunctions and empty reductant tanks, once the MIL has been illuminated, it may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions and the previously detected malfunction is no longer present provided no other malfunction has been detected that would independently illuminate the MIL according to the requirements outlined above.

(B) Erasing an active fault code. The OBD system may erase an active fault code in conjunction with extinguishing the MIL as described under section (d)(2.3.2)(A). In addition to the erasure of the active fault code, the OBD system shall store a previously active fault code for that failure.

(C) Erasing a previously active fault code. The OBD system may erase a previously active fault code if the identified malfunction has not been again detected in at least 40 engine warm-up cycles and the MIL is presently not illuminated for that malfunction.

(D) Erasing a permanent fault code. The OBD system shall erase a permanent fault code only if either of the following conditions occur:

(i) The OBD system itself determines that the malfunction that caused the active fault code to be stored is no longer present and is not commanding the MIL on, concurrent with the requirements of section (d)(2.3.2)(A), or

(ii) Subsequent to a clearing of the fault information in the on-board computer (i.e., through the use of a scan tool or battery disconnect), the diagnostic for the malfunction that caused the permanent fault code to be stored has fully executed (i.e., has executed the minimum number of checks necessary for MIL illumination) and determined the malfunction is no longer present.

(2.4) Exceptions to MIL and Fault Code Requirements.

(2.4.1) If the engine enters a default mode of operation, a manufacturer may request Executive Officer approval to be exempt from illuminating the MIL if any of the following conditions listed below occurs. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that verify the conditions below:

(A) The default strategy causes an overt indication (e.g., illumination of a red engine shut-down warning light) such that the driver is certain to respond and have the problem corrected; or

(B) The default strategy is an AECD that is properly activated due to the occurrence of conditions that have been approved by the Executive Officer.

(2.4.2) For gasoline engines, a manufacturer may elect to meet the MIL and fault code requirements in title 13, CCR section 1968.2(d)(2) in lieu of meeting the requirements of (d)(2).

(3) **Monitoring Conditions.**

Section (d)(3) sets forth the general monitoring requirements while sections (e)

through (g) sets forth the specific monitoring requirements as well as identifies which of the following general monitoring requirements in section (d)(3) are applicable for each monitored component or system identified in sections (e) through (g).

(3.1) For all engines:

(3.1.1) As specifically provided for in sections (e) through (g), manufacturers shall define monitoring conditions, subject to Executive Officer approval, for detecting malfunctions identified in sections (e) through (g). The Executive Officer shall approve manufacturer-defined monitoring conditions that are determined (based on manufacturer-submitted data and/or other engineering documentation) to be: technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false indications of malfunctions); designed to ensure monitoring will occur under conditions that may reasonably be expected to be encountered in normal vehicle operation and use; and designed to ensure monitoring will occur during the FTP cycle.

(3.1.2) Monitoring shall occur at least once per driving cycle in which the monitoring conditions are met.

(3.1.3) Manufacturers may request Executive Officer approval to define monitoring conditions that are not encountered during the FTP cycle as required in section (d)(3.1.1). In evaluating the manufacturer's request, the Executive Officer shall consider the degree to which the requirement to run during the FTP cycle restricts in-use monitoring, the technical necessity for defining monitoring conditions that are not encountered during the FTP cycle, data and/or an engineering evaluation submitted by the manufacturer which demonstrate that the component/system does not normally function, or monitoring is otherwise not feasible, during the FTP cycle, and, where applicable in section (d)(3.2), the ability of the manufacturer to demonstrate the monitoring conditions will satisfy the minimum acceptable in-use monitor performance ratio requirement as defined in section (d)(3.2).

(3.2) As specifically provided for in sections (e) through (g), manufacturers shall define monitoring conditions in accordance with the criteria in sections (d)(3.2.1) through (3.2.3).

(3.2.1) Manufacturers shall implement software algorithms in the OBD system to individually track and report in-use performance of the following monitors in the standardized format specified in section (d)(5):

(A) NMHC converting catalyst (section (e)(5.3.1))
(B) NOx converting catalyst (section (e)(6.3.1))
(C) Catalyst (section (f)(6.3));
(D) Exhaust gas sensor (sections (e)(9.3.1)(A) or (f)(8.3.1)(A));
(E) Evaporative system (section (f)(7.3.2));
(F) EGR system (sections (e)(3.3.2) and (3.3.3) or (f)(3.3.1)) and VVT system (section (g)(1.3));
(G) Secondary air system (section (f)(5.3.1));
(H) PM filter (section (e)(8.3));
(I) Boost pressure control system (sections (e)(4.3.2) and (e)(4.3.3)); and
(J) NOx adsorber (section (e)(7.3.1)).

The OBD system is not required to track and report in-use performance for monitors other than those specifically identified above.

(3.2.2) For all 2013 and subsequent model year engines, manufacturers shall define monitoring conditions that, in addition to meeting the criteria in sections (d)(3.1) and (d)(3.2.1), ensure that the monitor yields an in-use performance ratio (as defined in section (d)(4)) that meets or exceeds the minimum acceptable in-use monitor performance ratio for in-use vehicles. For purposes of this regulation, the minimum acceptable in-use monitor performance ratio is 0.100 for all monitors specifically required in sections (e) through (g) to meet the monitoring condition requirements of section (d)(3.2).

(3.2.3) Manufacturers may not use the calculated ratio (or any element thereof) or any other indication of monitor frequency as a monitoring condition for a monitor (e.g., using a low ratio to enable more frequent monitoring through diagnostic executive priority or modification of other monitoring conditions, or using a high ratio to enable less frequent monitoring).

(3.2.4) Upon request of a manufacturer or upon the best engineering judgment of the ARB, the Executive Officer may revise the minimum acceptable in-use monitoring performance ratio specified in section (d)(3.2.2) for a specific monitor if the most reliable monitoring method developed requires a lower ratio.

(4) **In-Use Monitor Performance Ratio Definition.**

(4.1) For monitors required to meet the requirements in section (d)(3.2), the ratio shall be calculated in accordance with the following specifications for the numerator, denominator, and ratio.

(4.2) Numerator Specifications

(4.2.1) Definition: The numerator is defined as a measure of the number of times a vehicle has been operated such that all monitoring conditions necessary for a specific monitor to detect a malfunction have been encountered.

(4.2.2) Specifications for incrementing:

(A) Except as provided for in section (d)(4.2.2)(E), the numerator, when incremented, shall be incremented by an integer of one. The numerator may not be incremented more than once per driving cycle.

(B) The numerator for a specific monitor shall be incremented within 10 seconds if and only if the following criteria are satisfied on a single driving cycle:

(i) Every monitoring condition necessary for the monitor of the specific component to detect a malfunction and store a pending fault code has been satisfied, including enable criteria, presence or absence of related fault codes, sufficient length of monitoring time, and diagnostic executive priority assignments (e.g., diagnostic “A” must execute prior to diagnostic “B”). For the purpose of incrementing the numerator, satisfying all the monitoring conditions necessary for a monitor to determine the component is passing may not, by itself, be sufficient to meet this criteria.

(ii) For monitors that require multiple stages or events in a single driving cycle to detect a malfunction, every monitoring condition necessary for all events to have completed must be satisfied.

(iii) For monitors that require intrusive operation of components to detect a malfunction, a manufacturer shall request Executive Officer approval of the strategy used to determine that, had a malfunction been present, the monitor would have detected the malfunction. Executive Officer approval of the request shall be based on the equivalence of the strategy to actual intrusive operation and the ability of the strategy to accurately determine if every monitoring condition necessary for the intrusive event to occur was satisfied.

(iv) For the secondary air system monitor, the criteria in sections (d)(4.2.2)(B)(i) through (iii) above are satisfied during normal operation of the secondary air system. Monitoring during intrusive operation of the secondary air system later in the same driving cycle solely for the purpose of monitoring may not, by itself, be sufficient to meet this criteria.

(C) For monitors that can generate results in a “gray zone” or “non-detection zone” (i.e., results that indicate neither a passing system nor a malfunctioning system) or in a “non-decision zone” (e.g., monitors that increment and decrement counters until a pass or fail threshold is reached), the manufacturer shall submit a plan for appropriate incrementing of the numerator to the Executive Officer for review and approval. In general, the Executive Officer shall not approve plans that allow the numerator to be incremented when the monitor indicates a result in the “non-detection zone” or prior to the monitor reaching a decision. In reviewing the plan for approval, the Executive Officer shall consider data and/or engineering evaluation submitted by the manufacturer demonstrating the expected frequency of results in the “non-detection zone” and the ability of the monitor to accurately determine if a monitor would have detected a malfunction instead of a result in the “non-detection zone” had an actual malfunction been present.

(D) For monitors that run or complete during engine-off operation, the numerator shall be incremented within 10 seconds after the monitor has completed during engine-off operation or during the first 10 seconds of engine start on the subsequent driving cycle.

(E) Manufacturers utilizing alternate statistical MIL illumination protocols as allowed in sections (d)(2.2.1)(C) and (d)(2.2.2)(C) for any of the monitors requiring a numerator shall submit a plan for appropriate incrementing of the numerator to the Executive Officer for review and approval. Executive Officer approval of the plan shall be conditioned upon the manufacturer providing supporting data and/or engineering evaluation demonstrating the equivalence of the incrementing in the manufacturer's plan to the incrementing specified in section (d)(4.2.2) for monitors using the standard MIL illumination protocol and the overall equivalence of the manufacturer's plan in determining that the minimum acceptable in-use performance ratio in section (d)(3.2) is satisfied.

(4.3) Denominator Specifications

(4.3.1) Definition: The denominator is defined as a measure of the number of times a vehicle has been operated as defined in (d)(4.3.2).

(4.3.2) Specifications for incrementing:

(A) The denominator, when incremented, shall be incremented by an integer of one. The denominator may not be incremented more than once per driving cycle.

(B) The denominator for each monitor shall be incremented within 10 seconds if and only if the following criteria are satisfied on a single driving cycle:

(i) Cumulative time since start of driving cycle is greater than or equal to 600 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit;

(ii) Cumulative gasoline engine operation at or above 25 miles per hour or diesel engine operation at or above 15% calculated load, either of which occurs for greater than or equal to 300 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit; and

(iii) Continuous vehicle operation at idle (e.g., accelerator pedal released by driver and vehicle speed less than or equal to one mile per hour) for greater than or equal to 30 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit.

(C) In addition to the requirements of section (d)(4.3.2)(B) above, the evaporative system monitor denominator(s) shall be incremented if and only if:

(i) Cumulative time since start of driving cycle is greater than or equal to 600 seconds while at an ambient temperature of greater than or equal to 40 degrees Fahrenheit but less than or equal to 95 degrees Fahrenheit; and

(ii) Engine cold start occurs with engine coolant temperature at engine start greater than or equal to 40 degrees Fahrenheit but less than or equal to 95 degrees Fahrenheit and less than or equal to 12 degrees Fahrenheit higher than ambient temperature at engine start.

(D) In addition to the requirements of section (d)(4.3.2)(B) above, the denominator(s) for the following monitors shall be incremented if and only if the component or strategy is commanded “on” for a time greater than or equal to 10 seconds:

(i) Secondary Air System (section (f)(5))

(ii) Cold Start Emission Reduction Strategy (section (f)(4))

(iii) Components or systems that operate only at engine start-up (e.g., glow plugs, intake air heaters) and are subject to monitoring under “other emission control systems” (section (g)(5)) or comprehensive component output components (section (g)(4))

For purposes of determining this commanded “on” time, the OBD system may not include time during intrusive operation of any of the components or strategies later in the same driving cycle solely for the purposes of monitoring.

(E) In addition to the requirements of section (d)(4.3.2)(B) above, the denominator(s) for the following monitors of output components (except those operated only at engine start-up and subject to the requirements of

the previous section (d)(4.3.2)(D)) shall be incremented if and only if the component is commanded to function (e.g., commanded “on”, “open”, “closed”, “locked”) on two or more occasions during the driving cycle or for a time greater than or equal to 10 seconds, whichever occurs first:

(i) Variable valve timing and/or control system (section (g)(1))

(ii) “Other emission control systems” (section (g)(5))

(iii) Comprehensive component output component (section (g)(4)) (e.g., turbocharger waste-gates, variable length manifold runners)

(F) For monitors of the following components, the manufacturer may request Executive Officer approval to use alternate or additional criteria to that set forth in section (d)(4.3.2)(B) above for incrementing the denominator. Executive Officer approval of the proposed criteria shall be based on the equivalence of the proposed criteria in measuring the frequency of monitor operation relative to the amount of vehicle operation in accordance with the criteria in section (d)(4.3.2)(B) above:

(i) Engine cooling system input components (section (g)(2))

(ii) “Other emission control systems” (section (g)(5))

(iii) Comprehensive component input components that require extended monitoring evaluation (section (g)(4)) (e.g., stuck fuel level sensor rationality)

(G) For monitors of the following components or other emission controls that experience infrequent regeneration events, the manufacturer may request Executive Officer approval to use alternate or additional criteria to that set forth in section (d)(4.3.2)(B) above for incrementing the denominator. Executive Officer approval of the proposed criteria shall be based on the effectiveness of the proposed criteria in measuring the frequency of monitor operation relative to the amount of vehicle operation:

(i) Oxidation catalyst (section (e)(5))

(ii) Particulate matter filters (section (e)(8))

(H) For hybrid vehicles, vehicles that employ alternate engine start hardware or strategies (e.g., integrated starter and generators), or alternate fuel vehicles (e.g., dedicated, bi-fuel, or dual-fuel applications), the manufacturer may request Executive Officer approval to use alternate criteria to that set forth in section (d)(4.3.2)(B) above for incrementing the denominator. In general, the Executive Officer shall not approve alternate criteria for vehicles that only employ engine shut off at or near idle/vehicle stop conditions. Executive Officer approval of the alternate criteria shall be based on the equivalence of the alternate criteria to determine the amount of vehicle operation relative to the measure of conventional vehicle operation in accordance with the criteria in section (d)(4.3.2)(B) above.

(4.4) Ratio Specifications

(4.4.1) Definition: The ratio is defined as the numerator divided by the denominator.

(4.5) Disablement of Numerators and Denominators

(4.5.1) Within 10 seconds of a malfunction being detected (i.e., a pending, confirmed, or active fault code being stored) that disables a monitor required to meet the monitoring conditions in section (d)(3.2), the OBD

system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the malfunction is no longer detected (e.g., the pending code is erased through self-clearing or through a scan tool command), incrementing of all corresponding numerators and denominators shall resume within 10 seconds.

(4.5.2) Within 10 seconds of the start of a PTO (see section (c)) operation that disables a monitor required to meet the monitoring conditions in section (d)(3.2), the OBD system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the PTO operation ends, incrementing of all corresponding numerators and denominators shall resume within 10 seconds.

(4.5.3) The OBD system shall disable further incrementing of all numerators and denominators within 10 seconds if a malfunction of any component used to determine if the criteria in sections (d)(4.3.2)(B) through (C) are satisfied (i.e., vehicle speed/calculated load, ambient temperature, elevation, idle operation, engine cold start, or time of operation) has been detected and the corresponding pending fault code has been stored. Incrementing of all numerators and denominators shall resume within 10 seconds when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command).

(5) **Standardized tracking and reporting of monitor performance.**

(5.1) For monitors required to track and report in-use monitor performance in section (d)(3.2), the performance data shall be tracked and reported in accordance with the specifications in sections (d)(4), (d)(5), and (h)(5.1). The OBD system shall separately report an in-use monitor performance numerator and denominator for each of the following components:

(5.1.1) For diesel engines, NMHC catalyst bank 1, NMHC catalyst bank 2, NOx catalyst bank 1, NOx catalyst bank 2, exhaust gas sensor bank 1, exhaust gas sensor bank 2, EGR/VVT system, PM filter, boost pressure control system, and NOx adsorber. The OBD system shall also report a general denominator and an ignition cycle counter in the standardized format specified in sections (d)(5.5), (d)(5.6), and (h)(5.1).

(5.1.2) For gasoline engines, catalyst bank 1, catalyst bank 2, oxygen sensor bank 1, oxygen sensor bank 2, evaporative leak detection system, EGR/VVT system, and secondary air system. The OBD system shall also report a general denominator and an ignition cycle counter in the standardized format specified in sections (d)(5.5), (d)(5.6), and (h)(5.1).

(5.2) Numerator

(5.2.1) The OBD system shall report a separate numerator for each of the components listed in section (d)(5.1).

(5.2.2) For specific components or systems that have multiple monitors that are required to be reported under section (e) (e.g., exhaust gas sensor bank 1 may have multiple monitors for sensor response or other sensor characteristics), the OBD system shall separately track numerators and denominators for each of the specific monitors and report only the corresponding numerator and denominator for the specific monitor that

has the lowest numerical ratio. If two or more specific monitors have identical ratios, the corresponding numerator and denominator for the specific monitor that has the highest denominator shall be reported for the specific component.

(5.2.3) The numerator(s) shall be reported in accordance with the specifications in section (h)(5.1.2)(A).

(5.3) Denominator

(5.3.1) The OBD system shall report a separate denominator for each of the components listed in section (d)(5.1).

(5.3.2) The denominator(s) shall be reported in accordance with the specifications in section (h)(5.1.2)(A).

(5.4) Ratio

(5.4.1) For purposes of determining which corresponding numerator and denominator to report as required in section (d)(5.2.2), the ratio shall be calculated in accordance with the specifications in section (h)(5.1.2)(B).

(5.5) Ignition cycle counter

(5.5.1) Definition:

(A) The ignition cycle counter is defined as a counter that indicates the number of ignition cycles a vehicle has experienced as defined in section (d)(5.5.2)(B).

(B) The ignition cycle counter shall be reported in accordance with the specifications in section (h)(5.1.2)(A).

(5.5.2) Specifications for incrementing:

(A) The ignition cycle counter, when incremented, shall be incremented by an integer of one. The ignition cycle counter may not be incremented more than once per ignition cycle.

(B) The ignition cycle counter shall be incremented within 10 seconds if and only if the engine exceeds an engine speed of 100 plus or minus 50 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission) for at least two seconds plus or minus one second.

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(C) The OBD system shall disable further incrementing of the ignition cycle counter within 10 seconds if a malfunction of any component used to determine if the criteria in section (d)(5.5.2)(B) are satisfied (i.e., engine speed or time of operation) has been detected and the corresponding pending fault code has been stored. The ignition cycle counter may not be disabled from incrementing for any other condition. Incrementing of the ignition cycle counter shall resume within 10 seconds when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command).

(5.6) General Denominator

(5.6.1) Definition:

(A) The general denominator is defined as a measure of the number of times a vehicle has been operated as defined in section (d)(5.6.2)(B).

(B) The general denominator shall be reported in accordance with the specifications in section (h)(5.1.2)(A).

(5.6.2) Specifications for incrementing:

(A) The general denominator, when incremented, shall be incremented by an

integer of one. The general denominator may not be incremented more than once per driving cycle.

(B) The general denominator shall be incremented within 10 seconds if and only if the criteria identified in section (d)(4.3.2)(B) are satisfied on a single driving cycle.

(C) The OBD system shall disable further incrementing of the general denominator within 10 seconds if a malfunction of any component used to determine if the criteria in section (d)(4.3.2)(B) are satisfied (i.e., vehicle speed/load, ambient temperature, elevation, idle operation, or time of operation) has been detected and the corresponding pending fault code has been stored. The general denominator may not be disabled from incrementing for any other condition (e.g., the disablement criteria in sections (d)(4.5.1) and (d)(4.5.2) may not disable the general denominator). Incrementing of the general denominator shall resume within 10 seconds when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command).

(6) **Malfunction Criteria Determination.**

(6.1) In determining the malfunction criteria for diesel engine monitors in sections (e) and (g) that are required to indicate a malfunction before emissions exceed an emission threshold based on any applicable standard (e.g., 2.0 times any of the applicable standards), the manufacturer shall:

(6.1.1) Use the emission test cycle and standard (i.e., FTP or SET) determined by the manufacturer to be more stringent (i.e., to result in higher emissions with the same level of monitored component malfunction). The manufacturer shall use data and/or engineering analysis to determine the test cycle and standard that is more stringent.

(6.1.2) Identify in the certification documentation required under section (j), the test cycle and standard determined by the manufacturer to be the most stringent for each applicable monitor.

(6.2) On engines equipped with emission controls that experience infrequent regeneration events, a manufacturer shall adjust the emission test results that are used to determine the malfunction criterion for monitors that are required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2.0 times any of the applicable standards). For each monitor, the manufacturer shall adjust the emission result using the procedure described in CFR title 40, part 86.004-28(i) with the component for which the malfunction criteria is being established deteriorated to the malfunction threshold. The adjusted emission value shall be used for purposes of determining whether or not the specified emission threshold is exceeded (e.g., a malfunction must be detected before the adjusted emission value exceeds 2.0 times any applicable standard).

(6.2.1) For purposes of section (d)(6.2), "regeneration" means an event during which emissions levels change while the emission control performance is being restored by design.

(6.2.2) For purposes of section (d)(6.2), "infrequent" means having an expected frequency of less than once per FTP cycle.

(6.3) In lieu of meeting the malfunction criteria for gasoline engine monitors in sections (f) and (g), the manufacturer may request Executive Officer approval

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to utilize OBD systems certified to the requirements of title 13, CCR section 1968.2 on medium-duty engines or vehicles. The Executive Officer shall approve the request upon finding that the manufacturer has used good engineering judgment in determining equivalent malfunction detection criteria on the heavy-duty engine.

(7) **Implementation Schedule**

(7.1) Except as specified in sections (d)(7.4) and (d)(7.5) for small volume manufacturers and alternate-fueled engines, for the 2010 through 2012 model year engines:

(7.1.1) Full OBD. Except as specified in section (d)(7.1.3) below, a manufacturer shall implement an OBD system meeting the requirements of section 1971.1 on one engine rating (i.e., the OBD parent rating) within one of the manufacturer's engine families. The OBD parent rating shall be from the manufacturer's heavy-duty engine family with the highest weighted sales number for the 2010 model year and shall be the engine rating with the highest weighted sales number within that engine family.

(7.1.2) Extrapolated OBD. For all other engine ratings within the engine family selected according to section (d)(7.1.1) (i.e., the OBD child ratings), except as specified in section (d)(7.1.3) below), a manufacturer shall implement an OBD system meeting the requirements of section 1971.1 with the exception that the OBD system is not required to detect a malfunction prior to exceeding the emission thresholds specified in the malfunction criteria in sections (e) through (g). In lieu of detecting a malfunction prior to exceeding the emission thresholds, a manufacturer shall submit a plan for Executive Officer review and approval detailing the engineering evaluation the manufacturer will use to establish the malfunction criteria for the OBD child ratings. The Executive Officer shall approve the plan upon determining that the manufacturer is using good engineering judgment to establish the malfunction criteria for robust detection of malfunctions, including consideration of differences of base engine, calibration, emission control components, and emission control strategies.

(7.1.3) For all engine ratings (i.e., OBD parent and OBD child ratings) within the engine family selected according to (d)(7.1.1):

(A) The OBD system is exempt from the requirements to comply with the requirements within the following sections:

(i) (d)(1.2) and (h)(2) (standardized connector)

(ii) (d)(2.1.1) and (2.1.5) (dedicated standardized MIL)

(iii) (h)(3) (communication protocol)

(iv) (h)(4) (standardized communication functions)

(v) (h)(5.1.1) and (h)(5.2.1) with respect to the requirements to make the data available in a standardized format or in accordance with SAE J1979/1939 specifications.

(B) The OBD system shall meet the requirements of either sections (d)(2.2.1) and (2.3.1) or (d)(2.2.2) and (2.3.2) regardless of the communication protocol (e.g., standardized, proprietary) used by the OBD system.

(7.1.4) Engine Manufacturer Diagnostic (EMD) Systems. For all engine ratings in the manufacturer's engine families not selected according to section

(d)(7.1.1), a manufacturer shall:

(A) Implement an EMD system meeting the requirements of title 13, CCR section 1971 in lieu of meeting the requirements of section 1971.1; and

(B) Monitor the NOx aftertreatment (i.e., catalyst, adsorber) on engines so-equipped. A malfunction shall be detected if:

(i) The NOx aftertreatment system has no detectable amount of NOx aftertreatment capability (i.e., NOx catalyst conversion or NOx adsorption);

(ii) The NOx aftertreatment substrate is completely destroyed, removed, or missing; or

(iii) The NOx aftertreatment assembly is replaced with a straight pipe.

(7.2) Except as specified in section (d)(7.5) for alternate-fueled engines, for the 2013 through 2015 model year engines:

(7.2.1) A manufacturer shall be required to define one or more OBD groups to cover all engine ratings in all engine families.

(7.2.2) Full OBD. A manufacturer shall implement an OBD system meeting the requirements of section 1971.1:

(A) On all engine ratings (i.e., OBD parent and OBD child ratings) within the engine family selected according to section (d)(7.1.1); and

(B) On one engine rating (i.e., OBD parent rating) within each of the manufacturer's OBD groups. The OBD parent rating shall be the engine rating with the highest weighted sales number for the 2013 model year within each OBD group.

(7.2.3) Extrapolated OBD. For all engine ratings not subject to section (d)(7.2.2) (i.e., OBD child ratings), a manufacturer shall implement an OBD system meeting the requirements of section 1971.1 with the exception that the OBD system is not required to detect a malfunction prior to exceeding the emission thresholds specified in the malfunction criteria in sections (e) through (g). In lieu of detecting a malfunction prior to exceeding the emission thresholds, a manufacturer shall submit a plan for Executive Officer review and approval detailing the engineering evaluation the manufacturer will use to establish the malfunction criteria for the OBD child ratings. The Executive Officer shall approve the plan upon determining that the manufacturer is using good engineering judgment to establish the malfunction criteria for robust detection of malfunctions, including consideration of differences of base engine, calibration, emission control components, and emission control strategies.

(7.3) Except as specified in section (d)(7.5) for alternate-fueled engines, for the 2016 and subsequent model year engines:

(7.3.1) A manufacturer shall implement an OBD system meeting the requirements of section 1971.1 on all engine ratings in all engine families.

(7.4) Small volume manufacturers shall be exempt from the requirements of section 1971.1 for 2010 through 2012 model year engines. For purposes of this requirement, a small volume manufacturer is defined as a manufacturer with projected engine sales for California heavy-duty vehicles of less than 1200 engines per year for the 2010 model year.

(7.5) For alternate-fueled engines:

(7.5.1) For 2010 through 2012 model year engines, a manufacturer shall be

exempt from the requirements of section 1971.1.

(7.5.2) For 2013 through 2019 model year engines, the manufacturer shall:

(A) Implement an EMD system meeting the requirements of title 13, CCR section 1971 in lieu of meeting the requirements of section 1971.1; and

(B) Monitor the NOx aftertreatment (i.e., catalyst, adsorber) on engines so-equipped. A malfunction shall be detected if:

(i) The NOx aftertreatment system has no detectable amount of NOx aftertreatment capability (i.e., NOx catalyst conversion or NOx adsorption);

(ii) The NOx aftertreatment substrate is completely destroyed, removed, or missing; or

(iii) The NOx aftertreatment assembly is replaced with a straight pipe.

(7.5.3) For 2020 and subsequent model year engines, a manufacturer shall implement an OBD system meeting the requirements of section 1971.1.

(e) MONITORING REQUIREMENTS FOR DIESEL/COMPRESSION-IGNITION ENGINES

(1) **FUEL SYSTEM MONITORING**

(1.1) Requirement:

The OBD system shall monitor the fuel delivery system to determine its ability to comply with emission standards. The individual electronic components (e.g., actuators, valves, sensors, pumps) that are used in the fuel system and not specifically addressed in this section shall be monitored in accordance with the comprehensive component requirements in section (g)(4).

(1.2) Malfunction Criteria:

(1.2.1) Fuel system pressure control: The OBD system shall detect a malfunction of the fuel system pressure control system (e.g., fuel, hydraulic fluid) when the fuel system pressure control system is unable to maintain an engine's NMHC, NOx, or CO emissions at or below 2.0 times the applicable standards or the engine's PM emissions at or below the applicable standard plus 0.02 grams per brake horsepower-hour (g/bhp-hr). For engines in which no failure or deterioration of the fuel system pressure control could result in an engine's emissions exceeding these emission levels, the OBD system shall detect a malfunction when the system has reached its control limits such that the commanded fuel system pressure cannot be delivered.

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(1.2.2) Injection quantity: The OBD system shall detect a malfunction of the fuel injection system when the system is unable to deliver the commanded quantity of fuel necessary to maintain an engine's NMHC, CO, and NOx emissions at or below 2.0 times the applicable standards or the engine's PM emissions at or below the applicable standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the fuel injection quantity could result in an engine's emissions exceeding these emission levels, the OBD system shall detect a malfunction when the system has reached its control limits such that the commanded fuel quantity cannot be delivered.

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(1.2.3) Injection Timing: The OBD system shall detect a malfunction of the fuel injection system when the system is unable to deliver fuel at the proper crank angle/timing (e.g., injection timing too advanced or too retarded)

necessary to maintain an engine's NMHC, CO, and NOx emissions at or below 2.0 times the applicable standards or the engine's PM emissions at or below the applicable standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the fuel injection timing could result in an engine's emissions exceeding these emission levels, the OBD system shall detect a malfunction when the system has reached its control limits such that the commanded fuel injection timing cannot be achieved.

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(1.2.4) Feedback control: Except as provided for in section (e)(1.2.5), if the engine is equipped with feedback control of the fuel system (e.g., feedback control of pressure or pilot injection quantity), the OBD system shall detect a malfunction:

(A) If the system fails to begin feedback control within a manufacturer specified time interval;

(B) If a failure or deterioration causes open loop or default operation; or

(C) If feedback control has used up all of the adjustment allowed by the manufacturer.

(1.2.5) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (e)(1.2.4)(C) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on an engine with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(1.2.6) In lieu of detecting the malfunctions specified in sections (e)(1.2.4)(A) and (B) with a fuel system-specific monitor, the OBD system may monitor the individual parameters or components that are used as inputs for fuel system feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (e)(1.2.4)(A) and (B).

(1.3) Monitoring Conditions:

(1.3.1) The OBD system shall monitor continuously for malfunctions identified in sections (e)(1.2.1) and (e)(1.2.4) (i.e., fuel pressure control and feedback operation).

(1.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(1.2.2) and (e)(1.2.3) (i.e., injection quantity and timing) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(1.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(2) **MISFIRE MONITORING**

(2.1) Requirement:

(2.1.1) The OBD system shall monitor the engine for misfire causing excess emissions. The OBD system shall be capable of detecting misfire occurring in one or more cylinders. To the extent possible without adding hardware for this specific purpose, the OBD system shall also identify the specific misfiring cylinder.

(2.1.2) If more than one cylinder is continuously misfiring, a separate fault code shall be stored indicating that multiple cylinders are misfiring. When identifying multiple cylinder misfire, the manufacturer OBD system is not required to also identify each of the continuously misfiring cylinders individually through separate fault codes.

(2.2) Malfunction Criteria:

(2.2.1) The OBD system shall detect a misfire malfunction when one or more cylinders are continuously misfiring.

(2.2.2) Additionally, for 2013 and subsequent model year engines equipped with sensors that can detect combustion or combustion quality (e.g., for use in homogeneous charge compression ignition (HCCI) control systems), the OBD system shall detect a misfire malfunction causing the engine's NMHC, CO, or NOx emissions to exceed 2.0 times the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr.

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(A) Manufacturers shall determine the percentage of misfire evaluated in 1000 revolution increments that would cause NMHC, CO, or NOx emissions from an emission durability demonstration engine to exceed 2.0 times any of the applicable standards or PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr if the percentage of misfire were present from the beginning of the test. To establish this percentage of misfire, the manufacturer shall utilize misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent.

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(B) Subject to Executive Officer approval, a manufacturer may employ other revolution increments. The Executive Officer shall grant approval upon determining that the manufacturer has demonstrated that the strategy would be equally effective and timely in detecting misfire.

(2.2.3) A malfunction shall be detected if the percentage of misfire established in section (e)(2.2.2)(A) is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous).

(2.3) Monitoring Conditions:

(2.3.1) The OBD system shall monitor for misfire during engine idle conditions at least once per driving cycle in which the monitoring conditions for misfire are met. A manufacturer shall submit monitoring conditions to the Executive Officer for approval. The Executive Officer shall approve manufacturer-defined monitoring conditions that are determined (based on manufacturer-submitted data and/or other engineering documentation) to: (i) be technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false detection of malfunctions), (ii) require no more than 1000 cumulative engine revolutions, and (iii) do not require any single continuous idle operation of more than 15 seconds to make a determination that a malfunction is present (e.g., a decision can be made with data gathered during several idle operations of 15 seconds or less); or satisfy the requirements of (d)(3.1) with alternative engine operating conditions.

(2.3.2) Manufacturers may request Executive Officer approval to use alternate monitoring conditions (e.g., off-idle). The Executive Officer shall approve alternate monitoring conditions that are determined (based on manufacturer-submitted data and/or other engineering documentation) to ensure equivalent robust detection of malfunctions and equivalent timeliness in detection of malfunctions.

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(2.3.3) Additionally, for 2013 and subsequent model year engines equipped with sensors that can detect combustion or combustion quality:

(A) The OBD system shall continuously monitor for misfire under all positive torque engine speeds and load conditions.

(B) If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions as required in section (e)(2.3.2)(A), the manufacturer may request Executive Officer approval to accept the monitoring system. In evaluating the manufacturer's request, the Executive Officer shall consider the following factors: the magnitude of the region(s) in which misfire detection is limited, the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events), the frequency with which said region(s) are expected to be encountered in-use, the type of misfire patterns for which misfire detection is troublesome, and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation shall be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders, single cylinder continuous misfire, and paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(2.4) MIL Illumination and Fault Code Storage:

(2.4.1) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(2.4.2) Additionally, for 2013 and subsequent model year engines equipped with sensors that can detect combustion or combustion quality:

(A) Upon detection of the percentage of misfire specified in section (e)(2.2.2)(A), the following criteria shall apply for MIL illumination and fault code storage:

(i) A pending fault code shall be stored no later than after the fourth exceedance of the percentage of misfire specified in section (e)(2.2.2) during a single driving cycle.

(ii) If a pending fault code is stored, the OBD system shall illuminate the MIL and store a confirmed/active fault code within 10 seconds if the percentage of misfire specified in section (e)(2.2.2) is again exceeded four times during: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered.

(iii) The pending fault code may be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered

without an exceedance of the specified percentage of misfire. The pending code may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following initial detection of the malfunction.

(B) Storage of freeze frame conditions.

(i) The OBD system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing a confirmed/active fault code and erasing a confirmed/previously active fault code.

(ii) If freeze frame conditions are stored for a malfunction other than a misfire malfunction when a fault code is stored as specified in section (e)(2.4.2), the stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction.

(C) Storage of misfire conditions for similar conditions determination. Upon detection of misfire under section (e)(2.4.2), the OBD system shall store the following engine conditions: engine speed, load, and warm-up status of the first misfire event that resulted in the storage of the pending fault code.

(D) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

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

(3.1) Requirement: The OBD system shall monitor the EGR system on engines so-equipped for low flow rate, high flow rate, and slow response malfunctions. For engines equipped with EGR coolers (e.g., heat exchangers), the OBD system shall monitor the cooler for insufficient cooling malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the EGR system shall be monitored in accordance with the comprehensive component requirements in section (g)(4).

(3.2) Malfunction Criteria:

(3.2.1) Low Flow: The OBD system shall detect a malfunction of the EGR system prior to a decrease from the manufacturer's specified EGR flow rate that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the EGR system that causes a decrease in flow could result in an engine's emissions exceeding these levels, the OBD system shall detect a malfunction when the system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate.

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(3.2.2) High Flow: The OBD system shall detect a malfunction of the EGR system, including a leaking EGR valve (i.e., exhaust gas flowing through the valve when the valve is commanded closed), prior to an increase from the manufacturer's specified EGR flow rate that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed the applicable

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standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the EGR system that causes an increase in flow could result in an engine's emissions exceeding these levels, the OBD system shall detect a malfunction when the system has reached its control limits such that it cannot reduce EGR flow to achieve the commanded flow rate.

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(3.2.3) Slow Response: The OBD system shall detect a malfunction of the EGR system prior to any failure or deterioration in the capability of the EGR system to achieve the commanded flow rate within a manufacturer-specified time that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr. The OBD system shall monitor both the capability of the EGR system to respond to a commanded increase in flow and the capability of the EGR system to respond to a commanded decrease in flow.

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(3.2.4) Feedback control: Except as provided for in section (e)(3.2.6), if the engine is equipped with feedback control of the EGR system (e.g., feedback control of flow, valve position, pressure differential across the valve via intake throttle or exhaust backpressure), the OBD system shall detect a malfunction:

(A) If the system fails to begin feedback control within a manufacturer specified time interval;

(B) If a failure or deterioration causes open loop or default operation; or

(C) If feedback control has used up all of the adjustment allowed by the manufacturer.

(3.2.5) EGR Cooler Performance: The OBD system shall detect a malfunction of the EGR system cooler prior to a reduction from the manufacturer's specified cooling performance that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the EGR system cooler could result in an engine's emissions exceeding these levels, the OBD system shall detect a malfunction when the system has no detectable amount of EGR cooling.

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(3.2.6) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (e)(3.2.4)(C) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on an engine with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(3.2.7) In lieu of detecting the malfunctions specified in sections (e)(3.2.4)(A) and (B) with an EGR system-specific monitor, the OBD system may monitor the individual parameters or components that are used as inputs for EGR system feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (e)(3.2.4)(A) and (B).

(3.3) Monitoring Conditions:

(3.3.1) The OBD system shall monitor continuously for malfunctions identified in sections (e)(3.2.1), (3.2.2), and (e)(3.2.4) (i.e., EGR low and high flow, feedback control).

(3.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(3.2.3) (i.e., slow response) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(3.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(3.3.3) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(3.2.5) (i.e., cooler performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(3.2.5) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(3.3.4) Manufacturers may request Executive Officer approval to temporarily disable the EGR system check under specific conditions (e.g., when freezing may affect performance of the system). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a reliable check cannot be made when these conditions exist.

(3.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(4) **BOOST PRESSURE CONTROL SYSTEM MONITORING**

(4.1) Requirement: The OBD system shall monitor the boost pressure control system (e.g., turbocharger) on engines so-equipped for under and over boost malfunctions. For engines equipped with variable geometry turbochargers (VGT), the OBD system shall monitor the VGT system for slow response malfunctions. For engines equipped with charge air cooler systems, the OBD system shall monitor the charge air cooler system for cooling system performance malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the boost pressure control system shall be monitored in accordance with the comprehensive component requirements in section (g)(4).

(4.2) Malfunction Criteria:

(4.2.1) Underboost: The OBD system shall detect a malfunction of the boost pressure control system prior to a decrease from the manufacturer's commanded boost pressure that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the boost pressure control system that causes a decrease in boost could result in an engine's emissions exceeding these levels, the OBD system shall detect a

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malfunction when the system has reached its control limits such that it cannot increase boost to achieve the commanded boost pressure.

(4.2.2) Overboost: The OBD system shall detect a malfunction of the boost pressure control system prior to an increase from the manufacturer's commanded boost pressure that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the boost pressure control system that causes an increase in boost could result in an engine's emissions exceeding these levels, the OBD system shall detect a malfunction when the system has reached its control limits such that it cannot decrease boost to achieve the commanded boost pressure.

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(4.2.3) VGT slow response: The OBD system shall detect a malfunction prior to any failure or deterioration in the capability of the VGT system to achieve the commanded turbocharger geometry within a manufacturer-specified time that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the VGT system response could result in an engine's emissions exceeding these levels, the OBD system shall detect a malfunction of the VGT system when proper functional response of the system to computer commands does not occur.

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(4.2.4) Charge Air Undercooling: The OBD system shall detect a malfunction of the charge air cooling system prior to a decrease from the manufacturer's specified cooling rate that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr. For engines in which no failure or deterioration of the charge air cooling system that causes a decrease in cooling performance could result in an engine's emissions exceeding these levels, the OBD system shall detect a malfunction when the system has no detectable amount of charge air cooling.

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(4.2.5) Feedback control: Except as provided for in section (e)(4.2.6), if the engine is equipped with feedback control of the boost pressure system (e.g., control of VGT position, turbine speed, manifold pressure) the OBD system shall detect a malfunction:

(A) If the system fails to begin feedback control within a manufacturer specified time interval;

(B) If a failure or deterioration causes open loop or default operation; or

(C) If feedback control has used up all of the adjustment allowed by the manufacturer.

(4.2.6) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (e)(4.2.5)(C) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on an engine with all

emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(4.2.7) In lieu of detecting the malfunctions specified in sections (e)(4.2.5)(A) and (B) with a boost pressure system-specific monitor, the OBD system may monitor the individual parameters or components that are used as inputs for boost pressure system feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (e)(4.2.5)(A) and (B).

(4.3) Monitoring Conditions:

(4.3.1) The OBD system shall monitor continuously for malfunctions identified in sections (e)(4.2.1), (4.2.2), and (4.2.5) (i.e., over and under boost, feedback control).

(4.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(4.2.3) (i.e., VGT slow response) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(4.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(4.3.3) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(4.2.4) (i.e., charge air cooler performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(4.2.4) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(4.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(5) **NON-METHANE HYDROCARBON (NMHC) CONVERTING CATALYST MONITORING**

(5.1) Requirement: The OBD system shall monitor the NMHC converting catalyst(s) for proper NMHC conversion capability. For engines equipped with catalyzed PM filters that convert NMHC emissions, the catalyst function of the PM filter shall be monitored in accordance with the PM filter requirements in section (e)(8).

(5.2) Malfunction Criteria:

(5.2.1) For purposes of section (e)(5), each catalyst that converts NMHC shall be monitored either individually or in combination with others.

(5.2.2) Conversion Efficiency:

(A) The OBD system shall detect an NMHC catalyst malfunction when the catalyst conversion capability decreases to the point that NMHC emissions exceed 2.0 times any of the applicable standards.

(B) If no failure or deterioration of the catalyst NMHC conversion capability could result in an engine's NMHC emissions exceeding 2.0 times any of the applicable standards, the OBD system shall detect a malfunction

when the catalyst has no detectable amount of NMHC conversion capability.

(5.2.3) Other Aftertreatment Assistance Functions:

(A) For catalysts used to generate an exotherm to assist PM filter regeneration, the OBD system shall detect a malfunction when the catalyst is unable to generate a sufficient exotherm to achieve regeneration of the PM filter.

(B) For catalysts used to generate a feedgas constituency to assist SCR systems (e.g., to increase NO_2 concentration upstream of an SCR system), the OBD system shall detect a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR system operation.

(C) For catalysts located downstream of a PM filter and used to convert NMHC emissions during PM filter regeneration, the OBD system shall detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

(5.2.4) Catalyst System Aging and Monitoring

(A) For purposes of determining the catalyst malfunction criteria in sections (e)(5.2.2) and (5.2.3) for individually monitored catalysts, the manufacturer shall use a catalyst deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions.

(B) For purposes of determining the catalyst malfunction criteria in sections (e)(5.2.2) and (5.2.3) for catalysts monitored in combination with others, the manufacturer shall submit a catalyst system aging and monitoring plan to the Executive Officer for review and approval. The plan shall include the description, emission control purpose, and location of each component, the monitoring strategy for each component and/or combination of components, and the method for determining the malfunction criteria of sections (e)(5.2.2) and (5.2.3) including the deterioration/aging process. Executive Officer approval of the plan shall be based on the representativeness of the aging to real world catalyst system component deterioration under normal and malfunctioning engine operating conditions, the effectiveness of the method used to determine the malfunction criteria of section (e)(5.2), the ability of the component monitor(s) to pinpoint the likely area of malfunction and ensure the correct components are repaired/replaced in-use, and the ability of the component monitor(s) to accurately verify that each catalyst component is functioning as designed and as required in sections (e)(5.2.2) and (5.2.3).

(5.3) Monitoring Conditions:

(5.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(5.2.2) and (5.2.3) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(5.2.2) and (5.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(5.4) MIL Illumination and Fault Code Storage:

(5.4.1) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(5.4.2) The monitoring method for the catalyst(s) shall be capable of detecting all instances, except diagnostic self-clearing, when a catalyst fault code has been cleared but the catalyst has not been replaced (e.g., catalyst overtemperature histogram approaches are not acceptable).

(6) **OXIDES OF NITROGEN (NOx) CONVERTING CATALYST MONITORING**

(6.1) Requirement: The OBD system shall monitor the NOx converting catalyst(s) for proper conversion capability. For engines equipped with selective catalytic reduction (SCR) systems or other catalyst systems that utilize an active/intrusive reductant injection (e.g., active lean NOx catalysts utilizing diesel fuel injection), the OBD system shall monitor the SCR or active/intrusive reductant injection system for proper performance. The individual electronic components (e.g., actuators, valves, sensors, heaters, pumps) in the SCR or active/intrusive reductant injection system shall be monitored in accordance with the comprehensive component requirements in section (g)(4).

(6.2) Malfunction Criteria: For purposes of section (e)(6), each catalyst that converts NOx shall be monitored either individually or in combination with others.

(6.2.1) Conversion Efficiency:

(A) For 2010 through 2012 model year engines:

(i) The OBD system shall detect a catalyst malfunction when the catalyst conversion capability decreases to the point that would cause an engine's NOx emissions to exceed any of the applicable standards by more than 0.3 g/bhp-hr (e.g., cause emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test (i.e., FTP or SET).

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(ii) If no failure or deterioration of the catalyst NOx conversion capability could result in an engine's NOx emissions exceeding any of the applicable standards by more than 0.3 g/bhp-hr, the OBD system shall detect a malfunction when the catalyst has no detectable amount of NOx conversion capability.

(B) For 2013 and subsequent model year engines:

(i) The OBD system shall detect a catalyst malfunction when the catalyst conversion capability decreases to the point that would cause an engine's NOx emissions to exceed any of the applicable standards by more than 0.2 g/bhp-hr (e.g., cause emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr).

(ii) If no failure or deterioration of the catalyst system NOx conversion capability could result in an engine's NOx emissions exceeding any of the applicable standards by more than 0.2 g/bhp-hr, the OBD system shall detect a malfunction when the catalyst has no detectable amount of NOx conversion capability.

(6.2.2) Selective Catalytic Reduction (SCR) or Other Active/Intrusive Reductant Injection System Performance:

(A) Reductant Delivery Performance:

(i) For 2010 through 2012 model year engines, the OBD system shall detect a malfunction prior to any failure or deterioration of the system to properly regulate reductant delivery (e.g., urea injection, separate injector fuel injection, post injection of fuel, air assisted injection/mixing) that would cause an engine's NOx emissions to exceed any of the applicable standards by more than 0.3 g/bhp-hr (e.g., cause emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test (i.e., FTP or SET). If no failure or deterioration of the SCR system could result in an engine's NOx emissions exceeding any of the applicable standards by more than 0.3 g/bhp-hr, the OBD system shall detect a malfunction when the system has reached its control limits such that it is no longer able to deliver the desired quantity of reductant.

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(ii) For 2013 and subsequent model year engines, the OBD system shall detect a system malfunction prior to any failure or deterioration of the system to properly regulate reductant delivery (e.g., urea injection, separate injector fuel injection, post injection of fuel, air assisted injection/mixing) that would cause an engine's NOx emissions to exceed any of the applicable standards by more than 0.2 g/bhp-hr (e.g., cause emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr). If no failure or deterioration of the SCR system could result in an engine's NOx emissions exceeding the applicable standards by more than 0.2 g/bhp-hr, the OBD system shall detect a malfunction when the system has reached its control limits such that it is no longer able to deliver the desired quantity of reductant.

(B) If the catalyst system uses a reductant other than the fuel used for the engine or uses a reservoir/tank for the reductant that is separate from the fuel tank used for the engine, the OBD system shall detect a malfunction when there is no longer sufficient reductant available (e.g., the reductant tank is empty).

(C) If the catalyst system uses a reservoir/tank for the reductant that is separate from the fuel tank used for the engine, the OBD system shall detect a malfunction when an improper reductant is used in the reductant reservoir/tank (e.g., the reductant tank is filled with something other than the reductant).

(D) Feedback control: Except as provided for in section (e)(6.2.2)(E), if the engine is equipped with feedback control of the reductant injection, the OBD system shall detect a malfunction:

(i) If the system fails to begin feedback control within a manufacturer specified time interval;

(ii) If a failure or deterioration causes open loop or default operation; or

(iii) If feedback control has used up all of the adjustment allowed by the manufacturer.

(E) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (e)(6.2.2)(D)(iii) during conditions that a manufacturer cannot robustly

distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on an engine with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(F) In lieu of detecting the malfunctions specified in sections (e)(6.2.2)(D)(i) and (ii) with a reductant injection system-specific monitor, the OBD system may monitor the individual parameters or components that are used as inputs for reductant injection feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (e)(6.2.2)(D)(i) and (ii).

(6.2.3) Catalyst System Aging and Monitoring

(A) For purposes of determining the catalyst malfunction criteria in section (e)(6.2.1) for individually monitored catalysts, the manufacturer shall use a catalyst deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions.

(B) For purposes of determining the catalyst malfunction criteria in section (e)(6.2.1) for catalysts monitored in combination with others, the manufacturer shall submit a catalyst system aging and monitoring plan to the Executive Officer for review and approval. The plan shall include the description, emission control purpose, and location of each component, the monitoring strategy for each component and/or combination of components, and the method for determining the malfunction criteria of section (e)(6.2.1) including the deterioration/aging process. Executive Officer approval of the plan shall be based on the representativeness of the aging to real world catalyst system component deterioration under normal and malfunctioning engine operating conditions, the effectiveness of the method used to determine the malfunction criteria of section (e)(6.2.1), the ability of the component monitor(s) to pinpoint the likely area of malfunction and ensure the correct components are repaired/replaced in-use, and the ability of the component monitor(s) to accurately verify that each catalyst component is functioning as designed and as required in section (e)(6.2.1).

(6.3) Monitoring Conditions:

(6.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(6.2.1) (i.e., catalyst efficiency) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(6.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(6.3.2) The OBD system shall monitor continuously for malfunctions identified in section (e)(6.2.2) (e.g., SCR performance).

(6.4) MIL Illumination and Fault Code Storage:

(6.4.1) Except as provided below for reductant faults, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(6.4.2) If the OBD system is capable of discerning that a system fault is being caused by a empty reductant tank:

(A) The manufacturer may request Executive Officer approval to delay illumination of the MIL if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The Executive Officer shall approve the request upon determining the alternative indicator is of sufficient illumination and location to be readily visible under all lighting conditions and provides equivalent assurance that a vehicle operator will be promptly notified and that corrective action will be undertaken.

(B) If the vehicle is not equipped with an alternative indicator and the MIL illuminates, the MIL may be immediately extinguished and the corresponding fault codes erased once the OBD system has verified that the reductant tank has been properly refilled and the MIL has not been illuminated for any other type of malfunction.

(C) The Executive Officer may approve other strategies that provide equivalent assurance that a vehicle operator will be promptly notified and that corrective action will be undertaken.

(6.4.3) The monitoring method for the catalyst(s) shall be capable of detecting all instances, except diagnostic self-clearing, when a catalyst fault code has been cleared but the catalyst has not been replaced (e.g., catalyst overtemperature histogram approaches are not acceptable).

(7) **NOx ADSORBER MONITORING**

(7.1) Requirement: The OBD system shall monitor the NOx adsorber on engines so-equipped for proper performance. For engines equipped with active/intrusive injection (e.g., in-exhaust fuel and/or air injection) to achieve desorption of the NOx adsorber, the OBD system shall monitor the active/intrusive injection system for proper performance. The individual electronic components (e.g., injectors, valves, sensors) that are used in the active/intrusive injection system shall be monitored in accordance with the comprehensive component requirements in section (g)(4).

(7.2) Malfunction Criteria:

(7.2.1) NOx adsorber capability:

(A) For 2010 through 2012 model year engines, the OBD system shall detect a NOx adsorber system malfunction when the NOx adsorber capability decreases to the point that would cause an engine's NOx emissions to exceed any of the applicable standards by more than 0.3 g/bhp-hr (e.g., cause emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test (i.e., FTP or SET). If no failure or deterioration of the NOx adsorber capability could result in an engine's NOx emissions exceeding any of the applicable standards by more than 0.3 g/bhp-hr, the OBD system shall detect a malfunction when the system has no detectable amount of NOx adsorber capability.

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(B) For 2013 and subsequent model year engines, the OBD system shall detect a NOx adsorber system malfunction when the NOx adsorber capability decreases to the point that would cause an engine's NOx

emissions to exceed any of the applicable standards by more than 0.2 g/bhp-hr (e.g., cause emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test (i.e., FTP or SET). If no failure or deterioration of the NOx adsorber capability could result in an engine's NOx emissions exceeding any of the applicable standards by more than 0.2 g/bhp-hr, the OBD system shall detect a malfunction when the system has no detectable amount of NOx adsorber capability.

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(7.2.2) For systems that utilize active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve desorption of the NOx adsorber, the OBD system shall detect a malfunction if any failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve desorption of the NOx adsorber.

(7.2.3) Feedback control: Except as provided for in section (e)(7.2.4), if the engine is equipped with feedback control of the NOx adsorber or active/intrusive injection system (e.g., feedback control of injection quantity, time), the OBD system shall detect a malfunction:

(A) If the system fails to begin feedback control within a manufacturer specified time interval;

(B) If a failure or deterioration causes open loop or default operation; or

(C) If feedback control has used up all of the adjustment allowed by the manufacturer.

(7.2.4) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (e)(7.2.3)(C) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on an engine with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(7.2.5) In lieu of detecting the malfunctions specified in sections (e)(7.2.3)(A) and (B) with a NOx adsorber-specific monitor, the OBD system may monitor the individual parameters or components that are used as inputs for NOx adsorber or active/intrusive injection system feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (e)(7.2.3)(A) and (B).

(7.3) Monitoring Conditions:

(7.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(7.2.1) (i.e., adsorber capability) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(7.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(7.3.2) The OBD system shall monitor continuously for malfunctions identified in sections (e)(7.2.2) and (7.2.3) (e.g., injection function, feedback control).

(7.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(8) **PARTICULATE MATTER (PM) FILTER MONITORING**

(8.1) Requirement: The OBD system shall monitor the PM filter on engines so-equipped for proper performance. For engines equipped with active regeneration systems that utilize an active/intrusive injection (e.g., in-exhaust fuel injection, in-exhaust fuel/air burner), the OBD system shall monitor the active/intrusive injection system for proper performance. The individual electronic components (e.g., injectors, valves, sensors) that are used in the active/intrusive injection system shall be monitored in accordance with the comprehensive component requirements in section (g)(4).

(8.2) Malfunction Criteria:

(8.2.1) Filtering Performance:

(A) Except as specified in section (e)(8.2.1.)(B) below, for 2010 through 2015 model year engines, the OBD system shall detect a malfunction prior to a decrease in the filtering capability of the PM filter (e.g., cracking) that would cause an engine's PM emissions to exceed either of the following thresholds, whichever is higher: 0.05 g/bhp-hr as measured from an applicable emission test cycle (i.e., FTP or SET); or the applicable PM standard plus 0.04 g/bhp-hr (e.g., 0.05 g/bhp-hr if the emission standard is 0.01 g/bhp-hr). If no failure or deterioration of the PM filtering performance could result in an engine's PM emissions exceeding these levels, the OBD system shall detect a malfunction when no detectable amount of PM filtering occurs.

(B) For 2013 through 2015 model year engines subject to (d)(7.2.2)(A) and for all 2016 and subsequent model year engines, the OBD system shall detect a malfunction prior to a decrease in the filtering capability of the PM filter (e.g., cracking) that would cause an engine's PM emissions to exceed either of the following thresholds, whichever is higher: 0.03 g/bhp-hr as measured from an applicable emission test cycle (i.e., FTP or SET); or the applicable PM standard plus 0.02 g/bhp-hr (e.g., 0.03 g/bhp-hr if the emission standard is 0.01 g/bhp-hr). If no failure or deterioration of the PM filtering performance could result in an engine's PM emissions exceeding these levels, the OBD system shall detect a malfunction when no detectable amount of PM filtering occurs.

(8.2.2) Frequent Regeneration: The OBD system shall detect a malfunction when the PM filter regeneration frequency increases from (i.e., occurs more often than) the manufacturer's specified regeneration frequency to a level such that it would cause an engine's NMHC emissions to exceed 2.0 times the applicable standards. If no failure or deterioration causes an increase in the PM filter regeneration frequency that could result in an engine's NMHC emissions exceeding 2.0 times the applicable standards, the OBD system shall detect a malfunction when the PM filter regeneration frequency exceeds the manufacturer's specified design limits for allowable regeneration frequency.

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(8.2.3) Incomplete regeneration: The OBD system shall detect a regeneration malfunction when the PM filter does not properly regenerate under manufacturer-defined conditions where regeneration is designed to occur.

(8.2.4) NMHC conversion: For catalyzed PM filters that convert NMHC emissions, the OBD system shall monitor the catalyst function of the PM filter and detect a malfunction when the NMHC conversion capability decreases to the point that NMHC emissions exceed 2.0 times the applicable standards. If no failure or deterioration of the NMHC conversion capability could result in an engine's NMHC emissions exceeding 2.0 times the applicable standards, the OBD system shall detect a malfunction when the system has no detectable amount of NMHC conversion capability.

(8.2.5) Missing substrate: The OBD system shall detect a malfunction if either the PM filter substrate is completely destroyed, removed, or missing, or if the PM filter assembly is replaced with a muffler or straight pipe.

(8.2.6) Active/Intrusive Injection: For systems that utilize active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve regeneration of the PM filter, the OBD system shall detect a malfunction if any failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve regeneration of the PM filter.

(8.2.7) Feedback Control: Except as provided for in section (e)(8.2.8), if the engine is equipped with feedback control of the PM filter regeneration (e.g., feedback control of oxidation catalyst inlet temperature, PM filter inlet or outlet temperature, in-cylinder or in-exhaust fuel injection), the OBD system shall detect a malfunction:

(A) If the system fails to begin feedback control within a manufacturer specified time interval;

(B) If a failure or deterioration causes open loop or default operation; or

(C) If feedback control has used up all of the adjustment allowed by the manufacturer.

(8.2.8) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (e)(8.2.7)(C) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on an engine with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(8.2.9) In lieu of detecting the malfunctions specified in sections (e)(8.2.7)(A) and (B) with a PM filter-specific monitor, the OBD system may monitor the individual parameters or components that are used as inputs for PM filter regeneration feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (e)(8.2.7)(A) and (B).

(8.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(8.2.1) through (8.2.7) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are

met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(8.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(8.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(9) **EXHAUST GAS SENSOR MONITORING**

(9.1) Requirement:

(9.1.1) The OBD system shall monitor all exhaust gas sensors (e.g., oxygen, air-fuel ratio, NOx) used for emission control system feedback (e.g., EGR control/feedback, SCR control/feedback, NOx adsorber control/feedback) or as a monitoring device for proper output signal, activity, response rate, and any other parameter that can affect emissions.

(9.1.2) For engines equipped with heated exhaust gas sensors, the OBD system shall monitor the heater for proper performance.

(9.2) Malfunction Criteria:

(9.2.1) Air-Fuel Ratio Sensors:

(A) For sensors located upstream of the aftertreatment:

(i) Sensor performance faults: The OBD system shall detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's NMHC, CO, or NOx emissions to exceed 2.0 times any of the applicable standards or the engine's PM emissions to exceed any of the applicable standards plus 0.02 g/bhp-hr.

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(ii) Circuit faults: The OBD system shall detect malfunctions of the sensor caused by either a lack of circuit continuity or out-of-range values.

(iii) Feedback faults: The OBD system shall detect a malfunction of the sensor when a sensor failure or deterioration causes an emission control system (e.g., EGR, SCR, or NOx adsorber) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(iv) Monitoring capability: To the extent feasible, the OBD system shall detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(B) For sensors located downstream of the aftertreatment:

(i) Sensor performance faults:

a. For 2010 through 2012 model year engines, the OBD system shall detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's NMHC emissions to exceed 2.5 times any of the applicable standards, cause an engine's NOx emissions to exceed

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any of the applicable standards by more than 0.3 g/bhp-hr (e.g., cause emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test (i.e., FTP or SET), or cause an engine's PM emissions to exceed (whichever is higher): 0.05 g/bhp-hr as measured from an applicable cycle emission test (i.e., FTP or SET); or any of the applicable standards by more than 0.04 g/bhp-hr (e.g., cause emissions to exceed 0.05 g/bhp-hr if the emission standard is 0.01 g/bhp-hr).

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b. For 2013 and subsequent model year engines, the OBD system shall detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's NMHC emissions to exceed 2.0 times any of the applicable standards, cause an engine's NOx emissions to exceed any of the applicable standards by more than 0.2 g/bhp-hr (e.g., cause emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test (i.e., FTP or SET), or cause an engine's PM emissions to exceed (whichever is higher): 0.03 g/bhp-hr as measured from an applicable cycle emission test (i.e., FTP or SET); or any of the applicable standards by more than 0.02 g/bhp-hr (e.g., cause emissions to exceed 0.03 g/bhp-hr if the emission standard is 0.01 g/bhp-hr).

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(ii) Circuit faults: The OBD system shall detect malfunctions of the sensor caused by either a lack of circuit continuity or out-of-range values.

(iii) Feedback faults: The OBD system shall detect a malfunction of the sensor when a sensor failure or deterioration causes an emission control system (e.g., EGR, SCR, or NOx adsorber) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(iv) Monitoring capability: To the extent feasible, the OBD system shall detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(9.2.2) NOx sensors:

(A) Sensor performance faults:

(i) For 2010 through 2012 model year engines, the OBD system shall detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's NOx emissions to exceed any of the applicable standards by more than 0.3 g/bhp-hr (e.g., cause emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test (i.e., FTP or SET), or cause an engine's PM emissions to exceed (whichever is higher): 0.05 g/bhp-hr as measured from an

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applicable cycle emission test (i.e., FTP or SET); or any of the applicable standards by more than 0.04 g/bhp-hr (e.g., cause emissions to exceed 0.05 g/bhp-hr if the emission standard is 0.01 g/bhp-hr).

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(ii) For 2013 and subsequent model year engines, the OBD system shall detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's NOx emissions to exceed any of the applicable standards by more than 0.2 g/bhp-hr (e.g., cause emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test (i.e., FTP or SET), or cause an engine's PM emissions to exceed (whichever is higher): 0.03 g/bhp-hr as measured from an applicable cycle emission test (i.e., FTP or SET); or any of the applicable standards by more than 0.02 g/bhp-hr (e.g., cause emissions to exceed 0.03 g/bhp-hr if the emission standard is 0.01 g/bhp-hr).

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(B) Circuit faults: The OBD system shall detect malfunctions of the sensor caused by either a lack of circuit continuity or out-of-range values.

(C) Feedback faults: The OBD system shall detect a malfunction of the sensor when a sensor failure or deterioration causes an emission control system (e.g., EGR, SCR, or NOx adsorber) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(D) Monitoring capability: To the extent feasible, the OBD system shall detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(9.2.3) Other exhaust gas sensors:

(A) For other exhaust gas sensors, the manufacturer shall submit a monitoring plan to the Executive Officer for approval. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and an engineering evaluation that demonstrate that the monitoring plan is as reliable and effective as the monitoring plan required for air-fuel ratio sensors and NOx sensors under sections (e)(9.2.1) and (e)(9.2.2).

(9.2.4) Sensor Heaters:

(A) The OBD system shall detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Subject to Executive Officer approval, other malfunction criteria for heater performance malfunctions may be used upon the Executive Officer determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate the monitoring reliability and timeliness to be equivalent to the stated criteria in section (e)(9.2.4)(A).

(B) The OBD system shall detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

(9.3) Monitoring Conditions:

(9.3.1) Exhaust Gas Sensors

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(9.2.1)(A)(i), (9.2.1)(B)(i), and (9.2.2)(A) (e.g., sensor performance faults) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(9.2.1)(A)(i), (9.2.1)(B)(i), and (9.2.2)(A) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(B) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (9.2.1)(A)(iv), (9.2.1)(B)(iv), and (9.2.2)(D) (e.g., monitoring capability) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements) with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(C) Except as provided in section (e)(9.3.1)(D), monitoring for malfunctions identified in sections (e)(9.2.1)(A)(ii), (9.2.1)(A)(iii), (9.2.1)(B)(ii), (9.2.1)(B)(iii), (9.2.2)(B), and (9.2.2)(C) (i.e., circuit continuity, and open-loop malfunctions) shall be conducted continuously.

(D) A manufacturer may request Executive Officer approval to disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(9.3.2) Sensor Heaters

(A) Manufacturers shall define monitoring conditions for malfunctions identified in section (e)(9.2.4)(A) (i.e., sensor heater performance) in accordance sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Monitoring for malfunctions identified in section (e)(9.2.4)(B) (i.e., circuit malfunctions) shall be conducted continuously.

(9.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(f) MONITORING REQUIREMENTS FOR GASOLINE/SPARK-IGNITED ENGINES

(1) **FUEL SYSTEM MONITORING**

(1.1) Requirement: The OBD system shall monitor the fuel delivery system to determine its ability to provide compliance with emission standards.

(1.2) Malfunction Criteria:

(1.2.1) The OBD system shall detect a malfunction of the fuel delivery system (including feedback control based on a secondary oxygen sensor) when the fuel delivery system is unable to maintain an engine's emissions at or below 1.5 times the applicable standards.

(1.2.2) Except as provided for in section (f)(1.2.3) below, if the engine is equipped with adaptive feedback control, the OBD system shall detect a malfunction when the adaptive feedback control has used up all of the adjustment allowed by the manufacturer.

(1.2.3) If the engine is equipped with feedback control that is based on a secondary oxygen (or equivalent) sensor, the OBD system is not required to detect a malfunction of the fuel system solely when the feedback control based on a secondary oxygen sensor has used up all of the adjustment allowed by the manufacturer. However, if a failure or deterioration results in engine emissions that exceed the malfunction criteria in section (f)(1.2.1), the OBD system is required to detect a malfunction.

(1.2.4) The OBD system shall detect a malfunction whenever the fuel control system fails to enter closed-loop operation within an Executive Officer-approved time interval after engine start. Executive Officer approval of the time interval shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times.

(1.2.5) Manufacturers may adjust the malfunction criteria and/or monitoring conditions to compensate for changes in altitude, for temporary introduction of large amounts of purge vapor, or for other similar identifiable operating conditions when they occur.

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

(1.4) MIL Illumination and Fault Code Storage:

(1.4.1) A pending fault code shall be stored immediately upon the fuel system exceeding the malfunction criteria established pursuant to section (f)(1.2).

(1.4.2) Except as provided below, if a pending fault code is stored, the OBD system shall immediately illuminate the MIL and store a confirmed fault code if a malfunction is again detected during either of the following two events: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to those that occurred when the pending fault code was stored are encountered.

(1.4.3) The pending fault code may be erased at the end of the next driving cycle in which similar conditions have been encountered without an exceedance of the specified fuel system malfunction criteria. The pending code may also be erased if similar conditions are not encountered during the 80 driving cycles immediately after the initial detection of a malfunction for which the pending code was set.

(1.4.4) Storage of freeze frame conditions.

(A) The OBD system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing and erasing a confirmed fault code.

(B) If freeze frame conditions are stored for a malfunction other than a misfire (see section (f)(2)) or fuel system malfunction when a fault code is stored as specified in section (f)(1.4) above, the stored freeze frame information shall be replaced with freeze frame information regarding the fuel system malfunction.

(1.4.5) Storage of fuel system conditions for determining similar conditions of operation. Upon detection of a fuel system malfunction under section (f)(1.2), the OBD system shall store the engine speed, load, and warm-up status of the first fuel system malfunction that resulted in the storage of the pending fault code.

(1.4.6) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without a malfunction of the fuel system.

(2) **MISFIRE MONITORING**

(2.1) Requirement:

(2.1.1) The OBD system shall monitor the engine for misfire causing catalyst damage and misfire causing excess emissions.

(2.1.2) The OBD system shall identify the specific cylinder that is experiencing misfire. Manufacturers may request Executive Officer approval to store a general misfire fault code instead of a cylinder specific fault code under certain operating conditions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that the misfiring cylinder cannot be reliably identified when the conditions occur.

(2.1.3) If more than one cylinder is misfiring, a separate fault code shall be stored indicating that multiple cylinders are misfiring except as allowed below. When identifying multiple cylinder misfire, the OBD system is not required to also identify each of the misfiring cylinders individually through separate fault codes. If more than 90 percent of the detected misfires occur in a single cylinder, the OBD system may elect to store the appropriate fault code indicating the specific misfiring cylinder in lieu of the multiple cylinder misfire fault code. If, however, two or more cylinders individually have more than 10 percent of the total number of detected misfires, a multiple cylinder fault code must be stored.

(2.2) Malfunction Criteria: The OBD system shall detect a misfire malfunction pursuant to the following:

(2.2.1) Misfire causing catalyst damage:

(A) Manufacturers shall determine the percentage of misfire evaluated in 200 revolution increments for each engine speed and load condition that would result in a temperature that causes catalyst damage. The manufacturer shall submit documentation to support this percentage of misfire as required in section (j)(2.5). For every engine speed and load condition that this percentage of misfire is determined to be lower than

five percent, the manufacturer may set the malfunction criteria at five percent.

(B) Subject to Executive Officer approval, a manufacturer may employ a longer interval than 200 revolutions but only for determining, on a given driving cycle, the first misfire exceedance as provided in section (f)(2.4.1)(A) below. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that catalyst damage would not occur due to unacceptably high catalyst temperatures before the interval has elapsed.

(C) A misfire malfunction shall be detected if the percentage of misfire established in section (f)(2.2.1)(A) is exceeded.

(D) For purposes of establishing the temperature at which catalyst damage occurs as required in section (f)(2.2.1)(A), manufacturers may not define catalyst damage at a temperature more severe than what the catalyst system could be operated at for 10 consecutive hours and still meet the applicable standards.

(2.2.2) Misfire causing emissions to exceed 1.5 times the applicable standards:

(A) Manufacturers shall determine the percentage of misfire evaluated in 1000 revolution increments that would cause emissions from an emission durability demonstration engine to exceed 1.5 times any of the applicable standards if the percentage of misfire were present from the beginning of the test. To establish this percentage of misfire, the manufacturer shall utilize misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent.

(B) Subject to Executive Officer approval, a manufacturer may employ other revolution increments. The Executive Officer shall grant approval upon determining that the manufacturer has demonstrated that the strategy would be equally effective and timely in detecting misfire.

(C) A malfunction shall be detected if the percentage of misfire established in section (f)(2.2.2)(A) is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous).

(2.3) Monitoring Conditions:

(2.3.1) The OBD system shall continuously monitor for misfire under the following conditions:

(A) From no later than the end of the second crankshaft revolution after engine start,

(B) During the rise time and settling time for engine speed to reach the desired idle engine speed at engine start-up (i.e., “flare-up” and “flare-down”), and

(C) Under all positive torque engine speeds and load conditions except within the following range: the engine operating region bound by the positive torque line (i.e., engine load with the transmission in neutral), and the two following engine operating points: an engine speed of 3000 rpm with the engine load at the positive torque line, and the redline engine speed

(defined in section (c)) with the engine's manifold vacuum at four inches of mercury lower than that at the positive torque line.

(2.3.2) If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions as required in section (f)(2.3.1) above, the manufacturer may request Executive Officer approval to accept the monitoring system. In evaluating the manufacturer's request, the Executive Officer shall consider the following factors: the magnitude of the region(s) in which misfire detection is limited, the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events), the frequency with which said region(s) are expected to be encountered in-use, the type of misfire patterns for which misfire detection is troublesome, and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation shall be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders, single cylinder continuous misfire, and paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(2.3.3) A manufacturer may request Executive Officer approval of a monitoring system that has reduced misfire detection capability during the portion of the first 1000 revolutions after engine start that a cold start emission reduction strategy that reduces engine torque (e.g., spark retard strategies) is active. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated that the probability of detection is greater than or equal to 75 percent during the worst case condition (i.e., lowest generated torque) for a vehicle operated continuously at idle (park/neutral idle) on a cold start between 50 and 86 degrees Fahrenheit and that the technology cannot reliably detect a higher percentage of the misfire events during the conditions.

(2.3.4) A manufacturer may request Executive Officer approval to disable misfire monitoring or employ an alternate malfunction criterion when misfire cannot be distinguished from other effects.

(A) Upon determining that the manufacturer has presented documentation that demonstrates the disablement interval or period of use of an alternate malfunction criterion is limited only to that necessary for avoiding false detection, the Executive Officer shall approve the disablement or use of the alternate malfunction criterion for conditions involving:

(i) rough road,

(ii) fuel cut,

(iii) gear changes for manual transmission vehicles,

(iv) traction control or other vehicle stability control activation such as anti-lock braking or other engine torque modifications to enhance vehicle stability,

(v) off-board control or intrusive activation of vehicle components or diagnostics during service or assembly plant testing,

(vi) portions of intrusive evaporative system or EGR diagnostics that can significantly affect engine stability (i.e., while the purge valve is open during the vacuum pull-down of a evaporative system leak check but

not while the purge valve is closed and the evaporative system is sealed or while an EGR diagnostic causes the EGR valve to be intrusively cycled on and off during positive torque conditions), or

(vii) engine speed, load, or torque transients due to throttle movements more rapid than occurs over the FTP cycle for the worst case engine within each engine family.

(B) Additionally, the Executive Officer will approve a manufacturer's request in accordance with sections (g)(6.3), (g)(6.4), and (g)(6.6) to disable misfire monitoring when the fuel level is 15 percent or less of the nominal capacity of the fuel tank, when PTO units are active, or while engine coolant temperature is below 20 degrees Fahrenheit. The Executive Officer will approve a request to continue disablement on engine starts when engine coolant temperature is below 20 degrees Fahrenheit at engine start until engine coolant temperature exceeds 70 degrees Fahrenheit.

(C) In general, the Executive Officer shall not approve disablement for conditions involving normal air conditioning compressor cycling from on-to-off or off-to-on, automatic transmission gear shifts (except for shifts occurring during wide open throttle operation), transitions from idle to off-idle, normal engine speed or load changes that occur during the engine speed rise time and settling time (i.e., “flare-up” and “flare-down”) immediately after engine starting without any vehicle operator-induced actions (e.g., throttle stabs), or excess acceleration (except for acceleration rates that exceed the maximum acceleration rate obtainable at wide open throttle while the vehicle is in gear due to abnormal conditions such as slipping of a clutch).

(D) The Executive Officer may approve misfire monitoring disablement or use of an alternate malfunction criterion for any other condition on a case by case basis upon determining that the manufacturer has demonstrated that the request is based on an unusual or unforeseen circumstance and that it is applying the best available computer and monitoring technology.

(2.3.5) For engines with more than eight cylinders that cannot meet the requirements of section (f)(2.3.1), a manufacturer may request Executive Officer approval to use alternative misfire monitoring conditions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that misfire detection throughout the required operating region cannot be achieved when employing proven monitoring technology (i.e., a technology that provides for compliance with these requirements on other engines) and provided misfire is detected to the fullest extent permitted by the technology. However, the Executive Officer may not grant the request if the misfire detection system is unable to monitor during all positive torque operating conditions encountered during an FTP cycle.

(2.4) MIL Illumination and Fault Code Storage:

(2.4.1) Misfire causing catalyst damage. Upon detection of the percentage of misfire specified in section (f)(2.2.1) above, the following criteria shall apply for MIL illumination and fault code storage:

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(A) Pending fault codes

(i) A pending fault code shall be stored immediately if, during a single driving cycle, the specified percentage of misfire is exceeded three times when operating in the positive torque region encountered during an FTP cycle or is exceeded on a single occasion when operating at any other engine speed and load condition in the positive torque region defined in section (f)(2.3.1).

(ii) Immediately after a pending fault code is stored as specified in section (f)(2.4.1)(A)(i) above, the MIL shall blink once per second at all times while misfire is occurring during the driving cycle.

a. The MIL may be extinguished during those times when misfire is not occurring during the driving cycle.

b. If, at the time a misfire malfunction occurs, the MIL is already illuminated for a malfunction other than misfire, the MIL shall blink as previously specified in section (f)(2.4.1)(A)(ii) while misfire is occurring. If misfiring ceases, the MIL shall stop blinking but remain illuminated as required by the other malfunction.

(B) Confirmed fault codes

(i) If a pending fault code for exceeding the percentage of misfire set forth in section (f)(2.2.1) is stored, the OBD system shall immediately store a confirmed fault code if the percentage of misfire specified in section (f)(2.2.1) is again exceeded one or more times during either: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered.

(ii) If a pending fault code for exceeding the percentage of misfire set forth in section (f)(2.2.2) is stored from a previous driving cycle, the OBD system shall immediately store a confirmed fault code if the percentage of misfire specified in section (f)(2.2.1) is exceeded one or more times regardless of the conditions encountered.

(iii) Upon storage of a confirmed fault code, the MIL shall blink as specified in subparagraph (f)(2.4.1)(A)(ii) above as long as misfire is occurring and the MIL shall remain continuously illuminated if the misfiring ceases.

(C) Erasure of pending fault codes

Pending fault codes shall be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without any exceedance of the specified percentage of misfire. The pending code may also be erased if similar driving conditions are not encountered during the next 80 driving cycles subsequent to the initial detection of a malfunction.

(D) Exemptions for engines with fuel shutoff and default fuel control.

Notwithstanding sections (f)(2.4.1)(A) and (B) above, in engines that provide for fuel shutoff and default fuel control to prevent over fueling during catalyst damage misfire conditions, the MIL is not required to blink.

Instead, the MIL may illuminate continuously in accordance with the requirements for continuous MIL illumination in sections (f)(2.4.1)(B)(iii) above upon detection of misfire, provided that the fuel shutoff and default control are activated as soon as misfire is detected. Fuel shutoff and default fuel control may be deactivated only to permit fueling outside of the misfire range. Manufacturers may also periodically, but not more than once every 30 seconds, deactivate fuel shutoff and default fuel control to determine if the specified catalyst damage percentage of misfire is still being exceeded. Normal fueling and fuel control may be resumed if the specified catalyst damage percentage of misfire is no longer being exceeded.

(E) Manufacturers may request Executive Officer approval of strategies that continuously illuminate the MIL in lieu of blinking the MIL during extreme catalyst damage misfire conditions (i.e., catalyst damage misfire occurring at all engine speeds and loads). Executive Officer approval shall be granted upon determining that the manufacturer employs the strategy only when catalyst damage misfire levels cannot be avoided during reasonable driving conditions and the manufacturer has demonstrated that the strategy will encourage operation of the vehicle in conditions that will minimize catalyst damage (e.g., at low engine speeds and loads).

(2.4.2) Misfire causing emissions to exceed 1.5 times the FTP standards. Upon detection of the percentage of misfire specified in section (f)(2.2.2), the following criteria shall apply for MIL illumination and fault code storage:

(A) Misfire within the first 1000 revolutions after engine start.

(i) A pending fault code shall be stored no later than after the first exceedance of the specified percentage of misfire during a single driving cycle if the exceedance occurs within the first 1000 revolutions after engine start (defined in section (c)) during which misfire detection is active.

(ii) If a pending fault code is stored, the OBD system shall illuminate the MIL and store a confirmed fault code within 10 seconds if an exceedance of the specified percentage of misfire is again detected in the first 1000 revolutions during any subsequent driving cycle, regardless of the conditions encountered during the driving cycle.

(iii) The pending fault code shall be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without an exceedance of the specified percentage of misfire. The pending code may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following the initial detection of the malfunction.

(B) Exceedances after the first 1000 revolutions after engine start.

(i) A pending fault code shall be stored no later than after the fourth exceedance of the percentage of misfire specified in section (f)(2.2.2) during a single driving cycle.

(ii) If a pending fault code is stored, the OBD system shall illuminate the MIL and store a confirmed fault code within 10 seconds if the percentage of misfire specified in section (f)(2.2.2) is again exceeded

four times during: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered.

(iii) The pending fault code may be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without an exceedance of the specified percentage of misfire. The pending code may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following initial detection of the malfunction.

(2.4.3) Storage of freeze frame conditions.

(A) The OBD system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing and erasing a confirmed fault code.

(B) If freeze frame conditions are stored for a malfunction other than a misfire or fuel system malfunction (see section (f)(1)) when a fault code is stored as specified in section (f)(2.4) above, the stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction.

(2.4.4) Storage of misfire conditions for similar conditions determination. Upon detection of misfire under sections (f)(2.4.1) or (2.4.2), the OBD system shall store the following engine conditions: engine speed, load, and warm-up status of the first misfire event that resulted in the storage of the pending fault code.

(2.4.5) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

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

(3.1) Requirement: The OBD system shall monitor the EGR system on engines so-equipped for low and high flow rate malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the EGR system shall be monitored in accordance with the comprehensive component requirements in section (g)(4).

(3.2) Malfunction Criteria:

(3.2.1) The OBD system shall detect a malfunction of the EGR system prior to a decrease from the manufacturer's specified EGR flow rate that would cause an engine's emissions to exceed 1.5 times any of the applicable standards. For engines in which no failure or deterioration of the EGR system that causes a decrease in flow could result in an engine’s emissions exceeding 1.5 times any of the applicable standards, the OBD system shall detect a malfunction when the system has no detectable amount of EGR flow.

(3.2.2) The OBD system shall detect a malfunction of the EGR system prior to an increase from the manufacturer's specified EGR flow rate that would

cause an engine's emissions to exceed 1.5 times any of the applicable standards. For engines in which no failure or deterioration of the EGR system that causes an increase in flow could result in an engine's emissions exceeding 1.5 times any of the applicable standards, the OBD system shall detect a malfunction when the system has reached its control limits such that it cannot reduce EGR flow.

(3.3) Monitoring Conditions:

(3.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(3.2) (i.e., flow rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(3.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(3.3.2) Manufacturers may request Executive Officer approval to temporarily disable the EGR system check under conditions when monitoring may not be reliable (e.g., when freezing may affect performance of the system). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a reliable check cannot be made when these conditions exist.

(3.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(4) **COLD START EMISSION REDUCTION STRATEGY MONITORING**

(4.1) Requirement: If an engine incorporates a specific engine control strategy to reduce cold start emissions, the OBD system shall monitor the key components (e.g., idle air control valve), other than secondary air, while the control strategy is active to ensure proper operation of the control strategy. Secondary air systems shall be monitored under the provisions of section (f)(5).

(4.2) Malfunction Criteria:

(4.2.1) The OBD system shall detect a malfunction prior to any failure or deterioration of the individual components associated with the cold start emission reduction control strategy that would cause an engine's emissions to exceed 1.5 times the applicable standards. Manufacturers shall:

(A) Establish the malfunction criteria based on data from one or more representative engine(s).

(B) Provide an engineering evaluation for establishing the malfunction criteria for the remainder of the manufacturer's product line. The Executive Officer shall waive the evaluation requirement each year if, in the judgment of the Executive Officer, technological changes do not affect the previously determined malfunction criteria.

(4.2.2) For components where no failure or deterioration of the component used for the cold start emission reduction strategy could result in an engine's emissions exceeding 1.5 times the applicable standards, the individual component shall be monitored for proper functional response in

accordance with the malfunction criteria in section (g)(4.2) while the control strategy is active.

(4.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(4.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(4.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(5) **SECONDARY AIR SYSTEM MONITORING**

(5.1) Requirement:

(5.1.1) The OBD system on engines equipped with any form of secondary air delivery system shall monitor the proper functioning of the secondary air delivery system including all air switching valve(s). The individual electronic components (e.g., actuators, valves, sensors) in the secondary air system shall be monitored in accordance with the comprehensive component requirements in section (g)(4).

(5.1.2) For purposes of section (f)(5), “air flow” is defined as the air flow delivered by the secondary air system to the exhaust system. For engines using secondary air systems with multiple air flow paths/distribution points, the air flow to each bank (i.e., a group of cylinders that share a common exhaust manifold, catalyst, and control sensor) shall be monitored in accordance with the malfunction criteria in section (f)(5.2).

(5.1.3) For purposes of section (f)(5), “normal operation” is defined as the condition when the secondary air system is activated during catalyst and/or engine warm-up following engine start. “Normal operation” does not include the condition when the secondary air system is intrusively turned on solely for the purpose of monitoring.

(5.2) Malfunction Criteria:

(5.2.1) Except as provided in section (f)(5.2.3), the OBD system shall detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow during normal operation that would cause an engine's emissions to exceed 1.5 times any of the applicable standards.

(5.2.2) Except as provided in section (f)(5.2.3), the OBD system shall detect a secondary air system malfunction prior to an increase from the manufacturer's specified air flow during normal operation that would cause an engine's emissions to exceed 1.5 times any of the applicable standards.

(5.2.3) For engines in which no deterioration or failure of the secondary air system would result in an engine’s emissions exceeding 1.5 times any of the applicable standards, the OBD system shall detect a malfunction when no detectable amount of air flow is delivered during normal operation of the secondary air system.

(5.3) Monitoring Conditions:

(5.3.1) Manufacturers shall define the monitoring conditions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(5.2) during

normal operation of the secondary air system shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(5.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(6) **CATALYST MONITORING**

(6.1) Requirement: The OBD system shall monitor the catalyst system for proper conversion capability.

(6.2) Malfunction Criteria:

(6.2.1) The OBD system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that any of the following occurs:

(A) Non-Methane Hydrocarbon (NMHC) emissions exceed 1.75 times the applicable standards to which the engine has been certified.

(B) The average FTP test NMHC conversion efficiency of the monitored portion of the catalyst system falls below 50 percent (i.e., the cumulative NMHC emissions measured at the outlet of the monitored catalyst(s) are more than 50 percent of the cumulative engine-out emissions measured at the inlet of the catalyst(s)). With Executive Officer approval, manufacturers may use a conversion efficiency malfunction criteria of less than 50 percent if the catalyst system is designed such that the monitored portion of the catalyst system must be replaced along with an adjacent portion of the catalyst system sufficient to ensure that the total portion replaced will meet the 50 percent conversion efficiency criteria. Executive Officer approval shall be based on data and/or engineering evaluation demonstrating the conversion efficiency of the monitored portion and the total portion designed to be replaced, and the likelihood of the catalyst system design to ensure replacement of the monitored and adjacent portions of the catalyst system.

(C) Oxides of nitrogen (NOx) emissions exceed 1.75 times the applicable NOx standard to which the engine has been certified.

(6.2.2) For purposes of determining the catalyst system malfunction criteria in section (f)(6.2.1):

(A) The manufacturer shall use a catalyst system deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning operating conditions.

(B) Except as provided below in section (f)(6.2.2)(C), the malfunction criteria shall be established by using a catalyst system with all monitored and unmonitored (downstream of the sensor utilized for catalyst monitoring) catalysts simultaneously deteriorated to the malfunction criteria.

(C) For engines using fuel shutoff to prevent over-fueling during misfire conditions (see section (f)(2.4.1)(D)), the malfunction criteria shall be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the engine's useful life.

(6.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(6.2) in accordance with sections

(d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(6.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(6.4) MIL Illumination and Fault Code Storage:

(6.4.1) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(6.4.2) The monitoring method for the catalyst(s) shall be capable of detecting when a catalyst fault code has been cleared (except OBD system self-clearing), but the catalyst has not been replaced (e.g., catalyst overtemperature histogram approaches are not acceptable).

(7) **EVAPORATIVE SYSTEM MONITORING**

(7.1) Requirement: The OBD system shall verify purge flow from the evaporative system and shall monitor the complete evaporative system, excluding the tubing and connections between the purge valve and the intake manifold, for vapor leaks to the atmosphere. Individual components of the evaporative system (e.g. valves, sensors) shall be monitored in accordance with the comprehensive components requirements in section (g)(4) (e.g., for circuit continuity, out of range values, rationality, proper functional response).

(7.2) Malfunction Criteria:

(7.2.1) For purposes of section (f)(7), an “orifice” is defined as an O’Keefe Controls Co. precision metal “Type B” orifice with NPT connections with a diameter of the specified dimension (e.g., part number B-31-SS for a stainless steel 0.031 inch diameter orifice).

(7.2.2) The OBD system shall detect an evaporative system malfunction when any of the following conditions exist:

(A) No purge flow from the evaporative system to the engine can be detected by the OBD system; or

(B) The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.150 inch diameter orifice.

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(7.2.3) A manufacturer may request the Executive Officer to revise the orifice size in section (f)(7.2.2)(B) if the most reliable monitoring method available cannot reliably detect a system leak of the magnitudes specified. The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or engineering analysis that demonstrate the need for the request.

(7.2.4) Upon request by the manufacturer and upon determining that the manufacturer has submitted data and/or engineering evaluation which support the request, the Executive Officer shall revise the orifice size in section (f)(7.2.2)(B) upward to exclude detection of leaks that cannot cause evaporative or running loss emissions to exceed 1.5 times the applicable evaporative emission standards.

(7.3) Monitoring Conditions:

(7.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(7.2.2)(A) (i.e., purge flow) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(7.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(7.2.2)(B) (i.e., 0.150 inch leak detection) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(7.2.2)(B) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

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(7.3.3) Manufacturers may disable or abort an evaporative system monitor when the fuel tank level is over 85 percent of nominal tank capacity or during a refueling event.

(7.3.4) Manufacturers may request Executive Officer approval to execute the evaporative system monitor only on driving cycles determined by the manufacturer to be cold starts if the condition is needed to ensure reliable monitoring. The Executive Officer shall approve the request upon determining that data and/or an engineering evaluation submitted by the manufacturer demonstrate that a reliable check can only be made on driving cycles when the cold start criteria are satisfied. However, in making a decision, the Executive Officer will not approve conditions that exclude engine starts from being considered as cold starts solely on the basis that ambient temperature exceeds (i.e., indicates a higher temperature than) engine coolant temperature at engine start.

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(7.3.5) Manufacturers may temporarily disable the evaporative purge system to perform an evaporative system leak check.

(7.4) MIL Illumination and Fault Code Storage:

(7.4.1) Except as provided below for fuel cap leaks, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(7.4.2) If the OBD system is capable of discerning that a system leak is being caused by a missing or improperly secured fuel cap:

(A) The manufacturer is not required to illuminate the MIL or store a fault code if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The alternative indicator shall be of sufficient illumination and location to be readily visible under all lighting conditions.

(B) If the vehicle is not equipped with an alternative indicator and the MIL illuminates, the MIL may be extinguished and the corresponding fault codes erased once the OBD system has verified that the fuel cap has been securely fastened and the MIL has not been illuminated for any other type of malfunction.

(C) The Executive Officer may approve other strategies that provide equivalent assurance that a vehicle operator will be promptly notified of a missing or improperly secured fuel cap and that corrective action will be undertaken.

(8) EXHAUST GAS SENSOR MONITORING

(8.1) Requirement:

(8.1.1) The OBD system shall monitor the output signal, response rate, and any other parameter which can affect emissions of all primary (fuel control)

exhaust gas sensors (e.g., oxygen, wide-range air/fuel) for malfunction. Both the lean-to-rich and rich-to-lean response rates shall be monitored.

(8.1.2) The OBD system shall also monitor all secondary exhaust gas sensors (those used for secondary fuel trim control or as a monitoring device) for proper output signal, activity, and response rate.

(8.1.3) For engines equipped with heated exhaust gas sensors, the OBD system shall monitor the heater for proper performance.

(8.2) Malfunction Criteria:

(8.2.1) Primary Sensors:

(A) The OBD system shall detect a malfunction prior to any failure or deterioration of the exhaust gas sensor output voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) (including drift or bias corrected for by secondary sensors) that would cause an engine's emissions to exceed 1.5 times any of the applicable standards.

(B) The OBD system shall detect malfunctions of the exhaust gas sensor caused by either a lack of circuit continuity or out-of-range values.

(C) The OBD system shall detect a malfunction of the exhaust gas sensor when a sensor failure or deterioration causes the fuel system to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(D) The OBD system shall detect a malfunction of the exhaust gas sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst monitoring).

(8.2.2) Secondary Sensors:

(A) The OBD system shall detect a malfunction prior to any failure or deterioration of the exhaust gas sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed 1.5 times any of the applicable standards.

(B) The OBD system shall detect malfunctions of the exhaust gas sensor caused by a lack of circuit continuity.

(C) To the extent feasible, the OBD system shall detect a malfunction of the exhaust gas sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst monitoring).

(D) The OBD system shall detect malfunctions of the exhaust gas sensor caused by out-of-range values.

(E) The OBD system shall detect a malfunction of the exhaust gas sensor when a sensor failure or deterioration causes the fuel system (e.g., fuel control) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(8.2.3) Sensor Heaters:

(A) The OBD system shall detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the

criteria required to be met by the component vendor for heater circuit performance at high mileage). Subject to Executive Officer approval, other malfunction criteria for heater performance malfunctions may be used upon the Executive Officer determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate the monitoring reliability and timeliness to be equivalent to the stated criteria in section (f)(8.2.3)(A).

(B) The OBD system shall detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

(8.3) Monitoring Conditions:

(8.3.1) Primary Sensors

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(8.2.1)(A) and (D) (e.g., proper response rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (f)(8.2.1)(A) and (D) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(B) Except as provided in section (f)(8.3.1)(C), monitoring for malfunctions identified in sections (f)(8.2.1)(B) and (C) (i.e., circuit continuity, out-of-range, and open-loop malfunctions) shall be conducted continuously.

(C) A manufacturer may request Executive Officer approval to disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(8.3.2) Secondary Sensors

(A) Manufacturers shall define monitoring conditions for malfunctions identified in sections (f)(8.2.2)(A), (B), and (C) (e.g., proper sensor activity) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Except as provided in section (f)(8.3.2)(C), monitoring for malfunctions identified in sections (f)(8.2.2)(D) and (E) (i.e., out-of-range malfunctions) shall be conducted continuously.

(C) A manufacturer may request Executive Officer approval to disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(8.3.3) Sensor Heaters

(A) Manufacturers shall define monitoring conditions for malfunctions identified in section (f)(8.2.3)(A) (i.e., sensor heater performance) in accordance sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Monitoring for malfunctions identified in section (f)(8.2.3)(B) (i.e., circuit malfunctions) shall be conducted continuously.

(8.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(g) MONITORING REQUIREMENTS FOR ALL ENGINES

(1) **VARIABLE VALVE TIMING AND/OR CONTROL (VVT) SYSTEM MONITORING**

(1.1) Requirement: The OBD system shall monitor the VVT system on engines so-equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the VVT system shall be monitored in accordance with the comprehensive components requirements in section (g)(4).

(1.2) Malfunction Criteria:

(1.2.1) Target Error: The OBD system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause:

(A) an engine's NHMC, NOx, or CO emissions to exceed 2.0 times any of the applicable standards or an engine's PM emissions to exceed a threshold of the applicable PM standard plus 0.02 g/bhp-hr for diesel engines, or

(B) an engine's emissions to exceed 1.5 times any of the applicable standards for gasoline engines.

(1.2.2) Slow Response: The OBD system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a manufacturer-specified time that would cause:

(A) an engine's NHMC, NOx, or CO emissions to exceed 2.0 times any of the applicable standards or an engine's PM emissions to exceed a threshold of the applicable PM standard plus 0.02 g/bhp-hr for diesel engines, or

(B) an engine's emissions to exceed 1.5 times any of the applicable standards for gasoline engines.

(1.2.3) For engines in which no failure or deterioration of the VVT system could result in an engine's emissions exceeding the thresholds of sections (g)(1.2.1) or (1.2.2), the OBD system shall detect a malfunction of the VVT system when proper functional response of the system to computer commands does not occur.

(1.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for VVT system malfunctions identified in section (g)(1.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in

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section (g)(1.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(1.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(2) **ENGINE COOLING SYSTEM MONITORING**

(2.1) Requirement:

(2.1.1) The OBD system shall monitor the thermostat on engines so-equipped for proper operation.

(2.1.2) The OBD system shall monitor the engine coolant temperature (ECT) sensor for circuit continuity, out-of-range values, and rationality faults.

(2.1.3) For engines that use a system other than the cooling system and ECT sensor (e.g., oil temperature, cylinder head temperature) for an indication of engine operating temperature for emission control purposes (e.g., to modify spark or fuel injection timing or quantity), the manufacturer shall submit a monitoring plan to the Executive Officer for approval. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and an engineering evaluation that demonstrate that the monitoring plan is as reliable and effective as the monitoring required for the engine cooling system under section (g)(2).

(2.2) Malfunction Criteria:

(2.2.1) Thermostat

(A) The OBD system shall detect a thermostat malfunction if, within an Executive Officer-approved time interval after engine start, any of the following conditions occur:

(i) The coolant temperature does not reach the highest temperature required by the OBD system to enable other diagnostics;

(ii) The coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit of the manufacturer's nominal thermostat regulating temperature. Subject to Executive Officer approval, a manufacturer may utilize lower temperatures for this criterion upon the Executive Officer determining that the manufacturer has demonstrated 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).

(B) Executive Officer approval of the time interval after engine start shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times.

(C) With Executive Officer approval, a manufacturer may use alternate malfunction criteria and/or monitoring conditions (see section (g)(2.3)) that are a function of temperature at engine start on engines that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data that demonstrate that a properly operating system does not reach the specified temperatures and that the possibility for cooling system malfunctions to go

undetected and disable other OBD monitors is minimized to the extent technically feasible.

(D) A manufacturer may request Executive Officer approval to be exempted from the requirements of thermostat monitoring. Executive Officer approval shall be granted upon determining that the manufacturer has demonstrated that a malfunctioning thermostat cannot cause a measurable increase in emissions during any reasonable driving condition nor cause any disablement of other monitors.

(2.2.2) ECT Sensor

(A) Circuit Continuity. The OBD system shall detect a malfunction when a lack of circuit continuity or out-of-range values occur.

(B) Time to Reach Closed-Loop/Feedback Enable Temperature.

(i) The OBD system shall detect a malfunction if the ECT sensor does not achieve the highest stabilized minimum temperature which is needed for closed-loop/feedback control of all emission control systems (e.g., fuel system, EGR system) within an Executive Officer-approved time interval after engine start.

(ii) The time interval shall be a function of starting ECT and/or a function of intake air temperature. Executive Officer approval of the time interval shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times.

(iii) Manufacturers are exempted from the requirements of section (g)(2.2.2)(B) if the manufacturer does not utilize ECT to enable closed-loop/feedback control of any emission control system.

(C) Stuck in Range Below the Highest Minimum Enable Temperature. To the extent feasible when using all available information, the OBD system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD system to enable other diagnostics (e.g., an OBD system that requires ECT to be greater than 140 degrees Fahrenheit to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature below 140 degrees Fahrenheit). Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (g)(2.2.1) or (g)(2.2.2)(B) will detect ECT sensor malfunctions as defined in section (g)(2.2.2)(C).

(D) Stuck in Range Above the Lowest Maximum Enable Temperature.

(i) To the extent feasible when using all available information, the OBD system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD system to enable other diagnostics (e.g., an OBD system that requires ECT to be less than 90 degrees Fahrenheit at engine start to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature above 90 degrees Fahrenheit).

(ii) Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (g)(2.2.1),

(g)(2.2.2)(B), or (g)(2.2.2)(C) (i.e., ECT sensor or thermostat malfunctions) will detect ECT sensor malfunctions as defined in section (g)(2.2.2)(D) or in which the MIL will be illuminated under the requirements of sections (d)(2.2.1)(E) or (d)(2.2.2)(E) for default mode operation (e.g., overtemperature protection strategies).

(iii) Manufacturers are exempted from the requirements of section (g)(2.2.2)(D) for temperature regions where the temperature gauge indicates a temperature in the red zone (engine overheating zone) for vehicles that have a temperature gauge (not a warning light) on the instrument panel and utilize the same ECT sensor for input to the OBD system and the temperature gauge.

(2.3) Monitoring Conditions:

(2.3.1) Thermostat

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(A) Manufacturers shall define the monitoring conditions for malfunctions identified in section (g)(2.2.1)(A) in accordance with section (d)(3.1). Additionally, except as provided for in sections (g)(2.3.1)(B) and (C), monitoring for malfunctions identified in section (g)(2.2.1)(A) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in section (g)(2.2.1)(A).

(B) Manufacturers may disable thermostat monitoring at ambient engine start temperatures below 20 degrees Fahrenheit.

(C) Manufacturers may request Executive Officer approval to suspend or disable thermostat monitoring if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 percent of the warm-up time, hot restart conditions). In general, the Executive Officer shall not approve disablement of the monitor on engine starts where the ECT at engine start is more than 35 degrees Fahrenheit lower than the thermostat malfunction threshold temperature determined under section (g)(2.2.1)(A). The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or engineering analysis that demonstrate the need for the request.

(2.3.2) ECT Sensor

(A) Except as provided below in section (g)(2.3.2)(E), monitoring for malfunctions identified in section (g)(2.2.2)(A) (i.e., circuit continuity and out-of-range) shall be conducted continuously.

(B) Manufacturers shall define the monitoring conditions for malfunctions identified in section (g)(2.2.2)(B) in accordance with section (d)(3.1). Additionally, except as provided for in section (g)(2.3.2)(D), monitoring for malfunctions identified in section (g)(2.2.2)(B) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates a temperature lower than the closed-loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out-of-range low temperature and less than the closed-loop enable temperature).

(C) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (g)(2.2.2)(C) and (D) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(D) Manufacturers may suspend or delay the time to reach closed-loop enable temperature diagnostic if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time).

(E) A manufacturer may request Executive Officer approval to disable continuous ECT sensor monitoring when an ECT sensor malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or engineering evaluation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(2.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(3) **CRANKCASE VENTILATION (CV) SYSTEM MONITORING**

(3.1) Requirement:

(3.1.1) The OBD system shall monitor the CV system on engines so-equipped for system integrity. Engines not required to be equipped with CV systems shall be exempt from monitoring of the CV system.

(3.1.2) For diesel engines, the manufacturer shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to OBD certification. Executive Officer approval shall be based on the effectiveness of the monitoring strategy to monitor the performance of the CV system to the extent feasible with respect to the malfunction criteria in section (g)(3.2) below and the monitoring conditions required by the diagnostic.

(3.2) Malfunction Criteria:

(3.2.1) For the purposes of section (g)(3), “CV system” is defined as any form of crankcase ventilation system, regardless of whether it utilizes positive pressure. “CV valve” is defined as any form of valve or orifice used to restrict or control crankcase vapor flow. Further, any additional external CV system tubing or hoses used to equalize crankcase pressure or to provide a ventilation path between various areas of the engine (e.g., crankcase and valve cover) are considered part of the CV system “between the crankcase and the CV valve” and subject to the malfunction criteria in section (g)(3.2.2) below.

(3.2.2) Except as provided below, the OBD system shall detect a malfunction of the CV system when a disconnection of the system occurs between either the crankcase and the CV valve, or between the CV valve and the intake manifold.

(3.2.3) The Executive Officer shall exempt a manufacturer from detecting a disconnection between the crankcase and the CV valve upon determining that the CV system is designed such that the CV 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 manufacturer shall file a request and submit data and/or engineering evaluation in support of the exemption.

(3.2.4) The Executive Officer shall exempt a manufacturer from detecting a disconnection between the crankcase and the CV valve for system designs that utilize tubing between the valve and the crankcase upon determining that the connections between the valve and the crankcase are: (1) resistant to deterioration or accidental disconnection, (2) significantly more difficult to disconnect than the line between the valve and the intake manifold, and (3) not subject to disconnection per manufacturer's repair procedures for non-CV system repair work. The manufacturer shall file a request and submit data and/or engineering evaluation in support of the exemption.

(3.2.5) The Executive Officer shall exempt a manufacturer from detecting a disconnection between the CV valve and the intake manifold upon determining that the disconnection (1) causes the vehicle to stall immediately during idle operation; or (2) is unlikely to occur due to a CV system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses). The manufacturer shall file a request and submit data and/or engineering evaluation in support of the exemption.

(3.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (g)(3.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(3.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2). The stored fault code need not specifically identify the CV system (e.g., a fault code for idle speed control or fuel system monitoring can be stored) if the manufacturer demonstrates that additional monitoring hardware would be necessary to make this identification, and provided the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the CV system.

(4) **COMPREHENSIVE COMPONENT MONITORING**

(4.1) Requirement:

(4.1.1) Except as provided in section (g)(5), the OBD system shall monitor for malfunction any electronic engine component/system not otherwise described in sections (e)(1) through (g)(3) that either provides input to (directly or indirectly) or receives commands from the on-board computer(s), and: (1) can affect emissions during any reasonable in-use driving condition, or (2) is used as part of the diagnostic strategy for any other monitored system or component.

(A) Input Components: Input components required to be monitored may include the crank angle sensor, knock sensor, throttle position sensor, cam position sensor, intake air temperature sensor, boost pressure sensor, manifold pressure sensor, mass air flow sensor, exhaust temperature sensor, exhaust pressure sensor, fuel pressure sensor, fuel

composition sensor (e.g. flexible fuel vehicles), and electronic components used to comply with any applicable engine idling requirements of title 13, CCR section 1956.8.

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(B) Output Components/Systems: Output components/systems required to be monitored may include the idle speed control system, glow plug system, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, the wait-to-start lamp on diesel applications, and the MIL.

(4.1.2) For purposes of criteria (1) in section (g)(4.1.1) above, the manufacturer shall determine whether an engine input or output component/system can affect emissions. If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system cannot affect emissions, the Executive Officer shall require the manufacturer to provide emission data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an emission effect. Emission data may be requested for any reasonable driving condition.

(4.1.3) For purposes of section (g)(4), ”electronic engine components/systems” does not include components that are driven by the engine and are not related to the control of the fueling, air handling, or emissions of the engine (e.g., PTO components, air conditioning system components, and power steering components).

(4.2) Malfunction Criteria:

(4.2.1) Input Components:

(A) The OBD system shall detect malfunctions of input components caused by a lack of circuit continuity, out-of-range values, and, where feasible, rationality faults. To the extent feasible, the rationality fault diagnostics shall verify that a sensor output is neither inappropriately high nor inappropriately low (i.e., shall be “two-sided” diagnostics).

(B) To the extent feasible, the OBD system shall separately detect and store different fault codes that distinguish rationality faults from lack of circuit continuity and out-of-range faults. For input component lack of circuit continuity and out-of-range faults, the OBD system shall, to the extent feasible, separately detect and store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit). The OBD system is not required to store separate fault codes for lack of circuit continuity faults that cannot be distinguished from other out-of-range circuit faults.

(C) For input components that are used to activate alternate strategies that can affect emissions (e.g., AECDs, engine shutdown systems or strategies to meet NOx idling standards required by title 13, CCR section 1956.8), the OBD system shall detect rationality malfunctions that cause the system to erroneously activate or deactivate the alternate strategy. To the extent feasible when using all available information, the rationality fault diagnostics shall detect a malfunction if the input component inappropriately indicates a value that activates or deactivates the alternate strategy. For example, if an alternate strategy requires the intake air temperature to be greater than 120 degrees Fahrenheit to activate, the

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OBD system shall detect malfunctions that cause the intake air temperature sensor to inappropriately indicate a temperature above 120 degrees Fahrenheit.

(D) For engines that require precise alignment between the camshaft and the crankshaft, the OBD system shall monitor the crankshaft position sensor(s) and camshaft position sensor(s) to verify proper alignment between the camshaft and crankshaft in addition to monitoring the sensors for circuit continuity and rationality malfunctions. Proper alignment monitoring between a camshaft and a crankshaft shall only be required in cases where both are equipped with position sensors. For engines equipped with VVT systems and a timing belt or chain, the OBD system shall detect a malfunction if the alignment between the camshaft and crankshaft is off by one or more cam/crank sprocket cogs (e.g., the timing belt/chain has slipped by one or more teeth/cogs). If a manufacturer demonstrates that a single tooth/cog misalignment cannot cause a measurable increase in emissions during any reasonable driving condition, the OBD system shall detect a malfunction when the minimum number of teeth/cogs misalignment needed to cause a measurable emission increase has occurred.

(4.2.2) Output Components/Systems:

(A) The OBD system shall detect a malfunction of an output component/system when proper functional response of the component and system to computer commands does not occur. If a functional check is not feasible, the OBD system shall detect malfunctions of output components/systems caused by a lack of circuit continuity or circuit fault (e.g., short to ground or high voltage). For output component lack of circuit continuity faults and circuit faults, the OBD system is not required to store different fault codes for each distinct malfunction (e.g., open circuit, shorted low). Manufacturers are not required to activate an output component/system when it would not normally be active exclusively for the purposes of performing functional monitoring of output components/systems as required in section (g)(4).

(B) The idle control system shall be monitored for proper functional response to computer commands.

(i) For gasoline engines using monitoring strategies based on deviation from target idle speed, a malfunction shall be detected when either of the following conditions occur:

a. The idle speed control system cannot achieve the target idle speed within 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed. The Executive Officer shall allow larger engine speed tolerances upon determining that a manufacturer has submitted data and/or an engineering evaluation which demonstrate that the tolerances can be exceeded without a malfunction being present.

b. The idle speed control system cannot achieve the target idle speed within the smallest engine speed tolerance range required by the OBD system to enable any other monitors.

(ii) For diesel engines, a malfunction shall be detected when either of the

following conditions occur:

a. The idle fuel control system cannot achieve the target idle speed or fuel injection quantity within +/-50 percent of the manufacturer-specified fuel quantity and engine speed tolerances.

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b. The idle fuel control system cannot achieve the target idle speed or fueling quantity within the smallest engine speed or fueling quantity tolerance range required by the OBD system to enable any other monitors.

(C) Glow plugs/intake air heater systems shall be monitored for proper functional response to computer commands and for circuit continuity faults. The glow plug/intake air heater circuit(s) shall be monitored for proper current and voltage drop. The Executive Officer shall approve other monitoring strategies based on manufacturer's data and/or engineering analysis demonstrating equally reliable and timely detection of malfunctions. Except as provided below, the OBD system shall detect a malfunction when a single glow plug no longer operates within the manufacturer's specified limits for normal operation. If a manufacturer demonstrates that a single glow plug failure cannot cause a measurable increase in emissions during any reasonable driving condition, the OBD system shall detect a malfunction for the minimum number of glow plugs needed to cause an emission increase. Further, to the extent feasible on existing engine designs (without adding additional hardware for this purpose) and on all new design engines, the stored fault code shall identify the specific malfunctioning glow plug(s).

(D) The wait-to-start lamp circuit and the MIL circuit shall be monitored for malfunctions that cause either lamp to fail to illuminate when commanded on (e.g., burned out bulb).

(4.3) Monitoring Conditions:

(4.3.1) Input Components:

(A) Except as provided in section (g)(4.3.1)(C), input components shall be monitored continuously for proper range of values and circuit continuity.

(B) For rationality monitoring (where applicable) manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that rationality monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(C) A manufacturer may request Executive Officer approval to disable continuous input component proper range of values or circuit continuity monitoring when a malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning input component cannot be distinguished from a malfunctioning input component and that the disablement interval is limited only to that necessary for avoiding false detection.

(4.3.2) Output Components/Systems:

(A) Except as provided in section (g)(4.3.2)(D), monitoring for circuit continuity and circuit faults shall be conducted continuously.

(B) Except as provided in section (g)(4.3.2)(C), for functional monitoring, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(C) For the idle control system, manufacturers shall define the monitoring conditions for functional monitoring in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that functional monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(D) A manufacturer may request Executive Officer approval to disable continuous output component circuit continuity or circuit fault monitoring when a malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning output component cannot be distinguished from a malfunctioning output component and that the disablement interval is limited only to that necessary for avoiding false detection.

(4.4) MIL Illumination and Fault Code Storage:

(4.4.1) Except as provided in sections (g)(4.4.2) and (4.4.3) below, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(4.4.2) Exceptions to general requirements for MIL illumination. MIL illumination is not required in conjunction with storing a confirmed or active fault code for any comprehensive component if:

(A) the component or system, when malfunctioning, could not cause engine emissions to increase by 15 percent or more of the FTP standard during any reasonable driving condition; and

(B) the component or system is not used as part of the diagnostic strategy for any other monitored system or component.

(4.4.3) Exceptions for MIL circuit faults. MIL illumination is not required if a malfunction in the MIL circuit that prevents the MIL from illuminating (e.g., burned out bulb or LED) has been detected. However, the electronic MIL status (see section (h)(4.2)) shall be reported as MIL commanded-on and a confirmed or active fault code (see section (h)(4.4)) shall be stored.

(5) **OTHER EMISSION CONTROL SYSTEM MONITORING**

(5.1) Requirement: For other emission control systems that are: (1) not identified or addressed in sections (e)(1) through (g)(4) (e.g., hydrocarbon traps, HCCI control systems), or (2) identified or addressed in section (g)(4) but not corrected or compensated for by an adaptive control system (e.g., swirl control valves), manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production engine. Executive Officer approval shall be based on the effectiveness of the monitoring strategy, the

malfunction criteria utilized, the monitoring conditions required by the diagnostic, and, if applicable, the determination that the requirements of section (g)(5.2) below are satisfied.

(5.2) For engines that utilize emission control systems that alter intake air flow or cylinder charge characteristics by actuating valve(s), flap(s), etc. in the intake air delivery system (e.g., swirl control valve systems), the manufacturers, in addition to meeting the requirements of section (g)(5.1) above, may elect to have the OBD system monitor the shaft to which all valves in one intake bank are physically attached in lieu of monitoring the intake air flow, cylinder charge, or individual valve(s)/flap(s) for proper functional response. For non-metal shafts or segmented shafts, the monitor shall verify all shaft segments for proper functional response (e.g., by verifying the segment or portion of the shaft furthest from the actuator properly functions). For systems that have more than one shaft to operate valves in multiple intake banks, manufacturers are not required to add more than one set of detection hardware (e.g., sensor, switch) per intake bank to meet this requirement.

(6) **EXCEPTIONS TO MONITORING REQUIREMENTS**

(6.1) Upon request of a manufacturer or upon the best engineering judgment of the ARB, the Executive Officer may revise the emission threshold for any monitor in sections (e) through (g) or revise the PM filter malfunction criteria of section (e)(8.2.1) to exclude detection of specific failure modes (e.g., partially melted substrates) if the most reliable monitoring method developed requires a higher threshold (or, in the case of section (e)(8.2.1), the exclusion of specific failure modes) to prevent significant errors of commission in detecting a malfunction.

(6.2) For 2010 through 2012 model year diesel engines, in determining the malfunction criteria for diesel engine monitors in sections (e)(1), (3), (4), (5), (8.2.2), (8.2.4), and (9.2.1)(A) that are required to indicate a malfunction before NMHC, CO, or NOx emissions exceed 2.0 times any of the applicable standards, the manufacturer shall use a malfunction criteria of 2.5 times any of the applicable standards in lieu of 2.0 times any of the applicable standards.

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(6.3) Manufacturers may request Executive Officer approval to disable an OBD system monitor at ambient engine start temperatures below 20 degrees Fahrenheit (low ambient temperature conditions may be determined based on intake air or engine coolant temperature at engine start) or at elevations above 8000 feet above sea level. The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or an engineering evaluation that demonstrate that monitoring during the conditions would be unreliable. A manufacturer may further request, and the Executive Officer shall approve, that an OBD system monitor be disabled at other ambient engine start temperatures upon determining that the manufacturer has demonstrated with data and/or an engineering evaluation that misdiagnosis would occur at the ambient temperatures because of its effect on the component itself (e.g., component freezing).

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(6.4) Manufacturers may request Executive Officer approval to disable monitoring systems that can be affected by low fuel level or running out of fuel (e.g.,

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misfire detection) when the fuel level is 15 percent or less of the nominal capacity of the fuel tank. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring at the fuel levels would be unreliable and the OBD system is able to detect a malfunction if the component(s) used to determine fuel level erroneously indicates a fuel level that causes the disablement.

(6.5) Manufacturers may disable monitoring systems that can be affected by vehicle battery or system voltage levels.

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(6.5.1) For monitoring systems affected by low vehicle battery or system voltages, manufacturers may disable monitoring systems when the battery or system voltage is below 11.0 Volts. Manufacturers may request Executive Officer approval to utilize a voltage threshold higher than 11.0 Volts to disable system monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring at the voltages would be unreliable and that either operation of a vehicle below the disablement criteria for extended periods of time is unlikely or the OBD system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

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(6.5.2) For monitoring systems affected by high vehicle battery or system voltages, manufacturers may request Executive Officer approval to disable monitoring systems when the battery or system voltage exceeds a manufacturer-defined voltage. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring above the manufacturer-defined voltage would be unreliable and that either the electrical charging system/alternator warning light is illuminated (or voltage gauge is in the “red zone”) or the OBD system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

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(6.6) A manufacturer may disable affected monitoring systems in vehicles designed to accommodate the installation of PTO units (as defined in section (c)), provided disablement occurs only while the PTO unit is active, and the OBD readiness status is cleared by the on-board computer (i.e., all monitors set to indicate “not complete”) while the PTO unit is activated (see section (h)(4.1) below). If the disablement occurs, the readiness status may be restored to its state prior to PTO activation when the disablement ends.

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(h) STANDARDIZATION REQUIREMENTS

(1) **Reference Documents:**

The following Society of Automotive Engineers (SAE) and International Organization of Standards (ISO) documents are incorporated by reference into this regulation:

(1.1) SAE J1930 "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms – Equivalent to ISO/TR 15031-2:April 30, 2002", April 2002 (SAE J1930).

(1.2) SAE J1962 "Diagnostic Connector – Equivalent to ISO/DIS 15031-3:

December 14, 2001", April 2002 (SAE J1962).

(1.3) SAE J1978 "OBD II Scan Tool – Equivalent to ISO/DIS 15031-4: December 14, 2001", April 2002 (SAE J1978).

(1.4) SAE J1979 "E/E Diagnostic Test Modes – Equivalent to ISO/DIS 15031-5:April 30, 2002", April 2002 (SAE J1979).

(1.5) SAE J2012 "Diagnostic Trouble Code Definitions – Equivalent to ISO/DIS 15031-6:April 30, 2002", April 2002 (SAE J2012).

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

(1.7) SAE J1939 APR00-"Recommended Practice for a Serial Control and Communications Vehicle Network" and the associated subparts included in SAE HS-1939, "Truck and Bus Control and Communications Network Standards Manual", 2001 Edition (SAE J1939).

(1.8) SAE J2403 "Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature," August 2004 (SAE J2403).

(2) **Diagnostic Connector:**

A standard data link connector conforming to SAE J1962 or SAE J1939-13 specifications (except as specified in section (h)(2.3)) shall be incorporated in each vehicle.

(2.1) The connector shall be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the center console (or the vehicle centerline if the vehicle does not have a center console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position. The connector may not be located on or in the center console (i.e., neither on the horizontal faces near the floor-mounted gear selector, parking brake lever, or cup-holders nor on the vertical faces near the car stereo, climate system, or navigation system controls). The location of the connector shall be capable of being easily identified and accessed (e.g., to connect an off-board tool) by a technician standing (or "crouched") on the ground outside the driver's side of the vehicle with the driver's side door open.

(2.2) If the connector is covered, the cover must be removable by hand without the use of any tools and be labeled "OBD" to aid technicians in identifying the location of the connector. Access to the diagnostic connector may not require opening or the removal of any storage accessory (e.g., ashtray, coinbox). The label shall be submitted to the Executive Officer for review and approval, at or before the time the manufacturer submits its certification application. The Executive Officer shall approve the label upon determining that it clearly identifies that the connector is located behind the cover and is consistent with language and/or symbols commonly used in the automotive industry.

(2.3) If the ISO 15765-4 protocol (see section (h)(3)) is used for the required OBD standardized functions, the connector shall meet the "Type A" specifications of SAE J1962. Any pins in the connector that provide electrical power shall be properly fused to protect the integrity and usefulness of the connector for

diagnostic purposes and may not exceed 20.0 Volts DC regardless of the nominal vehicle system or battery voltage (e.g., 12V, 24V, 42V).

(2.4) If the SAE J1939 protocol (see section (h)(3)) is used for the required OBD standardized functions, the connector shall meet the specifications of SAE J1939-13. Any pins in the connector that provide electrical power shall be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes.

(2.5) Manufacturers may equip vehicles with additional diagnostic connectors for manufacturer-specific purposes (i.e., purposes other than the required OBD functions). However, if the additional connector conforms to the "Type A" specifications of SAE J1962 or the specifications of SAE J1939-13 and is located in the vehicle interior near the required connector of section (h)(2.3) or (2.4), the connector(s) must be clearly labeled to identify which connector is used to access the standardized OBD information required in section (h).

(3) **Communications to a Scan Tool:**

All OBD control modules (e.g., engine, auxiliary emission control module) on a single vehicle shall use the same protocol for communication of required emission-related messages from on-board to off-board network communications to a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network. Engine manufacturers shall not alter normal operation of the engine emission control system due to the presence of off-board test equipment accessing information required by section (h). The OBD system shall use one of the following standardized protocols:

(3.1) ISO 15765-4. All required emission-related messages using this protocol shall use a 500 kbps baud rate.

(3.2) SAE J1939. This protocol may only be used on vehicles with diesel engines.

(4) **Required Emission Related Functions:**

The following standardized functions shall be implemented in accordance with the specifications in SAE J1979 or SAE J1939 to allow for access to the required information by a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network:

(4.1) Readiness Status: In accordance with SAE J1979/J1939-73 specifications, the OBD system shall indicate "complete" or "not complete" for each of the installed monitored components and systems identified in sections (e)(1) through (f)(8), (g)(1), and (g)(4) except (f)(4). All components or systems identified in (f)(1), (f)(2), or (g)(4) that are monitored continuously shall always indicate "complete". Components or systems that are not subject to continuous monitoring shall immediately indicate "complete" upon the respective diagnostic(s) being fully executed and determining that the component or system is not malfunctioning. A component or system shall also indicate "complete" if after the requisite number of decisions necessary for determining MIL status has been fully executed, the monitor indicates a malfunction for the component or system. The status for each of the monitored components or systems shall indicate "not complete" whenever fault memory has been cleared or erased by a means other than that allowed

in section (d)(2). Normal vehicle shut down (i.e., key off, engine off) may not cause the status to indicate “not complete”.

(4.1.1) Subject to Executive Officer approval, a manufacturer may request that the readiness status for a monitor be set to indicate “complete” without monitoring having been completed 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). Executive Officer approval shall be based on the conditions for monitoring system disablement and the number of driving cycles specified without completion of monitoring before readiness is indicated as “complete”.

(4.1.2) For the evaporative system monitor, the readiness status shall be set in accordance with section (h)(4.1) when both the functional check of the purge valve and, if applicable, the leak detection monitor of the orifice size specified in section (f)(7.2.2)(B) (e.g., 0.150 inch) indicate that they are complete.

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(4.1.3) If the manufacturer elects to additionally indicate readiness status through the MIL in the key on, engine off position as provided for in section (d)(2.1.3), the readiness status shall be indicated in the following manner: If the readiness status for all monitored components or systems is “complete”, the MIL shall remain continuously illuminated in the key on, engine off position for at least 15-20 seconds. If the readiness status for one or more of the monitored components or systems is “not complete”, after 15-20 seconds of operation in the key on, engine off position with the MIL illuminated continuously, the MIL shall blink once per second for 5-10 seconds. The data stream value for MIL status (section (h)(4.2)) shall indicate “commanded off” during this sequence unless the MIL has also been “commanded on” for a detected fault.

(4.2) Data Stream: The following signals shall be made available on demand through the standardized data link connector in accordance with SAE J1979/J1939 specifications. The actual signal value shall always be used instead of a default or limp home value.

(4.2.1) For all gasoline engines:

(A) Calculated load value, engine coolant temperature, engine speed, vehicle speed, time elapsed since engine start; and

(B) Absolute load, fuel level (if used to enable or disable any other diagnostics), barometric pressure (directly measured or estimated), engine control module system voltage, commanded equivalence ratio; and

(C) Number of stored confirmed fault codes, catalyst temperature (if directly measured or estimated for purposes of enabling the catalyst monitor(s)), monitor status (i.e., disabled for the rest of this driving cycle, complete this driving cycle, or not complete this driving cycle) since last engine shut-off for each monitor used for readiness status, distance traveled (or engine run time for engines not utilizing vehicle speed information) while MIL activated, distance traveled (or engine run time for engines not utilizing vehicle speed information) since fault memory last cleared, and number of warm-up cycles since fault memory last cleared, OBD requirements to

which the engine is certified (e.g., California OBD, EPA OBD, European OBD, non-OBD) and MIL status (i.e., commanded-on or commanded-off).

(4.2.2) For all diesel engines:

(A) Calculated load (engine torque as a percentage of maximum torque available at the current engine speed), driver's demand engine torque (as a percentage of maximum engine torque), actual engine torque (as a percentage of maximum engine torque), reference engine maximum torque, reference maximum engine torque as a function of engine speed (five points defined by SAE J1939 reference 5.3.17 and 5.2.4.1 engine configuration), engine coolant temperature, engine oil temperature (if used for emission control or any OBD diagnostics), engine speed, time elapsed since engine start; and

(B) Fuel level (if used to enable or disable any other diagnostics), vehicle speed (if used for emission control or any OBD diagnostics), barometric pressure (directly measured or estimated), engine control module system voltage; and

(C) Number of stored confirmed/active fault codes, monitor status (i.e., disabled for the rest of this driving cycle, complete this driving cycle, or not complete this driving cycle) since last engine shut-off for each monitor used for readiness status, distance traveled (or engine run time for engines not utilizing vehicle speed information) while MIL activated, distance traveled (or engine run time for engines not utilizing vehicle speed information) since fault memory last cleared, number of warm-up cycles since fault memory last cleared, OBD requirements to which the engine is certified (e.g., California OBD, EPA OBD, European OBD, non-OBD), and MIL status (i.e., commanded-on or commanded-off);

(D) NOx NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific NOx NTE carve-out area, or deficiency active area) and PM NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific PM NTE carve-out area, or deficiency active area).

(E) For purposes of the calculated load and torque parameters in section (h)(4.2.2)(A), manufacturers shall report the most accurate values that are calculated within the applicable electronic control unit (e.g., the engine control module). Most accurate, in this context, shall be of sufficient accuracy, resolution, and filtering to be used for the purposes of in-use emission testing with the engine still in a vehicle (e.g., using portable emission measurement equipment).

(4.2.3) For all engines so equipped:

(A) Absolute throttle position, relative throttle position, fuel control system status (e.g., open loop, closed loop), fuel trim, fuel pressure, ignition timing advance, fuel injection timing, intake air/manifold temperature, engine intercooler temperature, manifold absolute pressure, air flow rate from mass air flow sensor, secondary air status (upstream, downstream, or atmosphere), ambient air temperature, commanded purge valve duty cycle/position, commanded EGR valve duty cycle/position, actual EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), redundant absolute throttle position (for

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electronic throttle or other systems that utilize two or more sensors), absolute pedal position, redundant absolute pedal position, commanded throttle motor position, fuel rate, boost pressure, commanded/target boost pressure, turbo inlet air temperature, fuel rail pressure, commanded fuel rail pressure, PM filter inlet pressure, PM filter inlet temperature, PM filter outlet pressure, PM filter outlet temperature, PM filter delta pressure, exhaust pressure sensor output, exhaust gas temperature sensor output, injection control pressure, commanded injection control pressure, turbocharger/turbine speed, variable geometry turbo position, commanded variable geometry turbo position, turbocharger compressor inlet temperature, turbocharger compressor inlet pressure, turbocharger turbine inlet temperature, turbocharger turbine outlet temperature, wastegate valve position, glow plug lamp status; and

(B) Oxygen sensor output, air/fuel ratio sensor output, NOx sensor output, and evaporative system vapor pressure.

(4.3) Freeze Frame.

(4.3.1) "Freeze frame" information required to be stored pursuant to sections (d)(2.2.1)(D), (d)(2.2.2)(D), (f)(1.4.4), and (f)(2.4.3) shall be made available on demand through the standardized data link connector in accordance with SAE J1979/J1939-73 specifications.

(4.3.2) "Freeze frame" conditions must include the fault code which caused the data to be stored and all of the signals required in sections (h)(4.2.1)(A) and (4.2.2)(A). Freeze frame conditions shall also include all of the signals required on the engine in sections (h)(4.2.1)(B), (4.2.2)(B), and (4.2.3)(A) that are used for diagnostic or control purposes in the specific diagnostic or emission-critical powertrain control unit that stored the fault code.

(4.3.3) Only one frame of data is required to be recorded. Manufacturers may choose to store additional frames provided that at least the required frame can be read by a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network.

(4.4) Fault Codes

(4.4.1) For vehicles using the ISO 15765-4 protocol for the standardized functions required in section (h):

(A) For all monitored components and systems, stored pending, confirmed, and permanent fault codes shall be made available through the diagnostic connector in a standardized format in accordance with SAE J1979 specifications. Standardized fault codes conforming to SAE J2012 shall be employed.

(B) The stored fault code shall, to the fullest extent possible, pinpoint the likely cause of the malfunction. To the extent feasible, manufacturers shall use separate fault codes for every diagnostic where the diagnostic and repair procedure or likely cause of the failure is different. In general, rationality and functional diagnostics shall use different fault codes than the respective circuit continuity diagnostics. Additionally, input component circuit continuity diagnostics shall use different fault codes for distinct malfunctions (e.g., out-of-range low, out-of-range high, open circuit).

(C) Manufacturers shall use appropriate SAE-defined fault codes of SAE J2012 (e.g., P0xxx, P2xxx) whenever possible. With Executive Officer approval, manufacturers may use manufacturer-defined fault codes in accordance with SAE J2012 specifications (e.g., P1xxx). Factors to be considered by the Executive Officer for approval shall include the lack of available SAE-defined fault codes, uniqueness of the diagnostic or monitored component, expected future usage of the diagnostic or component, and estimated usefulness in providing additional diagnostic and repair information to service technicians. Manufacturer-defined fault codes shall be used consistently (i.e., the same fault code may not be used to represent two different failure modes) across a manufacturer's entire product line.

(D) A pending or confirmed fault code (as required in sections (d) and (e) through (g)) shall be stored and available to an SAE J1978 scan tool within 10 seconds after a diagnostic has determined that a malfunction has occurred. A permanent fault code shall be stored and available to an SAE J1978 scan tool no later than the end of an ignition cycle in which the corresponding confirmed fault code causing the MIL to be illuminated has been stored.

(E) Pending fault codes:

(i) Pending fault codes for all components and systems (including continuously and non-continuously monitored components) shall be made available through the diagnostic connector in accordance with SAE J1979 specifications (e.g., Mode/Service $07).

(ii) A pending fault code(s) shall be stored and available through the diagnostic connector for all currently malfunctioning monitored component(s) or system(s), regardless of the MIL illumination status or confirmed fault code status (e.g., even after a pending fault has matured to a confirmed fault code and the MIL is illuminated, a pending fault code shall be stored and available if the most recent monitoring event indicates the component is malfunctioning).

(iii) Manufacturers using alternate statistical protocols for MIL illumination as allowed in section (d)(2.2.1)(C) shall submit to the Executive Officer a protocol for setting pending fault codes. The Executive Officer shall approve the proposed protocol upon determining that, overall, it is equivalent to the requirements in sections (h)(4.4.1)(E)(i) and (ii) and that it effectively provides service technicians with a quick and accurate indication of a pending failure.

(F) Permanent fault codes:

(i) Permanent fault codes for all components and systems shall be made available through the diagnostic connector in a standardized format that distinguishes permanent fault codes from both pending fault codes and confirmed fault codes.

(ii) A confirmed fault code shall be stored as a permanent fault code no later than the end of the ignition cycle and subsequently at all times that the confirmed fault code is commanding the MIL on (e.g., for currently failing systems but not during the 40 warm-up cycle self-healing process described in section (d)(2.3.1)(B)).

(iii) Permanent fault codes shall be stored in NVRAM and may not be erasable by any scan tool command (generic or enhanced) or by disconnecting power to the on-board computer.

(iv) Permanent fault codes shall be erasable if the engine control module is reprogrammed and the readiness status (refer to section (h)(4.1)) for all monitored components and systems are set to “not complete.”

(v) The OBD system shall have the ability to store a minimum of four current confirmed fault codes as permanent fault codes in NVRAM. If the number of confirmed fault codes currently commanding the MIL on exceeds the maximum number of permanent fault codes that can be stored, the OBD system shall store the earliest detected confirmed fault codes as permanent fault codes. If additional confirmed fault codes are stored when the maximum number of permanent fault codes is already stored in NVRAM, the OBD system may not replace any existing permanent fault code with the additional confirmed fault codes.

(4.4.2) For vehicles using the SAE J1939 protocol for the standardized functions required in section (h):

(A) For all monitored components and systems, stored pending, active, and previously active fault codes shall be made available through the diagnostic connector in a standardized format in accordance with SAE J1939 specifications. Standardized fault codes conforming to SAE J1939 shall be employed.

(B) The stored fault code shall, to the fullest extent possible, pinpoint the likely cause of the malfunction. To the extent feasible, manufacturers shall use separate fault codes for every diagnostic where the diagnostic and repair procedure or likely cause of the failure is different. In general, rationality and functional diagnostics shall use different fault codes than the respective circuit continuity diagnostics. Additionally, input component circuit continuity diagnostics shall use different fault codes for distinct malfunctions (e.g., out-of-range low, out-of-range high, open circuit).

(C) Manufacturers shall use appropriate SAE-defined fault codes of SAE J939 whenever possible. With Executive Officer approval, manufacturers may use manufacturer-defined fault codes in accordance with SAE J1939 specifications. Factors to be considered by the Executive Officer for approval shall include the lack of available SAE-defined fault codes, uniqueness of the diagnostic or monitored component, expected future usage of the diagnostic or component, and estimated usefulness in providing additional diagnostic and repair information to service technicians. Manufacturer-defined fault codes shall be used consistently (i.e., the same fault code may not be used to represent two different failure modes) across a manufacturer’s entire product line.

(D) A pending or active fault code (as required in sections (d), (e), and (g)) shall be stored and available to an SAE J1939 scan tool within 10 seconds after a diagnostic has determined that a malfunction has occurred. A permanent fault code shall be stored and available to an SAE J1939 scan tool no later than the end of an ignition cycle in which the

corresponding active fault code causing the MIL to be illuminated has been stored.

(E) Pending fault codes:

(i) Pending fault codes for all components and systems (including continuously and non-continuously monitored components) shall be made available through the diagnostic connector in accordance with SAE J1939 specifications (e.g., Diagnostic Message 6 (DM6)).

(ii) Manufacturers using alternate statistical protocols for MIL illumination as allowed in section (d)(2.2.2)(C) shall submit to the Executive Officer a protocol for setting pending fault codes. The Executive Officer shall approve the proposed protocol upon determining that, overall, it is equivalent to the requirements in sections (h)(4.4.2)(E)(i) and that it effectively provides service technicians with a quick and accurate indication of a pending failure.

(F) Permanent fault codes:

(i) Permanent fault codes for all components and systems shall be made available through the diagnostic connector in a standardized format that distinguishes permanent fault codes from pending fault codes, active fault codes, and previously active fault codes.

(ii) An active fault code shall be stored as a permanent fault code no later than the end of the ignition cycle and subsequently at all times that the active fault code is commanding the MIL on (e.g., for currently failing systems).

(iii) Permanent fault codes shall be stored in NVRAM and may not be erasable by any scan tool command (generic or enhanced) or by disconnecting power to the on-board computer.

(iv) Permanent fault codes shall be erasable if the engine control module is reprogrammed and the readiness status (refer to section (h)(4.1)) for all monitored components and systems are set to “not complete.”

(v) The OBD system shall have the ability to store a minimum of four current active fault codes as permanent fault codes in NVRAM. If the number of active fault codes currently commanding the MIL on exceeds the maximum number of permanent fault codes that can be stored, the OBD system shall store the earliest detected active fault codes as permanent fault codes. If additional active fault codes are stored when the maximum number of permanent fault codes is already stored in NVRAM, the OBD system may not replace any existing permanent fault code with the additional active fault codes.

(4.5) Test Results

(4.5.1) Except as provided in section (h)(4.5.7), for all monitored components and systems identified in sections (e)(1) through (f)(8) and (g)(1), results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems shall be stored and available through the data link in accordance with the standardized format specified in SAE J1979 for the ISO 15765-4 protocol or SAE J1939.

(4.5.2) The test results shall be reported such that properly functioning components and systems (e.g., “passing” systems) do not store test

values outside of the established test limits. Test limits shall include both minimum and maximum acceptable values and shall be defined so that a test result equal to either test limit is a “passing” value, not a “failing” value.

(4.5.3) The test results shall be standardized such that the name of the monitored component (e.g., catalyst bank 1) can be identified by a generic scan tool and the test results and limits can be scaled and reported with the appropriate engineering units by a generic scan tool.

(4.5.4) The test results shall be stored until updated by a more recent valid test result or the fault memory of the OBD system computer is cleared. Upon fault memory being cleared, test results reported for monitors that have not yet completed with valid test results since the last time the fault memory was cleared shall report values of zero for the test result and test limits.

(4.5.5) All test results and test limits shall always be reported and the test results shall be stored until updated by a more recent valid test result or the fault memory of the OBD system computer is cleared.

(4.5.6) The OBD system shall store and report unique test results for each separate diagnostic.

(4.5.7) The requirements of section (h)(4.5) do not apply to continuous fuel system monitoring, cold start emission reduction strategy monitoring, and continuous circuit monitoring.

(4.6) Software Calibration Identification: On all vehicles, a single software calibration identification number (CAL ID) for each diagnostic or emission critical control unit(s) shall be made available through the standardized data link connector in accordance with the SAE J1979/J1939 specifications. A unique CAL ID shall be used for every emission-related calibration and/or software set having at least one bit of different data from any other emission-related calibration and/or software set. Control units coded with multiple emission or diagnostic calibrations and/or software sets shall indicate a unique CAL ID for each variant in a manner that enables an off-board device to determine which variant is being used by the vehicle. Control units that utilize a strategy that will result in MIL illumination if the incorrect variant is used (e.g., control units that contain variants for manual and automatic transmissions but will illuminate the MIL if the variant selected does not match the type of transmission on the vehicle) are not required to use unique CAL IDs.

(4.7) Software Calibration Verification Number

(4.7.1) All vehicles shall use an algorithm to calculate a single calibration verification number (CVN) that verifies the on-board computer software integrity for each diagnostic or emission critical electronically reprogrammable control unit. The CVN shall be made available through the standardized data link connector in accordance with the SAE J1979/J1939 specifications. The CVN shall be capable of being used to determine if the emission-related software and/or calibration data are valid and applicable for that vehicle and CAL ID.

(4.7.2) Manufacturers shall submit information for Executive Officer approval of the algorithm used to calculate the CVN. Executive Officer approval of

the algorithm shall be based on the complexity of the algorithm and the determination that the same CVN is difficult to achieve with modified calibration values.

(4.7.3) The CVN shall be calculated at least once per driving cycle and stored until the CVN is subsequently updated. Except for immediately after a reprogramming event or a non-volatile memory clear or for the first 30 seconds of engine operation after a volatile memory clear or battery disconnect, the stored value shall be made available through the data link connector to a generic scan tool in accordance with SAE J1979/J1939 specifications. The stored CVN value may not be erased when fault memory is erased by a generic scan tool in accordance with SAE J1979/J1939 specifications or during normal vehicle shut down (i.e., key off, engine off).

(4.7.4) For purposes of Inspection and Maintenance (I/M) testing, manufacturers shall make the CVN and CAL ID combination information available for all vehicles in a standardized electronic format that allows for off-board verification that the CVN is valid and appropriate for a specific vehicle and CAL ID.

(4.8) Vehicle Identification Number:

(4.8.1) All vehicles shall have the vehicle identification number (VIN) available in a standardized format through the standardized data link connector in accordance with SAE J1979/J1939 specifications. Only one electronic control unit per vehicle shall report the VIN to an SAE J1978/J1939 scan tool.

(4.8.2) If the VIN is reprogrammable through an off-board tool, all emission-related diagnostic information identified in section (h)(4.9.1) shall be erased whenever the VIN is reprogrammed.

(4.9) Erasure of Emission-Related Diagnostic Information:

(4.9.1) For purposes of section (h)(4.9), “emission-related diagnostic information” includes all the following:

(A) Readiness status (section (h)(4.1))

(B) Data stream information (section (h)(4.2)) including number of stored confirmed/active fault codes, distance traveled while MIL activated, number of warm-up cycles since fault memory last cleared, and distance traveled since fault memory last cleared.

(C) Freeze frame information (section (h)(4.3))

(D) Pending, confirmed, active, and previously active fault codes (section (h)(4.4.))

(E) Test results (section (h)(4.5))

(4.9.2) For all vehicles, the emission-related diagnostic information shall be erased if commanded by a scan tool (generic or enhanced) and may be erased if the power to the on-board computer is disconnected. If any of the emission-related diagnostic information is commanded to be erased by a scan tool (generic or enhanced), all emission-related diagnostic information from all diagnostic or emission critical control units shall be erased. The OBD system may not allow a scan tool to erase a subset of the emission-related diagnostic information (e.g., the OBD system may not allow a scan tool to erase only one of three stored fault codes or only

information from one control unit without erasing information from the other control unit(s)).

(5) **Tracking Requirements:**

(5.1) In-use Performance Ratio Tracking Requirements:

(5.1.1) For each monitor required in sections (e) through (g) to separately report an in-use performance ratio, manufacturers shall implement software algorithms to report a numerator and denominator in the standardized format specified below and in accordance with the SAE J1979/J1939 specifications.

(5.1.2) Numerical Value Specifications:

(A) For the numerator, denominator, general denominator, and ignition cycle counter:

(i) Each number shall have a minimum value of zero and a maximum value of 65,535 with a resolution of one.

(ii) Each number shall be reset to zero only when a non-volatile random access memory (NVRAM) reset occurs (e.g., reprogramming event) or, if the numbers are stored in keep-alive memory (KAM), when KAM is lost due to an interruption in electrical power to the control module (e.g., battery disconnect). Numbers may not be reset to zero under any other circumstances including when a scan tool command to clear fault codes or reset KAM is received.

(iii) If either the numerator or denominator for a specific component reaches the maximum value of 65,535 ±2, both numbers shall be divided by two before either is incremented again to avoid overflow problems.

(iv) If the ignition cycle counter reaches the maximum value of 65,535 ±2, the ignition cycle counter shall rollover and increment to zero on the next ignition cycle to avoid overflow problems.

(v) If the general denominator reaches the maximum value of 65,535 ±2, the general denominator shall rollover and increment to zero on the next driving cycle that meets the general denominator definition to avoid overflow problems.

(vi) If a vehicle is not equipped with a component (e.g., oxygen sensor bank 2, secondary air system), the corresponding numerator and denominator for that specific component shall always be reported as zero.

(B) For the ratio:

(i) The ratio shall have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122.

(ii) A ratio for a specific component shall be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.

(iii) A ratio for a specific component shall be considered to be the maximum value of 7.99527 if the corresponding denominator is zero or if the actual value of the numerator divided by the denominator exceeds the maximum value of 7.99527.

(5.2) Engine Run Time Tracking Requirements:

(5.2.1) For all gasoline and diesel engines, manufacturers shall implement software algorithms to individually track and report in a standardized format the engine run time while being operated in the following conditions:

(A) Total engine run time;

(B) Total idle run time (with “idle” defined as accelerator pedal released by driver, vehicle speed less than or equal to one mile per hour, and PTO not active);

(C) Total run time with PTO active.

(5.2.2) Numerical Value Specifications:

(A) For each counter specified in section (h)(5.2.1):

(i) Each number shall be a four-byte value with a minimum value of zero with a resolution of one minute per bit.

(ii) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event). Numbers may not be reset to zero under any other circumstances including when a scan tool (generic or enhanced) command to clear fault codes or reset KAM is received.

(iii) If any of the individual counters reach the maximum value, all counters shall be divided by two before any are incremented again to avoid overflow problems.

(6) **Service Information:**

(6.1) Engine manufacturers shall provide the aftermarket service and repair industry emission-related service information as set forth in sections (h)(6.3) through (6.5).

(6.2) The Executive Officer shall waive the requirements of sections (h)(6.3) through (6.5) upon determining that the ARB or U.S. EPA has adopted a service information regulation or rule that is in effect and operative and requires engine manufacturers to provide emission-related service information:

(A) of comparable or greater scope than required under these provisions;

(B) in an easily accessible format and in a timeframe that is equivalent to or exceeds the timeframes set forth below; and

(C) at fair and reasonable cost.

(6.3) Manufacturers shall make readily available, at a fair and reasonable price to the automotive repair industry, vehicle repair procedures which allow effective emission-related diagnosis and repairs to be performed using only the SAE J1978/J1939 generic scan tool and commonly available, non-microprocessor based tools.

(6.4) As an alternative to publishing repair procedures required under section (h)(6.3), a manufacturer may publish repair procedures referencing the use of manufacturer-specific or enhanced equipment provided the manufacturer makes available to the aftermarket scan tool industry the information needed to manufacture scan tools to perform the same emission-related diagnosis and repair procedures (excluding any reprogramming) in a comparable manner as the manufacturer-specific diagnostic scan tool.

(6.5) Manufacturers shall make available:

(6.5.1) Information to utilize the test results reported as required in section (h)(4.5). The information must include a description of the test and test result, typical passing and failing values, associated fault codes with the test result, and scaling, units, and conversion factors necessary to convert the results to engineering units.

(6.5.2) A generic description of each of the diagnostics used to meet the requirements of this regulation. The generic description must include a text description of how the diagnostic is performed, typical enable conditions, typical malfunction thresholds, typical monitoring time, fault codes associated with the diagnostic, and test results (section (h)(4.5)) associated with the diagnostic. Vehicles that have diagnostics not adequately represented by the typical values identified above shall be specifically identified along with the appropriate typical values.

(6.5.3) Information necessary to execute each of the diagnostics used to meet the requirements of sections (e)(1) through (f)(8) and (g)(1). The information must include either a description of sample driving patterns designed to be operated in-use or a written description of the conditions the vehicle needs to operate in to execute each of the diagnostics necessary to change the readiness status from “not complete” to “complete” for all monitors. The information shall be able to be used to exercise all necessary monitors in a single driving cycle as well as be able to be used to exercise the monitors to individually change the readiness status for each specific monitor from “not complete” to “complete”.

(7) **Exceptions to Standardization Requirements.**

(7.1) For 2020 and subsequent model year alternate-fueled engines derived from a diesel-cycle engine, a manufacturer may meet the standardized requirements of section (h) that are applicable to diesel engines in lieu of the requirements applicable to gasoline engines.

(i) MONITORING SYSTEM DEMONSTRATION REQUIREMENTS FOR CERTIFICATION

(1) **General.**

(1.1) Certification requires that manufacturers submit emission test data from one or more durability demonstration test engines (test engines).

(1.2) The Executive Officer may approve other demonstration protocols if the manufacturer can provide comparable assurance that the malfunction criteria are chosen based on meeting the malfunction criteria requirements and that the timeliness of malfunction detection is within the constraints of the applicable monitoring requirements.

(1.3) For flexible fuel engines capable of operating on more than one fuel or fuel combinations, the manufacturer shall submit a plan for providing emission test data to the Executive Officer for approval. The Executive Officer shall approve the plan if it is determined to be representative of expected in-use fuel or fuel combinations and provides accurate and timely evaluation of the monitored systems.

(2) **Selection of Test Engines:**

(2.1) Prior to submitting any applications for certification for a model year, a

manufacturer shall notify the Executive Officer of the engine families and engine ratings within each family planned for that model year. The Executive Officer will then select the engine family(ies) and the specific engine rating within the engine family(ies) that the manufacturer shall use as demonstration test engines to provide emission test data. The selection of test vehicles for production vehicle evaluation, as specified in section (l)(2), may take place during this selection process.

(2.2) Number of test engines:

(2.2.1) For the 2010 model year, a manufacturer shall provide emission test data of a test engine from the OBD parent rating.

(2.2.2) For the 2011 and 2012 model years, a manufacturer certifying one to seven engine families in a model year shall provide emission test data of a test engine from one OBD child rating. A manufacturer certifying eight or more engine families in a model year shall provide emission test data of test engines from two OBD child ratings. The Executive Officer may waive the requirement for submittal of data of one or more of the test engines if data have been previously submitted for all of the OBD parent and OBD child ratings.

(2.2.3) For the 2013 and subsequent model years, a manufacturer certifying one to five engine families in a model year shall provide emission test data of a test engine from one engine rating. A manufacturer certifying six to ten engine families in a model year shall provide emission test data from test engines from two engine ratings. A manufacturer certifying eleven or more engine families in a model year shall provide emission test data of test engines from three engine ratings. The Executive Officer may waive the requirement for submittal of data of one or more of the test engines if data have been previously submitted for all of the engine ratings.

(2.2.4) For a given model year, a manufacturer may elect to provide emission data of test engines from more engine ratings than required by section (i)(2.2.1) through (2.2.3). For each additional engine rating tested in that given model year, the Executive Officer shall reduce the number of engine ratings required for testing in one future model year under sections (i)(2.2.2) through (2.2.3) by one.

(2.3) For the test engine(s), a manufacturer shall use an engine(s) aged for a minimum of 125 hours plus exhaust aftertreatment emission controls aged to be representative of useful life. Manufacturers are required to submit for Executive Officer approval a description of the accelerated aging process and/or supporting data. The Executive Officer shall approve the process upon determining that the submitted description and/or data demonstrate that the process ensures that deterioration of the exhaust aftertreatment emission controls is stabilized sufficiently such that it is representative of the performance of the emission control at the end of the useful life.

(3) **Required Testing:**

Except as provided below, the manufacturer shall perform single-fault testing based on the applicable test with the following components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the requirements of sections (e), (f), and (g) or sections (d)(7.1.2) and (d)(7.2.3) for extrapolated OBD systems.

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(3.1) Required testing for Diesel/Compression Ignition Engines:

(3.1.1) Fuel System: The manufacturer shall perform a separate test for each malfunction limit established by the manufacturer for the fuel system parameters (e.g., fuel pressure, injection timing) specified in sections (e)(1.2.1) through (e)(1.2.3). When performing a test for a specific parameter, the fuel system shall be operating at the malfunction criteria limit for the applicable parameter only. All other parameters shall be with normal characteristics. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.1.2) Misfire Monitoring: For 2010 through 2012 model year engines, a misfire demonstration test is not required for diesel engines. For 2013 and subsequent model year engines, the manufacturer shall perform a test at the malfunction criteria limit specified in section (e)(2.2.2).

(3.1.3) EGR System: The manufacturer shall perform a test at each flow, slow response, and cooling limit calibrated to the malfunction criteria (e.g., 2.0 times the standard) in sections (e)(3.2.1) through (3.2.3) and (e)(3.2.5). In conducting the EGR system slow response demonstration tests, the manufacturer may use computer modifications to cause the EGR system to operate at the malfunction limit if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction.

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(3.1.4) Boost Pressure Control System: The manufacturer shall perform a test at each boost, response, and cooling limit calibrated to the malfunction criteria (e.g., 2.0 times the FTP standard) in sections (e)(4.2.1) through (4.2.3) and (e)(4.2.4).

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(3.1.5) NMHC Catalyst: The manufacturer shall perform a separate test for each monitored NMHC catalyst(s) (e.g., oxidation catalyst). The catalyst(s) being evaluated shall be deteriorated to the applicable malfunction criteria established by the manufacturer in section (e)(5.2.2) using methods established by the manufacturer in accordance with section (e)(5.2.4). For each monitored NMHC catalyst(s), the manufacturer shall also demonstrate that the OBD system will detect a catalyst malfunction with the catalyst at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or “empty” can). Emission data are not required for the empty can demonstration.

(3.1.6) NOx Catalyst: The manufacturer shall perform a separate test for each monitored NOx catalyst(s) (e.g., SCR catalyst). The catalyst(s) being evaluated shall be deteriorated to the applicable malfunction criteria established by the manufacturer in sections (e)(6.2.1)(A)(i), (e)(6.2.1)(B)(i), and (e)(6.2.2)(A) using methods established by the manufacturer in accordance with section (e)(6.2.3). For each monitored NOx catalyst(s), the manufacturer shall also demonstrate that the OBD system will detect a catalyst malfunction with the catalyst at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or “empty” can). Emission data are not required for the

empty can demonstration.

(3.1.7) NOx Adsorber: The manufacturer shall perform a test using a NOx adsorber(s) deteriorated to the malfunction criteria in section (e)(7.2.1). The manufacturer shall also demonstrate that the OBD system will detect a NOx adsorber malfunction with the NOx adsorber at its maximum level of deterioration (i.e., the substrate(s) completely removed from the container or "empty" can). Emission data are not required for the empty can demonstration.

(3.1.8) PM Filter: The manufacturer shall perform a test using a PM filter(s) deteriorated to each applicable malfunction criteria in sections (e)(8.2.1), (e)(8.2.2), and (e)(8.2.4). The manufacturer shall also demonstrate that the OBD system will detect a PM filter malfunction with the filter at its maximum level of deterioration (i.e., the filter(s) completely removed from the filter container or "empty" can). Emission data are not required for the empty can demonstration.

(3.1.9) Exhaust Gas Sensor: The manufacturer shall perform a test for each exhaust gas sensor parameter calibrated to the malfunction criteria (e.g., 2.0 times the FTP standard) in sections (e)(9.2.1)(A)(i), (e)(9.2.1)(B)(i)a. through b., and (e)(9.2.2)(A)(i) through (ii). When performing a test, all exhaust gas sensors used for the same purpose (e.g., for the same feedback control loop, for the same control feature on parallel exhaust banks) shall be operating at the malfunction criteria limit for the applicable parameter only. All other exhaust gas sensor parameters shall be with normal characteristics.

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(3.1.10) For each of the testing requirements of section (i)(3.1), if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could result in an engine's emissions exceeding the emission malfunction criteria (e.g., 2.0 times any of the applicable standards), the manufacturer is not required to perform a demonstration test; however the manufacturer is required to provide the data and/or engineering analysis used to determine that only a functional test of the system(s) is required.

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(3.2) Required testing for Gasoline/Spark-Ignited Engines:

(3.2.1) Fuel System:

(A) For engines with adaptive feedback based on the primary fuel control sensor(s), the manufacturer shall perform a test with the adaptive feedback based on the primary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer in section (f)(1.2.1) to detect a malfunction before emissions exceed 1.5 times the applicable standards.

(B) For engines with feedback based on a secondary fuel control sensor(s) and subject to the malfunction criteria in section (f)(1.2.1), the manufacturer shall perform a test with the feedback based on the secondary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer in section (f)(1.2.1) to detect a malfunction before emissions exceed 1.5 times the applicable standards.

(C) For other fuel metering or control systems, the manufacturer shall perform a test at the criteria limit(s).

(D) For purposes of fuel system testing, the fault(s) induced may result in a uniform distribution of fuel and air among the cylinders. Non-uniform distribution of fuel and air used to induce a fault may not cause misfire. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.2.2) Misfire: The manufacturer shall perform a test at the malfunction criteria limit specified in section (f)(2.2.2).

(3.2.3) EGR System: The manufacturer shall perform a test at each flow limit calibrated to the malfunction criteria (e.g., 1.5 times the standard) in sections (f)(3.2.1) and (f)(3.2.2).

(3.2.4) Cold Start Emission Reduction Strategy: The manufacturer shall perform a test at the malfunction criteria for each component monitored according to section (f)(4.2.1).

(3.2.5) Secondary Air System: The manufacturer shall perform a test at each flow limit calibrated to the malfunction criteria in sections (f)(5.2.1) and (f)(5.2.2).

(3.2.6) Catalyst: The manufacturer shall perform a test using a catalyst system deteriorated to the malfunction criteria in section (f)(6.2.1) using methods established by the manufacturer in accordance with section (f)(6.2.2). The manufacturer shall also demonstrate that the OBD system will detect a catalyst system malfunction with the catalyst system at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or “empty” can). Emission data are not required for the empty can demonstration.

(3.2.7) Exhaust Gas Sensor: The manufacturer shall perform a test with all primary exhaust gas sensors used for fuel control simultaneously possessing a response rate deteriorated to the malfunction criteria limit in section (f)(8.2.1)(A). Manufacturers shall also perform a test for any other primary or secondary exhaust gas sensor parameter under sections (f)(8.2.1)(A) and (f)(8.2.2)(A) that can cause engine emissions to exceed 1.5 times the applicable standards (e.g., shift in air/fuel ratio at which oxygen sensor switches, decreased amplitude). When performing additional test(s), all primary and secondary (if applicable) exhaust gas sensors used for emission control shall be operating at the malfunction criteria limit for the applicable parameter only. All other primary and secondary exhaust gas sensor parameters shall be with normal characteristics.

(3.2.8) For each of the testing requirements of section (i)(3.2), if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could result in an engine’s emissions exceeding the emission malfunction criteria (e.g., 1.5 times any of the applicable standards), the manufacturer is not required to perform a demonstration test; however the manufacturer is required to provide the data and/or engineering analysis used to determine that only a functional test of the system(s) is required.

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(3.3) Required Testing for All Engines:

(3.3.1) VVT System: The manufacturer shall perform a test at each target error limit and slow response limit calibrated to the malfunction criteria (e.g., 1.5 times the FTP standard) in sections (g)(1.2.1) and (g)(1.2.2). In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.3.2) Other Emission Control Systems: The manufacturer shall conduct demonstration tests for all other emission control components (e.g., hydrocarbon traps, adsorbers) designed and calibrated to an emission threshold malfunction criteria (e.g., 1.5 times the applicable emission standards) under the provisions of section (g)(5).

(3.3.3) For each of the testing requirements of section (i)(3.3), if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could result in an engine's emissions exceeding the emission malfunction criteria (e.g., 1.5 times any of the applicable standards), the manufacturer is not required to perform a demonstration test; however the manufacturer is required to provide the data and/or engineering analysis used to determine that only a functional test of the system(s) is required.

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(3.4) The manufacturer may electronically simulate deteriorated components but may not make any engine control unit modifications (unless otherwise provided above) when performing demonstration tests. All equipment necessary to duplicate the demonstration test must be made available to the ARB upon request.

(4) **Testing Protocol:**

(4.1) Preconditioning: The manufacturer shall use an applicable cycle for preconditioning test engines prior to conducting each of the above emission tests. Upon determining that a manufacturer has provided data and/or engineering evaluation that demonstrate that additional preconditioning is necessary to stabilize the emission control system, the Executive Officer shall allow the manufacturer to perform a single additional preconditioning cycle, identical to the initial preconditioning cycle following a 20 minute hot soak after the initial preconditioning cycle. The manufacturer may not require the test engine to be cold soaked prior to conducting preconditioning cycles in order for the monitoring system testing to be successful.

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(4.2) Test Sequence:

(4.2.1) The manufacturer shall set the system or component on the test engine for which detection is to be tested at the criteria limit(s) prior to conducting the applicable preconditioning cycle(s). If a second preconditioning cycle is permitted in accordance with section (i)(4.1) above, the manufacturer may adjust the system or component to be tested before conducting the second preconditioning cycle. The manufacturer may not replace, modify, or adjust the system or component after the last preconditioning cycle has taken place.

(4.2.2) After preconditioning, the test engine shall be operated over the applicable

cycle to allow for the initial detection of the tested system or component malfunction. This test cycle may be omitted from the testing protocol if it is unnecessary. If required by the designated monitoring strategy, a cold soak may be performed prior to conducting this test cycle.

(4.2.3) The test engine shall then be operated over the applicable exhaust emission test.

(4.3) A manufacturer required to test more than one test engine (section (i)(2.2)) may utilize internal calibration sign-off test procedures (e.g., forced cool downs, less frequently calibrated emission analyzers) instead of official test procedures to obtain the emission test data required in section (i) for all but one of the required test engines. The manufacturer may elect this option if the data from the alternative test procedure are representative of official emission test results. Manufacturers using this option are still responsible for meeting the malfunction criteria specified in sections (e) through (g) when emission tests are performed in accordance with official test procedures.

(4.4) A manufacturer may request Executive Officer approval to utilize an alternate testing protocol for demonstration of MIL illumination if the engine dynamometer emission test cycle does not allow all of a monitor's enable conditions to be satisfied. A manufacturer may request the use of an alternate engine dynamometer test cycle or the use of chassis testing to demonstrate proper MIL illumination. In evaluating the manufacturer's request, the Executive Officer shall consider the technical necessity for using an alternate test cycle and the degree to which the alternate test cycle demonstrates that in-use operation with the malfunctioning component will properly result in MIL illumination.

(5) **Evaluation Protocol:**

(5.1) Full OBD engine ratings subject to sections (d)(7.1.1), (d)(7.2.2), or (d)(7.3) shall be evaluated according to the following protocol.

(5.1.1) For all tests conducted under section (i), the MIL shall be illuminated upon detection of the tested system or component malfunction before the end of the first engine start portion of the exhaust test of the complete applicable test in accordance with requirements of sections (e) through (g).

(5.1.2) If the MIL illuminates prior to emissions exceeding the applicable malfunction criteria specified in sections (e) through (g), no further demonstration is required. With respect to the misfire monitor demonstration test, if a manufacturer has elected to use the minimum misfire malfunction criteria of one percent as allowed in sections (e)(2.2.2)(A) and (f)(2.2.2)(A), no further demonstration is required if the MIL illuminates with misfire implanted at the malfunction criteria limit.

(5.1.3) If the MIL does not illuminate when the system or component is set at its limit(s), the criteria limit or the OBD system is not acceptable.

(A) Except for testing of the catalyst or PM filter system, if the MIL first illuminates after emissions exceed the applicable malfunction criteria specified in sections (e) through (g), the test engine shall be retested with the tested system or component adjusted so that the MIL will illuminate before emissions exceed the applicable malfunction criteria specified in sections (e) through (g). If the component cannot be adjusted to meet this

criterion because a default fuel or emission control strategy is used when a malfunction is detected (e.g., open loop fuel control used after an oxygen sensor malfunction is determined), the test engine shall be retested with the component adjusted to the worst acceptable limit (i.e., the applicable monitor indicates the component is performing at or slightly better than the malfunction criteria). When tested with the component adjusted to the worst acceptable limit, the MIL must not illuminate during the test and the engine emissions must be below the applicable malfunction criteria specified in sections (e) through (g).

(B) In testing the catalyst or PM filter system, if the MIL first illuminates after emissions exceed the applicable emission threshold(s) specified in sections (e) and (f), the tested engine shall be retested with a less deteriorated catalyst/PM filter system (i.e., more of the applicable engine out pollutants are converted or trapped). For the OBD system to be approved, testing shall be continued until either of the following conditions are satisfied:

(i) The MIL is illuminated and emissions do not exceed the thresholds specified in sections (e) or (f); or

(ii) The manufacturer demonstrates that the MIL illuminates within the upper and lower limits of the threshold identified below. The manufacturer shall demonstrate acceptable limits by continuing testing until the test results show:

a. The MIL is illuminated and emissions exceed the thresholds specified in sections (e) or (f) by 10 percent or less of the applicable standard (e.g., emissions are less than 1.85 times the applicable standard for a malfunction criterion of 1.75 times the standard); and

b. The MIL is not illuminated and emissions are below the thresholds specified in sections (e) or (f) by no more than 20 percent of the standard (e.g., emissions are between 1.55 and 1.75 times the applicable standard for a malfunction criterion of 1.75 times the standard).

(5.1.4) If an OBD system is determined unacceptable by the above criteria, the manufacturer may recalibrate and retest the system on the same test engine. In such a case, the manufacturer must confirm, by retesting, that all systems and components that were tested prior to recalibration and are affected by the recalibration function properly under the OBD system as recalibrated.

(5.2) OBD child ratings subject to sections (d)(7.1.2) or (d)(7.2.3) (i.e., extrapolated OBD) shall be evaluated according to the following protocol.

(5.2.1) For all tests conducted under section (i), the MIL shall be illuminated upon detection of the tested system or component malfunction before the end of the first engine start portion of the exhaust test of the complete applicable test in accordance with the malfunction criteria established by the manufacturer under sections (d)(7.1.2) and (d)(7.2.3).

(5.2.2) Except for testing of the catalyst or PM filter system, if the MIL first illuminates after the tested component or system significantly exceeds the applicable malfunction criteria established by the manufacturer, the test

engine shall be retested with the tested system or component adjusted so that the MIL will illuminate at the applicable malfunction criteria established by the manufacturer.

(5.2.3) In testing the catalyst or PM filter system, if the MIL first illuminates after the tested component or system significantly exceeds the applicable malfunction criteria established by the manufacturer, the tested engine shall be retested with a less deteriorated catalyst/PM filter system (i.e., more of the applicable engine out pollutants are converted or trapped). For the OBD system to be approved, testing shall be continued until either of the following conditions are satisfied:

(A) The MIL is illuminated and the tested component or system is at the applicable malfunction criteria established by the manufacturer; or

(B) The manufacturer demonstrates that the MIL illuminates within the upper and lower limits of the threshold identified below. The manufacturer shall demonstrate acceptable limits by continuing testing until the test results show:

(i) The MIL is illuminated and monitoring results indicate the tested component or system exceeds the malfunction criteria established by the manufacturer by 10 percent or less of the monitored parameter; and

(ii) The MIL is not illuminated and monitoring results indicate the tested component or system is below the malfunction criteria established by the manufacturer by 10 percent or less of the monitored parameter.

(6) **Confirmatory Testing:**

(6.1) The ARB may perform confirmatory testing to verify the emission test data submitted by the manufacturer under the requirements of section (i) comply with the requirements of section (i) and the malfunction criteria identified in sections (e) through (g). This confirmatory testing is limited to the engine rating represented by the demonstration engine(s).

(6.2) The ARB or its designee may install appropriately deteriorated or malfunctioning components (or simulate a deteriorated or malfunctioning component) in an otherwise properly functioning test engine of an engine rating represented by the demonstration test engine(s) in order to test any of the components or systems required to be tested in section (i). Upon request by the Executive Officer, the manufacturer shall make available an engine and all test equipment (e.g., malfunction simulators, deteriorated components) necessary to duplicate the manufacturer's testing. The Executive Officer shall make the request within six months of reviewing and approving the demonstration test engine data submitted by the manufacturer for the specific engine rating.

(j) CERTIFICATION DOCUMENTATION

(1) When submitting an application for certification of an engine, the manufacturer shall submit the following documentation. If any of the items listed below are standardized for all of a manufacturer's engines, the manufacturer may, for each model year, submit one set of documents covering the standardized items for all of its engines.

(1.1) For the required documentation not standardized across all engines, the manufacturer may propose to the Executive Officer that documentation covering an OBD certification documentation group be used. If approved by the Executive Officer, the manufacturer may submit one set of documentation from one or more representative engines that are a part of the OBD certification documentation group. The Executive Officer shall determine whether a selected engine is representative of the OBD certification documentation group as a whole. To be approved as representative, the engine must possess the most stringent emission standards and OBD monitoring requirements and cover all of the emission control devices within the OBD certification documentation group.

(1.2) With Executive Officer approval, one or more of the documentation requirements of section (j) may be waived or modified if the information required would be redundant or unnecessarily burdensome to generate.

(1.3) To the extent possible, the certification documentation shall use SAE J1930 or J2403 terms, abbreviations, and acronyms.

(2) The following information shall be submitted as part of the certification application. Except as provided below for demonstration data, the Executive Officer will not issue an Executive Order certifying the covered engines without the information having been provided. The information must include:

(2.1) A description of the functional operation of the OBD system including a complete written description for each monitoring strategy that outlines every step in the decision-making process of the monitor. Algorithms, diagrams, samples of data, and/or other graphical representations of the monitoring strategy shall be included where necessary to adequately describe the information.

(2.2) A table, in the standardized format detailed in Attachment A of ARB Mail-Out #95-20, May 22, 1995, incorporated by reference.

(2.2.1) The table must include the following information for each monitored component or system (either computer-sensed or -controlled) of the emission control system:

(A) Corresponding fault code
(B) Monitoring method or procedure for malfunction detection
(C) Primary malfunction detection parameter and its type of output signal
(D) Fault criteria limits used to evaluate output signal of primary parameter
(E) Other monitored secondary parameters and conditions (in engineering units) necessary for malfunction detection
(F) Monitoring time length and frequency of checks
(G) Criteria for storing fault code
(H) Criteria for illuminating malfunction indicator light
(I) Criteria used for determining out-of-range values and input component rationality checks

(2.2.2) Wherever possible, the table shall use the following engineering units:

(A) Degrees Celsius (°C) for all temperature criteria
(B) KiloPascals (KPa) for all pressure criteria related to manifold or atmospheric pressure
(C) Grams (g) for all intake air mass criteria

(D) Pascals (Pa) for all pressure criteria related to evaporative system vapor pressure
(E) Miles per hour (mph) for all vehicle speed criteria
(F) Relative percent (%) for all relative throttle position criteria (as defined in SAE J1979/J1939)
(G) Voltage (V) for all absolute throttle position criteria (as defined in SAE J1979/J1939)
(H) Per crankshaft revolution (/rev) for all changes per ignition event based criteria (e.g., g/rev instead of g/stroke or g/firing)
(I) Per second (/sec) for all changes per time based criteria (e.g., g/sec)
(J) Percent of nominal tank volume (%) for all fuel tank level criteria

(2.3) A logic flowchart describing the step-by-step evaluation of the enable criteria and malfunction criteria for each monitored emission-related component or system.

(2.4) Emission test data, a description of the testing sequence (e.g., the number and types of preconditioning cycles), approximate time (in seconds) of MIL illumination during the test, fault code(s) and freeze frame information stored at the time of detection, corresponding test results (e.g. SAE J1979 Mode/Service $06, SAE J1939 Diagnostic Message 8 (DM8)) stored during the test, and a description of the modified or deteriorated components used for fault simulation with respect to the demonstration tests specified in section (i). The freeze frame data are not required for engines subject to sections (d)(7.1.2) or (d)(7.2.3). The Executive Officer may approve conditional certification of an engine prior to the submittal of this data for ARB review and approval. Factors to be considered by the Executive Officer in approving the late submission of information identified in section (j)(2.4) shall include the reason for the delay in the data collection, the length of time until data will be available, and the demonstrated previous success of the manufacturer in submitting the data prior to certification.

(2.5) For gasoline engines, data supporting the misfire monitor, including:

(2.5.1) The established percentage of misfire that can be tolerated without damaging the catalyst over the full range of engine speed and load conditions.

(2.5.2) Data demonstrating the probability of detection of misfire events of the misfire monitoring system over the full engine speed and load operating range for the following misfire patterns: random cylinders misfiring at the malfunction criteria established in section (f)(2.2.2), one cylinder continuously misfiring, and paired cylinders continuously misfiring.

(2.5.3) Data identifying all disablement of misfire monitoring that occurs during the FTP. For every disablement that occurs during the cycles, the data should identify: when the disablement occurred relative to the driver's trace, the number of engine revolutions that each disablement was present for, and which disable condition documented in the certification application caused the disablement.

(2.5.4) Manufacturers are not required to use the durability demonstration engine to collect the misfire data for sections (j)(2.5.1) through (2.5.3).

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

(2.7) Data supporting the criteria used to detect a malfunction of the fuel system, EGR system, boost pressure control system, catalyst, NOx adsorber, PM filter, cold start emission reduction strategy, secondary air, evaporative system, VVT system, exhaust gas sensors, and other emission controls which causes emissions to exceed the applicable malfunction criteria specified in sections (e), (f), and (g). For diesel engine monitors in sections (e) and (g) that are required to indicate a malfunction before emissions exceed an emission threshold based on any applicable standard (e.g., 1.5 times any of the applicable standards), the test cycle and standard determined by the manufacturer to be the most stringent for each applicable monitor in accordance with section (d)(6.1).

(2.8) A listing of all electronic powertrain input and output signals (including those not monitored by the OBD system) that identifies which signals are monitored by the OBD system. For input and output signals that are monitored as comprehensive components, the listing shall also identify the specific fault code for each malfunction criteria (e.g., out of range low, out of range high, open circuit, rationality low, rationality high).

(2.9) A written description of all parameters and conditions necessary to begin closed-loop/feedback control of emission control systems (e.g., fuel system, boost pressure, EGR flow, SCR reductant delivery, PM filter regeneration, fuel system pressure).

(2.10) A written identification of the communication protocol utilized by each engine for communication with an SAE J1978/J1939 scan tool.

(2.11) A pictorial representation or written description of the diagnostic connector location including any covers or labels.

(2.12) A written description of the method used by the manufacturer to meet the requirements of section (g)(3) for CV system monitoring including diagrams or pictures of valve and/or hose connections.

(2.13) A written description of each AECD utilized by the manufacturer including the sensor signals and/or calculated values used to invoke each AECD, the engineering data and/or analysis demonstrating the need for such an AECD, the actions taken when each AECD is activated, the expected in-use frequency of operation of each AECD, and the expected emission impact from each AECD activation.

(2.14) A written description of each NOx and PM NTE deficiency and emission carve-out utilized by the manufacturer including the sensor signals and/or calculated values used to invoke each NTE deficiency or carve-out, the engineering data and/or analysis demonstrating the need for such an NTE deficiency or carve-out, the actions taken when each NTE deficiency or carve-out is activated, the expected in-use frequency of operation of each NTE deficiency or carve-out, and the expected emission impact from each NTE deficiency or carve-out activation.

(2.15) Build specifications provided to engine purchasers or chassis manufacturers detailing all specifications or limitations imposed on the engine purchaser relevant to OBD requirements or emission compliance (e.g., allowable MIL locations, connector location specifications, cooling system heat rejection rates). A description of the method or copies of agreements used to ensure engine purchasers or chassis manufacturers will comply with the OBD and

emission relevant build specifications (e.g., signed agreements, required audit/evaluation procedures).

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

(k) DEFICIENCIES

(1) The Executive Officer, upon receipt of an application from the manufacturer, may certify OBD systems installed on engines even though the systems do not comply with one or more of the requirements of title 13, CCR section 1971.1. In granting the certification, the Executive Officer shall consider the following factors: the extent to which the requirements of section 1971.1 are satisfied overall based on a review of the engine applications in question, the relative performance of the resultant OBD system compared to systems fully compliant with the requirements of section 1971.1, and a demonstrated good-faith effort on the part of the manufacturer to: (1) meet the requirements in full by evaluating and considering the best available monitoring technology; and (2) come into compliance as expeditiously as possible.

(2) For 2013 and subsequent model year engines, manufacturers of OBD systems for which deficiencies have been granted are subject to fines pursuant to section 43016 of the California Health and Safety Code. The specified fines apply to: (1) the third and subsequently identified deficiency(ies), ordered according to section (k)(3), and (2) a monitoring system deficiency where a required monitoring strategy is completely absent from the OBD system.

(3) The fines for engines specified in section (k)(2) above are in the amount of $50 per deficiency per engine for non-compliance with any of the monitoring requirements specified in sections (e), (f), and (g)(5), and $25 per deficiency per engine for non-compliance with any other requirement of section 1971,1. In determining the identified order of deficiencies, deficiencies subject to a $50 fine are identified first. Total fines per engine under section (k) may not exceed $500 per engine and are payable to the State Treasurer for deposit in the Air Pollution Control Fund.

(4) Manufacturers must re-apply for Executive Officer approval of a deficiency each model year. In considering the request to carry-over a deficiency, the Executive Officer shall consider the factors identified in section (k)(1) including the manufacturer's progress towards correcting the deficiency. The Executive Officer may not allow manufacturers to carry over monitoring system deficiencies for more than two model years unless it can be demonstrated that substantial engine hardware modifications and additional lead time beyond two years would be necessary to correct the deficiency, in which case the Executive Officer shall allow the deficiency to be carried over for three model years.

(5) Except as allowed in section (k)(6), deficiencies may not be retroactively granted after certification.

(6) Request for retroactive deficiencies

(6.1) During the first 6 months after commencement of normal production, manufacturers may request that the Executive Officer grant a deficiency and amend an engine's certification to conform to the granting of the deficiencies for each aspect of the monitoring system: (a) identified by the manufacturer (during testing required by section (l)(2) or any other testing) to be functioning different than the certified system or otherwise not meeting the requirements of any aspect of section 1971.1; and (b) reported to the Executive Officer. If the Executive Officer grants the deficiencies and amended certification, their approval would be retroactive to the start of production.

(6.2) Executive Officer approval of the request for a retroactive deficiency shall be granted provided that the conditions necessary for a pre-certification deficiency determination are satisfied (see section (k)(1)) and the manufacturer could not have reasonably anticipated the identified problem before commencement of production.

(6.3) In granting the amended certification, the Executive Officer shall include any approved post-production deficiencies together with all previously approved deficiencies in computing fines in accordance with section (k)(2).

(l) PRODUCTION ENGINE/VEHICLE EVALUATION TESTING

(1) **Verification of Standardized Requirements.**

(1.1) Requirement: Manufacturers shall perform testing to verify that 2013 and subsequent model year production vehicles meet the requirements of section (h)(3) and (h)(4) relevant to proper communication of required emission-related messages to an SAE J1978/J1939 scan tool.

(1.2) Selection of Test Vehicles:

(1.2.1) Engine manufacturers shall perform this testing every model year on ten unique production vehicles (i.e., engine rating and chassis application combination) per engine family. If there are less than ten unique production vehicles for a certain engine family, the manufacturer shall test each unique production vehicle in that engine family. Manufacturers shall perform this testing within either three months of the start of engine production or one month of the start of vehicle production, whichever is later. Manufacturers may request Executive Officer approval to group multiple production vehicles together and test one representative vehicle per group. The Executive Officer shall approve the request upon finding that the software and hardware designed to comply with the standardization requirements of section (h) (e.g., communication protocol message timing, number of supported data stream parameters, engine and vehicle communication network architecture) in the representative vehicle are identical to all others in the group and that any differences in the production vehicles are not relevant with respect to meeting the criteria in section (l)(1.4).

(1.2.2) For 2016 and subsequent model year engines, the Executive Officer shall reduce the maximum required number of vehicles to be tested from ten per engine family to five per engine family for a manufacturer based on the demonstrated previous success of the manufacturer to meet the requirements of section (i)(1). For purposes of this requirement, a

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manufacturer shall be determined to be successful in meeting the requirements of section (i)(1) if zero vehicles fail the testing required by section (i)(1) for two consecutive years.

(1.2.3) For 2019 and subsequent model year engines, the Executive Officer shall further reduce the maximum required number of vehicles to be tested to three per engine family for a manufacturer based on the demonstrated previous success of the manufacturer to meet the requirements of section (i)(1). For purposes of this requirement, a manufacturer shall be determined to be successful in meeting the requirements of section (i)(1) if zero vehicles fail the testing required by section (i)(1) for three consecutive years.

(1.2.4) The Executive Officer may waive the requirement for submittal of data from one or more of the production vehicles if data have been previously submitted for all of the production vehicles. Manufacturers may request Executive Officer approval to carry over data collected in previous model years. The Executive Officer shall approve the request upon finding that the software and hardware designed to comply with the standardization requirements of section (h) are identical to the previous model year and no other hardware or software changes that affect compliance with the standardization requirements have been made.

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(1.3) Test Equipment: For the testing required in section (l)(1), manufacturers shall utilize an off-board device to conduct the testing. Prior to conducting testing, manufacturers are required to request and receive Executive Officer approval of the off-board device that the manufacturer will use to perform the testing. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data, specifications, and/or engineering analysis that demonstrate that the off-board device is able to verify that vehicles tested are able to perform all of the required functions in section (l)(1.4) with any other off-board device designed and built in accordance with the SAE J1978/J1939 generic scan tool specifications.

(1.4) Required Testing:

(1.4.1) The testing shall verify that communication can be properly established between all emission-related on-board computers and any SAE J1978/J1939 scan tool designed to adhere strictly to the communication protocols allowed in section (h)(3);

(1.4.2) The testing shall verify that all emission-related information is properly communicated between all emission-related on-board computers and any SAE J1978/J1939 scan tool in accordance with the requirements of section (h) and the applicable ISO and SAE specifications including specifications for physical layer, network layer, message structure, and message content.

(1.4.3) The testing shall further verify that the following information can be properly communicated to any SAE J1978/J1939 scan tool:

(A) The current readiness status from all on-board computers required to support readiness status in accordance with SAE J1979/J1939-73 and section (h)(4.1) in the key on, engine off position and while the engine is running;

(B) The MIL command status while the MIL is commanded off and while the MIL is commanded on in accordance with SAE J1979/J1939 and section (h)(4.2) in the key on, engine off position and while the engine is running, and in accordance with SAE J1979/J1939 and sections (d)(2.1.2) during the MIL functional check and, if applicable, (h)(4.1.3) during the MIL readiness status check while the engine is off;

(C) All data stream parameters required in section (h)(4.2) in accordance with SAE J1979/J1939 including, if applicable, the proper identification of each data stream parameter as supported in SAE J1979 (e.g., Mode/Service $01, PID $00);

(D) The CAL ID, CVN, and VIN in accordance with SAE J1979/J1939 and sections (h)(4.6) through (4.8);

(E) An emission-related fault code (permanent, confirmed, pending, active, and previously active) in accordance with SAE J1979/J1939-73 (including correctly indicating the number of stored fault codes (e.g., Mode/Service $01, PID $01, Data A for SAE J1979)) and section (h)(4.4);

(1.4.4) The testing shall also verify that the on-board computer(s) can properly respond to any SAE J1978/J1939 scan tool request to clear emission-related fault codes and reset readiness status in accordance with section (h)(4.9).

(1.5) Reporting of Results:

(1.5.1) The manufacturer shall submit to the Executive Officer the following, based on the results of testing:

(A) If a variant meets all the requirements of section (l)(1.4), a statement specifying that the variant passed all the tests, or

(B) If any variant does not meet the requirements of section (l)(1.4), a written report to the Executive Officer for approval within one month of testing the specific variant. The written report shall include the problem(s) identified and the manufacturer's proposed corrective action (if any) to remedy the problem(s). Factors to be considered by the Executive Officer in approving the proposed corrective action shall include the severity of the problem(s), the ability of the vehicle to be tested in a California inspection program (e.g., roadside inspection, fleet self-inspection program), the ability of service technicians to access the required diagnostic information, the impact on equipment and tool manufacturers, and the amount of time prior to implementation of the proposed corrective action.

(1.5.2) Upon request of the Executive Officer, a manufacturer shall submit a report of the results of any testing conducted pursuant to section (l)(1) to the Executive Officer for review.

(1.5.3) In accordance with section (k)(6), manufacturers may request Executive Officer approval for a retroactive deficiency to be granted for items identified during this testing.

(1.6) Alternative Testing Protocols. Manufacturers may request Executive Officer approval to use other testing protocols. The Executive Officer shall approve the protocol if the manufacturer can demonstrate that the alternate testing methods and equipment provide an equivalent level of verification of compliance with the standardized requirements to the requirements of section (l)(1).

(2) **Verification of Monitoring Requirements.**

(2.1) Within either the first six months of the start of engine production or the first three months of the start of vehicle production, whichever is later, manufacturers shall conduct a complete evaluation of the OBD system of one or more production vehicles (test vehicles) and submit the results of the evaluation to the Executive Officer.

(2.2) Selection of test vehicles:

(2.2.1) For each engine selected for monitoring system demonstration in section (i), the manufacturer shall evaluate one production vehicle equipped with an engine from the same engine family and rating as the demonstration engine. The Executive Officer shall select the specific production vehicle(s) to be tested.

(2.2.2) A manufacturer required to test more than one test vehicle may test an engine in lieu of a vehicle for all but one of the required test vehicles.

(2.2.3) The Executive Officer may waive the requirements for submittal of evaluation results from one or more of the test vehicles if data have been previously submitted for all of the engine ratings and variants.

(2.3) Evaluation requirements:

(2.3.1) The evaluation shall demonstrate the ability of the OBD system on the selected production vehicle to detect a malfunction, illuminate the MIL, and, where applicable, store an appropriate fault code readable by a scan tool conforming to SAE J1978/J1939 when a malfunction is present and the monitoring conditions have been satisfied for each individual diagnostic required by title 13, CCR section 1971.1.

(2.3.2) The evaluation shall verify that malfunctions detected by non-MIL illuminating diagnostics of components used to enable any other OBD system diagnostic (e.g., fuel level sensor) will not inhibit the ability of other OBD system diagnostics to properly detect malfunctions.

(2.3.3) The evaluation shall verify that the software used to track the numerator and denominator for purposes of determining in-use monitoring frequency correctly increments as required in section (d)(4).

(2.3.4) Malfunctions may be mechanically implanted or electronically simulated but internal on-board computer hardware or software changes may not be used to simulate malfunctions. For monitors that are required to indicate a malfunction before emissions exceed an emission threshold based on any applicable standard (e.g., 2.0 times any of the applicable standards), manufacturers are not required to use malfunctioning components/systems set exactly at their malfunction criteria limits. Emission testing to confirm that the malfunction is detected before the appropriate emission standards are exceeded is not required.

(2.3.5) Manufacturers shall submit a proposed test plan for Executive Officer approval prior to evaluation testing being performed. The test plan shall identify the method used to induce a malfunction for each diagnostic. If the Executive Officer determines that the requirements of section (l)(2) are satisfied, the proposed test plan shall be approved.

(2.3.6) Subject to Executive Officer approval, manufacturers may omit demonstration of specific diagnostics. The Executive Officer shall

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Deleted: <#>Prior to submitting any applications for certification for a model year, an engine manufacturer shall notify the Executive Officer of the unique variants (i.e., engine rating and chassis application combinations) and projected engine sales volume (including a sales breakdown by engine purchaser/coach builder) planned for that model year. The Executive Officer will then select the specific engine ratings for test engines and variants for test vehicles, in accordance with sections (l)(2.2.2) and (l)(2.2.3) below, that the engine manufacturer shall use to provide evaluation test results. This selection process may take place during selection of the engine rating(s) for monitoring system demonstration testing specified in section (i).¶ <#>A manufacturer shall evaluate one production engine from each engine rating selected for monitoring system demonstration in section (i).¶ In addition to the engine(s) selected in section (l)(2.2.2) above,

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approve a manufacturer's request if the demonstration cannot be reasonably performed without causing physical damage to the vehicle (e.g., on-board computer internal circuit faults).

(2.3.7) For evaluation of test vehicles selected in accordance with section (l)(2.2), manufacturers are not required to demonstrate diagnostics that were previously demonstrated prior to certification as required in section (i).

(2.4) Manufacturers shall submit a report of the results of all testing conducted pursuant to section (l)(2) to the Executive Officer for review. This report shall identify the method used to induce a malfunction in each diagnostic, the MIL illumination status, and the fault code(s) stored.

(2.5) In accordance with section (k)(6), manufacturers may request Executive Officer approval for a retroactive deficiency to be granted for items identified during this testing.

(3) **Verification and Reporting of In-use Monitoring Performance.**

(3.1) Manufacturers are required to collect and report in-use monitoring performance data representative of production vehicles (i.e., engine rating and chassis application combination). Manufacturers shall collect and report the data to the ARB within twelve months after the production vehicles were first introduced into commerce.

(3.2) Manufacturers shall separate production vehicles into the following monitoring performance groups and submit data representative of each group:

(3.2.1) Emission architecture. Engines shall be separated by emission architecture. All engines that use the same or similar emission control architecture and monitoring system shall be in the same emission architecture category.

(3.2.2) Monitoring performance group. Within an emission architecture category, engines shall be separated by vehicle application. The separate monitoring performance groups shall be based on three classifications: engines intended primarily for line-haul chassis applications, engines intended primarily for urban delivery chassis applications, and all other engines.

(3.3) Manufacturers may request Executive Officer approval to use an alternate grouping method to collect representative data. Executive Officer approval shall be granted upon determining that the proposed groupings include production vehicles using similar emission controls, OBD strategies, monitoring condition calibrations, and vehicle application driving/usage patterns such that they are expected to have similar in-use monitoring performance. If approved by the Executive Officer, the manufacturer may submit one set of data for each of the approved groupings.

(3.4) For each group, the data must include all of the in-use performance tracking data reported through SAE J1979/J1939 (i.e., all numerators, denominators, the general denominator, and the ignition cycle counter), the date the data were collected, the odometer reading, the VIN, and the ECM software calibration identification number.

(3.5) Manufacturers shall submit a plan to the Executive Officer for review and approval that details the types of production vehicles in each group, the

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number of vehicles per group to be sampled, the sampling method, the time line to collect the data, and the reporting format. The Executive Officer shall approve the plan upon determining that it provides for effective collection of data from a sample of vehicles that, at a minimum, is fifteen vehicles per group, will likely result in the collection and submittal of data within the required time frame, will generate data that are representative of California drivers and temperatures, and does not, by design, exclude or include specific vehicles in an attempt to collect data only from vehicles with the highest in-use performance ratios.

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(3.6) Upon request of the manufacturer, the Executive Officer may for good cause extend the twelve month time requirement set forth in section (l)(3.1) up to a maximum of eighteen months. In granting additional time, the Executive Officer shall consider, among other things, information submitted by the manufacturer to justify the delay, sales volume of the group(s), and the sampling mechanism utilized by the manufacturer to procure vehicles for data collection. If an extension beyond twelve months is granted, the manufacturer shall additionally be required to submit an interim report within twelve months for data collected up to the time of the interim report.

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(m) INTERMEDIATE IN-USE COMPLIANCE STANDARDS

(1) For 2010 through 2012 model year engines:

(1.1) For monitors that are required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2.5 times any of the applicable standards):

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(1.1.1) On the OBD parent rating (i.e., the engine rating subject to the "full OBD" requirement under section (d)(7.1.1)), the Executive Officer may not consider an OBD system noncompliant unless a representative sample indicates emissions exceed 2.0 times the malfunction criteria (e.g., 5.0 times the standard if the malfunction criterion is 2.5 times the standard) without MIL illumination on either of the applicable standards (i.e., FTP or SET).

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(1.1.2) On the OBD child ratings (i.e., the engine ratings subject to the "extrapolated OBD" requirement under section (7.1.2)), the Executive Officer may not consider an OBD system noncompliant based on emission levels.

(1.2) The Executive Officer shall use only the test cycle and standard determined and identified by the manufacturer at the time of certification in accordance with section (d)(6.1) as the most stringent for purposes of determining OBD system noncompliance in section (m)(1.1.1).

(2) For 2013 through 2015 model year engines:

(2.1) For monitors that are required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2.0 times any of the applicable standards):

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(2.1.1) On all OBD parent ratings and OBD child ratings subject to section (d)(7.2.2), the Executive Officer may not consider an OBD system noncompliant unless a representative sample indicates emissions exceed 2.0 times the malfunction criteria (e.g., 4.0 times the standard if the

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malfunction criterion is 2.0 times the standard) without MIL illumination on either of the applicable standards (i.e., FTP or SET).

(2.1.2) On all other engine ratings, the Executive Officer may not consider an OBD system noncompliant based on emission levels.

(2.2) The Executive Officer shall use only the test cycle and standard determined and identified by the manufacturer at the time of certification in accordance with section (d)(6.1) as the most stringent for purposes of determining OBD system noncompliance in section (m)(2.1.1).

(2.3) For monitors subject to meeting the minimum in-use monitor performance ratio of 0.100 in section (d)(3.2.2), the Executive Officer may not consider an OBD system noncompliant unless a representative sample indicates the in-use ratio is below 0.050.

(3) For 2016 through 2019 model year engines:

(3.1) For monitors of the PM filter subject to the malfunction criteria of section (e)(8.2.1)(B), the Executive Officer may not consider the PM filter monitor noncompliant with the malfunction threshold of section (e)(8.2.1)(B) unless a representative sample indicates emissions exceed 2.0 times the malfunction criteria (e.g., PM emission level of 0.06 g/bhp-hr if the malfunction criterion is 0.03 g/bhp-hr) without MIL illumination on either of the applicable standards (i.e., FTP or SET).

(3.2) For all ratings subject to section (d)(7.2.3) for extrapolated OBD in 2013 through 2015, the Executive Officer may not consider an OBD system noncompliant unless a representative sample indicates emissions exceed 2.0 times the malfunction criteria (e.g., 4.0 times the standard if the malfunction criterion is 2.0 times the standard) without MIL illumination on either of the applicable standards (i.e., FTP or SET),

(4) For 2010 and subsequent model year engines, the Executive Officer may not consider an OBD system noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

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NOTE: Authority cited: Sections 39600, 39601, 43000.5, 43013, 43018, 43100, 43101, 43104, 43105, 43105.5, and 43106, Health and Safety Code. Reference: Sections 39002, 39003, 39010-39060, 39515, 39600-39601, 43000, 43000.5, 43004, 43006, 43013, 43016, 43018, 43100, 43101, 43102, 43104, 43105,43105.5, 43106, 43150-43156, 43204, 43211, and 43212, Health and Safety Code.