FINAL REGULATION ORDER

Amend section 1968.2, title 13**,** California Code of Regulations, to read as follows:

(Note: The proposed amendments are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions from the existing regulatory text.)

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

(a) *Purpose.*

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

(b) *Applicability.*

Except as specified elsewhere in this regulation (title 13, CCR section 1968.2), all 2004 and subsequent model-year vehicles, defined as passenger cars, light-duty trucks, and medium-duty vehicles, including medium-duty vehicles with engines certified on an engine dynamometer and medium-duty passenger vehicles, shall be equipped with an OBD II system ~~and shall meet~~that has been certified by the Executive Officer as meeting all applicable requirements of this regulation (title 13, CCR section 1968.2). Except as specified in section (d)(2.2.5), medium-duty vehicles with engines certified on an engine dynamometer may comply with these requirements on an engine model year certification basis rather than a vehicle model year basis.

(c) *Definitions.*

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

"*Active off-cycle credit technology*" refers to a technology that generates off-cycle credits in accordance with title 13, CCR section 1961.3(a)(8) or 40 Code of Federal Regulations (CFR) §86.1869-12, as applicable, and that must be activated by the vehicle or driver in order to provide a carbon dioxide (CO_2) reduction benefit. Examples of active off-cycle credit technologies include active aerodynamic features (e.g., grill shutters or ride height that is automatically adjusted by the vehicle control system based on vehicle speed or other conditions), active engine warmup

technologies, and driver coaching and/or feedback systems that encourage the driver to alter his/her actions to maximize efficiency. Examples of off-cycle credit technologies that are not required to be tracked under section (g)(6) include non-active technologies such as solar glazing and solar reflective paint, thermal control technologies specified in title 13, CCR section 1961.3(a)(8)(A)1.a. or 40 CFR §86.1869-12(b)(1)(viii), engine idle stop-start systems, driver-activated technologies where the driver does not have a less efficient selectable option (e.g., high efficiency exterior lights), and technologies related solely to heating, ventilation, and air conditioning for vehicle cabin conditioning.

"*Alternate-fueled vehicle*" refers to a vehicle with an engine using a fuel different from or in addition to gasoline fuel or diesel fuel (e.g., compressed natural gas (CNG), liquefied petroleum gas). For the purposes of this regulation, alternate-fueled vehicles include vehicles with dedicated alternate-fueled engines (i.e., engines designed to operate exclusively on the alternate fuel) and engines that can use more than one type of fuel but cannot be reasonably operated in-use exclusively on gasoline or diesel fuel (e.g., engines with diesel pilot injection and CNG main injection where engine operation is limited to idle if CNG fuel is not available or engines which use gasoline-only operation during cold start and CNG-only operation for the rest of the driving cycle and engine operation defaults to a limp-home restricted speed and load if CNG fuel is not available). For vehicles with engines that can use more than one type of fuel but can be operated in-use exclusively on gasoline or diesel fuel, the vehicles are considered alternate-fueled vehicles only for the portion of operation the engine uses a fuel other than exclusively gasoline or diesel (e.g., a gasoline and CNG vehicle with an engine that can operate exclusively on gasoline is considered an alternate-fueled vehicle only while operating on CNG and is not subject to the provisions or relief of this regulation for alternate-fueled vehicles while operating exclusively on gasoline). For alternate-fueled vehicles, the manufacturer shall meet the requirements of section (d)(7.1).

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

requirements no later than two model years following the last year of the scheduled phase-in.

For alternate phase-in schedules resulting in all vehicles complying one model year following the last year of the scheduled phase-in, the compliance volume shall be calculated as described directly above. For example, a 30/60/100 percent scheduled phase-in during the 2010-2012 model years would have a cumulative total of 310. If the manufacturer's planned alternate phase-in schedule is 40/50/80/100 percent during the 2010-2013 model years, the final compliance volume calculation would be (40*3 years) + (50*2 years) + (80*1 year) = 300, which is less than 310 and therefore would not be acceptable as an alternate phase-in schedule.

For alternate phase-in schedules resulting in all vehicles complying two model years following the last year of the scheduled phase-in, the compliance volume calculation shall be calculated as described directly above and shall also include a negative calculation for vehicles not complying until one or two model years following the last year of the scheduled phase-in. The negative calculation shall be calculated by multiplying the percent of vehicles not meeting the new requirements in the final year of the phase-in by negative one and the percent of vehicles not meeting the new requirements in the one year after the final year of the phase-in by negative two. For example, if 10 percent of a manufacturer's vehicles did not comply by the final year of the scheduled phase-in and 5 percent did not comply by the end of the first year after the final year of the scheduled phase-in, the negative calculation result would be (10*(-1 years)) + (5*(-2 years)) = -20. The final compliance volume calculation is the sum of the original compliance volume calculation and the negative calculation. For example, a 30/60/100 percent scheduled phase-in during the 2010-2012 model years would have a cumulative total of 310. If a manufacturer's planned alternate phase-in schedule is 40/70/80/90/100 percent during the 2010-2014 model years, the final compliance volume calculation would be (40*3 years) + (70*2 years) + (80*1 year) + (20*(-1 year)) + (10*(-2 years)) = 300, which is less than 310 and therefore would not be acceptable as an alternate phase-in schedule.

"*Applicable standards*" refers to the specific exhaust emission standards or family emission limits (FEL) of the Federal Test Procedure (FTP) to which the vehicle or engine is certified. For 2010 and subsequent model year diesel engines, "applicable standards" shall also refer to the specific exhaust emission standards or family emission limits (FEL) of either the FTP or the Supplemental Emission Test (SET) to which the engine is certified, as determined according to section (d)(6).

"Auxiliary Emission Control Device (AECD)" refers to any approved AECD (as defined by 40 ~~Code of Federal Regulations (~~CFR~~)~~ 86.082-2 and 86.094-2).

"Emission Increasing Auxiliary Emission Control Device (EI-AECD)" refers to any approved AECD that: reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use; and the need for the AECD is justified in terms of protecting the vehicle against damage or accident. For medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, an AECD that is certified as an NTE deficiency shall not be considered an EI-AECD. An AECD that does not sense, measure, or calculate any parameter or command or trigger any action, algorithm, or alternate strategy shall not be

considered an EI-AECD. An AECD that is activated solely due to any of the following conditions shall not be considered an EI-AECD: (1) operation of the vehicle above 8000 feet in elevation; (2) ambient temperature; (3) when the engine is warming up and is not reactivated once the engine has warmed up in the same driving cycle; (4) failure detection (storage of a fault code) by the OBD system; (5) execution of an OBD monitor; or (6) execution of an infrequent regeneration event.

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

"Calculated load value" refers to an indication of the percent engine capacity that is being used and is defined in ~~Society of Automotive Engineers~~ SAE International (SAE) J1979 "E/E Diagnostic Test Modes", (SAE J1979), incorporated by reference (section (g)(1.4)[1]). For diesel applications, in lieu of the definition in SAE J1979, the calculated load value may alternatively be determined by the ratio of current engine ~~output~~ torque to maximum engine ~~output~~ torque at current engine speed as defined by suspect parameter number (SPN) 92 of SAE J1939 "~~Recommended Practice for a~~ Serial Control and Communications Heavy Duty Vehicle Network – Top Level Document" (SAE J1939), incorporated by reference.

"*Charge depleting operation*" means the state of vehicle operation when the current battery state of charge (SOC) is higher than the charge sustaining target SOC value and, while it may fluctuate, the intent of the vehicle control system is to deplete the SOC from a higher level down to the charge sustaining target SOC value. For the purposes of tracking grid energy consumed during charge depleting operation in section (g)(6.4), charge depleting operation shall also include when the vehicle is connected to the grid for charging. For the purposes of defining the transition of the control system from charge depleting operation to charge sustaining operating once the charge sustaining target SOC value has been met, the first occurrence of fueled engine operation once the SOC is less than or equal to the charge sustaining target SOC value shall be used as the transition point.

"*Charge sustaining operation*" means the state of vehicle operation when the battery SOC may fluctuate but the intent of the vehicle control system is to maintain, on average, the current SOC. Examples of this state include when a plug-in hybrid electric vehicle is operating as a conventional hybrid vehicle (i.e., if the vehicle has depleted all of the grid energy from the battery and is controlling to the charge sustaining target SOC value) as well as operation in any driver-selectable modes designed to maintain the current SOC (e.g., a 'hold' button intended to save electric drive operation for later in the driving cycle, a 'charge now' button after it has reached its target SOC and the intent of the control system is to maintain, on average, that target SOC, etc.).

"*Charge sustaining target SOC value*" means the nominal target SOC that the control system is designed to maintain, on average, when operating as a conventional hybrid vehicle after depletion of any grid energy in the battery.

"Confirmed fault code" is defined as the diagnostic trouble code stored when an OBD II system has confirmed that a malfunction exists (e.g., typically on the second

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

driving cycle that the malfunction is detected) in accordance with the requirements of sections (e), (f), and (g)(4.4).

"Continuously," if used in the context of monitoring conditions for circuit continuity, lack of circuit continuity, circuit faults, and out-of-range values, means monitoring is always enabled, unless alternate enable conditions have been approved by the Executive Officer in accordance with section (d)(3.1.1), and sampling of the signal used for monitoring occurs at a rate no less than two samples per second. If for control purposes, a computer input component is sampled less frequently, 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 vehicle.

"Diagnostic or emission critical" electronic powertrain control unit refers to the engine and transmission control unit(s). For the 2005 and subsequent model years, it also includes any other on-board electronic powertrain control unit ~~containing software~~ that:

(1) has primary control over any of the monitors required by sections (e)(1~~.0~~) through (e)(14~~.0~~), (e)(16~~.0~~), (f)(1) through (f)(14), and (f)(16)<u>, but does not include circuit or out-of-range fault monitors required by sections (e)(7.2.1)(B), (e)(7.2.2)(B), (e)(7.2.2)(D), (e)(7.2.3)(B), (e)(10.2.2)(A), (f)(5.2.1)(A)(ii), (f)(5.2.1)(B)(ii), (f)(5.2.2)(B), (f)(5.2.4)(B), and (f)(11.2.2)(A);</u> or,

(2) ~~excluding~~ <u>except for</u> anti-lock brake system (ABS) control units or stability/traction control units, has primary control over ~~the~~ <u>any rationality fault</u> diagnostic~~s~~ <u>or functional check</u> for more than <u>four input components or more than</u> two ~~of the~~<u>output</u> components required to be monitored by sections (e)(15~~.0~~) and (f)(15)~~.~~<u>; or</u>

<u>(3) for 2019 and subsequent model year vehicles, except for anti-lock brake system (ABS) control units or stability/traction control units, is field reprogrammable and has primary control over any rationality fault diagnostic or functional check for any input or output component required to be monitored by sections (e)(15) and (f)(15).</u>

<u>For purposes of criteria (1) through (3) above, "primary control" over a monitor means the control unit does any of the following: (a) determines if any enable conditions are satisfied; (b) calculates all or part of the diagnostic decision statistic or metric by which pass or fail decisions are made (e.g., the comparison of a component's measured or calculated level of performance to a fault threshold); or (c) makes or processes pass or fail decisions (e.g., debounces diagnostic decision statistics or commands MIL illumination or fault code storage). Further, ~~F~~</u>for purposes of criterion (2) above, all glow plugs in an engine shall be considered "one" component in lieu of each glow plug being considered a separate component. <u>For purposes of criteria (2) and (3) above, "input component" and "output component" includes hybrid components required to be monitored in accordance with the requirements under section (e)(15.2.1), (e)(15.2.2), (f)(15.2.1), or (f)(15.2.2).</u>

"Diesel engine~~s~~" refers to <u>an</u> engine~~s~~ using a compression ignition thermodynamic cycle.

<u>*"Diesel vehicle"* refers to a vehicle with a diesel engine.</u>

"*Driver-selectable charge increasing operation*" means the state of vehicle operation where both: (a) the driver has selected a mode of operation different than the default or normal mode of the vehicle that is intended to increase the battery SOC (e.g., 'charge now' button); and (b) that the current intent of the vehicle control system is to increase the battery SOC from its current level to a higher SOC target value (i.e., the current SOC is lower than the target SOC). This state does not include operation in a driver-selectable mode where the control system has reached the target SOC and is now operating with the intent to maintain, on average, the target SOC. For the purposes of defining the transition of the control system from an intent to increase the SOC to an intent to maintain the SOC once the target has been reached, either the first time the SOC is greater than or equal to the target SOC or the first occurrence of engine off once the SOC is greater than or equal to the target SOC shall be used as the transition point. For continued operation in the driver-selectable mode once the system has transitioned to an intent to maintain the SOC, the operation shall be considered charge sustaining operation unless the actual SOC falls below the target SOC by more than five percent at which time the system will be considered as transitioned back to an intent to increase the SOC (driver-selectable charge increasing operation).

"Driving cycle" is defined as a trip that consists of engine start~~up~~ and engine shutoff and may include~~s~~ the period of engine off time up to the next engine start~~up~~. For monitors that run during engine-off conditions, the period of engine off time following engine shutoff and up to the next engine start shall be considered part of the driving cycle. For vehicles that employ engine shutoff strategies (e.g., engine shutoff at idle), the manufacturer may request Executive Officer approval to use an alternate definition for driving cycle (e.g., key on and key off). Executive Officer approval of the alternate definition shall be based on equivalence to engine start~~up~~ and engine shutoff signaling the beginning and ending of a single driving event for a conventional vehicle. For applications that are used in both medium-duty and heavy-duty classes, the manufacturer may use the driving cycle definition of title 13, CCR, section 1971.1 in lieu of this definition. 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.

~~"*Emission standard*," as it applies to OBD compliance and the remedies provided for in the Health and Safety Code for noncompliance, relates to the emission characteristics of a motor vehicle and engine and means:~~

~~(1) a numerical limit on the amount of a given pollutant that a motor vehicle or motor vehicle engine may emit into the atmosphere; or~~

~~(2) a requirement that a motor vehicle or motor vehicle engine be equipped with a certain type of pollution-control device or some other design feature related to the control of emissions.~~

~~*"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.~~

"Emissions neutral default action" refers to any compensating control action or default mode of operation that meets all the following conditions:

(1) it cannot measurably increase emissions during any reasonable in-use driving condition,
(2) it does not cause any OBD II monitoring system to complete monitoring less frequently than required or cause its monitoring to be inaccurate,
(3) the compensating control action or default mode of operation remains activated for the remainder of the driving cycle. If the emissions neutral diagnostic and emissions neutral default action in the worst case take more than 30 seconds (from engine start or the first effect of the monitored system or component in the driving cycle) to detect the associated malfunction and completely achieve the emissions-neutral state, it must remain activated across driving cycles until: (a) the diagnostic that activated it has run and determined that a malfunction is no longer present or (b) the fault has been cleared with an external diagnostic tool,
(4) the OBD II system monitors and illuminates the MIL for any fault that prevents the compensating control action or default mode of operation from being activated (e.g., communication failure between modules prevents the default action from occurring) when the emissions neutral diagnostic that controls the control action or default mode of operation has detected that a fault is present, and
(5) if the default mode of operation prevents propulsion of the vehicle (e.g., no start condition, stuck in park condition), it is not activated by a component with a cost meeting or exceeding that of a "high-price" warranted part as defined by title 13, CCR section 2037(c).

"Emissions neutral diagnostic" refers to a monitoring strategy required pursuant to section (e)(15) or (f)(15) that meets the following conditions: (1) the diagnostic activates an emissions neutral default action (as defined in section (c)) when it detects a malfunction that would otherwise increase emissions or negatively impact OBD II system performance, and (2) the diagnostic is located within a diagnostic or emission critical electronic powertrain control unit or a control unit meeting the automotive safety integrity level C or D specifications as defined in International Organization for Standardization (ISO) 26262-5 (November 15, 2011), unless the manufacturer demonstrates to the satisfaction of the Executive Officer that the control unit the diagnostic is located within is not likely to be tampered with in-use. An example of an emissions neutral diagnostic is a cruise control system with a default action that disables cruise control when a system malfunction has been detected. Another example of an emissions neutral diagnostic is a monitoring system that overrides disablement of the engine start-stop system based on inputs from the steering angle sensing system when a malfunction in the steering angle sensing system has been detected.

"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, etc.), the manufacturer may request Executive Officer approval to use an alternate definition for engine start (e.g., ignition key "on"). Executive Officer approval of the alternate definition shall be based on equivalence to an engine start for a conventional vehicle.

~~"*Evaporative emission standards*" are a subset of emission standards that refer to the specific motor vehicle fuel evaporative emission standards and test procedures incorporated by reference in title 13, CCR section 1976 to which a vehicle is certified.~~

~~"*Exhaust emission standards*" or "*tailpipe emission standards*" are a subset of emission standards that collectively refer to the specific FTP standards and SET standards to which a vehicle is certified.~~

"*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.

"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 1961(d) that is used to determine compliance with the FTP standard to which a vehicle is certified.

"FTP cycle". For passenger vehicles, light-duty trucks, and medium-duty vehicles certified on a chassis dynamometer, FTP cycle refers to the driving schedule in Code of Federal Regulations (CFR) 40, Appendix 1, Part 86, section (a) entitled, "EPA Urban Dynamometer Driving Schedule for Light-Duty Vehicles and Light-Duty Trucks." For medium-duty engines certified on an engine dynamometer, FTP cycle refers to the engine dynamometer schedule in CFR 40, Appendix 1, Part 86, section (f)(1), entitled, "EPA Engine Dynamometer Schedule for Heavy-Duty Otto-Cycle Engines," or section (f)(2), entitled, "EPA Engine Dynamometer Schedule for Heavy-Duty Diesel Engines."

"FTP standard" refers to the certification tailpipe exhaust emission full useful life standards and test procedures applicable to the FTP cycle and to the class to which the vehicle is certified.

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

<u>*"50ºF FTP"* refers to the "50ºF Emission Test Procedure" defined in the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles," incorporated by reference in title 13, CCR section 1961.2.</u>

<u>*"Field reprogrammable"* means a control unit or device is capable of supporting a manufacturer service procedure intended to be executed in a dealership or other vehicle service environment that results in the downloading of new software and/or calibration data into the control unit or device.</u>

"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.

"Fueled engine operation" is the state where any fuel is introduced into the engine for the purpose of combustion.

"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 using a spark ignition thermodynamic cycle ~~or an alternate-fueled engine~~.

"*Gasoline vehicle*" refers to a vehicle with a gasoline engine.

"*Grid energy*", for the purposes of tracking grid energy parameters in section (g)(6.4), means all energy into the battery while connected to grid power (e.g., plugged-in) and with the engine off. Grid energy shall not include electrical losses between the grid and the battery (e.g., from on-board charger inefficiency) or energy directly used by the vehicle without first going into the battery (e.g., electricity utilized directly from before or after the on-board charger to power on-vehicle devices for cabin conditioning, charging control, etc.). For the purposes of tracking grid energy consumed during charge depleting operation in section (g)(6.4), energy consumed (i.e., out of the battery) shall be considered non-grid energy until all non-grid energy is depleted. Additionally, on any trip where the vehicle transitions from charge depleting operation to charge sustaining operation once the charge sustaining target SOC value has been met, the values currently assumed for grid and non-grid energy remaining in the battery shall be reset to zero to minimize the accumulation of errors over time.

"*Non-grid energy*", for the purposes of tracking grid energy parameters in section (g)(6.4), means all energy into the battery during charge depleting operation and during driver-selectable charge increasing operation from any source other than grid power (i.e., while not connected to a source of power for charging). Examples of non-grid energy include energy recovered during braking and energy supplied to the battery during engine operation. If an engine running condition exists while connected to a source of grid power for charging, all energy going into the battery during the engine running event shall be considered non-grid energy. Non-grid energy may not include any energy into the battery during charge sustaining operation.

"Highway Fuel Economy Driving Cycle" refers to the "Highway Driving Schedule" defined in Part II of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles," incorporated by reference in section 1961.2, title 13, CCR.

"*Highway Fuel Economy Test (HWFET)*" refers to test defined in 40 CFR 600 Subpart B or 40 CFR §1066.840 with the migration provisions of §600.111-08 introduction.

"*Hybrid vehicle*" refers to a vehicle (including a plug-in hybrid electric vehicle) that can draw propulsion energy from either or both of the following on-vehicle sources of stored energy: 1) a consumable fuel and 2) an energy storage device such as a battery, capacitor, or flywheel.

"*Ignition cycle,"* except as noted below for hybrid vehicles, means a trip 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. For hybrid vehicles, "ignition cycle" means a trip that begins when the propulsion system active definition

is met for at least two seconds plus or minus one second, and ends when the propulsion system active definition is no longer met.

"*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 not in the state of propulsion system active and not with the engine ~~not~~ running.

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

"Low Emission Vehicle I application" refers to a vehicle or engine certified in California to the exhaust emission standards defined in title 13, CCR sections 1956.8(g), 1960.1(g)(1), and 1960.1(h)(1) for any of the following vehicle emission categories: Transitional Low Emission Vehicle (TLEV), Low Emission Vehicle (LEV), Ultra Low Emission Vehicle (ULEV), or Super Ultra Low Emission Vehicle (SULEV). Additionally, vehicles certified to Federal emission standards (bins) in California but categorized in a Low Emission Vehicle I vehicle emission category for purposes of calculating non-methane organic gas (NMOG) fleet average in accordance with the certification requirements and test procedures incorporated by reference in title 13, CCR section 1961 (d) are subject to all monitoring requirements applicable to Low Emission Vehicle I applications but shall use the Federal tailpipe emission standard (i.e., the Federal bin) for purposes of determining the malfunction thresholds in sections (e) and (f).

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

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

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

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

"Low Emission Vehicle II application" refers to a vehicle or engine certified in California to the exhaust emission standards defined in title 13, CCR section 1961, or optionally certified to the exhaust emission standards defined in title 13, CCR section 1956.8, for any of the following emission categories: LEV, ULEV, or SULEV. Additionally, except as provided for in sections (e)(17.1.3) and (f)(17.1.2), vehicles certified to Federal emission standards (bins) in California but categorized in a Low Emission Vehicle II vehicle emission category for purposes of calculating NMOG fleet average in accordance with the certification requirements and test procedures incorporated by reference in title 13, CCR section 1961 (d) are subject to all monitoring requirements applicable to Low Emission Vehicle II applications but shall use the Federal tailpipe emission standard (i.e., the Federal bin) for purposes of determining the malfunction thresholds in sections (e) and (f).

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

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

"LEV II vehicles" refer only to Low Emission Vehicle II applications certified to the LEV vehicle emission category.

"ULEV II vehicles" refer only to Low Emission Vehicle II applications certified to the ULEV vehicle emission category.

"Low Emission Vehicle III application" refers to a vehicle or engine certified in California to the exhaust emission standards defined in title 13, CCR section 1961.2, Additionally, vehicles certified to Federal emission standards (bins) in California but categorized in a Low Emission Vehicle III vehicle emission category for purposes of calculating NMOG+NOx fleet average in accordance with the certification requirements and test procedures incorporated by reference in title 13, CCR section 1961.2 (d) are subject to all monitoring requirements applicable to Low Emission Vehicle III applications but shall use the Federal tailpipe emission standard (i.e., the Federal bin) for purposes of determining the malfunction thresholds in sections (e) and (f).

"LEV160 vehicles" refer only to Low Emission Vehicle III applications certified to the LEV160 vehicle emission category.

"ULEV125 vehicles" refer only to Low Emission Vehicle III applications certified to the ULEV125 vehicle emission category.

"ULEV70 vehicles" refer only to Low Emission Vehicle III applications certified to the ULEV70 vehicle emission category.

"ULEV50 vehicles" refer only to Low Emission Vehicle III applications certified to the ULEV50 vehicle emission category.

"SULEV30 vehicles" refer only to Low Emission Vehicle III applications certified to the SULEV30 vehicle emission category.

"SULEV20 vehicles" refer only to Low Emission Vehicle III applications certified to the SULEV20 vehicle emission category.

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

"Medium-duty vehicle" or "MDV" is defined in title 13, CCR section 1900 (b).

"Medium-duty passenger vehicle" or *"MDPV"* is defined in Title 40, Section 86.1803-01, Code of Federal Regulations.

"Mild hybrid electric vehicle" means a hybrid vehicle that has start/stop capability and regenerative braking capability, where the recaptured braking energy over the FTP is at least 15 percent but less than 75 percent of the total braking energy, where the percent of recaptured braking energy is measured and calculated according to 40 CFR §600.116(d).

"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.

"*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.

"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 86.1370-2007(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 86.1370-2007(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).

"Normal production" is the time after the start of production when the manufacturer has produced two percent of the projected volume for the test group or calibration, whichever is ~~being evaluated in accordance with~~specified in sections (j) and (k).

"Passenger car" is defined in title 13, CCR section 1900 (b).

"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 (e), (f), and (g)(4.4).

"~~Percentage of misfire~~*Percentage of misfire*" as used in (e)(3.2) and (f)(3.2) means the percentage of misfires out of the total number of ~~firing~~ intended combustion events for the specified interval.

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

"*Plug-in hybrid electric vehicle*" ~~refers to a hybrid vehicle that has the capability to charge a battery from an off-vehicle electric energy source that cannot be connected or coupled to the vehicle in any manner while the vehicle is being driven~~ means an "off-vehicle charge capable" hybrid electric vehicle as defined in the "California Exhaust Emission Standards and Test Procedures for 2018 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," incorporated by reference in title 13, CCR section 1962.2.

"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).

"Propulsion system active" is the state where the powertrain (e.g., engine, electric machine) is enabled by the driver (e.g., after ignition on for conventional vehicles, after power button pushed for some hybrid vehicles, or after remote start activation) such that the vehicle is ready to be used (e.g., vehicle is ready to be driven, ready to be shifted from "park" to "drive", heating, ventilation, and air conditioning (HVAC) turned on to condition cabin prior to driving). For purposes of this definition, "the state where the powertrain is enabled" does not include activations that are not driver-initiated (e.g., conditions where portions of the vehicle system wake up to perform OBD II monitoring or off-board charging). This state

also does not include remote start activations that cannot cause the engine to start (e.g., in a remote activation to condition the cabin, the engine will not start until there is further action by the driver to enable the vehicle for operation regardless of cabin conditioning demand or length of cabin conditioning operation).

"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 from when the sensor is exposed to a different make-up of exhaust gas constituents until it outputs a signal reflecting the different make-up of exhaust gas constituents. For example, for oxygen sensors, response rate is the delay from when the oxygen sensor is exposed to a change in exhaust gas from richer/leaner than stoichiometric to leaner/richer than stoichiometric to the time when the oxygen sensor indicates the lean/rich condition. This includes delays in the sensor to initially react to a change in exhaust gas composition (i.e., delayed response) as well as slower transitions from a rich-to-lean (or lean-to-rich) sensor output (i.e., slow response). Similarly, for wide-range air-fuel (A/F) sensors, response rate is the delay from when the sensor is exposed to a different A/F ratio to the time it indicates the different A/F ratio. For NOx and PM sensors, response rate is the delay from when the sensor is exposed to a different NOx or PM exhaust gas level until it indicates the different NOx or PM exhaust gas level.

"Safety-only component or system" refers to a component or system that is designed and intended to be used by the vehicle solely to prevent or mitigate personal injury to the vehicle occupant(s), pedestrians, and/or service technicians. Examples include traction control systems, anti-lock braking systems, hybrid high voltage containment systems (e.g., high voltage interlock loop, high voltage isolation detection), and lane departure control systems.

"SC03 emission standards" refers to the certification tailpipe exhaust emission standards for the air conditioning (A/C) test of the Supplemental Federal Test Procedure Off-Cycle Emission Standards specified in title 13, CCR section 1961(a) applicable to the class to which the vehicle is certified.

"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)(3), (e)(6), (f)(3), and (f)(4) means engine conditions having an engine speed within 375 rpm, load conditions within 20 percent, and the same warm-up status (i.e., cold or hot) as the engine conditions stored pursuant to (e)(3.4.45), (e)(6.4.5), (f)(3.4.2)(C), and (f)(4.4.2)(E). The Executive Officer may approve other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine operation.

"Small volume manufacturer" is defined in title 13, CCR section 1900(b). However, for a manufacturer that transitions from a small volume manufacturer to a non-small volume manufacturer, the manufacturer is still considered a small volume manufacturer for the first three model years that it no longer meets the definition in title 13, CCR section 1900(b).

"Smart device" refers to an electronic powertrain component or system that uses a microprocessor or microcontroller and does not meet the criteria to be classified as a "diagnostic or emission critical electronic powertrain control unit." Devices that provide high level control of transmissions or battery packs are excluded from this definition. Any component or system externally connected to the smart device shall not be considered part of the smart device unless:

(1) It is a subcomponent integral to the function of the smart device;

(2) It is permanently attached to the smart device with wires or one-time connectors; and

(3) The smart device and subcomponent are designed, manufactured, installed, and serviced (per manufacturer published procedures) as a single component.

"Strong hybrid electric vehicle" means a hybrid vehicle that has start/stop capability and regenerative braking capability, where the recaptured braking energy over the FTP is at least 75 percent of the total braking energy, where the percent of recaptured braking energy is measured and calculated according to 40 CFR §600.116(d).

"*Supplemental Emission Test (SET) cycle*" refers to the driving schedule defined as the "supplemental steady state emission test" in 40 CFR 86.1360-2007, as amended July 13, 2005.

"Supplemental Federal Test Procedure (SFTP) Composite Emission Standard" refers to the "SFTP NMOG+NOx and CO Composite Exhaust Emission Standards" defined in the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles," incorporated by reference in title 13, CCR section 1961.2.

"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.

"Unified cycle" refers to the "Unified Cycle Driving Schedule" ~~is~~ defined in ~~"Speed Versus Time Data for California's Unified Driving Cycle", dated December 12, 1996, incorporated by reference~~ Part II of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles," incorporated by reference in title 13, CCR section 1961.2.

"US06 cycle" refers to the driving schedule in 40 CFR 86, Appendix 1, section (g), as amended July 13, 2005, entitled, "EPA US06 Driving Schedule for Light-Duty Vehicles and Light-Duty Trucks."

"Warm-up cycle" means a driving cycle with sufficient vehicle operation such that the coolant temperature has risen by at least 40 degrees Fahrenheit or 22.2 degrees Celsius from engine start~~ing~~ and reaches a minimum temperature of at least 160 degrees Fahrenheit or 71.1 degrees Celsius (140 degrees Fahrenheit or 60 degrees Celsius for applications with diesel engines). Alternatively, manufacturers may define warm-up cycle as a driving cycle with vehicle operation in which the criteria specified in sections (d)(2.5.2)(B)(iii)a. (or f. if applicable), b., and c. are met.

(d) *General Requirements.*

Section (d) sets forth the general requirements of the OBD II system. Specific performance requirements for components and systems that shall be monitored are set forth in sections (e) and (f) below.

(1) *The OBD II System*.

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

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

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

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

(2) *MIL and Fault Code Requirements*.

(2.1) MIL Specifications.

(2.1.1) The MIL shall be located on the driver's side instrument panel and be of sufficient illumination and location to be readily visible under all lighting conditions and shall be amber in color when illuminated. The MIL, when illuminated, shall display the phrase "Check Engine" or "Service Engine Soon". The word "Powertrain" may be substituted for "Engine" in the previous phrases. Alternatively, the International Standards Organization (ISO) engine symbol may be substituted for the word "Engine" or for the entire phrase.

(2.1.2) The MIL shall illuminate in the key on, engine off position before engine cranking to indicate that the MIL is functional. <u>For all 2019 and subsequent model year vehicles containing a non-analog MIL (e.g., liquid-crystal display), any delay in MIL illumination prior to the functional check may not exceed 5 seconds.</u> For all 2005 and subsequent model year vehicles, the MIL shall continuously illuminate during this functional check for a minimum of 15~~-20~~ seconds. During this functional check of the MIL, the data stream value for MIL status shall indicate commanded off (see section (g)(4.2)) unless the MIL has also been commanded on for a detected malfunction. This functional check of the MIL is not required

during vehicle operation in the key on, engine off position subsequent to the initial engine cranking of each driving cycle (e.g., due to an engine stall or other non-commanded engine shutoff).

(2.1.3) At the manufacturer's option, the MIL may be used to indicate readiness status in a standardized format (see section (g)(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 activated during a California Inspection and Maintenance 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) Upon detection of a malfunction, the OBD II system shall store a pending fault code within ten seconds indicating the likely area of the malfunction.

(2.2.2) After storage of a pending fault code, if the identified malfunction is again detected before the end of the next driving cycle in which monitoring occurs, the MIL shall illuminate continuously and a confirmed fault code shall be stored within 10 seconds. Additionally, the pending fault code shall continue to be stored in accordance with section (g)(4.4.5). 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) shall be erased at the end of the driving cycle.

(2.2.3) Except as provided for in section (d)(2.6), ~~T~~the OBD II system shall illuminate the MIL and store a pending fault code and confirmed fault code within 10 seconds to inform the vehicle operator whenever the powertrain enters a default or "limp home" mode of operation that can affect emissions or the performance of the OBD II system or in the event of a malfunction of any on-board computer(s) ~~itself~~ that can affect the performance of the OBD II system.

(A) If the default or "limp home" mode of operation is recoverable (i.e., the diagnostic or control strategy that caused the default or "limp home" mode of operation can run on the next driving cycle and confirm the presence of the condition that caused the default or "limp home" operation), the OBD II system may, in lieu of illuminating the MIL and storing a confirmed fault code within 10 seconds on the first driving cycle where the default or "limp home" mode of operation is entered, delay illumination of the MIL and storage of a confirmed fault code until the condition causing the default or "limp home" mode of operation is again detected before the end of the next driving cycle~~.~~, in which case the OBD II system shall illuminate the MIL and store a confirmed fault code within 10 seconds of detection.

(B) MIL illumination and fault code storage is not required for engine overtemperature default strategies that are only initiated after the

temperature gauge indicates a temperature in the red zone, or after an overtemperature "hot" light is illuminated, or due to the verified occurrence of severe operating conditions (e.g., extended trailer towing up a grade).

(2.2.4) For all 2010 and subsequent model year vehicles, the OBD II system shall default to a MIL on state if the instrument panel receives and/or processes instructions or commands from other diagnostic or emission critical electronic powertrain control units to illuminate the MIL and a malfunction occurs (e.g., communication is lost) such that the instrument panel is no longer able to properly receive the MIL illumination requests. Storage of a fault code is not required for this malfunction.

(2.2.5) For 50 percent of all 2010, 75 percent of all 2011, and 100 percent of all 2012 and subsequent model year vehicles (including 2012 model year medium-duty vehicles with 2011 model year engines certified on an engine dynamometer), before the end of an ignition cycle, the OBD II 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 (g)(4.4.6)).

(2.2.6) 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. Except as otherwise provided in section (e) for evaporative system malfunctions, strategies requiring on average more than six driving cycles for MIL illumination may not be accepted.

(2.2.7) A manufacturer shall store and erase "freeze frame" conditions (as defined in section (g)(4.3)) present at the time a malfunction is detected. A manufacturer shall store and erase freeze frame conditions in conjunction with storage and erasure of either pending or confirmed fault codes as required elsewhere in section (d)(2.2). <u>If freeze frame conditions are currently stored for a fault code, the freeze frame conditions may not be replaced with freeze frame conditions for another fault code except as allowed for gasoline and diesel misfire and fuel system monitors under sections (e)(3.4.5), (e)(6.4.4), (f)(3.4.2)(B), and (f)(4.4.2)(D).</u>

(2.3) Extinguishing the MIL.

Except as otherwise provided in sections (e)(3.4.~~5~~<u>6</u>), (e)(4.4.2), (e)(6.4.6), <u>(f)(2.4.2),</u> (f)(3.4.2)(D), and (f)(4.4.2)(F) <u>(</u>for <u>gasoline</u> misfire, <u>gasoline</u> evaporative system, ~~and~~ <u>gasoline</u> fuel system<u>, diesel empty reductant tank, diesel misfire, and diesel fuel system</u> malfunctions<u>, respectively)</u>, once the MIL has been illuminated<u>:</u>

<u>(2.3.1) For 2004 through 2018 model year vehicles,</u> ~~it~~<u>the MIL</u> ~~may~~ <u>shall</u> be extinguished after <u>at least</u> three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions and the previously detected malfunction is no longer present provided no other malfunction has been detected that would

independently illuminate the MIL according to the requirements outlined above.

(2.3.2) For 2019 and subsequent model year vehicles, the MIL shall be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions and the previously detected malfunction is no longer present provided no other malfunction has been detected that would independently illuminate the MIL according to the requirements outlined above.

(2.4) Erasing a confirmed fault code.

For 2004 through 2018 model year vehicles, ~~T~~the OBD II system may erase a confirmed fault code if the identified malfunction has not been again detected in at least 40 ~~engine~~ warm-up cycles, and the MIL is presently not illuminated for that malfunction. For 2019 and subsequent model year vehicles, the OBD II system shall erase a confirmed fault code: (1) no sooner than the end of the driving cycle in which the identified malfunction has not been again detected in at least 40 consecutive warm-up cycles and the MIL has not been illuminated for that malfunction for at least 40 consecutive warm-up cycles, and (2) no later than the end of the driving cycle in which no malfunction has been detected in 41 consecutive warm-up cycles and the MIL has not been illuminated for any malfunction for 41 consecutive warm-up cycles.

(2.5) Erasing a permanent fault code. The OBD system shall erase a permanent fault code under the following conditions:

(2.5.1) If the OBD II system is commanding the MIL on, the OBD II system shall erase a permanent fault code only if the OBD II system itself determines that the malfunction that caused the permanent fault code to be stored is no longer present and is not commanding the MIL on, pursuant to the requirements of section (d)(2.3) (which for purposes of this section shall apply to all monitors). Erasure of the permanent fault code shall occur in conjunction with extinguishing the MIL or no later than the start of the first driving cycle that begins with the MIL commanded off.

(2.5.2) If all fault information in the on-board computer other than the permanent fault code has been cleared (i.e., through the use of a scan tool or battery disconnect) and the OBD II system is not commanding the MIL on:

(A) Except as provided for in sections (d)(2.5.2)(C) through (~~E~~F), if the monitor of the malfunction that caused the permanent fault code to be stored is subject to the minimum ratio requirements of section (d)(3.2) (e.g., catalyst monitor, comprehensive component input component rationality ~~monitors~~fault diagnostics), the OBD II system shall erase the permanent fault code at the end of a driving cycle if the monitor has run and made one or more determinations during a driving cycle that the malfunction of the component or the system is not present and has not made any determinations within the same driving cycle that the malfunction is present.

(B) Except as provided for in sections (d)(2.5.2)(D)~~ and (E)~~ through (F), if the monitor of the malfunction that caused the permanent fault code to be stored is not subject to the minimum ratio requirements of section (d)(3.2) (e.g., gasoline misfire monitor, fuel system monitor, comprehensive

component circuit continuity monitors), the OBD II system shall erase the permanent fault code at the end of a driving cycle if:

(i) The monitor has run and made one or more determinations during a driving cycle that the malfunction of the component or the system is not present and has not made any determinations within the same driving cycle that the malfunction is present;

(ii) The monitor has not made any determinations that the malfunction is present subsequent to the most recent driving cycle in which the criteria of section (d)(2.5.2)(B)(i) are met; and

(iii) The following criteria are satisfied on any single driving cycle (which may be a different driving cycle than that in which the criteria of section (d)(2.5.2)(B)(i) are satisfied):

a. Except as provided in section (d)(2.5.2)(B)(iii)f. below, cumulative time since engine start is greater than or equal to 600 seconds;

b. Except as provided in section (d)(2.5.2)(B)(iii)e. below, cumulative vehicle operation at or above 25 miles per hour occurs for greater than or equal to 300 seconds (medium-duty vehicles with diesel engines certified on an engine dynamometer may use cumulative operation at or above 1150 rpm in lieu of at or above 25 miles per hour for purposes of this criteria);

c. Continuous vehicle operation at idle (i.e., accelerator pedal released by driver and either vehicle speed less than or equal to one mile per hour or engine speed less than or equal to 200 rpm above normal warmed-up idle (as determined in the drive position for vehicles equipped with an automatic transmission)) for greater than or equal to 30 seconds; and

d. For 2013 and subsequent model year engines, the monitor has not made any determination that the malfunction is present.

e. For 2004 through 2012 model year medium-duty vehicles with diesel engines certified on an engine dynamometer, manufacturers may use diesel engine operation at or above 15 percent calculated load in lieu of 1150 rpm for the criterion in section (d)(2.5.2)(B)(iii)b. above.

f. For hybrid vehicles, manufacturers shall use “cumulative propulsion system active time” in lieu of “cumulative time since engine start” for the criterion in section (d)(2.5.2)(B)(iii)a.

(iv) Monitors required to use “similar conditions” as defined in section (c) to store and erase pending and confirmed fault codes may not require that the similar conditions be met prior to erasure of the permanent fault code.

(C) For monitors subject to section (d)(2.5.2)(A), the manufacturer may choose to erase the permanent fault code using the criteria under section (d)(2.5.2)(B) in lieu of the criteria under section (d)(2.5.2)(A).

(D) For 2009 and 2010 model year vehicles meeting the permanent fault code requirements of section (d)(2.2.5), manufacturers may request Executive Officer approval to use alternate criteria to erase the permanent fault code. The Executive Officer shall approve alternate criteria that:

(i) Will not likely require driving conditions that are longer and more difficult to meet than those required under section (d)(2.5.2)(B), and

(ii) Do not require access to enhanced scan tools (i.e., tools that are not generic SAE J1978 scan tools) to determine conditions necessary to erase the permanent fault code.

(E) If alternate criteria to erase the permanent fault code are approved by the Executive Officer under section (d)(2.5.2)(D), a manufacturer may continue to use the approved alternate criteria for 2011 model year vehicles previously certified in the 2009 or 2010 model year to the alternate criteria and carried over to the 2011 model year.

(F) For the engine cooling system monitors required to detect faults specified under sections (e)(10.2.1)(A) and (B), (e)(10.2.2)(B), (f)(11.2.1)(A) and (B), and (f)(11.2.2)(B) (e.g., thermostat monitor and ECT sensor time to closed-loop monitor), the manufacturer may erase the permanent fault code using the criteria under section (d)(2.5.2)(A) in lieu of the criteria under section (d)(2.5.2)(B).

(2.5.3) If more than one permanent fault code are currently stored, the OBD II system shall erase a specific permanent fault code immediately after the monitor for the specific permanent fault code meets the criteria above in section (d)(2.5.1) or (d)(2.5.2). The OBD II system may not require that the criteria under section (d)(2.5.1) or (d)(2.5.2) be met for all the stored permanent fault codes before erasing a specific permanent fault code.

(2.6) Exceptions to MIL and Fault Code Requirements.

(2.6.1) If the vehicle enters a default mode of operation that can affect emissions or the performance of the OBD II system, a manufacturer may request Executive Officer approval to be exempt from illuminating the MIL and storing a fault code. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that verify that the default strategy:

(A) Causes an overt indication (e.g., vehicle operation limited to idle only) such that the driver is certain to respond and have the problem corrected,

(B) Is not otherwise caused by a component required to be monitored by the OBD II system under sections (e) through (f), and

(C) Is not invoked to protect a component required to be monitored by the OBD II system under sections (e) through (f).

(2.6.2) The manufacturer is exempt from illuminating the MIL and storing a fault code under section (d)(2.2) for a fault detected by an emissions neutral diagnostic.

(2.6.3) The manufacturer is exempt from illuminating the MIL and storing a fault code under section (d)(2.2) for an AECD when it is properly activated due to the occurrence of conditions that have been approved by the Executive Officer.

(3) *Monitoring Conditions*.

Section (d)(3) sets forth the general monitoring requirements while sections (e) and (f) set forth the specific monitoring requirements as well as identify which of the following general monitoring requirements in section (d)(3) are applicable for each monitored component or system identified in sections (e) and (f).

(3.1) For all 2004 and subsequent model year vehicles:

(3.1.1) As specifically provided for in sections (e) and (f), manufacturers shall define monitoring conditions, subject to Executive Officer approval, for detecting malfunctions identified in sections (e) and (f). 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 which may reasonably be expected to be encountered in normal urban vehicle operation and use, and designed to ensure monitoring will occur during the FTP cycle or Unified cycle.

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

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

(3.2) As specifically provided for in sections (e) and (f), manufacturers shall define monitoring conditions in accordance with the criteria in sections (d)(3.2.1) through (3.2.3). The requirements of section (d)(3.2) shall be phased in as follows: 30 percent of all 2005 model year vehicles, 60 percent of all 2006 model year vehicles, and 100 percent of all 2007 and subsequent model year vehicles. Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) with the exception that 100 percent of 2007 and subsequent model year vehicles shall comply with the requirements. Small volume manufacturers shall meet the requirements on 100 percent of 2007 and subsequent model year vehicles but shall not be required to meet the specific phase-in requirements for the 2005 and 2006 model years.

(3.2.1) Manufacturers shall define monitoring conditions that, in addition to meeting the criteria in section (d)(3.1), ensure that the monitor yields an in-use performance ratio (as defined in section (d)(4)) that meets or exceeds the minimum acceptable in-use monitor performance ratio on in-use vehicles. For purposes of this regulation, except as provided below in section (d)(3.2.1)(D), the minimum acceptable in-use monitor performance

ratio is:

(A) 0.260 for secondary air system monitors and other cold start related monitors utilizing a denominator incremented in accordance with section (d)(4.3.2)(E);

(B) For evaporative system monitors:

(i) 0.260 for monitors designed to detect malfunctions identified in section (e)(4.2.2)(C) (i.e., 0.020 inch leak detection); and

(ii) 0.520 for monitors designed to detect malfunctions identified in sections (e)(4.2.2)(A) and (B) (i.e., evaporative system purge flow and 0.040 inch leak detection);

(C) 0.336 for catalyst, oxygen sensor, EGR, VVT system, evaporative system high-load purge flow, and all other monitors specifically required in sections (e) and (f) to meet the monitoring condition requirements of section (d)(3.2);

(D) For interim years:

(i) through the 2007 model year, for the first three years a vehicle is certified to the in-use performance ratio monitoring requirements of section (d)(3.2), 0.100 for all monitors specified in section (d)(3.2.1)(A) through (C) above. For example, the 0.100 ratio shall apply to the 2004, 2005, and 2006 model years for vehicles first certified in the 2004 model year and to the 2007, 2008, and 2009 model years for vehicles first certified in the 2007 model year;

(ii) through the 2014 model year, for fuel system air-fuel ratio cylinder imbalance monitors, 0.100;

(iii) through the 2011 model year, for secondary exhaust gas sensor monitors specified in (e)(7.2.2)(C), 0.100;

(iv) through the 2012 model year, for vehicles subject to the monitoring requirements of section (f), 0.100 for all monitors specified in section (d)(3.2.1)(C) above;

(v) through the 201~~6~~9 model year for plug-in hybrid electric vehicles, 0.100 for all monitors specifically required in sections (e) and (f) to meet the monitoring condition requirements of section (d)(3.2) and that are for systems or components that require engine operation;

(vi) for 2016 through 2018 model year medium-duty vehicles certified to an engine dynamometer tailpipe emission standard and 2019 through 2021 model year passenger cars, light-duty trucks, and medium-duty vehicles certified to a chassis dynamometer tailpipe emission standard, 0.100 for diesel PM filter filtering performance monitors (section (f)(9.2.1)) and missing substrate monitors (section (f)(9.2.5)) not using the denominator criteria in section(d)(4.3.2)(G)~~.~~;

(vii) through the 2027 model year, 0.100 for positive crankcase ventilation (PCV) system monitors specified in section (e)(9.2.3)(A) and crankcase ventilation (CV) system monitor specified in section (f)(10.2.3).

(viii) through the 2020 model year, for evaporative system monitors specified in section (e)(4.2.2)(D) (i.e., high-load purge flow monitor), 0.100.

(3.2.2) In addition to meeting the requirements of section (d)(3.2.1),

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

a. Catalyst (section (e)(1.3) or, where applicable, (f)(1.3));
b. Oxygen/exhaust gas sensor (section (e)(7.3.1)(A) or, where applicable, (f)(5.3.1)(A));
c. Evaporative system (section (e)(4.3.2));
d. EGR system (section (e)(8.3.1)) and VVT system (section (e)(13.3) or, where applicable, (f)(6.3.1)(A), (f)(6.3.2), (f)(6.3.4), and, (f)(13.3));
e. Secondary air system (section (e)(5.3.2)(B));
f. PM filter (section (f)(9.3));
g. NOx adsorber (section (f)(8.3.1)); ~~and~~
h. NOx catalyst (section (f)(2.3.1));
~~h.~~i. Secondary oxygen sensor (section (e)(7.3.2)(A));
~~i.~~j. Boost pressure control system (sections (f)(7.3.2) and (f)(7.3.3)); and
~~j.~~k. Fuel system (section (e)(6.3.2) or (f)(4.3.3)).

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

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

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

(4.1) For monitors required to meet the minimum in-use monitor performance ratio in section (d)(3.2.1), the ratio shall be calculated in accordance with the following specifications for the numerator, denominator, and ratio.

(4.2) Numerator Specifications

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

(4.2.2) Specifications for incrementing:

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

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

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

sufficient to meet this criteria;

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

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

(iv) In addition to the requirements of section (d)(4.2.2)(B)(i) through (iii) above, the secondary air system monitor numerator(s) shall be incremented if and only if the criteria in section (B) above have been satisfied during normal operation of the secondary air system for vehicles that require monitoring during normal operation (sections (e)(5.2.2) through (5.2.4)). Monitoring during intrusive operation of the secondary air system later in the same driving cycle solely for the purpose of monitoring may not, by itself, be sufficient to meet this criteria.

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

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

(E) Except as specified in section (d)(4.2.2)(F) for exponentially weighted moving averages, manufacturers utilizing alternate statistical MIL illumination protocols as allowed in section (d)(2.2.6) for any of the monitors requiring a numerator shall submit a plan for appropriate incrementing of the numerator to the Executive Officer for review and approval. Executive Officer approval of the plan shall be conditioned upon the manufacturer providing supporting data and/or engineering evaluation for the proposed plan, the equivalence of the incrementing in

the manufacturer's plan to the incrementing specified in section (d)(4.2.2) for monitors using the standard MIL illumination protocol, and the overall equivalence of the manufacturer's plan in determining that the minimum acceptable in-use performance ratio in section (d)(3.2.1) is satisfied.

(F) Manufacturers using an exponentially weighted moving average (EWMA) as the alternate statistical MIL illumination protocol approved in accordance with section (d)(2.2.6) shall increment the numerator as follows:

(i) Following a reset or erasure of the EWMA result, the numerator may not be incremented until after the requisite number of decisions necessary for MIL illumination have been fully executed.

(ii) After the number of decisions required in section (d)(4.2.2)(F)(i) above, the numerator, when incremented, shall be incremented by an integer of one and may not be incremented more than once per driving cycle. Incrementing of the numerator shall also be in accordance with sections (d)(4.2.2)(B), (C), and (D).

(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) Except as provided for in sections (d)(4.3.2)(H), (J), and (K), the denominator for each monitor shall be incremented within ten seconds if and only if the following criteria are satisfied on a single driving cycle:

(i) Cumulative time since engine start is greater than or equal to 600 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit or -6.7 degrees Celsius;

(ii) Except as provided in section (d)(4.3.2)(B)(iv) below, cumulative vehicle operation at or above 25 miles per hour occurs for greater than or equal to 300 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit or -6.7 degrees Celsius (medium-duty vehicles with diesel engines certified on an engine dynamometer may use cumulative operation at or above 1150 rpm in lieu of at or above 25 miles per hour for purposes of this criteria); and

(iii) Continuous vehicle operation at idle (i.e., accelerator pedal released by driver and either vehicle speed less than or equal to one mile per hour or engine speed less than or equal to 200 rpm above normal warmed-up idle (as determined in the drive position for vehicles equipped with an automatic transmission)) 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 or -6.7 degrees Celsius.

(iv) For 2004 through 2012 model year medium-duty vehicles with diesel engines certified on an engine dynamometer, manufacturers may use

diesel engine operation at or above 15 percent calculated load in lieu of 1150 rpm for the criterion in section (d)(4.3.2)(B)(ii) above.

(v) In lieu of the criteria under sections (d)(4.3.2)(B)(i) through (iv) above, a manufacturer may increment the denominator for each monitor within ten seconds if the criteria under sections (d)(4.3.2)(K)(i) through (iv) are satisfied on a single driving cycle on non-hybrid vehicles.

(C) In addition to the requirements of section (d)(4.3.2)(B) above, the secondary air system monitor denominator(s) shall be incremented if and only if commanded "on" operation of the secondary air system occurs for a cumulative time greater than or equal to ten seconds. For purposes of determining this commanded "on" time, the OBD II system may not include time during intrusive operation of the secondary air system solely for the purposes of monitoring;

(D) Except as provided for in sections (d)(4.3.2)(D)(iv) and (d)(4.3.2)(L), for the evaporative system monitors (sections (e)(4.2.2)(A) through (C)), the comprehensive component input component temperature sensor rationality fault diagnostics (sections (e)(15) and (f)(15))(e.g., intake air temperature sensor, hybrid component temperature sensor), and the engine cooling system input component rationality monitors (sections (e)(10.2.2)(C) and (D) and (f)(11.2.2)(C) and (D)), the denominator(s) shall be incremented if and only if:

(i) The requirements of section (d)(4.3.2)(B) have been met;

(ii) Cumulative time since engine start is greater than or equal to 600 seconds while at an ambient temperature of greater than or equal to 40 degrees Fahrenheit (or 4.4 degrees Celsius) but less than or equal to 95 degrees Fahrenheit (or 35 degrees Celsius); and

(iii) Engine cold start occurs with engine coolant temperature at engine start greater than or equal to 40 degrees Fahrenheit (or 4.4 degrees Celsius) but less than or equal to 95 degrees Fahrenheit (or 35 degrees Celsius) and less than or equal to 12 degrees Fahrenheit (or 6.7 degrees Celsius) higher than ambient temperature at engine start.

(iv) For plug-in hybrid electric vehicles, manufacturers may choose to increment the evaporative system denominator(s) using the criteria under section (d)(4.3.2)(L) in lieu of the criteria under sections (d)(4.3.2)(D)(i) through (iii) above.

For the comprehensive component input component temperature sensor rationality fault diagnostics and the engine cooling system input component rationality monitors, the manufacturer shall use the criteria in section (d)(4.3.2)(D) on 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles (except plug-in hybrid electric vehicles). For vehicles (except plug-in hybrid electric vehicles) not included in the phase-in, the manufacturer may use the criteria in section (d)(4.3.2)(H) in lieu of the criteria in section (d)(4.3.2)(D) for these monitors.

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

(i) Heated catalyst (section (e)(2))
(ii) Cold Start Emission Reduction Strategy (sections (e)(11) and (f)(12))
(iii) Components or systems that operate only at engine start-up (e.g., glow plugs, intake air heaters, etc.) and are subject to monitoring under "other emission control or source devices" (sections (e)(16) and (f)(16)) or comprehensive component output components (sections (e)(15) and (f)(15))

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

(F) In addition to the requirements of section (d)(4.3.2)(B) above, the denominator(s) for the following component monitors ~~of components~~ (except those operated only at engine start-up and subject to the requirements of the previous section (d)(4.3.2)(E)) shall be incremented if and only if the component is commanded to function (e.g., commanded "on", "open", "closed", "locked", etc.) on two or more occasions for greater than two seconds during the driving cycle or for a cumulative time greater than or equal to ten seconds, whichever occurs first:

(i) Air conditioning system (section (e)(12))
(ii) Variable valve timing and/or control system (sections (e)(13) and (f)(13))
~~(iii) "Other emission control or source device" (sections (e)(16) and (f)(16))~~
~~(iv)~~(iii) Comprehensive component output component (sections (e)(15) and (f)(15)) (e.g., turbocharger waste-gates, variable length manifold runners, torque converter clutch lock-up solenoids, idle speed control system, idle fuel control system ~~etc.~~)
~~(v)~~(iv) PM sensor heater (section (f)(5.2.4)(A))
~~(vi)~~(v) PM filter active/intrusive injection (section (f)(9.2.6))

For the PM sensor heater monitor, as an alternative for 2013 through 2015 model year vehicles, the manufacturer may use the criteria in section (d)(4.3.2)(B) in lieu of the criteria specified in section (d)(4.3.2)(F) above.

For the PM filter active/intrusive injection monitor, as an alternative for 2013 through 2015 model year vehicles, the manufacturer may use the criteria in section (d)(4.3.2)(I) in lieu of the criteria specified in section (d)(4.3.2)(F) above.

(G) For the following monitors, the denominator(s) shall be incremented by one during a driving cycle in which the following two criteria are met: (1) the requirements of section (d)(4.3.2)(B) have been met on at least one driving cycle since the denominator was last incremented, and (2) the number of cumulative miles of vehicle operation since the denominator was last incremented is greater than or equal to 500 miles. The 500-mile counter shall be reset to zero and begin counting again after the denominator has been incremented and no later than the start of the next ignition cycle.~~:~~

(i) Diesel NMHC converting catalyst (section (f)(1.2.2))
(ii) Diesel NMHC converting catalyst other aftertreatment assistance

functions (sections (f)(1.2.3)(B) and (f)(1.2.3)(D))

(iii) Diesel PM filter NMHC conversion (section (f)(9.2.4)(A))

(iv) Diesel PM filter filtering performance and missing substrate (sections (f)(9.2.1) and (f)(9.2.5)) for 2004 through 2018 model year passenger cars, light-duty trucks, and ~~MDPVs~~ medium-duty vehicles certified to a chassis dynamometer tailpipe emission standard and for 2004 through 2015 model year medium-duty vehicles certified to an engine dynamometer tailpipe emission standard

(v) Diesel PM filter feedgas generation (section (f)(9.2.4)(B)) for 2019 and subsequent model year vehicles

~~(v) Diesel PM filter filtering performance and missing substrate (sections (f)(9.2.1) and (f)(9.2.5)) for 2004 through 2015 model year medium-duty vehicles certified to an engine dynamometer tailpipe emission standard~~

(H) For ~~monitors of~~ the following component~~s~~ monitors, 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 (sections (e)(10) and (f)(11))~~

~~(ii)~~(i) Air conditioning system input components (section (e)(12))

~~(iii)~~(ii) Direct ozone reduction systems (section (e)(14))

~~(iv)~~(iii) "Other emission control or source devices" (sections (e)(16) and (f)(16))

~~(v)~~(iv) Comprehensive component input components that require extended monitoring evaluation (sections (e)(15) and (f)(15)) (e.g., stuck fuel level sensor rationality)

~~(vi) Comprehensive component input component temperature sensor rationality monitors (sections (e)(15) and (f)(15)) (e.g, intake air temperature sensor, ambient temperature sensor, fuel temperature sensor)~~

~~(vii)~~(v) PM filter frequent regeneration (section (f)(9.2.2))

~~(viii)~~(vi) PM sensor monitoring capablity monitor (section (f)(5.2.2)(D))

(I) For 2013 and subsequent model year vehicles, 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 a regeneration event is commanded for a time greater than or equal to ten seconds:

(i) Diesel NMHC converting catalyst other aftertreatment assistance functions (sections (f)(1.2.3)(A) and (f)(1.2.3)(C))

(ii) PM filter incomplete regeneration (section (f)(9.2.3))

(J) For vehicles that employ alternate engine start hardware or strategies (e.g., a vehicle with a start-stop system that does not meet the definition of a hybrid vehicle as defined in section (c)~~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.

(K) For 2014 and subsequent model year hybrid vehicles, in lieu of the criteria in section (d)(4.3.2)(B) above, the denominator for each monitor shall be incremented within ten seconds if and only if the following criteria are satisfied on a single driving cycle:

(i) Cumulative propulsion system active time 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 (or -6.7 degrees Celsius);

(ii) Cumulative vehicle operation at or above 25 miles per hour occurs for greater than or equal to 300 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit (or -6.7 degrees Celsius) (medium-duty vehicles with diesel engines certified on an engine dynamometer may use cumulative operation at or above 1150 rpm in lieu of at or above 25 miles per hour for purposes of this criteria);

(iii) Continuous vehicle operation at idle (i.e., accelerator pedal released by driver and either vehicle speed less than or equal to one mile per hour or engine speed less than or equal to 200 rpm above normal warmed-up idle (as determined in the drive position for vehicles equipped with an automatic transmission)) 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 (or -6.7 degrees Celsius); and

(iv) Cumulative fueled engine operation for greater than or equal to 10 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 (or -6.7 degrees Celsius).

(L) For 2015 and subsequent model year plug-in hybrid electric vehicles, ~~in addition to the requirements of sections (d)(4.3.2)(K)(i) through (iii) above,~~ the denominators for the evaporative system monitors (sections (e)(4.2.2)(A) through (C)), ~~denominator(s)~~ the comprehensive component input component temperature sensor rationality fault diagnostics (sections (e)(15) and (f)(15))(e.g., intake air temperature sensor, hybrid component temperature sensor), and the engine cooling system input component rationality monitors (sections (e)(10.2.2)(C) and (D) and (f)(11.2.2)(C) and (D)) and (f)(11)) shall be incremented if and only if:

(i) The requirements of section (d)(4.3.2)(K)(i) through (iv) have been met for the evaporative system purge flow monitor (section (e)(4.2.2)(A)), or the requirements of section (d)(4.3.2)(K)(i) through (iii) have been met for all other monitors specified in section (d)(4.3.2)(L) above;

~~(i)~~(ii) Cumulative propulsion system active time is greater than or equal to

600 seconds while at an ambient temperature of greater than or equal to 40 degrees Fahrenheit (or 4.4 degrees Celsius) but less than or equal to 95 degrees Fahrenheit (or 35 degrees Celsius);

~~(ii)~~(iii) Engine coolant temperature at the start of propulsion system active is greater than or equal to 40 degrees Fahrenheit (or 4.4 degrees Celsius) but less than or equal to 95 degrees Fahrenheit (or 35 degrees Celsius); and

~~(iii)~~(iv) Continuous time while the vehicle is not in the state of 'propulsion system active' during the period immediately preceding the start of propulsion system active ~~the driving cycle~~ is greater than or equal to 6 hours.

For the comprehensive component input component temperature sensor rationality fault diagnostics and the engine cooling system input component rationality monitors, as an alternative for 2015 through 2018 model year plug-in hybrid electric vehicles, the manufacturer may use the criteria in section (d)(4.3.2)(H) in lieu of the criteria specified in section (d)(4.3.2)(L) above.

For the evaporative system purge flow monitor (section (e)(4.2.2)(A)), as an alternative for 2015 through 2018 model year plug-in hybrid electric vehicles, the manufacturer may choose the increment the denominator if the requirements of section (d)(4.3.2)(K)(i) through (iii) have been met in lieu of the criteria specified in section (d)(4.3.2)(L)(i) above.

(M) The denominator(s) for the evaporative system high-load purge flow monitor (section (e)(4.2.2)(D)) shall be incremented if and only if:

(i) The requirements of section (d)(4.3.2)(B) have been met (hybrid vehicles shall use section (d)(4.3.2)(K) in lieu of (d)(4.3.2)(B));

(ii) Cumulative time since engine start is greater than or equal to 600 seconds while at an ambient temperature of greater than or equal to 40 degrees Fahrenheit (or 4.4 degrees Celsius) (hybrid vehicles shall use cumulative propulsion system active time in lieu of cumulative time since engine start); and

(iii) High-load purging conditions occur on two or more occasions for greater than two seconds during the driving cycle or for a cumulative time greater than or equal to ten seconds, whichever occurs first.

(iv) For purposes of section (d)(4.3.2)(M)(iii) above, "high-load purging conditions" means an event during which the engine manifold pressure is greater than or equal to 7 kPa above atmospheric pressure.

As an alternative for 2004 through 2018 model year vehicles, the manufacturer may use the criteria in section (d)(4.3.2)(D) or (d)(4.3.2)(L), whichever is applicable, in lieu of the criteria specified above in section (d)(4.3.2)(M).

(4.4) Ratio Specifications

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

(4.5) Disablement of Numerators and Denominators

(4.5.1) Within ten seconds of a malfunction being detected that disables a monitor required to meet the monitoring conditions in section (d)(3.2.1) ~~being detected~~ (i.e., a pending or confirmed code is stored), the OBD II

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

(4.5.2) Within ten seconds of the start of a PTO (see section (c)) operation that disables a monitor required to meet the monitoring conditions in section (d)(3.2.1), the OBD II system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the PTO operation ends, incrementing of all corresponding numerators and denominators shall resume within ten seconds.

(4.5.3) For 2004 through 2018 model year vehicles, ~~T~~the OBD II system shall disable further incrementing of all numerators and denominators within ten seconds if a malfunction of any component used to determine if the criteria ~~in~~ of sections (d)(4.3.2)(B) through (D) are satisfied (i.e., vehicle speed, ambient temperature, elevation, idle operation, engine cold start, or time of operation) has been detected (i.e., a pending or confirmed fault code has been stored). When the malfunction is no longer detected (e.g., the pending code is erased through self-clearing or through a scan tool command), ~~I~~incrementing of all numerators and denominators shall resume within ten seconds ~~when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command)~~.

(4.5.4) For 2019 and subsequent model year vehicles, the OBD II system shall disable further incrementing of all numerators and denominators within ten seconds if a malfunction has been detected (i.e., a pending or confirmed fault code has been stored) for any component used to determine if the criteria of section (d)(4.3.2)(B) or (d)(4.3.2)(K), whichever is applicable, are satisfied (i.e., vehicle speed, ambient temperature, elevation, idle operation, or time of operation). 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 numerators and denominators shall resume within ten seconds.

(4.5.5) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles, within ten seconds of a malfunction being detected for of any component used to determine if any of the criteria in sections (d)(4.3.2)(C) through (J) and (L) are satisfied (e.g., engine cold start), the OBD II system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is affected. When the malfunction is no longer detected (i.e., the pending code is erased through self-clearing or through a scan tool command), incrementing of the corresponding numerators and denominators shall resume within ten seconds.

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

(5.1) For monitors required to track and report in-use monitor performance in section (d)(3.2.2), the performance data shall be tracked and reported in

accordance with the specifications in sections (d)(4), (d)(5), and (g)(5). ~~The OBD II system shall separately report an in-use monitor performance numerator and denominator for each of the following components:~~

(5.1.1) For gasoline vehicles, the OBD II system shall separately report an in-use monitor performance numerator and denominator for each of the following components: catalyst bank 1, catalyst bank 2, primary oxygen~~/exhaust gas~~ sensor bank 1, primary oxygen~~/exhaust gas~~ sensor bank 2, evaporative 0.020 inch leak detection system, EGR/VVT system, secondary air system, ~~diesel fuel system, PM filter, NOx aftertreatment (e.g., NOx adsorber, NOx catalyst),~~ secondary oxygen sensor bank 1, secondary oxygen sensor bank 2, and fuel system~~, and boost pressure control system~~. The OBD II system shall also report a general denominator and an ignition cycle counter(s) in the standardized format specified in sections (d)(5.5), (d)(5.6) and (g)(5).

(5.1.2) For diesel vehicles, the OBD II system shall separately report an in-use monitor performance numerator and denominator for each of the following components: NMHC converting catalyst, NOx converting catalyst, fuel system, exhaust gas sensor, EGR/VVT system, boost pressure control system, NOx adsorber, and PM filter. The OBD II system shall also report a general denominator and an ignition cycle counter(s) in the standardized format specified in sections (d)(5.5), (d)(5.6) and (g)(5).

(5.2) Numerator

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

(5.2.2) For specific components or systems that have multiple monitors that are required to be reported under sections (e) or (f) (e.g., oxygen sensor bank 1 may have multiple monitors for sensor response or other sensor characteristics), the OBD II system shall separately track numerators and denominators for each of the specific monitors and report only the corresponding numerator and denominator for the specific monitor that has the lowest numerical ratio. If two or more specific monitors have identical ratios, the corresponding numerator and denominator for the specific monitor that has the highest denominator shall be reported for the specific component.

(5.2.3) The numerator(s) shall be reported in accordance with the specifications in section (g)(5.2.1).

(5.3) Denominator

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

(5.3.2) The denominator(s) shall be reported in accordance with the specifications in section (g)(5.2.1).

(5.4) Ratio

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

(5.5) Ignition cycle counter

(5.5.1) Definition:

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

(B) Except as required in section (d)(5.5.1)(C) below, the OBD II system shall report one ignition cycle counter (as defined in section (d)(5.5.2)(B)). As an alternative, the OBD II system may report two ignition cycle counters, one counter defined in section (d)(5.5.2)(B) and one counter defined in section (d)(5.5.2)(C).

(C) For 2014 and subsequent model year plug-in hybrid electric vehicles, the OBD II system shall report two ignition cycle counters (as defined in sections (d)(5.5.2)(B) and (C)).

(D) The ignition cycle counter shall be reported in accordance with the specifications in section (g)(5.2.1).

(5.5.2) Specifications for incrementing:

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

(B) The ignition cycle counter shall be incremented within ten seconds if and only if the following criteria are met:

(i) Except as required in section (d)(5.5.2)(B)(ii) below, the vehicle meets the engine start definition (see section (c)) for at least two seconds plus or minus one second.

(ii) For hybrid vehicles, the vehicle meets the propulsion system active definition (see section (c)) for at least two seconds plus or minus one second.

(C) In addition to the counter described in section (d)(5.5.2)(B) above, 2014 and subsequent model year plug-in hybrid electric vehicles shall track and report a second ignition cycle counter that shall be incremented within ten seconds if and only if the vehicle has met the fueled engine operation definition (see section (c)) for at least two seconds plus or minus one second.

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

(5.6) General Denominator

(5.6.1) Definition:

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

(B) The general denominator shall be reported in accordance with the specifications in section (g)(5.2.1).

(5.6.2) Specifications for incrementing:

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

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

(i) For non-hybrid vehicles, the criteria identified in section (d)(4.3.2)(B).

(ii) For hybrid vehicles except plug-in hybrid electric vehicles, the criteria identified in sections (d)(4.3.2)(K)(i) through (iv).

(iii) For plug-in hybrid electric vehicles, the criteria identified in sections (d)(4.3.2)(K)(i) through (iii). For 2014 through 2018 model year vehicles, manufacturers may increment the general denominator using the criteria identified in sections (d)(4.3.2)(K)(i) through (iv).

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

(6) *Malfunction Criteria Determination and Adjustment Factors for Diesel Vehicles*.

(6.1) For 2010 and subsequent model year medium-duty vehicles certified to an engine dynamometer exhaust emission standard, in determining the malfunction criteria for diesel engine monitors in section (f) that are required to indicate a malfunction before emissions exceed an emission threshold based on the applicable standard, the manufacturer shall:

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

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

(6.1.3) If the Executive Officer reasonably believes that a manufacturer has incorrectly determined the test cycle and standard that is more stringent, the Executive Officer shall require the manufacturer to provide emission data and/or engineering analysis showing that the other test cycle and standard are less stringent.

(6.2) For 2007 and subsequent model year light-duty and medium-duty vehicles equipped with emission controls that experience infrequent regeneration events (e.g., active PM filter regeneration, NOx adsorber desulfation), 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. Except as provided in section (d)(6.2.7), for each monitor on medium-duty vehicles using engines certified on an engine dynamometer, 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. For light-duty and medium-duty vehicles certified on a chassis dynamometer, the manufacturer shall submit a plan for Executive Officer approval to adjust the emission results using an approach similar to the procedure described in CFR title 40, part 86.004-28(i). Executive Officer approval shall be based on the effectiveness of the proposed plan to quantify the emission impact and frequency of regeneration events. 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 1.5 times any applicable standard).

(6.2.1) For purposes of section (d)(6.2), “regeneration” means an event during which emission 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.

(6.2.3) Except as specified in section (d)(6.2.4) for NMHC catalyst monitoring, for 2007 through 2009 model year vehicles, in lieu of establishing the adjustment factor for each monitor with the component for which the malfunction criteria is being established deteriorated to the malfunction threshold as required in section (d)(6.2), the manufacturer may use the adjustment factor established for certification (e.g., without components deteriorated to the malfunction threshold).

(6.2.4) For NMHC catalyst monitoring (section (f)(1)) on 2008 and subsequent model year vehicles, a manufacturer shall establish the adjustment factor for the NMHC catalyst monitor with the NMHC catalyst deteriorated to the malfunction threshold as required in section (d)(6.2). In lieu of establishing this adjustment factor for 2008 and 2009 model year vehicles, a manufacturer may provide emission data demonstrating that the worst case emission levels from a deteriorated NMHC catalyst are below the malfunction threshold specified in section (f)(1.2.2). The demonstration shall include emission testing with a NMHC catalyst deteriorated to the malfunction threshold or worse and with both the infrequent regeneration event occurring and without it occurring. The manufacturer shall calculate the worst case emission level by applying the frequency factor (“F” as calculated according to CFR, title 40, part 86.004-28(i)) of the infrequent regeneration event used for tailpipe certification to the measured emissions with the infrequent regeneration event occurring and adding that result to the measured emissions without the infrequent regeneration event occurring. This calculated final sum shall be used as the adjusted emission level and compared to the malfunction threshold for purposes of determining compliance with the monitoring requirements. The manufacturer shall submit a test plan for Executive Officer approval

describing the emission testing procedure and how the worst case components will be established. The Executive Officer shall approve it upon finding the test procedure and components used will likely generate a worst case emission level.

(6.2.5) For purposes of determining the adjustment factors for each monitor, the manufacturer shall submit engineering data, analysis, and/or emission data to the Executive Officer for approval. The Executive Officer shall approve the factors upon finding the submitted information supports the adjustment factors.

(6.2.6) For purposes of enforcement testing in accordance with section (d)(~~7~~8) and title 13, CCR section 1968.5, the adjustment factors established for each monitor by the manufacturer according to section (d)(6.2) shall be used when determining compliance with emission thresholds.

(6.2.7) In lieu of using the procedure described in CFR title 40, part 86.004-28(i), the manufacturer may submit an alternate plan to calculate the adjustment factors for determining the adjusted emission values to the Executive Officer for review and approval. Executive Officer approval of the plan shall be conditioned upon the manufacturer providing data and/or engineering evaluation demonstrating the procedure is consistent with good engineering judgment in determining appropriate modifications to the tailpipe certification adjustment factors.

(6.3) For every 2007 through 2012 model year light-duty vehicle test group certified to the higher allowable emission thresholds specified in section (f) (e.g., 5.0 or 3.0 times the applicable standards for NMHC converting catalyst monitoring) for vehicles prior to the 2013 model year:

(6.3.1) The manufacturer shall conduct in-use enforcement testing for compliance with the tailpipe emission standards in accordance with title 13, CCR sections 2136 through 2140. Within six months after OBD II certification of a test group, the manufacturer shall submit a plan for conducting the testing to the Executive Officer for approval. The Executive Officer shall approve the plan upon determining that the testing will be done in accordance with the procedures used by ARB when conducting such testing, that the plan will allow for a valid sample of at least 10 vehicles in the mileage range of 30,000 to 40,000 miles for comparison to the FTP intermediate (e.g., 50,000 mile) useful life standard and at least 10 vehicles in the mileage range of 90,000 to 100,000 miles for comparison to the FTP full useful life standard, and that copies of all records and data collected during the program will be provided to ARB. Manufacturers may also submit testing plans and supporting data for Executive Officer approval that differ from compliance testing under title 13, CCR, sections 2136 through 2140. The Executive Officer shall also approve the plans upon determining that the plan provides equivalent assurance in verifying vehicles are meeting the tailpipe emission standards within the useful life. The Executive Officer may use the submitted data in lieu of or in addition to data collected pursuant to title 13, CCR section 2139 for purposes of the notification and use of test results described in title 13, CCR section 2140; and

(6.3.2) The certification shall be conditioned upon the manufacturer agreeing

that, for any test group(s) determined to be noncompliant in accordance with title 13, CCR section 2140 or title 13, CCR section 1968.5, the Executive Officer shall determine the excess emissions caused by the noncompliance and the manufacturer shall fund a program(s) that will offset any such excess emissions.

(6.4) For 2019 and subsequent model year vehicles equipped with emission controls that experience infrequent regeneration events, a manufacturer shall adjust the emission test results using the procedure described in CFR title 40, part 86.004-28(i). The manufacturer shall conduct testing to determine the adjustment factors using the same deteriorated component(s) used to determine if the test-out criteria in the following sections are met:

(6.4.1) Section (f)(1.2.3)(B)

(6.4.2) Section (f)(1.2.3)(D)

(6.4.3) Section (f)(6.2.6)(C)

(6.4.4) Section (f)(9.2.4)

(6.4.5) Section (f)(15.1.2)

(6.4.6) Section (f)(15.2.2)(F)(ii)

(7) *Determination of Requirements for Applicable Vehicles.*

(7.1) Alternate-Fueled Vehicles:

(7.1.1) For 2004 through 2018 model year alternate-fueled vehicles, a manufacturer shall meet the same requirements in section 1968.2 as those required for gasoline engines.

(7.1.2) For 2019 and subsequent model year alternate-fueled vehicles, the manufacturer shall submit a plan to the Executive Officer for approval of the requirements in section 1968.2 (including the in-use monitor performance requirements in section (d), the monitoring requirements in sections (e) through (f), and the standardization requirements of section (g)) determined by the manufacturer to be applicable to the vehicle. Executive Officer approval shall be based on the appropriateness of the plan with respect to the components and systems on the vehicle (e.g., a spark-ignited dedicated CNG vehicle with a PM filter and a selective catalytic reduction (SCR) system would be monitored in accordance with the misfire monitoring requirements in section (e) for spark-ignited engines and with the PM filter and SCR system monitoring requirements in section (f) for diesel engines typically equipped with the same components).

(7.2) The requirements of section (d)(7.2) apply to gasoline vehicles equipped with components/systems that are not covered under sections (e)(1) through (14) but are analogous to components/systems covered under sections (f)(1) through (14), and apply to diesel vehicles equipped with components/systems that are not covered under sections (f)(1) through (14) but are analogous to components/systems covered under sections (e)(1) through (14). For these vehicles, the manufacturer shall submit a plan to the Executive Officer for approval of the requirements in section 1968.2 (including the in-use monitor performance requirements in section (d), the monitoring requirements in sections (e) through (f) and the standardization requirements of section (g)), determined by the manufacturer to be applicable to the vehicle. Executive

Officer approval shall be based on the appropriateness of the plan with respect to the components and systems on the vehicle (e.g., a spark-ignited gasoline lean-burn vehicle with a NOx adsorber and an SCR system would be monitored in accordance with the misfire monitoring requirements in section (e) for spark-ignited engines and with the NOx adsorber and SCR system monitoring requirements in section (f) for diesel engines typically equipped with the same components).

(7.3) For 2019 and subsequent model year plug-in hybrid electric vehicles, malfunction criteria for each monitor in sections (e) or (f) that are required to indicate a malfunction before emissions exceed an emission threshold based on the applicable standard shall be determined in the driving mode that results in the worst case emissions (i.e., charge depleting or charge sustaining operation) for each monitor.

~~(7)~~(8) *Enforcement Testing*.

~~(7.1)~~(8.1) The procedures used to assure compliance with the requirements of title 13, CCR section 1968.2 are set forth in title 13, CCR section 1968.5.

~~(7.2)~~(8.2) Consistent with the requirements of title 13, CCR section 1968.5(b)(4)(A) for enforcement OBD II emission testing, the manufacturer shall make available upon request by the Executive Officer all test equipment (e.g., malfunction simulators, deteriorated “threshold” components, etc.) necessary to determine the malfunction criteria in sections (e) and (f) for major monitors subject to OBD II emission testing as defined in title 13, CCR section 1968.5. To meet the requirements of this section, the manufacturers shall only be required to make available test equipment necessary to duplicate “threshold” testing performed by the manufacturer. This test equipment shall include, but is not limited to, aged “threshold” catalyst systems and computer equipment used to simulate misfire, oxygen sensor, fuel system, VVT system, and cold start reduction strategy system faults. The manufacturer is not required to make available test equipment for vehicles that exceed the applicable full useful life age (e.g., 10 years for vehicles certified to a full useful life of 10 years and 100,000 miles).

(9) *Exceptions to General Requirements.*

(9.1) Whenever the requirements in section (d) of this regulation require a manufacturer to meet a specific phase-in schedule:

(9.1.1) The phase-in percentages shall be based on the manufacturer’s projected sales volume for all vehicles subject to the requirements of title 13, CCR section 1968.2 unless specifically stated otherwise in section (d).

(9.1.2) Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) except as specifically noted for the phase-in of in-use monitor performance ratio monitoring conditions in section (d)(3.2).

(9.1.3) Small volume manufacturers may use an alternate phase-in schedule in accordance with section (d)(9.1.2) in lieu of the required phase-in schedule or may meet the requirement on all vehicles by the final year of the phase-in in lieu of meeting the specific phase-in requirements for each model year.

(e) *Monitoring Requirements for Gasoline/Spark-Ignited Engines.*

For non-Low Emission Vehicle III applications (e.g., Low Emission Vehicle applications and Low Emission Vehicle II applications), the emission thresholds are specified in the monitoring sections in section (e) below. For Low Emission Vehicle III applications, wherever an emission threshold for a malfunction on a diagnostic is required in section (e), the emission thresholds shall be set in accordance with Table 1 below:

Table 1

Table 1: LEV-III OBD II Gasoline Thresholds

Exhaust Standards		Monitor Thresholds (except catalyst)				Catalyst Monitor Threshold
Vehicle Type	**Vehicle Emission Category**	**NMOG+NOx Mult.**	**CO Mult.**	**PM Mult.**	**PM THD (mg/mi)**	**NMOG+NOx Mult.**
Passenger Cars, Light-Duty Trucks, and Chassis Certified MDPVs	LEV160	1.50	1.50	N/A	17.50[1]	1.75
	ULEV125					
	ULEV70	2.00				2.00
	ULEV50					
	SULEV30	2.50	2.50			2.50
	SULEV20[4]					
Chassis Certified MDVs (except MDPVs)	All MDV Emission Categories	1.50	1.50	1.50[2]	17.50[3]	1.75

1. Applies to 2019 and subsequent model year vehicles
2. Applies to 2019 and subsequent model year vehicles not included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2
3. Applies to 2019 and subsequent model year vehicles included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2
4. Manufacturer shall use the 2.50 times NMOG+NOx multiplier for vehicles not using the provisions of section (e)(17.1.5)

THD = Threshold; mg/mi = milligram per mile; Mult. = Multiplier to be used with the applicable standard (e.g., 2.0 times the NMOG+NOx standard);

(1) *Catalyst Monitoring*

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

(1.2) Malfunction Criteria:

(1.2.1) Low Emission Vehicle I applications: The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that ~~either~~ any of the following occurs:

(A) Non-Methane Organic Gas (NMOG) emissions exceed 1.75 times the FTP full useful life standards to which the vehicle has been certified with NMOG emissions multiplied by the certification reactivity adjustment factor for the vehicle;

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

(1.2.2) Low Emission Vehicle II applications and all 2009 and subsequent model year non-Low Emission Vehicle III ~~vehicles~~applications:

(A) 2004 model year vehicles.

(i) All LEV II, ULEV II, and MDV SULEV II vehicles shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1).

(ii) All PC/LDT SULEV II vehicles shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1) except the malfunction criterion in paragraph (e)(1.2.1)(A) shall be 2.5 times the applicable FTP full useful life NMOG standard.

(B) Except as provided below in section (e)(1.2.5~~4~~), for 2005 through 2008 model years, the OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that any of the following occurs:

(i) For all vehicles other than PC/LDT SULEV II vehicles.

a. NMOG emissions exceed the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(A).

b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).

c. Oxides of nitrogen (NOx) emissions exceed 3.5 times the FTP full useful life NOx standard to which the vehicle has been certified.

(ii) PC/LDT SULEV II vehicles shall use the same malfunction criteria as 2005 through 2008 model year LEV II, ULEV II, and MDV SULEV II vehicles (section (e)(1.2.2)(B)(i)) except the malfunction criteria in paragraph a. shall be 2.5 times the applicable FTP full useful life NMOG standard.

(C) Except as provided below in section (e)(1.2.~~5~~6), for 2009 and subsequent model years, the OBD II system shall detect a catalyst system malfunction

when the catalyst system's conversion capability decreases to the point that any of the following occurs.

(i) For all vehicles other than PC/LDT SULEV II vehicles.

a. NMOG emissions exceed the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(A).

b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).

c. NOx emissions exceed 1.75 times the FTP full useful life NOx standard to which the vehicle has been certified.

(ii) For PC/LDT SULEV II vehicles.

a. NMOG emissions exceed 2.5 times the applicable FTP full useful life NMOG standard to which the vehicle has been certified.

b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).

c. NOx emissions exceed 2.5 times the applicable FTP full useful life NOx standard to which the vehicle has been certified.

(1.2.3) Low Emission Vehicle III applications: The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that any of the following occurs:

(A) The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).

(B) The vehicle's emissions exceed any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

~~(1.2.3)~~(1.2.4) 2004 through 2008 model year non-Low Emission Vehicle I or II applications: The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that NMHC emissions increase by more than 1.5 times the applicable FTP full useful life standards over an FTP test performed with a representative 4000 mile catalyst system.

~~(1.2.4)~~(1.2.5) In lieu of using the malfunction criteria in section (e)(1.2.2)(B) for all 2005 and 2006 model year Low Emission Vehicle II applications, a manufacturer may phase-in the malfunction criteria on a portion of its Low Emission Vehicle II applications as long as that portion of Low Emission Vehicle II applications comprises at least 30 percent of all 2005 model year vehicles and 60 percent of all 2006 model year vehicles. For 2005 and 2006 model year Low Emission Vehicle II applications not included in the phase-in, the malfunction criteria in section (e)(1.2.2)(A) shall be used.

~~(1.2.5)~~(1.2.6) In lieu of using the malfunction criteria in section (e)(1.2.2)(C) for all 2009 model year vehicles, for the 2009 model year only, a manufacturer may continue to use the malfunction criteria in section (e)(1.2.2)(B) for any vehicles previously certified in the 2005, 2006, 2007, or 2008 model year to the malfunction criteria in section (e)(1.2.2~~.~~)(B) and carried over to the 2009 model year.

~~(1.2.6)~~(1.2.7) For purposes of determining the catalyst system malfunction criteria in sections (e)(1.2.1), (1.2.2)(A), ~~and~~ (1.2.~~3~~4), the malfunction criteria shall

be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the vehicle's full useful life.

~~(1.2.7)~~(1.2.8) For purposes of determining the catalyst system malfunction criteria in sections (e)(1.2.2)(B)~~, and~~ (1.2.2)(C), and (1.2.3):

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

(B) Except as provided below in section (e)(1.2.8~~7~~)(C), the malfunction criteria shall be established by using a catalyst system with all monitored and unmonitored (downstream of the sensor utilized for catalyst monitoring) catalysts simultaneously deteriorated to the malfunction criteria.

(C) For vehicles using fuel shutoff to prevent over-fueling during misfire conditions (see section (e)(3.4.1)(D)), the malfunction criteria shall be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the vehicle's full useful life.

(1.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(1.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the catalyst monitor under section (e)(1.2) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(1.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(1.4) MIL Illumination and Fault Code Storage:

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

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

(2) *Heated Catalyst Monitoring*

(2.1) Requirement:

(2.1.1) The OBD II system shall monitor all heated catalyst systems for proper heating.

(2.1.2) The efficiency of heated catalysts shall be monitored in conjunction with the requirements of section (e)(1).

(2.2) Malfunction Criteria:

(2.2.1) The OBD II system shall detect a catalyst heating system malfunction when the catalyst does not reach its designated heating temperature within a requisite time period after engine starting. The manufacturer shall determine the requisite time period, but the time period may not exceed

the time that would cause emissions from a vehicle equipped with the heated catalyst system to exceed:

(A) For non-Low Emission Vehicle III applications, 1.75 times any of the applicable FTP full useful life standards.

(B) For Low Emission Vehicle III applications, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

(2.2.2) Manufacturers may use other monitoring strategies for the heated catalyst but must submit the alternate plan to the Executive Officer for approval. The Executive Officer shall approve alternate strategies for monitoring heated catalyst systems based on comparable reliability and timeliness to these requirements in detecting a catalyst heating malfunction.

(2.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(2.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

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

(3) *Misfire Monitoring*

(3.1) Requirement:

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

(3.1.2) The OBD II system shall identify the specific cylinder that is experiencing misfire. Manufacturers may request Executive Officer approval to store a general misfire fault code instead of a cylinder specific fault code under certain operating conditions. 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.

(3.1.3) If more than one cylinder is misfiring, a separate fault code shall be stored indicating that multiple cylinders are misfiring except as allowed below. When identifying multiple cylinder misfire, the ~~manufacturer~~ OBD II system is not required to also identify each of the misfiring cylinders individually through separate fault codes. For 2005 and subsequent model year vehicles, if more than 90 percent of the detected misfires occur in a single cylinder, the manufacturer may elect to store the appropriate fault code indicating the specific misfiring cylinder in lieu of the multiple cylinder misfire fault code. If, however, two or more cylinders individually have more than 10 percent of the total number of detected misfires, a multiple cylinder fault code must be stored.

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

(3.2.1) Misfire causing catalyst damage for all vehicles:

(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 (i)(2.5). For every engine speed and load condition that this percentage of misfire is determined to be lower than

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

(B) Subject to Executive Officer approval, a manufacturer may employ a longer interval than 200 revolutions but only for determining, on a given driving cycle, the first misfire exceedance as provided in section (e)(3.4.1)(A) below. Executive Officer approval shall be 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 (e)(3.2.1)(A) is exceeded. For multiple cylinder misfire situations that result in a misfire rate greater than or equal to 50 percent of all engine firings, the OBD II system shall only be required to detect a misfire malfunction for situations that are caused by a single component failure.

(D) For purposes of establishing the temperature at which catalyst damage occurs as required in section (e)(3.2.1)(A), on 2005 and subsequent model year vehicles, manufacturers may not define catalyst damage at a temperature more severe than what the catalyst system could be operated at for ten consecutive hours and still meet the applicable FTP full useful life standards.

(3.2.2) Misfire causing emissions to exceed ~~1.5 times the FTP standards~~an emission threshold:

(A) Except as provided for plug-in hybrid electric vehicles in section (e)(3.2.3) below, ~~M~~manufacturers shall determine the percentage of misfire evaluated in 1000 revolution increments that would cause emissions from an emission durability demonstration vehicle to exceed ~~1.5 times any of the applicable FTP standards~~ the thresholds specified in section (e)(3.2.2)(A)(i) or (ii) 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.

(i) For non-Low Emission Vehicle III applications, the threshold is 1.5 times any of the applicable FTP standards.

(ii) For Low Emission Vehicle III applications, the thresholds are any of the applicable thresholds set forth in Table 1 in the beginning of section (e).

(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 (3.2.2)(A) is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous, etc.). For multiple cylinder

misfire situations that result in a misfire rate greater than or equal to 50 percent of all engine firings, the OBD II system shall only be required to detect a misfire malfunction for situations that are caused by a single component failure.

(3.2.3) Misfire on plug-in hybrid electric vehicles:

(A) A manufacturer shall detect a misfire malfunction when the percentage of misfire is equal to or exceeds two percent. The manufacturer shall evaluate the percentage of misfire in 1000 cumulative revolution increments.

(B) 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 percentage of misfire malfunction criteria in section (e)(3.2.3)(A) upward to exclude detection of misfire that cannot cause the vehicle's emissions to exceed:

(i) For non-Low Emission Vehicle III applications, 1.5 times any of the applicable FTP standards.

(ii) For Low Emission Vehicle III applications, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

(C) For 2004 through 2018 model year vehicles, a manufacturer may detect a misfire malfunction in accordance with the requirements in section (e)(3.2.2) in lieu of the requirements in section (e)(3.2.3).

(D) For multiple cylinder misfire situations that result in a misfire rate greater than or equal to 50 percent of all engine firings, the OBD II system shall only be required to detect a misfire malfunction for situations that are caused by a single component failure.

(3.3) Monitoring Conditions:

(3.3.1) Manufacturers shall continuously monitor for misfire under the following conditions:

(A) Except as provided in section (e)(3.3.6) below, from no later than the end of the second crankshaft revolution after engine start,

(B) While under positive torque conditions during the rise time and settling time for engine speed to reach the desired idle engine speed at engine start-up (i.e., "flare-up" and "flare-down"), and

(C) Under all positive torque engine speeds and load conditions except within the following range: the engine operating region bound by the positive torque line (i.e., engine load with the transmission in neutral), and the two following engine operating points: an engine speed of 3000 rpm with the engine load at the positive torque line, and the redline engine speed (defined in section (c)) with the engine's manifold vacuum at four inches of mercury lower than that at the positive torque line.

(3.3.2) If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions as required in section (e)(3.3.1) above, the manufacturer may request Executive Officer approval to accept the monitoring system. In evaluating the manufacturer's request, the Executive Officer shall consider the following factors: the magnitude of the region(s) in which misfire detection is limited, the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events), the frequency with which said region(s) are expected to be

encountered in-use, the type of misfire patterns for which misfire detection is troublesome, and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation shall be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders, single cylinder continuous misfire, and paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(3.3.3) A manufacturer may request Executive Officer approval of a monitoring system that has reduced misfire detection capability during the portion of the first 1000 revolutions after engine start that a cold start emission reduction strategy that reduces engine torque (e.g., spark retard strategies) is active. The Executive Officer shall approve the request 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 50-86 degrees Fahrenheit (or 10-30 degrees Celsius) and that the technology cannot reliably detect a higher percentage of the misfire events during the conditions.

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

(A) Upon 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 US06 cycle for the worst case vehicle within each test group.

(B) Additionally, the Executive Officer will approve a manufacturer's request in accordance with sections (e)(17.3), (17.4), and (17.6) to disable misfire monitoring when fuel level is 15 percent or less of the nominal capacity of

the fuel tank, when PTO units are active, or while engine coolant temperature is below 20 degrees Fahrenheit (or -6.7 degrees Celsius). The Executive Officer will approve a request to continue disablement on engine starts when engine coolant temperature is below 20 degrees Fahrenheit (or -6.7 Celsius) at engine start until engine coolant temperature exceeds 70 degrees Fahrenheit (or 21.1 degrees Celsius).

(C) In general, for 2005 and subsequent model year vehicles, the Executive Officer shall not approve disablement for conditions involving normal air conditioning compressor cycling from on-to-off or off-to-on, automatic transmission gear shifts (except for shifts occurring during wide open throttle operation), transitions from idle to off-idle, normal engine speed or load changes that occur during the engine speed rise time and settling time (i.e., “flare-up” and “flare-down”) immediately after engine starting without any vehicle operator-induced actions (e.g., throttle stabs), or excess acceleration (except for acceleration rates that exceed the maximum acceleration rate obtainable at wide open throttle while the vehicle is in gear due to abnormal conditions such as slipping of a clutch).

(D) The Executive Officer may approve misfire monitoring disablement or use of an alternate malfunction criterion for any other condition on a case by case basis 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.

(3.3.5) For engines with more than eight cylinders that cannot meet the requirements of section (e)(3.3.1), a manufacturer may request Executive Officer approval to use alternative misfire monitoring conditions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which 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.

(3.3.6) For engines that employ engine shutoff strategies that do not require the vehicle operator to restart the engine to continue driving (e.g., hybrid vehicle or a vehicle with a start-stop system with engine shutoff at idle), a manufacturer shall request Executive Officer approval of the monitoring conditions under which misfire monitoring occurs after engine fueling begins for the initial start and after each time fueling resumes. Executive Officer approval of the monitoring conditions shall be based on the equivalence of the conditions to those specified in section (e)(3.3.1)(A) above. For 2019 and subsequent model year hybrid vehicles, the OBD II system shall monitor for misfire from no later than the end of the second crankshaft revolution after engine fueling begins for the initial start and after each time fueling resumes.

(3.4) MIL Illumination and Fault Code Storage:

(3.4.1) Misfire causing catalyst damage. Upon detection of the percentage of misfire specified in section (e)(3.2.1) above, the following criteria shall apply for MIL illumination and fault code storage:

(A) Pending fault codes

(i) A pending fault code 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 (e)(3.3.1).

(ii) Immediately after a pending fault code is stored as specified in section (e)(3.4.1)(A)(i) above, the MIL shall blink once per second at all times while misfire is occurring during the driving cycle.

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

b. If, at the time a misfire malfunction occurs, the MIL is already illuminated for a malfunction other than misfire, the MIL shall blink as previously specified in section (e)(3.4.1)(A)(ii) while misfire is occurring. If misfiring ceases, the MIL shall stop blinking but remain illuminated as required by the other malfunction.

(B) Confirmed fault codes

(i) If a pending fault code for exceeding the percentage of misfire set forth in section (e)(3.2.1) is stored, the OBD II system shall immediately store a confirmed fault code if the percentage of misfire specified in section (e)(3.2.1) is again exceeded one or more times during ~~either~~<u>any of the two following events</u>: (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 (e)(3.2.2) is stored from a previous drive cycle, the OBD II system shall immediately store a confirmed fault code if the percentage of misfire specified in section (e)(3.2.1) is exceeded one or more times regardless of the conditions encountered.

(iii) Upon storage of a confirmed fault code, the MIL shall blink as specified in subparagraph (e)(3.4.1)(A)(ii) above as long as 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 vehicles with fuel shutoff and default fuel control. Notwithstanding sections (e)(3.4.1)(A) and (B) above, in vehicles that provide for fuel shutoff and default fuel control to prevent over fueling during catalyst damage misfire conditions, the MIL need not blink. Instead, the MIL may illuminate continuously in accordance with the requirements for continuous MIL illumination in sections (e)(3.4.1)(B)(iii) above upon detection of misfire, provided that the fuel shutoff and default control are activated as soon as misfire is detected. Fuel shutoff and default fuel control may be deactivated only to permit fueling outside of the misfire range. Manufacturers may also periodically, but not more than once every 30 seconds, deactivate fuel shutoff and default fuel control to determine if the specified percentage of misfire for catalyst damage is still being exceeded. Normal fueling and fuel control may be resumed if the specified percentage of misfire for catalyst damage 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).

(3.4.2) Misfire causing emissions to exceed ~~1.5 times the FTP standards~~an emission threshold. Upon detection of the percentage of misfire specified in section (e)(3.2.2), the following criteria shall apply for MIL illumination and fault code storage:

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

(i) A pending fault code 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 II system shall illuminate the MIL and store a confirmed fault code within ten 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 (e)(3.2.2) during a single driving cycle.

(ii) If a pending fault code is stored, the OBD II system shall illuminate the MIL and store a confirmed fault code within ten seconds if the percentage of misfire specified in section (e)(3.2.2) is again exceeded four times during: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered. Additionally, the pending fault code shall continue to be stored in accordance with section (g)(4.4.5).

(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.

(3.4.3) Misfire on plug-in hybrid electric vehicles. Upon detection of the percentage of misfire specified in section (e)(3.2.3)(A), the following criteria shall apply for MIL illumination and fault code storage:

(A) 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.

(B) If a pending fault code is stored, the OBD II system shall illuminate the MIL and store a confirmed fault code within ten seconds if the percentage of misfire specified in section (e)(3.2.3)(A) is again exceeded one time 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. Additionally, the pending fault code shall continue to be stored in accordance with section (g)(4.4.5).

(C) 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.

~~(3.4.3)~~(3.4.4) Storage of freeze frame conditions.

(A) A manufacturer 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 misfire or fuel system malfunction (see section (e)(6)) when a misfire fault code is stored as specified in section (e)(3.4) above, the stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction.

~~(3.4.4)~~(3.4.5) Storage of misfire conditions for similar conditions determination. Upon detection of misfire under sections (e)(3.4.1), ~~or~~ (3.4.2), or (3.4.3), manufacturers shall store the following engine conditions: engine speed, load, and warm-up status of the first misfire event that resulted in the storage of the pending fault code.

~~(3.4.5)~~(3.4.6) 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.

(4) *Evaporative System Monitoring*

(4.1) Requirement: The OBD II system shall verify purge flow from the evaporative system and shall monitor the complete evaporative system, excluding the tubing and connections between the purge valve and the intake manifold, for vapor leaks to the atmosphere. Individual components of the evaporative system (e.g. valves, sensors, etc.) shall be monitored in accordance with the comprehensive components requirements in section (e)(15) (e.g., for circuit continuity, out of range values, rationality, proper functional response, etc.). Vehicles not ~~required to be equipped with~~subject to evaporative emission ~~systems~~ standards shall be exempt from monitoring of the evaporative system. For alternate-fueled vehicles subject to evaporative emission standards, manufacturers 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/or engineering evaluation that demonstrate that the monitoring plan is as reliable and effective as the monitoring plan required for gasoline vehicles under section (e)(4).

(4.2) Malfunction Criteria:

(4.2.1) For purposes of section (e)(4), an orifice shall be defined as an O'Keefe Controls Co. precision metal "Type B" orifice with NPT connections with a diameter of the specified dimension (e.g., part number B-20-SS for a stainless steel 0.020 inch diameter orifice).

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

(A) Except as specified in section (e)(4.2.2)(D), ~~N~~no purge flow from the evaporative system to the engine (i.e., to the enclosed area of the air intake system) can be detected by the OBD II system;

(B) The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.040 inch diameter orifice; ~~or~~

(C) The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.020 inch diameter orifice~~.~~; or

(D) For high-load purge lines (i.e., lines for purging the evaporative system canister under conditions where the intake manifold pressure is greater than ambient pressure) on vehicles with forced induction engines, no purge flow from the evaporative system to the engine (i.e., to the enclosed area of the air intake system) can be detected by the OBD II system.

(4.2.3) On vehicles with fuel tank capacity greater than 25.0 gallons, a manufacturer may request the Executive Officer to revise the orifice size in sections (e)(4.2.2)(B) and/or (C) if the most reliable monitoring method available cannot reliably detect a system leak of the magnitudes specified. The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or engineering analysis that demonstrate the need for the request.

(4.2.4) 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 sections (e)(4.2.2)(B) and/or (C) upward to exclude detection of leaks that cannot cause evaporative or running loss emissions to exceed 1.5 times the applicable standards.

(4.2.5) A manufacturer may request Executive Officer approval to revise the orifice size in section (e)(4.2.2)(B) to a 0.090 inch diameter orifice. The Executive Officer shall approve the request upon the manufacturer submitting data and/or engineering analysis and the Executive Officer finding that:

(A) the monitoring strategy for detecting orifices specified in section (e)(4.2.2)(C) meets the monitoring conditions requirements of section (e)(4.3.2); and

(B) the monitoring strategy for detecting 0.090 inch diameter orifices yields an in-use monitor performance ratio (as defined in section (d)(4)) that meets or exceeds 0.620.

(4.2.6) For the 2004 and 2005 model years only, manufacturers that use separate monitors to identify leaks (as specified in (e)(4.2.2.)(B) or (C)) in different portions of the complete evaporative system (e.g., separate monitors for the fuel tank to canister portion and for the canister to purge valve portion of the system) may request Executive Officer approval to revise the malfunction criteria in sections (e)(4.2.2)(B) and (C) to identify a malfunction when the separately monitored portion of the evaporative system (e.g., the fuel tank to canister portion) has a leak (or leaks) that is greater than or equal to the specified size in lieu of when the complete evaporative system has a leak (or leaks) that is greater than or equal to the specified size. The Executive Officer shall approve the request upon determining that the manufacturer utilized the same monitoring strategy (e.g., monitoring portions of the complete system with separate monitors) on vehicles prior to the 2004 model year and that the monitoring strategy provides further isolation of the malfunction for repair technicians by

utilizing separate fault codes for each monitored portion of the evaporative system.

(4.2.7) For vehicles with multiple fuel tanks, canisters, and/or purge valves, a manufacturer may request the Executive Officer to approve multiple "complete evaporative systems" on the vehicle with regards to the requirements of sections (e)(4.2.2)(B) and (C) if the most reliable monitoring method available cannot reliably detect a system leak of the magnitudes specified. The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or engineering analysis that demonstrate the need for the request and that show the "complete evaporative system" does not have any shared vapor lines or paths with any other "complete evaporative system" in the vehicle. The manufacturer is required to meet the requirements of sections (e)(4.2.2)(B) and (C) for each "complete evaporative system."

~~(4.2.7)~~(4.2.8) For vehicles subject to the requirements of section (e)(4.2.2)(A) or (e)(4.2.2)(D):

(A) Except as provided for in sections (e)(4.2.8)(A)(i), (e)(4.2.8)(A)(ii), and (e)(4.2.8)(C)(i), ~~F~~for vehicles that utilize more than one purge flow path (e.g., a turbo-charged engine with a low-load ~~pressure~~ purge line and a high-load ~~pressure~~ purge line), the OBD II system shall verify the criteria of section (e)(4.2.2)(A) or (D) (i.e., purge flow to the engine) for ~~both~~ all purge flow paths.

(i) Except as provided for high-load purge lines under section (e)(4.2.8)(A)(ii), ~~I~~if a manufacturer demonstrates that blockage, leakage, or disconnection of one of the purge flow paths cannot cause a measurable emission increase during any reasonable in-use driving conditions, monitoring of that flow path is not required.

(ii) For manufacturers subject to the requirements of section (e)(4.2.2)(D) on forced induction engines with separate low-load purge lines and high-load purge lines, if a manufacturer demonstrates that the purge mass flow through the high-load flow path is less than 1 percent of the total purge mass flow to the engine on the US06 cycle, monitoring of purge flow through the high-load purge line is not required.

(B) For monitoring strategies designed to detect malfunctions identified in sections (e)(4.2.2)(A) and (e)(4.2.2)(D), a manufacturer may request Executive Officer approval to detect the malfunctions using monitoring strategies that do not directly confirm evaporative purge delivery to the engine but infer it through other sensed parameters or conditions. The Executive Officer shall approve the monitoring strategy upon determining that data and/or engineering analysis submitted by the manufacturer demonstrate equivalent effectiveness in detecting malfunctions.

(C) For vehicles subject to the requirements of section (e)(4.2.2)(D) and that do not meet the criteria of section (e)(4.2.8)(A)(ii):

(i) For vehicles not included in the phase-in specified in section (e)(4.2.8)(C)(ii), a manufacturer may request Executive Officer approval of a monitoring strategy that cannot detect all disconnections, broken lines, blockages, or any other malfunctions that can impact purge flow delivery to the engine as required in section (e)(4.2.2)(D).

The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation demonstrating the following: the degree to which purge flow monitoring is limited is small relative to the fully monitored purge lines (e.g., blocked high-load purge lines can be detected but disconnections or broken lines cannot be detected, or high-load purge lines are fully monitored for purge flow delivery except for a one-inch portion after the venturi where a disconnection or broken fitting cannot be detected), the monitoring of the high-load purge lines cannot be fully achieved when employing proven monitoring technology (i.e., a technology that provides for compliance with these requirements on other engines), and the high-load purge system design is inherently resistant to deterioration (e.g., breakage, disconnections, blockage) of the unmonitored portions of the purge lines.

(ii) For 20 percent of 2019 model year vehicles, 50 percent of 2020 model year vehicles, and 100 percent of 2021 model year vehicles, the manufacturer may not design monitoring strategies for section (e)(4.2.2)(D) that cannot detect disconnections, broken lines, blockages, or any other malfunctions that prevent purge flow delivery to the engine (e.g., monitors that cannot detect a disconnection or blockage of any portion of the purge lines prior to purge flow delivery to the engine).

(4.3) Monitoring Conditions:

(4.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(4.2.2)(A), ~~and~~ (B), and (D) (i.e., purge flow and 0.040 inch leak detection) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(4.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(4.2.2)(C) (i.e., 0.020 inch leak detection) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the evaporative system monitors under section (e)(4.2.2)(C) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(4.2.2)(C) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

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

(4.3.4) Manufacturers may request Executive Officer approval to execute the evaporative system monitor only on driving cycles determined by the manufacturer to be cold starts if the condition is needed to ensure reliable monitoring. The Executive Officer may not approve criteria that exclude engine starts from being considered as cold starts solely on the basis that ambient temperature exceeds (i.e., indicates a higher temperature than) engine coolant temperature at engine start. The Executive Officer shall approve the request upon 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.

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

(4.4) MIL Illumination and Fault Code Storage:

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

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

(A) The manufacturer is not required to illuminate the MIL or store a fault code if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The alternative indicator shall 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 II system has verified that the fuel cap has been securely fastened and the MIL has not been illuminated for any other type of malfunction.

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

(4.4.3) Notwithstanding section (d)(2.2.6), manufacturers may request Executive Officer approval to use alternative statistical MIL illumination and fault code storage protocols that require up to twelve driving cycles on average for monitoring strategies designed to detect malfunctions specified by section (e)(4.2.2)(C). Executive Officer approval shall be granted in accordance with the bases identified in section (d)(2.2.6) and upon determination that the manufacturer has submitted data and/or an engineering analysis demonstrating that the most reliable monitoring method available cannot reliably detect a malfunction of the specified size without the additional driving cycles and that the monitoring system will still meet the monitoring conditions requirements specified in sections (d)(3.1) and (3.2).

(5) *Secondary Air System Monitoring*

(5.1) Requirement: The OBD II system on vehicles equipped with any form of secondary air delivery system shall monitor the proper functioning of the secondary air delivery system including all air switching valve(s). The individual electronic components (e.g., actuators, valves, sensors, etc.) in the secondary air system shall be monitored in accordance with the comprehensive component requirements in section (e)(15).

(5.2) Malfunction Criteria:

(5.2.1) For purposes of section (e)(5),:

(A) "~~air~~ Air flow" is defined as the air flow delivered by the secondary air system to the exhaust system. For vehicles using secondary air systems with multiple air flow paths/distribution points, the air flow to each bank (i.e., a group of cylinders that share a common exhaust manifold, catalyst, and control sensor) shall be monitored in accordance with the malfunction criteria in section~~s~~ (e)(5.2.3) ~~and (5.2.4)~~ unless complete blocking of air delivery to one bank does not cause a measurable increase in emissions.

(B) "Normal operation" is defined as the condition when the secondary air system is activated during catalyst and/or engine warm-up following engine start and may not include the condition when the secondary air system is intrusively turned on solely for the purpose of monitoring.

(5.2.2) For all Low Emission Vehicle I applications:

(A) Except as provided in sections (e)(5.2.2)(B) and ~~(e)(5.2.4)~~(C), the OBD II system shall detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(B) Manufacturers may request Executive Officer approval to detect a malfunction when no detectable amount of air flow is delivered in lieu of the malfunction criteria in section (e)(5.2.2)(A). The Executive Office shall grant approval upon determining that deterioration of the secondary air system is unlikely based on data and/or engineering evaluation submitted by the manufacturer demonstrating that the materials used for the secondary air system (e.g., air hoses, tubing, valves, connectors, etc.) are inherently resistant to disconnection, corrosion, or other deterioration.

(C) For vehicles in which no deterioration or failure of the secondary air system would result in a vehicle's emissions exceeding the thresholds specified in section (e)(5.2.2)(A), the OBD II system shall detect a malfunction when no detectable amount of air flow is delivered.

(5.2.3) For all Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles:

(A) For 2004 and 2005 model year vehicles, manufacturers shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(5.2.2).

(B) For 2006 and subsequent model year vehicles, except as provided in sections (e)(5.2.3)(C) and (D) ~~and (e)(5.2.4)~~, the OBD II system shall detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow during normal operation that would cause a vehicle's emissions to exceed:

(i) For non-Low Emission Vehicle III applications, 1.5 times any of the applicable FTP standards. ~~For purposes of sections (e)(5.2) and (5.3), "normal operation" shall be defined as the condition when the secondary air system is activated during catalyst and/or engine warm-up following engine start and may not include the condition when the secondary air system is intrusively turned on solely for the purpose of monitoring.~~

(ii) For Low Emission Vehicle III applications, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

(C) For 2006 and 2007 model year vehicles only, a manufacturer may request Executive Officer approval to detect a malfunction when no detectable amount of air flow is delivered during normal operation in lieu of the malfunction criteria in section (e)(5.2.3)(B) (e.g., 1.5 times the standard) during normal operation. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering analysis that demonstrate that the monitoring system is capable of detecting malfunctions prior to a decrease from the manufacturer's specified air flow that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards during an intrusive operation of the secondary air system later in the same driving cycle.

~~(5.2.4)~~(D) For vehicles in which no deterioration or failure of the secondary air system would result in a vehicle's emissions exceeding the thresholds specified in section (e)(5.2.3)(B)~~1.5 times any of the applicable standards~~, the OBD II system shall detect a malfunction when no detectable amount of air flow is delivered during normal operation. ~~For vehicles subject to the malfunction criteria in section (e)(5.2.3)(B), this monitoring for no detectable amount of air flow shall occur during normal operation of the secondary air system.~~

(5.3) Monitoring Conditions:

(5.3.1) For all Low Emission Vehicle I applications: Manufacturers shall define the monitoring conditions in accordance with section (d)(3.1).

(5.3.2) For all Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles:

(A) For 2004 and 2005 model year vehicles, manufacturers shall define the monitoring conditions in accordance with section (d)(3.1).

(B) For 2006 and subsequent model year vehicles, manufacturers shall define the monitoring conditions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the secondary air system monitors under section (e)(5.2) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(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) *Fuel System Monitoring*

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

~~(6.1.1) The OBD II system shall monitor the fuel delivery system to determine its ability to provide compliance with applicable standards.~~

(6.2) Malfunction Criteria:

(6.2.1) The OBD II system shall detect a malfunction of the fuel delivery system when any of the following occurs:

(A) The fuel delivery system is unable to maintain a vehicle's emissions at or below:

(i) For non-Low Emission Vehicle III applications, 1.5 times any of the applicable FTP standards; or

(ii) For Low Emission Vehicle III applications, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e); or

(B) If equipped, the feedback control based on a secondary oxygen or exhaust gas sensor is unable to maintain a vehicle's emissions (except as a result of a malfunction specified in section (e)(6.2.1)(C)) at or below:

(i) For non-Low Emission Vehicle III applications, 1.5 times any of the applicable FTP standards; or

(ii) For Low Emission Vehicle III applications, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e); or

(C) Except as required in section (e)(6.2.6), for 25 percent of all 2011 model year vehicles, 50 percent of all 2012 model year vehicles, 75 percent of all 2013 model year vehicles, and 100 percent of all 2014 model year vehicles, an air-fuel ratio cylinder imbalance (e.g., the air-fuel ratio in one or more cylinders is different than the other cylinders due to a cylinder specific malfunction such as an intake manifold leak at a particular cylinder, fuel injector problem, an individual cylinder EGR runner flow delivery problem, an individual variable cam lift malfunction such that an individual cylinder is operating on the wrong cam lift profile, or other similar problems) occurs in one or more cylinders such that the fuel delivery system is unable to maintain a vehicle's emissions at or below:

(i) For non-Low Emission Vehicle III applications:

a. For 2011 through 2014 model year vehicles, 4.0 times any of the applicable FTP standards for PC/LDT SULEV II vehicles and 3.0 times any of the applicable FTP standards for all other vehicles ~~for the 2011 through 2013 model years;~~. ~~and~~

b. For 2015 and subsequent model year vehicles, 1.5 times any of the applicable FTP standards ~~for all 2014 and subsequent model year vehicles~~.

c. In lieu of using 1.5 times any of the applicable FTP standards for all ~~2014~~ 2015 model year applications, for the ~~2014~~ 2015 model year only, a manufacturer may continue to use 4.0 times any of the applicable FTP standards for PC/LDT SULEV II vehicles and 3.0 times any of the applicable FTP standards for other applications previously certified in the 2011, 2012, ~~or~~ 2013, or 2014 model year to 4.0 times or 3.0 times any of the applicable FTP standards and carried over to the ~~2014~~ 2015 model year.

(ii) For Low Emission Vehicle III applications:

a. For LEV160 vehicles, ULEV125 vehicles, and medium-duty vehicles (except MDPVs) certified to a chassis dynamometer tailpipe emission standard:

1. For 2014 model year vehicles, 3.0 times any of the applicable FTP NMOG+NOx or CO standards.

2. For 2015 and subsequent model vehicles, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

b. For ULEV70 and ULEV50 vehicles:

1. For 2014 through 2018 model year vehicles, 3.0 times any of the applicable FTP NMOG+NOx or CO standards.

2. For 2019 and subsequent model year vehicles, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e);

c. For SULEV30 and SULEV20 vehicles:

1. For 2014 through 2018 model year vehicles, 4.0 times any of the applicable FTP NMOG+NOx or CO standards.

2. For 2019 and subsequent model year vehicles, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e);

(6.2.2) Except as provided for in section (e)(6.2.3) below, if the vehicle is equipped with adaptive feedback control, the OBD II system shall detect a malfunction when the adaptive feedback control has used up all of the adjustment allowed by the manufacturer.

(6.2.3) If the vehicle is equipped with feedback control that is based on a secondary oxygen (or equivalent) sensor, the OBD II system is not required to detect a malfunction of the fuel system solely when the feedback control based on a secondary oxygen sensor has used up all of the adjustment allowed by the manufacturer. However, if a failure or deterioration results in vehicle emissions that exceed the malfunction criteria in section (e)(6.2.1)(B), the OBD II system is required to detect a malfunction.

(6.2.4) Except as provided in section (e)(6.2.4)(D) below, t~~T~~he OBD II system shall detect a malfunction whenever the fuel control system fails to enter closed-loop operation (if employed) within an Executive Officer approved ~~manufacturer specified~~ time interval. 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.

(A) For vehicles not included in the phase-in specified in section (e)(6.2.4)(B) below, “closed-loop operation” as specified in section (e)(6.2.4) above shall mean either stoichiometric or non-stoichiometric closed-loop operation, whichever one the manufacturer chooses.

(B) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles, “closed-loop operation” as specified in section (e)(6.2.4) above shall mean stoichiometric closed-loop operation.

(C) For engines that employ engine shutoff strategies that do not require the vehicle operator to restart the engine to continue driving (e.g., hybrid vehicle or a vehicle with a start-stop system with engine shutoff at idle) on 2019 and subsequent model year vehicles, the OBD II system shall detect whenever the fuel control system fails to enter closed-loop operation within an Executive Officer-approved time interval after an engine restart. 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.

(D) In lieu of detecting the malfunctions specified (e)(6.2.4) above with a fuel-system specific monitor, the OBD II system may monitor the individual parameters or components that are used as inputs for fuel system closed-loop operation if the manufacturer demonstrates that the monitor(s) detect all malfunctions and is equally as effective and timely in detecting faults that prevent achieving closed-loop operation in the time interval approved by the Executive Officer.

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

(6.2.6) Notwithstanding the phase-in specified in section (e)(6.2.1)(C), if a vehicle is equipped with separate EGR flow delivery passageways (internal or external) that deliver EGR flow to individual cylinders (e.g., an EGR system with individual delivery pipes to each cylinder), the OBD II system shall monitor the fuel delivery system for malfunctions specified in section (e)(6.2.1)(C) on all 2011 and subsequent model year vehicles so equipped.

(6.2.7) For purposes of determining the fuel system malfunction criteria in section (e)(6.2.1)(C), the manufacturer shall establish the malfunction criteria using a fault that affects a single cylinder.

(6.3) Monitoring Conditions:

(6.3.1) Except as provided in section (e)(6.3.~~2~~5), the OBD II system shall monitor ~~the fuel system shall be monitored~~ continuously for ~~the presence of a~~ malfunctions identified in sections (e)(6.2.1)(A), (e)(6.2.1)(B), and (e)(6.2.2) (i.e., fuel delivery system, secondary feedback control, adaptive feedback control).

(6.3.2) Manufacturers shall define monitoring conditions for malfunctions identified in section (e)(6.2.1)(C) (i.e., air-fuel ratio cylinder imbalance malfunctions) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, for 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year gasoline vehicles, manufacturers shall track and report the in-use performance of the fuel system monitors under section (e)(6.2.1)(C) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all dedicated monitors used to detect malfunctions identified in section (e)(6.2.1)(C) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2). Manufacturers that use other existing monitors (e.g., misfire monitor under section (e)(3), fuel system monitor under section (e)(6.2.1)(A)) to detect malfunctions identified in section (e)(6.2.1)(C) are subject to the tracking and reporting requirements of the other monitors.

(6.3.3) Manufacturers shall define monitoring conditions for malfunctions identified in section (e)(6.2.4) (except malfunctions identified in section

(e)(6.4.2)(C), which is provided for per section (e)(6.3.4) below) in accordance with section (d)(3.1).

(6.3.4) Manufacturers shall define monitoring conditions for malfunctions identified in section (e)(6.2.4)(C) in accordance with section (d)(3.1) 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).

(6.3.5) Manufacturers may request Executive Officer approval to temporarily disable continuous monitoring under conditions technically necessary to ensure robust detection of malfunctions and to avoid false passes and false indications of malfunctions (e.g., for temporary introduction of large amounts of purge vapor). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a properly operating system cannot be distinguished from a malfunctioning system and that the disablement interval is limited only to that which is technically necessary.

(6.4) MIL Illumination and Fault Code Storage: For malfunctions described under section (e)(6.2.1)(C) (i.e., air-fuel ratio cylinder imbalance malfunctions), general requirements for MIL illumination and fault code storage are set forth in section (d)(2). The stored fault code shall pinpoint the likely cause of the malfunction to the fullest extent that is inherently possible based on the monitoring strategy used. Further, the stored fault code is not required to specifically identify the air-fuel ratio cylinder imbalance malfunction (e.g., a fault code for misfire monitoring can be stored) if the manufacturer demonstrates that additional monitoring hardware would be necessary to make this identification and that the other monitor(s) robustly detects the malfunction. For all other fuel system malfunctions, the MIL illumination and fault code storage requirements are set forth in sections (e)(6.4.1) through (6.4.6) below.

(6.4.1) A pending fault code shall be stored immediately upon the fuel system exceeding the malfunction criteria established pursuant to section (e)(6.2).

(6.4.2) Except as provided below, if a pending fault code is stored, the OBD II system shall immediately illuminate the MIL and store a confirmed fault code if a malfunction is again detected during ~~either~~ any 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. Additionally, the pending fault code shall continue to be stored in accordance with section (g)(4.4.5).

(6.4.3) 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.

(6.4.4) Storage of freeze frame conditions.

(A) The OBD II 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 misfire (see section (e)(3)) or fuel system malfunction when a fuel system fault code is stored as specified in section (e)(6.4) above, the stored freeze frame information shall be replaced with freeze frame information regarding the fuel system malfunction.

(6.4.5) Storage of fuel system conditions for determining similar conditions of operation.

(A) Upon detection of a fuel system malfunction under section (e)(6.2), the OBD II 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.

(B) For fuel system faults detected using feedback control that is based on a secondary oxygen (or equivalent) sensor, the manufacturer may request Executive Officer approval to use an alternate definition of similar conditions in lieu of the definition specified in section (c). The Executive Officer shall approve the alternate definition upon the manufacturer providing data or analysis demonstrating that the alternate definition provides for equivalent robustness in detection of fuel system faults that vary in severity depending on engine speed, load, and/or warm-up status.

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

(7) *Exhaust Gas Sensor Monitoring*

(7.1) Requirement:

(7.1.1) The OBD II system shall monitor the output voltage, response rate, and any other parameter which can affect emissions of all primary (fuel control) oxygen sensors (conventional switching sensors and wide range or universal sensors) for malfunction.

(7.1.2) The OBD II system shall also monitor all secondary oxygen sensors (those used for fuel trim control or as a monitoring device) for proper output voltage, activity, and/or response rate.

(7.1.3) For vehicles equipped with heated oxygen sensors, the OBD II system shall monitor the heater for proper performance.

(7.1.4) For other types of sensors (e.g., hydrocarbon sensors, NOx 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 conventional sensors under section (e)(7).

(7.2) Malfunction Criteria:

(7.2.1) Primary Sensors:

(A) The OBD II system shall detect a malfunction prior to any failure or deterioration of the oxygen sensor voltage, response rate, amplitude, or

other characteristic(s) (including drift or bias corrected for by secondary sensors) that would cause a vehicle's emissions to exceed ~~1.5 times any of the applicable FTP standards~~the emission thresholds in sections (e)(7.2.1)(A)(i) or (ii) below. For response rate (see section (c)), the OBD II system shall detect asymmetric malfunctions (i.e., malfunctions that primarily affect only the lean-to-rich response rate or only the rich-to-lean response rate) and symmetric malfunctions (i.e., malfunctions that affect both the lean-to-rich and rich-to-lean response rates). As defined in section (c), response rate includes delays in the sensor to initially react to a change in exhaust gas composition (i.e., delayed response) as well as ~~delays during the~~slower transitions from a rich-to-lean (or lean-to-rich) sensor output (i.e., slow response). For 25 percent of 2011, 50 percent of 2012, and 100 percent of 2013 and subsequent model year vehicles, the manufacturer shall submit data and/or engineering analysis to demonstrate that the calibration method used ensures proper detection of all symmetric and asymmetric response rate malfunctions as part of the certification application.

(i) For non-Low Emission Vehicle III applications, the threshold is 1.5 times any of the applicable FTP standards.

(ii) For Low Emission Vehicle III applications, the thresholds are any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

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

(C) The OBD II system shall detect a malfunction of the oxygen sensor when a sensor failure or deterioration causes the fuel system to stop using that sensor as a feedback input (e.g., causes default or open loop operation) or causes the fuel system to fail to enter closed-loop operation within a manufacturer-specified time interval.

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

(7.2.2) Secondary Sensors:

(A) The OBD II system shall detect a malfunction prior to any failure or deterioration of the oxygen sensor voltage, response rate, amplitude, or other characteristic(s) that would cause a vehicle's emissions to exceed:

(i) For non-Low Emission Vehicle III applications, 1.5 times any of the applicable FTP standards.

(ii) For Low Emission Vehicle III applications, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

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

(C) Sufficient sensor performance for other monitors.

(i) The OBD II system shall detect a malfunction of the oxygen sensor when the sensor output voltage, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD II system monitoring device (e.g., for catalyst monitoring). For this requirement,

"sufficient" is defined as the capability of the worst performing acceptable sensor to detect the best performing unacceptable other monitored system or component (e.g., catalyst).

(ii) For systems where it is not technically feasible to satisfy the criteria of section (e)(7.2.2)(C)(i) completely, the OBD II system shall, at a minimum, detect a slow rich-to-lean response malfunction during a fuel shut-off event (e.g., deceleration fuel cut event). The rich-to-lean response check shall monitor both the sensor response time from a rich condition (e.g., 0.7 Volts) prior to the start of fuel shut-off to a lean condition (e.g., 0.1 Volts) expected during fuel shut-off conditions and the sensor transition time in the intermediate sensor range (e.g., from 0.55 Volts to 0.3 Volts). Monitoring of the rich-to-lean response shall be phased in on at least 25 percent of the 2009, 50 percent of the 2010, and 100 percent of the 2011 model year vehicles. For purposes of this phase-in, vehicles meeting the criteria of section (e)(7.2.2)(C)(i) shall be counted as vehicles meeting the rich-to-lean response rate monitoring requirement of section (e)(7.2.2)(C)(ii).

(iii) Additionally, for systems where it is not technically feasible to satisfy the criteria in section (e)(7.2.2)(C)(i), prior to certification of 2009 model year vehicles, the manufacturer must submit a comprehensive plan to the Executive Officer demonstrating the manufacturer's efforts to minimize any gap remaining between the worst performing acceptable sensor and a sufficient sensor. The plan should include quantification of the gap and supporting documentation for efforts to close the gap including sensor monitoring improvements, other system component monitor improvements (e.g., changes to make the catalyst monitor less sensitive to oxygen sensor response), and sensor specification changes, if any. The Executive Officer shall approve the plan upon determining the submitted information supports the necessity of the gap and the plan demonstrates that the manufacturer is taking reasonable efforts to minimize or eliminate the gap in a timely manner.

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

<u>(E) For 2019 and subsequent model year vehicles, the OBD II system shall detect a malfunction of the oxygen 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).</u>

(7.2.3) Sensor Heaters:

(A) The OBD II system shall detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Subject to Executive Officer approval, other malfunction criteria for heater performance malfunctions may be used 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)(7.2.3)(A).

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

(7.3) Monitoring Conditions:

(7.3.1) Primary Sensors

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(7.2.1)(A) and (D) (e.g., proper response rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the primary sensor monitors under sections (e)(7.2.1)(A) and (D) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (e)(7.2.1)(A) and (D) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(B) Except as provided in section (e)(7.3.1)(C), monitoring for malfunctions identified in sections (e)(7.2.1)(B) and (C) (i.e., circuit continuity, out-of-range, and open-loop malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

(ii) Conducted continuously for all 2006 through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles.

(C) A manufacturer may request Executive Officer approval to disable continuous oxygen sensor monitoring when an oxygen sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon 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.

(7.3.2) Secondary Sensors

(A) Manufacturers shall define monitoring conditions for malfunctions identified in sections (e)(7.2.2)(A) and (C) (e.g., proper sensor activity) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, ~~F~~for all 2010 and subsequent model year vehicles meeting the monitoring requirements of section (e)(7.2.2)(C)(i) or (ii), manufacturers shall track and report the in-use performance of the secondary sensor monitors under (e)(7.2.2)(A) and (C) in accordance with section (d)(3.2.2). ~~f~~For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (e)(7.2.2)(A) and (C) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(B) Except as provided in section (e)(7.3.2)(~~C~~D), monitoring for malfunctions identified in sections (e)(7.2.2)(B) and (D) (i.e., open circuit, out-of-range malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

(ii) Conducted continuously for all 2006 through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles.

(C) Except as provided in section (e)(7.3.2)(D), monitoring for malfunctions identified in section (e)(7.2.2)(E) (e.g., open-loop malfunctions) shall be conducted continuously.

~~(C)~~(D) A manufacturer may request Executive Officer approval to disable continuous oxygen sensor monitoring when an oxygen sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon 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.

(7.3.3) Sensor Heaters

(A) Manufacturers shall define monitoring conditions for malfunctions identified in section (e) (7.2.3)(A) (e.g., sensor heater performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Monitoring for malfunctions identified in section (e)(7.2.3)(B) (e.g., circuit malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for 2004 and 2005 model year vehicles;

(ii) Conducted continuously for all 2006 and subsequent model year vehicles.

(7.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2). To the extent feasible, the OBD II system shall separately detect lack of circuit continuity and out-of-range faults as required under sections (e)(7.2.1)(B), (e)(7.2.2)(B), and (e)(7.2.2)(D) and store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit). For sensors with sensing elements externally connected to a sensor control module, manufacturers are not required to store different fault codes for lack of circuit continuity and out-of-range faults if: (1) the sensing element (i.e., probe or sensor externally connected to the sensor control module) is a subcomponent integral to the function of the complete sensor unit; (2) the sensing element is permanently attached to the sensor control module with wires or one-time connectors; (3) the complete sensor unit is designed, manufactured, installed, and serviced per manufacturer published procedures as a single component; and (4) the sensor control module and sensing element are calibrated together during the manufacturing process such that

neither can be individually replaced in a repair scenario. Additionally, manufacturers are not required to store separate fault codes for lack of circuit continuity faults that cannot be distinguished from other out-of-range or circuit faults.

(8) *Exhaust Gas Recirculation (EGR) System Monitoring*

(8.1) Requirement: The OBD II system shall monitor the EGR system on vehicles so-equipped for low and high flow rate malfunctions. The individual electronic components (e.g., actuators, valves, sensors, etc.) that are used in the EGR system shall be monitored in accordance with the comprehensive component requirements in section (e)(15).

(8.2) Malfunction Criteria:

(8.2.1) The OBD II system shall detect a malfunction of the EGR system prior to a~~n increase or~~ decrease from the manufacturer's specified EGR flow rate that would cause a vehicle's emissions to exceed:

(A) For non-Low Emission Vehicle III applications, 1.5 times any of the applicable FTP standards.

(B) For Low Emission Vehicle III applications, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

(8.2.2) The OBD II system shall detect a malfunction of the EGR system prior to an increase from the manufacturer's specified EGR flow rate that would cause a vehicle's emissions to exceed:

(A) For non-Low Emission Vehicle III applications, 1.5 times any of the applicable FTP standards.

(B) For Low Emission Vehicle III applications, any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

~~(8.2.2)~~(8.2.3) For vehicles in which no failure or deterioration of the EGR system that causes a decrease in flow could result in a vehicle's emissions exceeding the thresholds specified in section (e)(8.2.1) ~~1.5 times any of the applicable standards~~, the OBD II system shall detect a malfunction when either the EGR system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate or, for non-feedback controlled EGR systems, the system has no detectable amount of EGR flow when EGR flow is expected.

(8.2.4) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year gasoline vehicles in which no failure or deterioration of the EGR system that causes an increase in flow could result in a vehicle's emissions exceeding the thresholds specified in section (e)(8.2.2), the OBD II system shall detect a malfunction when either the EGR system has reached its control limits such that it cannot reduce EGR flow to achieve the commanded flow rate or, for non-feedback controlled EGR systems, the EGR system has maximum detectable EGR flow when little or no EGR flow is expected. Manufacturers may request Executive Officer approval to be exempt from monitoring for this failure or deterioration. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that (1)

the failure or deterioration cannot be detected during off-idle conditions, and (2) the failure or deterioration causes the vehicle to immediately stall during idle conditions.

(8.3) Monitoring Conditions:

(8.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(8.2) (e.g., flow rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the EGR system monitors under section (e)(8.2) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(8.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(8.3.2) Manufacturers may request Executive Officer approval to temporarily disable the EGR system check under specific conditions (e.g., when freezing may affect performance of the system). The Executive Officer shall approve the request 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.

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

(9) *Positive Crankcase Ventilation (PCV) System Monitoring*

(9.1) Requirement:

(9.1.1) On all 2004 and subsequent model year vehicles, manufacturers shall monitor the PCV system on vehicles so-equipped for system integrity. A manufacturer may use an alternate phase-in schedule in lieu of meeting the requirements of section (e)(9) on all 2004 model year vehicles if the alternate phase-in schedule provides for equivalent compliance volume (as defined in section (c)) to the phase-in schedule specified in title 13, CCR section 1968.1(b)(10.1). Vehicles not ~~required to be equipped with PCV systems~~ subject to crankcase emission control requirements shall be exempt from monitoring of the PCV system.

(9.2) Malfunction Criteria:

(9.2.1) For the purposes of section (e)(9), “PCV system” is defined as any form of crankcase ventilation system, regardless of whether it utilizes positive pressure. “PCV valve” is defined as any form of valve or orifice used to restrict or control crankcase vapor flow. Further, any additional external PCV system tubing or hoses used to equalize crankcase pressure or to provide a ventilation path between various areas of the engine (e.g., between the crankcase and valve cover, between the crankcase and the fresh air intake system on naturally aspirated engines with dry sump lubrication systems) are considered part of the PCV system “between the crankcase and the PCV valve” in section (e)(9.2.2) and considered part of the “PCV system” in section (e)(9.2.3), and subject to the malfunction criteria in sections (e)(9.2.2) and (e)(9.2.3) below.

(9.2.2) For vehicles not included in the phase-in specified in section (e)(9.2.3), the following criteria apply for PCV system monitoring:

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

~~(9.2.3)~~(B) If the PCV system is designed such that the PCV valve is fastened directly to the crankcase in a manner which makes it significantly more difficult to remove the valve from the crankcase rather than disconnect the line between the valve and the intake manifold (taking aging effects into consideration), the Executive Officer shall exempt the manufacturer from detection of disconnection between the crankcase and the PCV valve.

~~(9.2.4)~~(C) Subject to Executive Officer approval, system designs that utilize tubing between the PCV valve and the crankcase shall also be exempted from the portion of the monitoring requirement for detection of disconnection between the crankcase and the PCV valve. The manufacturer shall file a request and submit data and/or engineering evaluation in support of the request. The Executive Officer shall approve the request upon determining that the connections between the valve and the crankcase are: (i) resistant to deterioration or accidental disconnection, (ii) significantly more difficult to disconnect than the line between the valve and the intake manifold, and (iii) not subject to disconnection per manufacturer's repair procedures for non-PCV system repair work.

~~(9.2.5)~~(D) Manufacturers are not required to detect disconnections between the PCV valve and the intake manifold if said disconnection (1) causes the vehicle to stall immediately during idle operation; or (2) is unlikely to occur due to a PCV system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses).

(9.2.3) For 20 percent of 2023 model year vehicles, 50 percent of 2024 model year vehicles, and 100 percent of 2025 model year vehicles, the following criteria apply for PCV system monitoring:

(A) Except as provided below, the OBD II system shall detect a PCV system malfunction when any hose, tube, or line that transports crankcase vapors contains a disconnection or break equal to or greater than the smallest internal cross-sectional area of that hose, tube, or line. For the purposes of section (e)(9.2.3), "hose, tube, or line" includes any fittings that are used for connection such as nipples or barbs that the hoses must be placed over for proper attachment.

(B) Manufacturers are not required to detect disconnections or break of any PCV system hose, tube, or line if said disconnection or break (1) causes the vehicle to stall immediately during idle operation; or (2) is unlikely to occur due to a PCV system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses); (3) results in a rapid loss of oil or other overt indication of a PCV system malfunction such that the vehicle operator is certain to respond and have the vehicle

repaired; or (4) occurs downstream of where the crankcase vapors are delivered to the air intake system.

(C) For engines with dry sump lubrication systems that cannot meet the requirements of sections (e)(9.2.3)(A) and (e)(9.2.3)(B) for any PCV system hose, tube, or line, a manufacturer may request Executive Officer approval to be exempt from monitoring the affected hose, tube, or line. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that monitoring of the PCV system hose, tube, or line cannot be achieved when employing proven monitoring technology (i.e., a technology that provides for compliance with these requirements on other engines) and provided the PCV system design meets the requirements of section (e)(9.2.2).

(D) For forced induction engines with PCV systems utilizing hoses, tubes or lines between the crankcase and fresh air intake system that are intended to evacuate the crankcase under boosted operation and/or supply fresh air to the crankcase, a manufacturer may request Executive Officer approval to be exempt from monitoring this hose, tube, or line. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that boosted operation does not occur on the US06 cycle.

(9.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(9.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

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

(10) *Engine Cooling System Monitoring*

(10.1) Requirement:

(10.1.1) The OBD II system shall monitor the thermostat on vehicles so-equipped for proper operation.

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

(10.1.3) For vehicles equipped with a component other than a thermostat that regulates the ECT (e.g., electric water pump), the manufacturer shall submit a monitoring plan to the Executive Officer for approval. The Executive Officer shall approve the plan 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 requirements specified for the thermostat under section (e)(10).

(10.1.4) Vehicles that use an engine and/or engine component temperature sensor or system (e.g. oil temperature sensor, cylinder head temperature sensor) in lieu of or in addition to the cooling system and ECT sensor for an indication of engine operating temperature for emission control purposes (e.g., to modify spark or fuel injection timing or quantity), the following requirements shall apply:

(A) For vehicles that use an engine and/or engine component temperature sensor or system in lieu of the cooling system and ECT sensor, 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 (e)(10).

(B) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles that use an engine and/or engine component temperature sensor or system in addition to the cooling system and ECT sensor (including systems that use more than one thermostat or flow control device to regulate different temperatures in different cooling circuits and use input from at least two temperature sensors in separate cooling circuits for an indication of engine operating temperatures for emission control purposes), 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 (e)(10).

(10.2) Malfunction Criteria:

(10.2.1) Thermostat

(A) The OBD II system shall detect a thermostat malfunction if, within an Executive Officer approved time interval or time-equivalent calculated value after starting the engine, either of the following two conditions occur:

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

(ii) The coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit (or 11.1 degrees Celsius) 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, etc.).

(B) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year gasoline vehicles, the OBD II system shall detect a thermostat fault if, after the coolant temperature has reached the temperatures indicated in sections (e)(10.2.1)(A)(i) and (ii), the coolant

temperature drops below the temperature indicated in section (e)(10.2.1)(A)(i).

~~(B)~~(C) Executive Officer approval of the time interval or time-equivalent calculated value after engine start under section (e)(10.2.1)(A) above shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times.

~~(C)~~(D) For monitoring of malfunctions under section (e)(10.2.1)(A) and (B), ~~W~~with Executive Officer approval, a manufacturer may use alternate malfunction criteria and/or monitoring conditions (see section (e)(10.3)) that are a function of temperature at engine start on vehicles that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data that demonstrate that a properly operating system does not reach the specified temperatures, that the monitor is capable of meeting the specified malfunction criteria at engine start temperatures greater than 50°F, and that the overall effectiveness of the monitor is comparable to a monitor meeting these thermostat monitoring requirements at lower temperatures.

~~(D)~~(E) A manufacturer may request Executive Officer approval to be exempted from the requirements of thermostat monitoring under sections (e)(10.2.1)(A) and (B)~~With Executive Officer approval, manufacturers may omit this monitor~~. 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.

(10.2.2) ECT Sensor

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

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

(i) The OBD II system shall detect a malfunction if the ECT sensor does not achieve the stabilized minimum temperature which is needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature) within an Executive Officer approved time interval after starting the engine.

a. For vehicles not included in the phase-in specified in section (e)(10.2.2)(B)(i)b. below, “closed-loop operation” as specified in section (e)(10.2.2)(B)(i) above shall mean either stoichiometric or non-stoichiometric closed-loop operation, whichever one the manufacturer chooses.

b. For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles, “closed-loop operation” as specified in section (e)(10.2.2)(B)(i) above shall mean stoichiometric closed-loop operation across the engine loads observed on the FTP cycle.

(ii) The time interval shall be a function of starting ECT and/or a function of intake air temperature and, except as provided below in section (e)(10.2.2)(B)(iii), may not exceed:

a. two minutes for engine start temperatures at or above 50 degrees Fahrenheit (or 10 degrees Celsius) and five minutes for engine start temperatures at or above 20 degrees Fahrenheit (or -6.7 degrees Celsius) and below 50 degrees Fahrenheit (or 10 degrees Celsius) for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

b. two minutes for engine start temperatures up to 15 degrees Fahrenheit (or 8.3 degrees Celsius) below the closed-loop enable temperature and five minutes for engine start temperatures between 15 and 35 degrees Fahrenheit (or between 8.3 and 19.4 degrees Celsius) below the closed-loop enable temperature for all 2006 through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles.

(iii) 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 and, for monitors meeting section (e)(10.2.2)(B)(i)b. above, demonstrates that closed-loop operation has been achieved across the range of engine loads observed on the FTP cycle. The Executive Officer shall allow longer time intervals upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that the vehicle requires a longer time to warm up under normal conditions.

(iv) The Executive Officer shall exempt manufacturers from the requirement of section (e)(10.2.2)(B) if the manufacturer does not utilize ECT to enable closed loop fuel control.

(C) Stuck in Range Below the Highest Minimum Enable Temperature. To the extent feasible when using all available information, the OBD II system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be greater than 140 degrees Fahrenheit to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature below 140 degrees Fahrenheit). Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (e)(10.2.1) or (e)(10.2.2)(B) will detect ECT sensor malfunctions as defined in section (e)(10.2.2)(C).

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

(i) To the extent feasible when using all available information, the OBD II system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be less than 90 degrees Fahrenheit at engine start to enable a diagnostic must detect malfunctions that cause the ECT sensor to 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 (e)(10.2.1),

(e)(10.2.2)(B), or (e)(10.2.2)(C) (i.e., ECT sensor or thermostat malfunctions) will detect ECT sensor malfunctions as defined in section (e)(10.2.2)(D) or in which the MIL will be illuminated under the requirements of section (d)(2.2.3) for default mode operation (e.g., overtemperature protection strategies).

(iii) For Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications only, manufacturers are also exempted from the requirements of section (e)(10.2.2)(D) for vehicles that have a temperature gauge (not a warning light) on the instrument panel and utilize the same ECT sensor for input to the OBD II system and the temperature gauge.

(iv) For 2006 through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles, manufacturers are also exempted from the requirements of section (e)(10.2.2)(D) for temperature regions where the temperature gauge indicates a temperature in the red zone (engine overheating zone) for vehicles that have a temperature gauge (not a warning light) on the instrument panel and utilize the same ECT sensor for input to the OBD II system and the temperature gauge.

(10.3) Monitoring Conditions:

(10.3.1) Thermostat

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(10.2.1)(A) in accordance with section (d)(3.1) except as provided for in section (e)(10.3.1)(~~D~~F). Additionally, except as provided for in sections (e)(10.3.1)(~~B~~C) ~~and~~ through (~~C~~E), monitoring for malfunctions identified in section (e)(10.2.1)(A) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in section (e)(10.2.1)(A).

(B) Manufacturer shall define the monitoring conditions for malfunctions identified in section (e)(10.2.1)(B) in accordance with section (d)(3.1) 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.

~~(B)~~(C) Manufacturers may disable thermostat monitoring at ambient temperatures below 20 degrees Fahrenheit (or -6.7 degrees Celsius).

~~(C)~~(D) Manufacturers may request Executive Officer approval to suspend or disable thermostat monitoring required under sections (e)(10.2.1)(A) and (B) if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 percent of the warm-up time, ~~hot restart conditions, etc.~~engine block heater operation). With respect to disablement on driving cycles solely due to warm ECT at engine start conditions for thermostat monitoring under section (e)(10.2.1)(A), the manufacturer shall disable the monitor during driving cycles where the ECT at engine start is within 35 degrees Fahrenheit (or 19.4 degrees Celsius) of the thermostat malfunction threshold temperature determined under section (e)(10.2.1)(A) (e.g., if the malfunction threshold temperature is 160 degrees Fahrenheit, the monitor shall be disabled if the ECT at engine start is above 125 degrees

Fahrenheit)~~In general, the Executive Officer shall not approve disablement of the monitor on engine starts where the ECT at engine start is more than 35 degrees Fahrenheit lower than the thermostat malfunction threshold temperature determined under section (e)(10.2.1)(A). The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or engineering analysis that demonstrate the need for the request~~.

(E) Notwithstanding section (e)(10.3.1)(D), manufacturers may request Executive Officer approval to enable thermostat monitoring required under section (e)(10.2.1)(A) during a portion of the driving cycles where the ECT at engine start is warmer than 35 degrees Fahrenheit (or 19.4 degrees Celsius) below the thermostat malfunction threshold temperature determined under section (e)(10.2.1)(A) (e.g., if the malfunction threshold temperature is 160 degrees Fahrenheit, the manufacturer may request approval to have the monitor enabled for a portion of the ECT at engine start region between 125 and 160 degrees Fahrenheit). The Executive Officer shall approve the request upon determining that the manufacturer has submitted test data and/or engineering evaluation that demonstrate that the monitor is able to robustly detect thermostat malfunctions (e.g., cannot result in false passes or false indications of malfunctions) on driving cycles where it is enabled.

~~(D)~~(F) With respect to defining enable conditions that are encountered during the FTP or Unified cycle as required in (d)(3.1.1) for malfunctions identified in section (e)(10.2.1)(A), the FTP cycle or Unified cycle shall refer to on-road driving following the FTP or Unified cycle in lieu of testing on a chassis dynamometer.

(10.3.2) ECT Sensor

(A) Except as provided below in section (e)(10.3.2)(E), monitoring for malfunctions identified in section (e)(10.2.2)(A) (i.e., circuit continuity and out-of-range) shall be conducted continuously.

(B) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(10.2.2)(B) in accordance with section (d)(3.1). Additionally, except as provided for in section (e)(10.3.2)(D), monitoring for malfunctions identified in section (e)(10.2.2)(B) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates a temperature lower than the closed loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out of range low temperature and less than the closed loop enable temperature).

(C) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(10.2.2)(C) and (D) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

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

(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.

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

(11) *Cold Start Emission Reduction Strategy Monitoring*

(11.1) Requirement:

(11.1.1) For all 2006 through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year applications, if a vehicle incorporates a specific engine control strategy to reduce cold start emissions, the OBD II system shall monitor the commanded elements/components for proper function (e.g., increased engine idle speed, commanded ignition timing retard~~, etc.~~), other than secondary air, while the control strategy is active to ensure proper operation of the control strategy. Secondary air systems shall be monitored under the provisions of section (e)(5).

(11.1.2) In lieu of meeting the requirements of section (e)(11) on all 2006 through 2008 model year Low Emission Vehicle II applications, a manufacturer may phase in the requirements on a portion of its Low Emission Vehicle II applications as long as that portion of Low Emission Vehicle II applications comprises at least 30 percent of all 2006 model year vehicles, 60 percent of all 2007 model year vehicles, and 100 percent of all 2008 and subsequent model year vehicles.

(11.1.3) For an element/component associated with the cold start emission reduction control strategy under section (e)(11) that is also required to be monitored elsewhere in section (e) (e.g., idle control system), the manufacturer shall use different diagnostics to distinguish faults detected under section (e)(11) (i.e., faults associated with the cold start strategy) from faults detected under sections other than section (e)(11) (i.e., faults not associated with the cold start strategy).

(11.2) Malfunction Criteria:

(11.2.1) For vehicles not included in the phase-in specified in section (e)(11.2.2):

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

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

(ii) 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.

(B) For elements/components where no failure or deterioration of the element/component used for the cold start emission reduction strategy could result in a vehicle's emissions exceeding 1.5 times the applicable standards, the individual element/component shall be monitored for proper functional response in accordance with the malfunction criteria in section (e)(15.2) while the control strategy is active.

(11.2.2) For 25 percent of 2010, 50 percent of 2011, and 100 percent of 2012 and subsequent model year vehicles, the OBD II system shall, to the extent feasible, detect a malfunction if either of the following occurs:

(A) Any single commanded element/component does not properly respond to the commanded action while the cold start strategy is active. For elements/components involving spark timing (e.g., retarded spark timing), the monitor may verify final commanded spark timing in lieu of verifying actual delivered spark timing. For purposes of this section, "properly respond" is defined as when the element/component responds:

(i) by a robustly detectable amount; and

(ii) in the direction of the desired command; and

(iii) above and beyond what the element/component would achieve on start-up without the cold start strategy active (e.g., if the cold start strategy commands a higher idle engine speed, a fault must be detected if there is no detectable amount of engine speed increase above what the system would achieve without the cold start strategy active);

(B) Any failure or deterioration of the cold start emission reduction control strategy while the cold start strategy is active that would cause a vehicle's emissions to be equal to or above the emission thresholds in sections (e)(11.2.2)(B)(i) or (ii) below.~~1.5 times the applicable FTP standards.~~ For this requirement, the OBD II system shall either monitor elements/components of the system as a whole (e.g., measuring air flow and modeling overall heat into the exhaust) or the individual elements/components (e.g., increased engine speed, commanded final spark timing) for failures that cause vehicle emissions to exceed the emission thresholds in sections (e)(11.2.2)(B)(i) or (ii) below. ~~1.5 times the applicable FTP standards.~~

(i) For non-Low Emission Vehicle III applications, the threshold is 1.5 times the applicable FTP standards.

(ii) For Low Emission Vehicle III applications, the thresholds are any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

(11.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(11.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

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

(12) *Air Conditioning (A/C) System Component Monitoring*

(12.1) Requirement: If a vehicle incorporates an engine control strategy that alters off-idle fuel and/or spark control when the A/C system is on, the OBD II

system shall monitor all electronic air conditioning system components for malfunctions that cause the system to fail to invoke the alternate control while the A/C system is on or cause the system to invoke the alternate control while the A/C system is off. Additionally, the OBD II system shall monitor for malfunction all electronic air conditioning system components that are used as part of the diagnostic strategy for any other monitored system or component. The requirements of section (e)(12) shall be phased in as follows: 30 percent of all 2006 model year vehicles, 60 percent of all 2007 model year vehicles, and 100 percent of all 2008 and subsequent model year vehicles. As applicable, the A/C system shall also be subject to the comprehensive component monitoring requirements in section (e)(15.2.3)(B).

(12.2) Malfunction Criteria:

(12.2.1) The OBD II system shall detect a malfunction prior to any failure or deterioration of an electronic component of the air conditioning system that would cause any of the criteria in section (e)(12.2.1)(A) through (C) to be met. For sections (e)(12.2.1)(A) and (B), for~~cause a vehicle's emissions to exceed 1.5 times any of the appropriate applicable emission standards or would, through software, effectively disable any other monitored system or component covered by this regulation. For~~ malfunctions that result in the alternate control being erroneously invoked while the A/C system is off, the appropriate emission standards shall be the FTP standards. For malfunctions that result in the alternate control failing to be invoked while the A/C system is on, the appropriate emission standards shall be the SC03 emission standards.

(A) For non-Low Emission Vehicle III applications, the OBD II system shall detect a malfunction that causes a vehicle's emissions to exceed 1.5 times any of the appropriate applicable emissions standards.

(B) For Low Emission Vehicle III applications, the OBD II system shall detect a malfunction that causes a vehicle's emissions to exceed any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

(C) For all vehicles, the OBD II system shall detect a malfunction if, through software, the malfunction effectively disables any other monitored system or component covered by this regulation.

(12.2.2) If no single electronic component failure or deterioration meets any of the criteria specified in section (e)(12.2.1), ~~causes emissions to exceed 1.5 times any of the appropriate applicable emission standards as defined above in section (e)(12.2.1) nor is used as part of the diagnostic strategy for any other monitored system or component,~~ manufacturers are not required to monitor any air conditioning system component for purposes of section (e)(12).

(12.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(12.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

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

(13) *Variable Valve Timing, Lift, and/or Control (VVT) System Monitoring*

(13.1) Requirement: On all 2006 through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles, the OBD II system shall monitor the VVT system on vehicles so-equipped for target error and slow response malfunctions. Manufacturers must perform a comprehensive failure modes and effects analysis for every reasonable hydraulic or mechanical failure (e.g., partial or complete blockage of hydraulic passages, broken return springs, a failure of a single cylinder-specific pin to move into the desired position on a lift mechanism) to identify target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors, etc.) that are used in the VVT system shall be monitored in accordance with the comprehensive components requirements in section (e)(15). VVT systems on Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications shall be monitored in accordance with the comprehensive components requirements in section (e)(15).

(13.2) Malfunction Criteria:

(13.2.1) Target Error. The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause a vehicle's emissions to exceed the emission thresholds in sections (e)(13.2.1)(A) or (B) below. Systems with discrete operating states (e.g., two step valve train systems) are not required to detect a malfunction prior to exceeding the threshold but are required to detect all failures that exceed the threshold.

(A) For non-Low Emission Vehicle III applications, the threshold is 1.5 times any of the applicable FTP standards.

(B) For Low Emission Vehicle III applications, the thresholds are any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

(13.2.2) Slow Response. The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a time that would cause a vehicle's emissions to exceed the emission thresholds in sections (e)(13.2.2)(A) or (B) below. Systems with discrete operating states are not required to detect a malfunction prior to exceeding the threshold but are required to detect all failures that exceed the threshold.

(A) For non-Low Emission Vehicle III applications, the threshold is 1.5 times any of the applicable FTP standards.

(B) For Low Emission Vehicle III applications, the thresholds are any of the applicable emission thresholds set forth in Table 1 in the beginning of section (e).

(13.2.3) For vehicles in which no failure or deterioration of the VVT system could result in a vehicle's emissions exceeding the thresholds specified in sections (e)(13.2.1) and (e)(13.2.2)~~1.5 times any of the applicable standards~~, the VVT system shall be monitored for proper functional response of the electronic components in accordance with the malfunction criteria in section (e)(15.2).

(13.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for VVT system malfunctions identified in section (e)(13.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). Additionally, manufacturers shall track and report the in-use performance of the VVT system monitors ~~performance~~ under section (e)(13.2) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(13.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

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

(14) *Direct Ozone Reduction (DOR) System Monitoring*

(14.1) Requirement:

(14.1.1) The OBD II system shall monitor the DOR system on vehicles so-equipped for malfunctions that reduce the ozone reduction performance of the system.

(14.1.2) For 2003, 2004, and 2005 model year vehicles subject to the malfunction criteria of section (e)(14.2.1) below, manufacturers may request to be exempted from DOR system monitoring. The Executive Officer shall approve the exemption upon the manufacturer:

(A) Agreeing that the DOR system receive only 50 percent of the NMOG credit assigned to the DOR system as calculated under Air Resources Board (ARB) Manufacturers Advisory Correspondence (MAC) No. 99-06, December 20, 1999, which is hereby incorporated by reference herein.

(B) Identifying the DOR system component(s) as an emission control device on both the underhood emission control label and a separate label as specified below. The DOR system shall be included in the list of emission control devices on the underhood emission control label and be identified as a “DOR system” or other equivalent term from SAE J1930 "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms – Equivalent to ISO/TR 15031-2~~:April 30, 2002~~ (SAE 1930)", incorporated by reference. A separate label shall be located on or near the DOR system component(s) in a location that is visible to repair technicians prior to the removal of any parts necessary to replace the DOR system component(s) and shall identify the components as a “DOR system” or other equivalent SAE J1930 term.

(14.2) Malfunction Criteria:

(14.2.1) For non-Low Emission Vehicle III applications:

~~(14.2.1)~~(A) For vehicles in which the NMOG credit assigned to the DOR system, as calculated in accordance with ARB MAC No. 99-06, is less than or equal to 50 percent of the applicable FTP NMOG standard, the OBD II system shall detect a malfunction when the DOR system has no detectable amount of ozone reduction.

~~(14.2.2)~~(B) For vehicles in which the NMOG credit assigned to the DOR system, as calculated in accordance with ARB MAC No. 99-06, is greater than 50 percent of the applicable FTP NMOG standard, the OBD II system shall detect a malfunction when the ozone reduction performance of the DOR system deteriorates to a point where the difference between the NMOG credit assigned to the properly operating DOR system and the NMOG credit calculated for a DOR system performing at the level of the malfunctioning system exceeds 50 percent of the applicable FTP NMOG standard.

~~(14.2.3)~~(C) For vehicles equipped with a DOR system, the manufacturer may modify any of the applicable NMOG malfunction criteria in sections (e)(1)-(3), (e)(5)-(8), (e)(11)-(e)(13), and (e)(16) by adding the NMOG credit received by the DOR system to the required NMOG malfunction criteria (e.g., a malfunction criteria of 1.5 x NMOG standard would be modified to (1.5 x NMOG standard) + DOR system NMOG credit).

(14.2.2) For Low Emission Vehicle III applications:

(A) For vehicles in which the NMOG credit assigned to the DOR system, as calculated in accordance with ARB MAC No. 99-06, is less than or equal to 5 mg/mi NMOG, the OBD II system shall detect a malfunction when the DOR system has no detectable amount of ozone reduction.

(B) For vehicles in which the NMOG credit assigned to the DOR system, as calculated in accordance with ARB MAC No. 99-06, is greater 5 mg/mi NMOG, the OBD II system shall detect a malfunction when the ozone reduction performance of the DOR system deteriorates to a point where the difference between the NMOG credit assigned to the properly operating DOR system and the NMOG credit calculated for a DOR system performing at the level of the malfunctioning system exceeds 5 mg/mi NMOG.

(C) For vehicles equipped with a DOR system, the manufacturer may modify any of the applicable malfunction criteria in sections (e)(1)-(3), (e)(5)-(8), (e)(11)-(e)(13), and (e)(16) by adding the NMOG credit received by the DOR system to the required malfunction criteria (e.g., a malfunction criteria of 1.5 x NMOG+NOx standard would be modified to (1.5 x NMOG+NOx standard) + DOR system NMOG credit).

(14.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(14.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

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

(15) *Comprehensive Component Monitoring*

(15.1) Requirement:

(15.1.1) Except as provided in sections (e)(15.1.3), (e)(15.1.4), (e)(15.1.5), and (e)(16), the OBD II system shall monitor for malfunction any electronic powertrain component/system not otherwise described in sections (e)(1) through (e)(14) that either provides input to (directly or indirectly) or receives commands from ~~the~~ an on-board computer~~(s)~~ or smart device,

and: (1) can affect emissions as determined by the criteria in section (e)(15.1.2) ~~during any reasonable in-use driving condition~~, or (2) is used as part of the diagnostic strategy for any other monitored system or component. Each input to or output from a smart device that meets criterion (1) or (2) above shall be monitored pursuant to section (e)(15). Further detection or pinpointing of faults internal to the smart device is not required. If the control system detects deterioration or malfunction of the component/system and takes direct action to compensate or adjust for it, manufacturers may not use the criteria under section (e)(15.1.2) and are instead subject to the default action requirements of section (d)(2.2.3) or (e)(15.4.4) as applicable.

(A) Input Components: Input components required to be monitored may include the vehicle speed sensor, crank angle sensor, knock sensor, throttle position sensor, cam position sensor, fuel composition sensor (e.g. flexible fuel vehicles), and transmission electronic components such as sensors, modules, and solenoids which provide signals to the powertrain control system.

(B) Output Components/Systems: Output components/systems required to be monitored may include the idle speed control system, automatic transmission solenoids or controls, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, and a warm-up catalyst bypass valve.

(15.1.2) For purposes of criteria (1) in section (e)(15.1.1) above, the manufacturer shall determine whether a powertrain input or output component/system can affect emissions when operating without any control system compensation or adjustment for deterioration or malfunction based on the following: (1) for 2004 through 2017 model year vehicles, the manufacturer shall use the criteria in section (e)(15.1.2)(G); and (2) for 2018 and subsequent model year vehicles, the manufacturer shall use the criteria in sections (e)(15.1.2) (A) through (F). ~~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. The Executive Officer may request emission data for any reasonable driving condition.~~

(A) The OBD II system shall monitor an electronic powertrain component or system in accordance with the monitoring requirements of section (e)(15) if any condition (e.g., deterioration, failure) of the component or the system could cause:

(i) Vehicle emissions to exceed any applicable standard, or

(ii) An increase in vehicle emissions greater than 15 percent of the standard on the following test cycles: FTP test, 50°F FTP, HWFET, SC03, US06 cycle, Unified cycle. The emissions impact of the failure shall be determined by taking the mean of three or more emission measurements on a vehicle aged to represent full useful life with the component or system malfunctioning compared to the same testing without a malfunction present.

a. For cycles without standards (e.g., Unified cycle), 15 percent of the SFTP Composite Emission Standard shall be used.

b. Additionally, if function of the component or system would not necessarily occur during any of the test cycles specified (e.g., global positioning system components that control engine start/stop operation based on battery state of charge, cruise control), the manufacturer shall request Executive Officer approval of an added alternate test cycle or vehicle operating conditions for which the emission increase will also be evaluated. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the testing conditions proposed represent in-use driving conditions under which the component or system will function and where emissions are likely to be most affected by the malfunctioning component. The component or system is required to meet the monitoring requirements under section (e)(15) if any condition (e.g., deterioration, failure) of the component or the system could cause an increase in vehicle emissions greater than 15 percent of SFTP Composite Emission Standard.

(B) Manufacturers that have determined that a component or system is not subject to monitoring because a malfunction would not cause emissions to exceed the criteria specified in section (e)(15.1.2)(A) above shall demonstrate for purposes of OBD II system approval that the criteria are satisfied by meeting the requirements in either section (e)(15.1.2)(B)(i) or (e)(15.1.2)(B)(ii) below:

(i) The manufacturer shall conduct an engineering evaluation demonstrating that no malfunction of the component/system could cause an increase in vehicle emissions during any reasonable in-use driving condition, or

(ii) The manufacturer shall meet the following testing requirements:

a. The manufacturer shall conduct an FTP test with the component or system malfunctioning, and provide test data to show that no applicable standard has been exceeded; and

b. The manufacturer shall conduct testing using the component condition causing the largest emission impact during the worst case test cycle or in-use driving condition specified in section (e)(15.1.2)(A)(ii) (as determined by the manufacturer based on sound engineering judgment), and provide test data to show that the difference between the mean emission values do not exceed 15 percent of any standard.

(iii) The Executive Officer may request one additional test cycle for either section (e)(15.1.2)(B)(i) or (ii) above if the Executive Officer reasonably believes, based on the component being tested, that the manufacturer's engineering evaluation is insufficient or the cycle chosen by the manufacturer was not the worst case for demonstration of the malfunction.

(C) Notwithstanding successfully demonstrating that no malfunction would cause emissions to exceed the criteria specified in section

(e)(15.1.2)(A)(ii) under the manufacturer-selected worst case test cycle, the manufacturer's determination that the component or system is not subject to monitoring under section (e)(15) is subject to Executive Officer review. If additional testing under any of the other conditions specified in section (e)(15.1.2)(A)(ii) demonstrate that the component or system meets the criteria of that section (i.e., that the component or system can affect emissions), the ARB may deny certification of test groups for which the component or system is not monitored by the OBD II system, and any vehicles produced with OBD II systems that do not monitor the component or system are subject to corrective action, up to and including recall.

(D) For purposes of verifying a manufacturer's determination that a component or system does not affect emissions under section (e)(15.1.2)(A), within six weeks of a request by the Executive Officer, the manufacturer shall make available all test equipment (e.g. malfunction simulators, deteriorated components) used to for the demonstration conducted pursuant to section (e)(15.1.2)(B) above.

(E) Components described in sections (e)(1) through (e)(14) (including components described in sections (e)(1) through (e)(14) that are required to meet the monitoring requirements of section (e)(15)) may not be exempted from any of the monitoring requirements of section (e)(1) through (e)(15) regardless of any demonstration that any malfunction of the component would not cause emissions to exceed the criteria specified in section (e)(15.1.2)(A).

(F) For 2018 and 2019 model year vehicles carried over from 2017 or earlier model year vehicles, a component/system is determined to not affect emissions and the manufacturer is not required to use the criteria in sections (e)(15.1.2)(A) through (E) if the Executive Officer determined that the component/system does not affect emissions on the vehicles in question in the 2017 or earlier model year in accordance with section (e)(15.1.2)(G).

(G) For 2004 through 2017 model year vehicles, in lieu of the criteria in sections (e)(15.1.2)(A) through (E) above, the manufacturer shall determine whether a powertrain input or output component/system can affect emissions during any reasonable in-use driving condition. 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. The Executive Officer may request emission data for any reasonable driving condition. Alternatively, for 2017 model year vehicles, manufacturers may use the criteria in sections (e)(15.1.2)(A) through (E) in lieu of the criteria stated above in section (e)(15.1.2)(G).

(15.1.3) A manufacturer may request Executive Officer approval to exempt safety-only components or systems from the monitoring requirements of section (e)(15). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the component or system (1) meets the

definition of a “safety-only component or system” in section (c), and (2) is not used as part of the diagnostic strategy for any other monitored system or component.

~~(15.1.3)~~(15.1.4) Manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with an electronic transfer case, electronic power steering system, or other components that are driven by the engine and not related to the control of fueling, air handling, or emissions only if the component or system is used as part of the diagnostic strategy for any other monitored system or component.

~~(15.1.4)~~(15.1.5) Except as specified for hybrid~~s~~ vehicles in section (e)(15.1.~~5~~6), manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with components that only affect emissions by causing additional electrical load to the engine and are not related to the control of fueling, air handling, or emissions only if the component or system is used as part of the diagnostic strategy for any other monitored system or component.

~~(15.1.5)~~(15.1.6) For hybrid~~s~~ vehicles, manufacturers shall submit a plan to the Executive Officer for approval of the hybrid components determined by the manufacturer to be subject to monitoring in section (e)(15.1.1). In general, the Executive Officer shall approve the plan if it includes monitoring of all components/systems that affect emissions or are used as part of the diagnostic strategy for any other monitored system or component, monitoring of all energy input devices to the electrical propulsion system, monitoring of battery and charging system performance, monitoring of electric motor performance, and monitoring of regenerative braking performance. For 2019 and subsequent model year mild hybrid electric, strong hybrid electric, and plug-in hybrid electric vehicles , manufacturers are subject to the applicable requirements specified in (e)(15.2.3).

(15.2) Malfunction Criteria:

(15.2.1) Input Components:

(A) The OBD II system shall detect malfunctions of input components caused by ~~a lack of~~ circuit ~~continuity~~ faults (or for digital inputs, lack of communication to the on-board computer), out of range values, and, where feasible, rationality faults. To the extent feasible, the rationality fault diagnostics shall verify that a sensor output is neither inappropriately high nor inappropriately low (e.g., “two-sided” diagnostics).

(B) ~~To the extent feasible on~~ Except for input components monitored solely by emissions neutral diagnostics, for all 2005 and subsequent model year vehicles, rationality faults shall be separately detected and store different fault codes than the respective ~~lack of~~ circuit ~~continuity~~ fault and out of range diagnostics. Two-sided rationality diagnostics are not required to set separate fault codes for each side. Additionally:~~,~~

(i) For computer encoded digital inputs: lack of communication from the input to the on-board computer shall be separately detected and store a separate fault code. Separate fault codes are not required for each distinct out-of-range fault.

(ii) For all other inputs: component ~~lack of~~ circuit ~~continuity~~ and out of

range faults shall be separately detected and store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit, etc.). Notwithstanding, ~~M~~manufacturers are not required to store separate fault codes for lack of circuit continuity faults that cannot be distinguished from other out-of-range ~~circuit~~ faults. For sensors that are fixed to a circuit board within a diagnostic or emission critical control unit, as defined in section (c), manufacturers may combine circuit and out-of-range value faults into a single fault code that identifies the malfunctioning sensor.

(C) For vehicles that require precise alignment between the camshaft and the crankshaft, the OBD II 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.

(i) For 2006 through 2008 model year Low Emission Vehicle II applications, ~~and~~ all 2009 ~~and subsequent~~ through 2018 model year vehicles equipped with VVT cam phasing systems and a timing belt or chain, the OBD II 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 manufacturer shall detect a malfunction when the minimum number of teeth/cogs misalignment needed to cause a measurable emission increase has occurred.

(ii) For the 2006 through 2009 model years only, a manufacturer may also request Executive Officer approval to use a larger threshold than one tooth/cog. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated that hardware modifications are necessary to meet the one tooth/cog threshold and that further software modifications are not able to reduce the larger threshold.

(iii) For all 2019 and subsequent model year vehicles equipped with VVT systems and a timing belt or chain, the OBD II system shall detect a malfunction of the misalignment between the camshaft and crankshaft at one of the following two levels:

a. The smallest number of teeth/cogs misalignment that can be detected using the existing hardware; or

b. The minimum number of teeth/cogs misalignment needed to cause emissions to exceed the criteria in section (e)(15.1.2).

(D) For input components that are directly or indirectly used for any emission control strategies that are not covered under sections (e)(1) through (e)(14) (e.g., exhaust gas temperature sensors used for a control strategy that regulates catalyst inlet temperature within a target window), the OBD II system shall detect rationality malfunctions that prevent the component from correctly sensing any condition necessary for the

strategy to operate in its intended manner. These malfunctions include faults that inappropriately prevent or delay the activation of the emission control strategy, cause the system to erroneously exit the emission control strategy, or where the control strategy has used up all of the adjustments or authority allowed by the manufacturer and is still unable to achieve the desired condition. The Executive Officer may waive detection of specific malfunctions upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that reliable detection of the malfunction is technically infeasible or would require additional hardware.

(15.2.2) Output Components/Systems:

(A) The OBD II system shall detect a malfunction of an output component/system when proper functional response of the component and system to computer commands does not occur. If a functional check is not feasible, the OBD II system shall detect malfunctions of output components/systems caused by a lack of circuit continuity or circuit fault (e.g., short to ground or high voltage), or communication errors or the lack of communication if the signal to the output component is digital. For output component lack of circuit continuity faults and circuit faults, manufacturers are not required to store different fault codes for each distinct malfunction (e.g., open circuit, shorted low, etc.). Manufacturers are not required to activate an output component/system when it would not normally be active for the purposes of performing a functional ~~monitoring~~ check of the output component~~s~~/system~~s~~ as required in section (e)(15).

(B) The idle speed control system shall be monitored for proper functional response to computer commands. For strategies based on deviation from target idle speed, a malfunction shall be detected when either of the following conditions occur:

(i) The idle speed control system cannot achieve the target idle speed within 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed. The Executive Officer shall allow larger engine speed tolerances 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.

(ii) The idle speed control system cannot achieve the target idle speed within the smallest engine speed tolerance range required by the OBD II system to enable any other monitor.

(C) For output components/systems that are directly or indirectly used for any emission control strategies that are not covered under sections (e)(1) through (e)(14) (e.g., a high pressure fuel pump used for a control strategy that regulates fuel pressure), the OBD II system shall detect functional malfunctions that prevent the component/system from achieving the desired functional response necessary for the strategy to operate in its intended manner. These malfunctions include faults that inappropriately prevent or delay the activation of the emission control strategy, cause the system to erroneously exit the emission control

strategy, or where the control strategy has used up all of the adjustments or authority allowed by the manufacturer and is still unable to achieve the desired condition. The Executive Officer may waive detection of specific malfunctions upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that reliable detection of the malfunction is technically infeasible or would require additional hardware.

(15.2.3) Hybrid Components

(A) Energy Storage System (ESS)

(i) Manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions for monitoring of the hybrid ESS state of health. The Executive Officer shall approve the plan upon determining that the manufacturer has demonstrated the monitor properly detects malfunctions and that the monitor is able to detect any hybrid ESS state of health fault that prevents any of the following: (1) activating and maintaining emission control strategies, (2) operation of the vehicle to meet or exceed the minimum acceptable in-use monitor performance ratio requirements specified in section (d)(3.2.1), or (3) utilization of the ESS in movement of the vehicle (e.g. the engine cannot be started, the motor is unable to move the vehicle or provide motor assist due to ESS deterioration).

(ii) The OBD II system shall monitor the ESS state of charge for malfunctions that result in any of the following:

a. The state of charge cannot be controlled within the normal manufacturer-defined useable range intended for hybrid vehicle operation.

b. The hybrid system is not able to maintain the state of charge required by the OBD II system to enable other diagnostics.

(iii) The OBD II system shall monitor the ESS cell balancing system for proper functional response to computer commands. The OBD II system shall detect a malfunction when the ESS cell balancing system can no longer maintain the individual cell voltages desired. In lieu of monitoring individual cell voltages, manufacturers may monitor the individual switches used to command cell balancing for proper functional response. If the OBD II system does not determine cell balance using individual cell voltages, manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions for monitoring the ESS cell balancing system. In general, the Executive Officer will approve the plan if it includes functional monitoring of components used for cell balancing.

(iv) The individual electronic components that are used as inputs or outputs for the ESS (e.g., battery temperature sensors, battery voltage sensors, battery cells) shall be monitored in accordance with the requirements of sections (e)(15.2.1) and (15.2.2).

(v) For monitors of malfunctions specified under sections (e)(15.2.3)(iii) and (iv), manufacturers at a minimum shall store separate fault codes relating to hybrid ESS malfunctions pinpointing the smallest

replaceable unit for in-use repair as defined by the manufacturer. Manufacturers may further pinpoint components and/or failure modes.

(B) Hybrid Thermal Management Systems

(i) ESS Thermal Management Systems

a. The individual electronic input and output components that are used for ESS thermal management (i.e., heating or cooling) shall be monitored in accordance with the requirements of sections (e)(15.2.1) and (15.2.2). Electronic components used for hybrid battery thermal management and commanded solely by driver demand are exempt from this monitoring requirement.

b. To the extent feasible, the OBD II system shall perform a functional check of the cooling performance and, if applicable, heating performance.

(ii) Inverter Thermal Management Systems

a. The individual electronic input and output components that are used for inverter thermal management (i.e., heating or cooling) shall be monitored in accordance with the requirements of sections (e)(15.2.1) and (15.2.2). Electronic components used for inverter thermal management and commanded solely by driver demand are exempt from this monitoring requirement.

b. To the extent feasible, the OBD II system shall perform a functional check of the cooling performance and, if applicable, heating performance.

(C) Regenerative Braking: The OBD II system shall detect a malfunction of a component when a failure disables the regenerative braking function or affects regenerative braking performance.

(D) Drive Motor: Manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions for the drive motor system. The Executive Officer shall approve the plan upon determining that the manufacturer has demonstrated that the monitor properly detects malfunctions, and that the monitor is able to detect any drive motor fault that prevents any of the following: (1) activating and maintaining emission control strategies, (2) operation of the vehicle to meet or exceed the minimum acceptable in-use monitor performance ratio requirements specified in section (d)(3.2.1), or (3) utilization of the motor in movement of the vehicle (e.g. the motor can no longer be used to move the vehicle or provide assist, the engine cannot be started).

(E) Generator: Manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions for the generator system. The Executive Officer shall approve the plan upon determining that the manufacturer has demonstrated that the monitor properly detects malfunctions, and that the monitor is able to detect any generator fault that prevents any of the following: (1) activating and maintaining emission control strategies, (2) operation of the vehicle to meet or exceed the minimum acceptable in-use monitor performance ratio requirements specified in section (d)(3.2.1), or (3) proper functional response in accordance with the malfunction criteria in section (e)(15.2).

(F) Plug-in Hybrid Electric Vehicle ESS Charger: For plug-in hybrid electric vehicles, the OBD II system shall detect malfunctions of the on-board ESS charger when a failure disables ESS charging or affects charging performance (e.g., preventing the ESS from fully charging or limits charging rate). Detection of indeterminate ESS charging failures that cannot be distinguished from failures originating outside the vehicle (e.g., same symptom could be caused by a malfunction of a vehicle component or the off-board power supply) or charging failures originating outside the vehicle (e.g., malfunction of the electric vehicle supply equipment, poor electrical service) is not required.

(G) For hybrid components that are not addressed in sections (e)(15.2.3)(A) through (F) above, manufacturers shall monitor those hybrid components determined by the manufacturer to be subject to monitoring in section (e)(15.1.1) in accordance with the input component and output component requirements in sections (e)(15.2.1) and (e)(15.2.2).

(H) Monitoring of hybrid components as specified in sections (e)(15.2.3)(A) through (G) above on mild hybrid electric vehicles and strong hybrid electric vehicles is not required if manufacturers can demonstrate:

(i) The component is not used as part of the diagnostic strategy for any other monitored system or component, and

(ii) No malfunction of the component or system can affect emissions as determined by the criteria in section (e)(15.1.2).

(I) Monitoring of hybrid components as specified in sections (e)(15.2.3)(A) through (G) above on plug-in hybrid electric vehicles is not required if manufacturers can demonstrate:

(i) The component is not used as part of the diagnostic strategy for any other monitored system or component, and

(ii) In lieu of the criteria in section (e)(15.1.2), except as specified in (e)(15.2.3)(I)(iii) and (iv), no malfunction of the component or system could cause:

a. An engine in a vehicle with a fully charged ESS to start over any of the following test cycles where a properly-functioning fully charged vehicle does not start its engine during a single test cycle: FTP test, HWFET, Unified cycle, and US06 cycle; and

b. An increase greater than 15 percent of the integrated net energy used for a mean of three or more tests conducted with a malfunction compared to testing without a malfunction for any of the following test cycles where a properly-functioning fully charged vehicle does not start its engine during a single test cycle: FTP test, US06 cycle, HWFET, and Unified cycle. All tests shall be run with a fully charged high voltage battery, with integrated net energy measured at the electric drive system inlet. If measuring the electric drive system's inlet net energy is not feasible, the Executive Officer may approve an alternative method based on the ability of that method to measure net energy delivered to the powertrain.

(iii) For hybrid thermal management systems, in lieu of the test procedure specified in section (e)(15.2.3)(I)(ii) above, manufacturers shall submit a plan for Executive Officer approval for an alternate test cycle/vehicle

operating conditions for the purposes of determining whether a malfunction would cause an engine in a vehicle with a fully-charged ESS to start where a properly-functioning fully charged vehicle does not and a 15 percent reduction of all electric range if the component/system is malfunctioning. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that considers all conditions under which the thermal management system may be activated (e.g., high ambient temperatures, ESS charging, high load driving) and demonstrates that the chosen test cycle and operating conditions are representative of in-use conditions where all electric range is likely to be most affected by the malfunctioning component/system.

(iv) If function of the hybrid component or system would not necessarily occur during any of the test cycles specified in section (e)(15.2.3)(I)(ii) above (e.g., global positioning system components that control plug-in hybrid operation based on battery state of charge), the manufacturer shall request Executive Officer approval of an added alternate test cycle or vehicle operating conditions for which the determination of vehicle engine starts and increase in integrated net energy will be evaluated. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the testing conditions proposed represent in-use driving conditions under which the component or system will function and where energy usage is likely to be most affected by the malfunctioning component. The component or system is required to meet the monitoring requirements under section (e)(15) if any condition (e.g., deterioration, failure) of the component or the system could cause the vehicle's engine to start when it otherwise would not, or an increase greater than 15 percent of the integrated net energy used for a mean of three or more tests conducted with a malfunction compared to testing without a malfunction.

(15.3) Monitoring Conditions:

(15.3.1) Input Components:

(A) Except as provided in section (e)(15.3.1)(C), input components shall be monitored continuously for proper range of values and circuit continuity.

(B) For rationality ~~monitoring~~ fault diagnostics (where applicable):

(i) For 2004 model year vehicles, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with section (d)(3.1).

(ii) For 2005 and subsequent model year vehicles, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that rationality ~~monitoring~~ fault diagnostics 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.

(15.3.2) Output Components/Systems:

(A) Except as provided in section (e)(15.3.2)(D), monitoring for circuit continuity and circuit faults shall be conducted continuously.

(B) Except as provided in section (e)(15.3.2)(C), for functional ~~monitoring~~checks, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(C) For the idle speed control system on all 2005 and subsequent model year vehicles, manufacturers shall define the monitoring conditions for functional ~~monitoring~~ checks in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that functional ~~monitoring~~ checks 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.

(15.3.3) Hybrid Components

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(15.2.3)(A)(i) through (iii), (e)(15.2.3)(B)(i)b., (e)(15.2.3)(B)(ii)b., and (e)(15.2.3)(C) through (F) 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).

(15.4) MIL Illumination and Fault Code Storage:

(15.4.1) Except as provided in sections (e)(15.4.2) and (15.4.4) below, general requirements for MIL illumination and fault code storage are set forth in section (d)(2). Additional fault code storage requirements are provided in section (e)(15.2.1)(B) for input components, section (e)(15.2.2)(A) for output components/systems, and section (e)(15.2.3)(A)(v) for hybrid components.

(15.4.2) Exceptions to general requirements for MIL illumination. For applications that are not using the criteria of sections (e)(15.1.2)(A) through (E) to determine if a component/system can affect emissions, MIL illumination is not required in conjunction with storing a confirmed fault code for any comprehensive component if both conditions (A) and (B) below are met:

(A) the component or system, when malfunctioning, could not cause vehicle emissions to increase by:

(i) 25 percent or more for PC/LDT SULEV II vehicles, or

(ii) 15 percent or more for all other vehicles, and

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

(15.4.3) For purposes of determining the emission increase in section (e)(15.4.2)(A), the manufacturer shall request Executive Officer approval of the test cycle/vehicle operating conditions for which the emission increase will be determined. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the testing conditions represent in-use driving conditions where emissions are likely to be most affected by the malfunctioning component. For purposes of determining whether the specified percentages in section (e)(15.4.2)(A) are exceeded, if the approved testing conditions are comprised of an emission test cycle with an exhaust emission standard, the measured increase shall be compared to a percentage of the exhaust emission standard (e.g., if the increase is equal to or more than 15 percent of the exhaust emission standard for that test cycle). If the approved testing conditions are comprised of a test cycle or vehicle operating condition that does not have an exhaust emission standard, the measured increase shall be calculated as a percentage of the baseline test (e.g., if the increase from a back-to-back test sequence between normal and malfunctioning condition is equal to or more than 15 percent of the baseline test results from the normal condition).

(15.4.4) Exceptions to general requirements for MIL illumination and fault code storage. MIL illumination and fault code storage is not required for faults of components/systems monitored solely by emissions neutral diagnostics. Executive Officer approval is required for the emissions neutral default action activated by the emissions neutral diagnostic. The Executive Officer shall approve the emissions neutral default action upon determining that the manufacturer has submitted data and/or engineering evaluation adequately demonstrating that the action meets the conditions described under the definition of “emissions neutral default action” in section (c).

(16) *Other Emission Control or Source System Monitoring*

(16.1) Requirement: For other emission control or source systems that are: (1) not identified or addressed in sections (e)(1) through (e)(15) (e.g., hydrocarbon traps, homogeneous charge compression ignition (HCCI) controls, NOx storage devices, fuel-fired passenger compartment heaters, etc.), or (2) identified or addressed in section (e)(15) but not corrected or compensated

for by the adaptive fuel control system (e.g., swirl control valves), manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production vehicle intended for sale in California. 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 sections (e)(16.3) and (e)(16.4) below are satisfied.

(16.2) For purposes of section (e)(16), emission source systems are components or devices that emit pollutants subject to vehicle evaporative and exhaust emission standards (e.g., NMOG, CO, NOx, PM, etc.) and include non-electronic components and non-powertrain components (e.g., fuel-fired passenger compartment heaters, on-board reformers, etc.).

(16.3) Except as provided below in this paragraph, for 2005 and subsequent model year vehicles that utilize emission control systems that alter intake air flow or cylinder charge characteristics by actuating valve(s), flap(s), etc. in the intake air delivery system (e.g., swirl control valve systems), the manufacturers, in addition to meeting the requirements of section (e)(16.1) above, may elect to have the OBD II 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, etc.) per intake bank to meet this requirement. Vehicles utilizing these emission control systems designed and certified for 2004 or earlier model year vehicles and carried over to the 2005 through 2009 model year shall not be required to meet the provisions of section (e)(16.3) until the engine or intake air delivery system is redesigned.

(16.4) For emission control strategies that are not covered under sections (e)(1) through (e)(14) (e.g., a control strategy that regulates fuel pressure), Executive Officer approval shall be based on the effectiveness of the plan in detecting malfunctions that prevent the strategy from operating in its intended manner. These malfunctions include faults that inappropriately prevent or delay the activation of the emission control strategy, faults that cause the system to erroneously exit the emission control strategy, and faults where the control strategy has used up all of the adjustments or authority allowed by the manufacturer and is still unable to achieve the desired condition. The Executive Officer may waive detection of specific malfunctions upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that reliable detection of the malfunction is technically infeasible or would require additional hardware.

(17) *Exceptions to Monitoring Requirements*

(17.1) Except as provided in sections (e)(17.1.1) through (17.1.3) below, upon request of a manufacturer or upon the best engineering judgment of the ARB,

the Executive Officer may revise the emission threshold for a malfunction on any diagnostic required in section (e) if the most reliable monitoring method developed requires a higher threshold to prevent ~~significant errors of commission in detecting~~ false indications of a malfunction.

(17.1.1) For PC/LDT SULEV II vehicles, the Executive Officer shall approve a malfunction criteria of 2.5 times the applicable FTP standards in lieu of 1.5 wherever required in section (e).

(17.1.2) For 2004 model year PC/LDT SULEV II vehicles only, the Executive Officer shall approve monitors with thresholds that exceed 2.5 times the applicable FTP standard if the manufacturer demonstrates that a higher threshold is needed given the state of development of the vehicle and that the malfunction criteria and monitoring approach and technology (e.g., fuel system limits, percent misfire, monitored catalyst volume, etc.) are at least as stringent as comparable ULEV (not ULEV II) vehicles.

(17.1.3) Manufacturers shall use the following malfunction criteria for vehicles certified to the Federal Tier 2 or Tier 3 emission standards:

(A) For vehicles certified to Tier 2 Federal Bin 3 or Bin 4 tailpipe emission standards (as defined in 40 CFR 86.1811-04), manufacturers shall utilize the ULEV II vehicle NMOG and CO malfunction criteria (e.g., 1.5 times the Bin 3 or Bin 4 NMOG and CO standards) and the PC/LDT SULEV II vehicle NOx malfunction criteria (e.g., 2.5 times the Bin 3 or Bin 4 NOx standards).

(B) For vehicles certified to the Tier 3 Federal Bin 85 or Bin 110 tailpipe emission standards (as defined in 40 CFR 86.1811-17), manufacturers shall utilize the following malfunction criteria in accordance with the table below (with the NMOG+NOx and CO multipliers to be used with the applicable standard (e.g., 2.0 times the NMOG+NOx standard)):

	NMOG+NOx Multiplier	CO Multiplier	PM Threshold (mg/mi)[1]
Monitors (except for catalyst)	1.85	1.50	17.50
Catalyst Monitor	2.00	N/A	N/A

1. Applies to 2019 and subsequent model year vehicles

(17.1.4) For medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, the manufacturer shall request Executive Officer approval of a malfunction criterion that is equivalent to that proposed for each monitor in section (e). The Executive Officer shall approve the request upon finding that the manufacturer has used good engineering judgment in determining the equivalent malfunction criterion and that the criterion will provide for similar timeliness in detection of malfunctioning components.

(17.1.5) For SULEV20 vehicles, in lieu of the NMOG+NOx emission threshold set forth in Table 1 in the beginning of section (e), manufacturers may use a malfunction criterion of 3.25 times the applicable NMOG+NOx standard for the first three model years a vehicle is certified, but no later than the

2025 model year. For example, for SULEV20 vehicles first certified to the SULEV20 standard in the 2024 model year, the manufacturer may use the 3.25 multiplier for the 2024 and 2025 model years and shall use the NMOG+NOx emission threshold set forth in Table 1 in the beginning of section (e) for the 2026 and subsequent model years.

(17.2) Whenever the requirements in section (e) of this regulation require a manufacturer to meet a specific phase-in schedule (e.g., (e)(11) cold start emission reduction strategy monitoring requires 30 percent in 2006 model year, 60 percent in 2007 model year, and 100 percent in 2008 model year):

(17.2.1) The phase-in percentages shall be based on the manufacturer's projected sales volume for all vehicles subject to the requirements of title 13, CCR section 1968.2 unless specifically stated otherwise in section (e).

(17.2.2) Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) except as specifically noted for the phase in of in-use monitor performance ratio monitoring conditions in section (d)(3.2).

(17.2.3) Small volume manufacturers may use an alternate phase-in schedule in accordance with section (e)(17.2.2) in lieu of the required phase-in schedule or may meet the requirement on all vehicles by the final year of the phase-in in lieu of meeting the specific phase-in requirements for each model year (e.g., in the example in section (e)(17.2), small volume manufacturers are required to meet 100 percent in the 2008 model year for cold start emission reduction strategy monitoring, but not 30 percent in the 2006 model year or 60 percent in the 2007 model year).

(17.3) Manufacturers may request Executive Officer approval to disable an OBD II system monitor at ambient temperatures below ~~twenty~~ 20 degrees Fahrenheit (~~20°F~~or -6.7 degrees Celsius) (low ambient temperature conditions may be determined based on intake air or engine coolant temperature) 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 II system monitor be disabled at other ambient 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).

(17.4) Manufacturers may request Executive Officer approval to disable monitoring systems that can be affected by low fuel level or running out of fuel (e.g., misfire detection) when the fuel level is 15 percent or less of the nominal capacity of the fuel tank. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring at the fuel levels would be unreliable.

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

(17.5.1) 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 II system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(17.5.2) 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 one of the following conditions is met:

(A) ~~either~~ T~~t~~he electrical charging system/alternator warning light is illuminated (or voltage gauge is in the "red zone") at the voltage used to disable other monitors.

(B) The instrument cluster completely shuts down at the voltage used to disable other monitors. For purposes of this section, "instrument cluster shutdown" is defined as a lack of display or improper zero reading of, at a minimum, vehicle speed, fuel level, and engine speed, and includes information displayed on alternate duplicate displays (e.g., heads up displays).

(C) ~~or that the~~ The OBD II system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(17.6) A manufacturer may request Executive Officer approval to disable monitors that can be affected by PTO activation on vehicles designed to accommodate the installation of PTO units (as defined in section (c)).

(17.6.1) Except as allowed in section (e)(17.6.2) below, a manufacturer may request Executive Officer approval to disable an affected monitor provided disablement occurs only while the PTO unit is active and the OBD II readiness status (specified under section (g)(4.1)) and PTO activation time are appropriately tracked and erased as described in this section. The Executive Officer shall approve the request for disablement based on the manufacturer's demonstration that the affected monitor cannot robustly detect malfunctions (e.g., cannot avoid false passes or false indications of malfunctions) while the PTO unit is active. The OBD II system shall track the cumulative engine runtime with PTO active and clear OBD II readiness status (i.e., set all monitors to indicate "not complete") no later than the start of the next ignition cycle if 750 minutes of cumulative engine runtime with PTO active has occurred since the last time the affected monitor has determined the component or system monitored by the affected monitor is or is not malfunctioning (i.e., has

completed). The PTO timer shall pause whenever PTO changes from active to not active and resume counting when PTO is re-activated. The timer shall be reset to zero after the affected monitor has completed and no later than the start of the next ignition cycle. Once the PTO timer has reached 750 minutes and the OBD II readiness status has been cleared, the PTO timer may not cause the OBD system to clear the readiness status again until after the PTO timer has reset to zero (after the monitor has completed) and again reached 750 minutes.

(17.6.2) In lieu of requesting Executive Officer approval for disabling an affected monitor according to section (e)(17.6.1) above, ~~A~~a manufacturer may disable affected monitors~~ing systems in vehicles designed to accommodate the installation of Power Take-Off (PTO) units (as defined in section (c))~~, provided disablement occurs only while the PTO unit is active~~,~~ and the OBD II readiness status is cleared by the on-board computer (i.e., all monitors set to indicate "not complete") while the PTO unit is activated (see section (g)(4.1)). If the disablement occurs, the readiness status may be restored to its state prior to PTO activation when the disablement ends.

(17.7) A manufacturer may request Executive Officer approval to disable affected monitoring systems in vehicles equipped with tire pressure monitoring systems that cause a vehicle to enter a default mode of operation (e.g., reduced top speed) when a tire pressure problem is detected. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that the default mode can affect monitoring system performance, that the tire pressure monitoring system will likely result in action by the consumer to correct the problem, and that the disablement will not prevent or hinder effective testing in an Inspection and Maintenance program.

(17.8) The manufacturer may request to exempt a specific component from all monitoring requirements if all malfunctions of the component affect emissions or the diagnostic strategy for any other monitored component or system only when the ambient temperature is below 20 degrees Fahrenheit. The Executive Officer shall approve the request upon the manufacturer submittal of data or engineering evaluation supporting that the following criteria are met when the ambient temperature is above 20 degrees Fahrenheit (or -6.7 degrees Celsius): (1) a malfunction of the component does not affect emissions during any reasonable driving condition, (2) a malfunction of the component does not affect the diagnostic strategy for any other monitored component or system, and (3) the ambient temperature is determined based on a temperature sensor monitored by the OBD II system (e.g., IAT sensor). If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system meets these criteria, the Executive Officer shall require the manufacturer to provide emission and/or other diagnostic data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an effect on emissions or other diagnostic strategies. The Executive Officer may request emission data for any reasonable driving condition at ambient temperatures above 20 degrees Fahrenheit (or -6.7 degrees Celsius).

(17.9) The manufacturer may request to exempt a specific component from all monitoring requirements if all malfunctions of the component affect emissions or the diagnostic strategy for any other monitored component or system only when the vehicle speed is above 82 miles-per-hour. The Executive Officer shall approve the request upon the manufacturer submittal of data or engineering evaluation supporting that the following criteria are met when the vehicle speed is below 82 miles-per-hour: (1) a malfunction of the component does not affect emissions during any reasonable driving condition, (2) a malfunction of the component does not affect the diagnostic strategy for any other monitored component or system, and (3) the vehicle speed is determined based on a sensor monitored by the OBD II system (e.g., vehicle speed sensor). If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system meets these criteria, the Executive Officer shall require the manufacturer to provide emission and/or other diagnostic data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an effect on emissions or other diagnostic strategies.

~~(17.8)~~(17.10) Whenever the requirements in section (e) of this regulation require monitoring "to the extent feasible", the manufacturer shall submit its proposed monitor(s) for Executive Officer approval. The Executive Officer shall approve the proposal upon determining that the proposed monitor(s) meets the criteria of "to the extent feasible" by considering the best available monitoring technology to the extent that it is known or should have been known to the manufacturer and given the limitations of the manufacturer's existing hardware, the extent and degree to which the monitoring requirements are met in full, the limitations of monitoring necessary to prevent significant errors of commission and omission, and the extent to which the manufacturer has considered and pursued alternative monitoring concepts to meet the requirements in full. The manufacturer's consideration and pursuit of alternative monitoring concepts shall include evaluation of other modifications to the proposed monitor(s), the monitored components themselves, and other monitors that use the monitored components (e.g., altering other monitors to lessen the sensitivity and reliance on the component or characteristic of the component subject to the proposed monitor(s)).

~~(17.9)~~(17.11) For 2004 model year vehicles certified to run on alternate fuels, manufacturers may request the Executive Officer to waive specific monitoring requirements in section (e) for which monitoring may not be reliable with respect to the use of alternate fuels. The Executive Officer shall grant the request upon determining that the manufacturer has demonstrated that the use of the alternate fuel could cause false illumination of the MIL even when using the best available monitoring technologies.

~~(17.10)~~(17.12) For 2004 model year vehicles only, wherever the requirements of section (e) reflect a substantive change from the requirements of title 13, CCR section 1968.1(b) for 2003 model year vehicles, the manufacturer may request Executive Officer approval to continue to use the requirements of section 1968.1 in lieu of the requirements of section (e). The Executive

Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that software or hardware changes would be required to comply with the requirements of section (e) and that the system complies with the requirements of section 1968.1(b).

(f) *Monitoring Requirements for Diesel/Compression-Ignition Engines.*
For non-Low Emission Vehicle III applications (e.g., Low Emission Vehicle applications and Low Emission Vehicle II applications), the emission thresholds are specified in the monitoring sections in section (f) below. For Low Emission Vehicle III applications, wherever an emission threshold for a malfunction on a diagnostic is required in section (f), the emission thresholds shall be set in accordance with Table 2 and Table 3 below:

Table 2

LEV-III OBD II Diesel Thresholds							
Exhaust Standards		**Monitor Thresholds[1]**			**Aftertreatment Monitor Thresholds[2]**		
Vehicle Type	**Vehicle Emission Category**	**NMOG+ NOx Mult.**	**CO Mult.**	**PM Mult.**	**NMOG+ NOx Mult.**	**CO Mult.[3]**	**PM Mult.**
Passenger Cars, Light-Duty Trucks, and Chassis Certified MDPVs	LEV160	1.50	1.50	2.00	1.75	1.50	2.00[3]
	ULEV125						
	ULEV70	2.00			2.00		
	ULEV50						
	SULEV30	2.50	2.50		2.50	2.50	
	SULEV20[6]						
2016MY-2018MY Chassis Certified MDVs (except MDPVs)	All MDV Emission Categories	1.50	1.50	2.00	1.75	N/A	N/A
2019+MY Chassis Certified MDVs (except MDPVs)	All MDV Emission Categories	1.50	1.50	1.50[4] or 2.00[5]	1.75	1.50	1.50[4] or 2.00[5]

1. Applies to (f)(3.2.5), (f)(4)-(f)(7), (f)(9.2.2), (f)(12)-(f)(13)
2. Applies to (f)(1)-(f)(2), (f)(8), and (f)(9.2.4)(A)
3. Applies to 2019 and subsequent model years
4. Applies to vehicles not included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2
5. Applies to vehicles included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2
6. Manufacturer shall use the 2.50 times NMOG+NOx multiplier for vehicles not using the provisions of section (f)(17.1.7)

Table 3

LEV-III OBD II Diesel PM Filter Filtering Performance Monitor Threshold					
Exhaust Standards		**PM Filter Filtering Performance Monitor Threshold**			
Vehicle Type	**Vehicle Emission Category**	**NMOG+NOx Mult.[1]**	**CO Mult.[1]**	**PM Mult.**	**PM THD (mg/mi)**
Passenger Cars, Light-Duty Trucks, and Chassis Certified MDPVs	LEV160	1.50	1.50	N/A	17.50
	ULEV125				
	ULEV70	2.00			
	ULEV50				
	SULEV30	2.50	2.50		
	SULEV20[4]				
2016MY-2018MY Chassis Certified MDVs (except MDPVs)	All MDV Emission Categories	N/A	N/A	1.75[2]	17.50[3]
2019+MY Chassis Certified MDVs (except MDPVs)	All MDV Emission Categories	1.50	1.50	1.50[2]	17.50[3]

1. Applies to 2019 and subsequent model years
2. Applies to vehicles not included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2
3. Applies to vehicles included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2
4. Manufacturer shall use the 2.50 times NMOG+NOx multiplier for vehicles not using the provisions of section (f)(17.1.7)

(1) *Non-Methane Hydrocarbon (NMHC) Converting Catalyst Monitoring*

(1.1) Requirement: The OBD II system shall monitor the NMHC converting catalyst(s) for proper NMHC conversion capability. For vehicles 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 (f)(9).

(1.2) Malfunction Criteria:

(1.2.1) For purposes of section (f)(1), each catalyst in a series configuration that converts NMHC shall be monitored either individually or in combination with others.

(1.2.2) Conversion Efficiency:

(A) The OBD II system shall detect an NMHC catalyst malfunction when the catalyst conversion capability decreases to the point that emissions exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. For non-Low Emission Vehicle III applications:

~~a.~~1. 5.0 times the applicable FTP full useful life NMHC standards for 2004 through 2009 model year vehicles;

~~b.~~2. 3.0 times the applicable FTP full useful life NMHC standards for 2010 through 2012 model year vehicles; and

~~c.~~3. 1.75 times the applicable FTP full useful life NMHC standards for 2013 and subsequent model year vehicles.

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 2.5 times the applicable NMHC standards for 2007 through 2012 model year vehicles; and

b. 2.0 times the applicable NMHC standards or the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) for 2013 and subsequent model year vehicles.

(B) Except as provided below in section (f)(1.2.2)(C), if no failure or deterioration of the catalyst conversion capability could result in ~~NMHC or NOx~~ emissions exceeding the applicable malfunction criteria of section (f)(1.2.2)(A), the OBD II system shall detect a malfunction when the catalyst has no detectable amount of ~~NMHC or NOx~~ conversion capability.

(C) For 2004 through 2009 model year vehicles, a manufacturer may request to be exempted from the requirements for NMHC catalyst conversion efficiency monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NMHC conversion efficiency of the system is less than 30 percent (i.e., the cumulative NMHC emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NMHC emissions measured at the inlet of the catalyst(s)).

(1.2.3) Other Aftertreatment Assistance Functions. Additionally, for 2010 and subsequent model year vehicles, the catalyst(s) shall be monitored for other aftertreatment assistance functions:

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

(B) For 2015 and subsequent model year passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard and 2015 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, 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 II system shall detect a malfunction when the catalyst is

unable to generate the necessary feedgas constituents for proper SCR system operation. Catalysts are exempt from this monitoring if both of the following criteria are satisfied: (1) no malfunction of the catalyst's feedgas generation ability can cause emissions to increase by ~~15 percent or more of~~ 25 percent or more for SULEV30 and SULEV20 vehicles, 20 percent or more for ULEV70 and ULEV50 vehicles, and 15 percent or more for all other vehicles, where the percentage is based on the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle; and (2) no malfunction of the catalyst's feedgas generation ability can cause emissions to exceed the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle.

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

(D) For catalysts located downstream of an SCR system (e.g., to prevent ammonia slip), the OBD II system shall detect a malfunction when the catalyst has no detectable amount of NMHC, CO, NOx, or PM conversion capability. ~~Monitoring of the catalyst shall not be required if there is no measurable emission impact on the criteria pollutants (i.e., NMHC, CO, NOx, and PM) during any reasonable driving condition where the catalyst is most likely to affect criteria pollutants (e.g., during conditions most likely to result in ammonia generation or excessive reductant delivery).~~ Catalysts are exempt from this monitoring if both of the following criteria are satisfied: (1) no malfunction of the catalyst's conversion capability can cause emissions to increase by 15 percent or more of the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle; and (2) no malfunction of the catalyst's conversion capability can cause emissions to exceed the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle.

(1.2.4) Catalyst System Aging and Monitoring

(A) For purposes of determining the catalyst malfunction criteria in sections (f)(1.2.2) and (1.2.3) for individually monitored catalysts, the manufacturer shall use a catalyst(s) deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions. If the catalyst system contains catalysts in parallel (e.g., a two bank exhaust system where each bank has its own catalyst), the malfunction criteria shall be determined with the "parallel" catalysts equally deteriorated.

(B) For purposes of determining the catalyst malfunction criteria in sections (f)(1.2.2) and (1.2.3) 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 (f)(1.2.2) and (1.2.3) including the deterioration/aging process. If the catalyst system contains catalysts in parallel (e.g., a two bank exhaust system where each bank has its own catalyst), the malfunction criteria shall be determined with the "parallel" catalysts equally deteriorated. 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 (f)(1.2), 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 (f)(1.2.2) and (1.2.3).

(1.3) Monitoring Conditions:

(1.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(1.2.2) and (1.2.3) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the NMHC converting catalyst monitors under sections (f)(1.2.2) and (f)(1.2.3) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (f)(1.2.2) and (1.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(1.4) MIL Illumination and Fault Code Storage:

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

(1.4.2) The monitoring method for the catalyst(s) shall be capable of detecting 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).

(2) *Oxides of Nitrogen (NOx) Converting Catalyst Monitoring*

(2.1) Requirement: The OBD II system shall monitor the NOx converting catalyst(s) for proper conversion capability. For vehicles 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 II 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 (f)(15).

(2.2) Malfunction Criteria:

(2.2.1) For purposes of section (f)(2), each catalyst in a series configuration that converts NOx shall be monitored either individually or in combination with others.

(2.2.2) Conversion Efficiency:

(A) The OBD II system shall detect a NOx catalyst malfunction when the catalyst conversion capability decreases to the point that ~~NOx or NMHC~~ emissions exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. For non-Low Emission Vehicle III applications:

~~a.~~1. 3.0 times the applicable FTP full useful life NMHC or NOx standards for 2004 through 2009 model year vehicles;

~~b.~~2. 2.5 times the applicable FTP full useful life NMHC or NOx standards for 2010 through 2012 model year vehicles; and

~~c.~~3. 1.75 times the applicable FTP full useful life NMHC or NOx standards for 2013 and subsequent model year vehicles.

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. the applicable NOx standard by more than 0.5 g/bhp-hr (e.g., cause NOx emissions to exceed 0.7 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 3.5 times the applicable NMHC standard for 2007 through 2009 model year vehicles;

b. the applicable NOx standard by more than 0.4 g/bhp-hr (e.g., cause NOx emissions to exceed 0.6 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.5 times the applicable NMHC standard for 2010 through 2012 model year vehicles;

c. the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.0 times the applicable NMHC standard for 2013 through 2015 model year vehicles; and

d. the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.0 times the applicable NMHC standard for 2016 and subsequent model year vehicles.

(B) Except as provided below in section (f)(2.2.2)(C), if no failure or deterioration of the catalyst ~~NOx or NMHC~~ conversion capability could result in ~~NOx or NMHC~~ emissions exceeding the applicable malfunction criteria of section (f)(2.2.2), the OBD II system shall detect a malfunction when the catalyst has no detectable amount of ~~NOx or NMHC~~ conversion capability.

(C) For 2004 through 2009 model year vehicles, a manufacturer may request to be exempted from the requirements for NOx catalyst conversion efficiency monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data

and/or engineering evaluation, that the average FTP test NOx conversion efficiency of the system is less than 30 percent (i.e., the cumulative NOx emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NOx emissions measured at the inlet of the catalyst(s)).

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

(A) Reductant Delivery Performance:

(i) For 2007 and subsequent model year vehicles, the OBD II 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 a vehicle's ~~NOx or NMHC~~ emissions to exceed the applicable emission levels specified in sections (f)(2.2.2)(A).

(ii) If no failure or deterioration of the reductant delivery system could result in a vehicle's ~~NOx or NMHC~~ emissions exceeding the applicable malfunction criteria specified in section (f)(2.2.3)(A)(i), the OBD II 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) Except as provided for in section (f)(2.2.3)(G), ~~I~~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 II system shall detect a malfunction when there is no longer sufficient reductant available to properly operate the reductant system (e.g., the reductant tank is empty).

(C) Except as provided for in section (f)(2.2.3)(H), ~~I~~if the catalyst system uses a reservoir/tank for the reductant that is separate from the fuel tank used for the vehicle, the OBD II 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 (f)(2.2.3)(E), if the vehicle is equipped with feedback or feed-forward control of the reductant injection (e.g., dosing quantity, pressure control), the OBD II system shall detect a malfunction:

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

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

(iii) If the control system has used up all of the adjustment allowed by the manufacturer or reached its maximum authority and cannot achieve the target.

(E) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(2.2.3)(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 a vehicle 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 (f)(2.2.3)(D)(i) and (ii) with a reductant injection system-specific monitor, the OBD II 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 (f)(2.2.3)(D)(i) and (ii).

(G) A manufacturer may request to be exempted from the monitoring requirements specified in section (f)(2.2.3)(B) (i.e., monitoring for insufficient reductant). The Executive Officer shall approve the request upon determining that the vehicle has an inducement strategy designed to prevent sustained vehicle operation with no reductant and that the manufacturer is monitoring all inputs to the inducement strategy (e.g., reductant level sensor) in accordance with the comprehensive component requirements in section (f)(15).

(H) A manufacturer may request to be exempted from the monitoring requirements specified in section (f)(2.2.3)(C) (i.e., monitoring for improper reductant). The Executive Officer shall approve the request upon determining that the vehicle has an inducement strategy designed to prevent sustained vehicle operation with poor quality reductant and that the manufacturer is monitoring all inputs to the inducement strategy (e.g., reductant quality sensor) in accordance with the comprehensive component requirements in section (f)(15).

(2.2.4) Catalyst System Aging and Monitoring

(A) For purposes of determining the catalyst malfunction criteria in section (f)(2.2.2) 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. If the catalyst system contains catalysts in parallel (e.g., a two bank exhaust system where each bank has its own catalyst), the malfunction criteria shall be determined with the “parallel” catalysts equally deteriorated.

(B) For purposes of determining the catalyst malfunction criteria in section (f)(2.2.2) 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 (f)(2.2.2) including the deterioration/aging process. If the catalyst system contains catalysts in parallel (e.g., a two bank exhaust system where each bank has its own catalyst), the malfunction criteria shall be determined with the “parallel” catalysts equally deteriorated. 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 (f)(2.2.2), 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 section (f)(2.2.2).

(2.3) Monitoring Conditions:

(2.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(2.2.2), (f)(2.2.3)(A), and (f)(2.2.3)(C) (i.e., catalyst efficiency, reductant delivery performance, and improper reductant) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the NOx converting catalyst monitors under section (f)(2.2.2) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(2.2.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(2.3.2) Except as provided for in section (f)(2.3.3), the OBD II system shall monitor continuously for malfunctions identified in sections (f)(2.2.3)(B) and (D) (i.e., insufficient reductant, feedback control).

(2.3.3) Manufacturers may request Executive Officer approval to temporarily disable continuous monitoring under conditions technically necessary to ensure robust detection of malfunctions and to avoid false passes and false indications of malfunctions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a properly operating system cannot be distinguished from a malfunctioning system and that the disablement interval is limited only to that which is technically necessary.

(2.4) MIL Illumination and Fault Code Storage:

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

(2.4.2) If the OBD II system is capable of discerning that a system fault is being caused by an 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 II 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.

(2.4.3) 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).

(3) *Misfire Monitoring*

(3.1) Requirement:

(3.1.1) The OBD II system shall monitor the engine for misfire. The OBD II 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 II system shall also identify the specific misfiring cylinder.

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

(3.2) Malfunction Criteria:

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

(3.2.2) Additionally, the requirements of section (f)(3.2.2) shall apply to the following vehicles: (1) for all combustion sensor or combustion quality sensor-equipped (e.g., for use in homogeneous charge compression ignition control systems) 2010 and subsequent model year passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard, (2) for all combustion sensor or combustion quality sensor-equipped 2010 through 2015 model year medium-duty vehicles, ~~and~~ (3) for 20 percent of 2016 model year, 50 percent of 2017 model year, and 100 percent of 2018 model year medium-duty vehicles (percentage based on the manufacturer's projected California sales volume for all medium-duty diesel vehicles except MDPVs certified to a chassis dynamometer tailpipe emission standard), and (4) for 20 percent of 2019 model year, 50 percent of 2020 model year, and 100 percent of 2021 model year passenger cars and light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard (percentage based on the manufacturer's projected California sales volume for all passenger cars and light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard):

(A) The OBD II system shall detect a misfire malfunction ~~as follows~~when the percentage of misfire is equal to or exceeds five percent.~~:~~

~~(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard, the OBD II system shall detect a misfire malfunction that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed1.5 times any of the applicable FTP standards.~~

~~(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the OBD II system shall detect a misfire malfunction when the percentage of misfire is equal to or exceeds five percent.~~

(B) The manufacturers shall evaluate the percentage of misfire ~~as follows~~in 1000 revolution increments.~~:~~

~~(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard, manufacturers shall determine the percentage of misfire evaluated in 1000 revolution increments that would cause NMHC, CO, NOx, or PM emissions from an emission durability demonstration vehicle to exceed the levels specified in section (f)(3.2.2)(A) 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.~~

~~(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the manufacturer shall evaluate the percentage of misfire in 1000 revolution increments.~~

(C) 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.

(3.2.3) A malfunction shall be detected if the percentage of misfire established in section (f)(3.2.2) is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous).

(3.2.4) For multiple cylinder misfire situations that result in a misfire rate greater than or equal to 50 percent of all engine firings, the OBD II system shall only be required to detect a misfire malfunction for situations that are caused by a single component failure.

(3.2.5) 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 percentage of misfire malfunction criteria in section (f)(3.2.2)(A)~~(ii)~~ upward to exclude detection of misfire that cannot cause the vehicle's emissions to exceed the following:

(A) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

(i) For non-Low Emission Vehicle III applications, 1.5 times any of the applicable NMHC, CO, or NOx standards, or 2.0 times the applicable PM standards; or

(ii) For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(B) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, ~~NMHC, CO, and NOx emissions~~

~~to exceed~~ 2.0 times any of the applicable NMHC, CO, or NOx standards ~~and~~ or ~~the vehicle's PM emissions to exceed~~ 0.03 g/bhp-hr PM as measured from an applicable cycle emission test.

(3.3) Monitoring Conditions:

(3.3.1) Except as provided in section (f)(3.3.2), the OBD II system shall monitor for misfires identified in section (f)(3.2.1) 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.

(3.3.2) Manufacturers may request Executive Officer approval to use alternate monitoring conditions (e.g., off-idle) in lieu of the monitoring conditions specified in section (f)(3.3.1). 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.

(3.3.3) For misfires identified in section (f)(3.2.2), the OBD II system shall monitor for misfire as follows:

(A) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard, the OBD II system shall continuously monitor for misfire under ~~all positive torque engine speeds and load~~ the following conditions:~~.~~

(i) For 2010 through 2021 model year vehicles and 2022 and subsequent model year vehicles that are not included in the phase-in specified in section (f)(3.3.3)(A)(ii), under positive torque conditions up to75 percent of peak torque with engine speed up to 75 percent of the maximum engine speed except within the following range: the engine operating region bound by the positive torque line (i.e., engine torque with transmission in neutral) and the two following points: engine speed of 50 percent of maximum engine speed with the engine torque at the positive torque line, and 75 percent of the maximum engine speed with the engine torque at 5 percent of peak torque above the positive torque line.

(ii) For 20 percent of 2022 model year, 50 percent of 2023 model year, and 100 percent of 2024 model year vehicles (percentage based on the manufacturer's projected California sales volume for all passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard), under all positive torque engine speed

conditions except within the following range: the engine operating region bound by the positive torque line (i.e., engine load with transmission in neutral) and the two following points: engine speed of 50 percent of maximum engine speed with the engine torque at the positive torque line, and 100 percent of the maximum engine speed with the engine torque at 10 percent of peak torque above the positive torque line.

(B) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the OBD II system shall continuously monitor for misfire under the following conditions:

(i) For 2010 through 2018 model year vehicles and 2019 and subsequent model year vehicles that are not included in the phase-in specified in section (f)(3.3.3)(B)(ii), under positive torque conditions up to75 percent of peak torque with engine speed up to 75 percent of the maximum engine speed except within the following range: the engine operating region bound by the positive torque line (i.e., engine torque with transmission in neutral) and the two following points: engine speed of 50 percent of maximum engine speed with the engine torque at the positive torque line, and 75 percent of the maximum engine speed with the engine torque at 5 percent of peak torque above the positive torque line.

(ii) For 20 percent of 2019 model year, 50 percent of 2020 model year, and 100 percent of 2021 model year medium-duty vehicles (percentage based on the manufacturer's projected California sales volume for all medium-duty diesel vehicles except MDPVs certified to a chassis dynamometer tailpipe emission standard), under all positive torque engine speed conditions except within the following range: the engine operating region bound by the positive torque line (i.e., engine load with transmission in neutral) and the two following points: engine speed of 50 percent of maximum engine speed with the engine torque at the positive torque line, and 100 percent of the maximum engine speed with the engine torque at 10 percent of peak torque above the positive torque line.

(C) If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions as required in sections (f)(3.3.3)(A) and (B), 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, 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), and the extent to which the most reliable monitoring method developed is unable to ensure robust detection of misfire in the region(s). 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.

(D) 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. 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. Such disablements may include but are not limited to events 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) intrusive diagnostics during portions that can significantly affect engine stability, ~~or~~

(vii) infrequent regeneration events during portions that can significantly affect engine stability~~.~~, or

(viii) conditions where the engine coolant temperature is below 70 degrees Fahrenheit (or 21.1 degrees Celsius) on driving cycles where the engine coolant temperature at engine start is below 20 degrees Fahrenheit (or -6.7 degrees Celsius).

(3.4) MIL Illumination and Fault Code Storage:

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

(3.4.2) Additionally, for 2010 and subsequent model year vehicles subject to (f)(3.2.2):

(A) Upon detection of the percentage of misfire specified in section (f)(3.2.2), 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 (f)(3.2.2) during a single driving cycle.

(ii) If a pending fault code is stored, the OBD II system shall illuminate the MIL and store a confirmed fault code within 10 seconds if the percentage of misfire specified in section (f)(3.2.2) is again exceeded four times during: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered. Additionally, the pending fault code shall continue to be stored in accordance with section (g)(4.4.5).

(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 II 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 fault code and erasing a confirmed fault code.

(ii) If freeze frame conditions are stored for a malfunction other than a misfire <u>or fuel system</u> malfunction <u>(see section (f)(4))</u> when a <u>misfire</u> fault code is stored as specified in section (f)(3.4.2), the stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction. <u>Alternatively, for the 2004 through 2018 model years, if freeze frame conditions are stored and reported for a fuel system malfunction (section (f)(4)) when a misfire fault code is stored as specified in section (f)(3.4.2) above, the stored freeze frame information may be replaced with freeze frame information regarding the misfire malfunction.</u>

(C) Storage of misfire conditions for similar conditions determination. Upon detection of misfire under section (f)(3.4.2), the OBD II 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.

(4) *Fuel System Monitoring*

(4.1) Requirement:

The OBD II system shall monitor the fuel delivery system to determine its ability to comply with applicable 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 (f)(15).

(4.2) Malfunction Criteria:

(4.2.1) Fuel system pressure control:

(A) The OBD II system shall detect a malfunction of the fuel system pressure control system (e.g., fuel, hydraulic fluid) prior to any failure or deterioration that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. For non-Low Emission Vehicle III applications:

~~a.~~1. 3.0 times the applicable FTP standards for 2004 through 2009 model year vehicles;

~~b.~~2. 2.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

~~c.~~3. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 1.5 times any of the applicable NMHC, CO, and NOx standards or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of greater than 0.50 g/bhp-hr NOx;

b. 2.5 times any of the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2012 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx; and

c. 2.0 times any of the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx;

(B) For vehicles in which no failure or deterioration of the fuel system pressure control could result in a vehicle's emissions exceeding the applicable malfunction criteria specified in section (f)(4.2.1)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that the commanded fuel system pressure cannot be delivered.

(4.2.2) Injection quantity. Additionally, for all 2010 and subsequent model year vehicles, the fuel system shall be monitored for injection quantity:

(A) The OBD II 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 a vehicle's NMHC, CO, NOx and PM emissions at or below:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. For non-Low Emission Vehicle III applications:

~~a.~~1. 3.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

~~b.~~2. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the applicable emission levels specified in sections (f)(4.2.1)(A)(ii).

(B) For vehicles in which no failure or deterioration of the fuel injection quantity could result in a vehicle's emissions exceeding the applicable malfunction criteria specified in section (f)(4.2.2)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that the commanded fuel quantity cannot be delivered.

(4.2.3) Injection Timing. Additionally, for all 2010 and subsequent model year vehicles, the fuel system shall be monitored for injection timing:

(A) The OBD II 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 a vehicle's NMHC, CO, NOx, and PM emissions at or below the applicable emission levels specified in sections (f)(4.2.2)(A).

(B) For vehicles in which no failure or deterioration of the fuel injection timing could result in a vehicle's emissions exceeding the applicable malfunction criteria specified in section (f)(4.2.3)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that the commanded fuel injection timing cannot be achieved.

(4.2.4) Feedback control:

(A) Except as provided for in section (f)(4.2.4)(B), if the vehicle is equipped with feedback or feed-forward control of the fuel system (e.g., feedback control of pressure or pilot injection quantity), the OBD II system shall detect a malfunction:

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

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

(iii) If control system has used up all of the adjustment allowed by the manufacturer or reached its maximum authority and cannot achieve the target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(4.2.4)(A)(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 a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(4.2.4)(A)(i) and (ii) with a fuel system-specific monitor, the OBD II 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 (f)(4.2.4)(A)(i) and (ii).

(4.2.5) For purposes of determining the fuel system malfunction criteria in sections (f)(4.2.1) through (4.2.3)~~ for medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard~~, the manufacturer shall do the following:

(A) For 2004 through 2018 model year passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard and 2004 through 2012 model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the malfunction criteria shall be established by using a fault that affects either a single injector or all injectors equally.

(B) For 2019 and subsequent model year passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard and 2013 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, for section (f)(4.2.1), the malfunction criteria shall be established by using a fault that affects all injectors equally. Additionally, for systems that have single component failures which could affect a single injector (e.g., systems that build injection pressure within the injector that could have a single component pressure fault caused by the injector itself), the malfunction criteria shall also be established by using a fault that affects a single injector.

(C) For 2019 and subsequent model year passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard and 2013 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, for sections (f)(4.2.2) through (4.2.3), the malfunction criteria shall be established by both (1) a fault that affects all the injectors equally and (2) a fault that affects only one injector.

(4.3) Monitoring Conditions:

(4.3.1) Except as provided in sections (f)(4.3.2) and (f)(4.3.4), the OBD II system shall monitor continuously for malfunctions identified in sections (f)(4.2.1) and (f)(4.2.4) (i.e., fuel pressure control and feedback operation).

(4.3.2) For fuel systems that achieve injection fuel pressure within the injector or increase pressure within the injector (e.g. in the injector of an amplified common rail system), manufacturers may request Executive Officer approval to define the monitoring conditions for malfunctions identified in sections (f)(4.2.1) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). The Executive Officer shall approve the monitoring conditions upon the manufacturer submitting data and/or analysis identifying all possible failure modes and the effect each has (e.g., failure modes and effects analysis) on fuel pressure across the entire range of engine operating conditions, and upon the Executive Officer determining based on the data and/or analysis that the monitoring

conditions allow for robust detection of all causes of fuel pressure malfunctions.

(4.3.3) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(4.2.2) and (f)(4.2.3) (i.e., injection quantity and timing) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, ~~F~~for all 2013 and subsequent model year vehicles, manufacturers shall track and report the in-use performance of the fuel system monitors under sections (f)(4.2.2) and (f)(4.2.3) in accordance with section (d)(3.2.2). ~~f~~For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (f)(4.2.2) and (f)(4.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(4.3.4) Manufacturers may request Executive Officer approval to temporarily disable continuous monitoring under conditions technically necessary to ensure robust detection of malfunctions and to avoid false passes and false indications of malfunctions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a properly operating system cannot be distinguished from a malfunctioning system and that the disablement interval is limited only to that which is technically necessary.

(4.4) MIL Illumination and Fault Code Storage:

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

(4.4.2) Additionally, for malfunctions identified in section (f)(4.2.1) (i.e., fuel pressure control) on all 2010 and subsequent model year vehicles:

(A) A pending fault code shall be stored immediately upon the fuel system exceeding the malfunction criteria established pursuant to section (f)(4.2.1).

(B) Except as provided below, if a pending fault code is stored, the OBD II system shall immediately illuminate the MIL and store a confirmed fault code if a malfunction is again detected during ~~either~~ any 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. Additionally, the pending fault code shall continue to be stored in accordance with section (g)(4.4.5).

(C) 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.

(D) Storage of freeze frame conditions.

(i) A manufacturer 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.

(ii) If freeze frame conditions are stored for a malfunction other than misfire (see section (f)(3)) or fuel system malfunction when a fuel system fault code is stored as specified in section (f)(4.4.2) above, the stored freeze frame information shall be replaced with freeze frame information regarding the fuel system malfunction.

(E) Storage of fuel system conditions for determining similar conditions of operation.

(i) Upon detection of a fuel system malfunction under section (f)(4.4.2), the OBD II 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.

(ii) The manufacturer may request Executive Officer approval to use an alternate definition of similar conditions in lieu of the definition specified in section (c). The Executive Officer shall approve the alternate definition upon the manufacturer providing data or analysis demonstrating that the alternate definition provides for equivalent robustness in detection of fuel system faults that vary in severity depending on engine speed, load, and/or warm-up status.

(F) 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.

(5) *Exhaust Gas Sensor Monitoring*

(5.1) Requirement:

(5.1.1) The OBD II 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.

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

(5.2) Malfunction Criteria:

(5.2.1) Air-Fuel Ratio Sensors:

(A) For sensors located upstream of the exhaust aftertreatment:

(i) Sensor performance faults: The OBD II 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 a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

a. For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

1. For non-Low Emission Vehicle III applications:

~~1.~~ i. 2.5 times the applicable FTP standards for 2004 through 2009 model year vehicles;

~~2.~~ii. 2.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

~~3.~~iii. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

2. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

b. For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

1. 1.5 times the applicable NMHC, CO, and NOx standards or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of greater than 0.50 g/bhp-hr NOx;
2. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2012 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx; and
3. 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx.

(ii) Circuit faults: The OBD II 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 II 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 or feed-forward input (e.g., causes default or open-loop operation).

(iv) Monitoring capability: To the extent feasible, the OBD II 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 II system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(B) For sensors located downstream of the exhaust aftertreatment:

(i) Sensor performance faults: The OBD II 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 a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

a. For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

1. For non-Low Emission Vehicle III applications:

~~1.~~ i. 3.5 times the applicable FTP NMHC, CO, or NOx standards or 5.0 times the applicable FTP PM standard for 2004 through 2009 model year vehicles;

~~2.~~ ii. 2.5 times the applicable FTP NMHC, CO, or NOx standards or 4.0 times the applicable FTP PM standard for 2010 through 2012 model year vehicles;

~~3.~~ iii. 1.5 times the applicable FTP NMHC or CO standards, 1.75 times the applicable FTP NOx standard, or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

2. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

b. For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

1. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.5 g/bhp-hr (e.g., cause NOx emissions to exceed 0.7 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.05 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2009 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of greater than 0.50 g/bhp-hr NOx;

2. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.05 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2012 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx; and

3. 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx.

(ii) Circuit faults: The OBD II 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 II 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 or feed-forward input (e.g., causes default or open-loop operation).

(iv) Monitoring capability: To the extent feasible, the OBD II 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 II system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(5.2.2) NOx and PM sensors:

(A) Sensor performance faults: The OBD II 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 a vehicle's emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

<u>a. For non-Low Emission Vehicle III applications:</u>

1. 3.5 times the applicable FTP NMHC, CO, or NOx standards or 5.0 times the applicable FTP PM standard for 2004 through 2009 model year vehicles;
2. 2.5 times the applicable FTP NMHC, CO, or NOx standards, or 4.0 times the applicable FTP PM standard for 2010 through 2012 model year vehicles;
3. 1.5 times the applicable FTP NMHC or CO standards, 1.75 times the applicable FTP NOx standard, or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

<u>b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).</u>

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 2.5 times the applicable NMHC standards, the applicable NOx standard by more than 0.5 g/bhp-hr (e.g., cause NOx emissions to exceed 0.7 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 0.05 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2009 model year vehicles;

b. 2.5 times the applicable NMHC standards, the applicable NOx standard by more than 0.4 g/bhp-hr (e.g., cause NOx emissions to exceed 0.6 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 0.05

g/bhp-hr PM as measured from an applicable cycle emission test for 2010 through 2012 model year vehicles;

c. 2.0 times the applicable NMHC standard, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 through 2015 model year vehicles; and

d. 2.0 times the applicable NMHC standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2016 and subsequent model year vehicles.

(B) Circuit faults: The OBD II 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 II 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 or feed-forward input (e.g., causes default or open-loop operation).

(D) Monitoring capability: To the extent feasible, the OBD II 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 II system monitoring device (e.g., for catalyst, EGR, PM filter, SCR, or NOx adsorber monitoring).

(5.2.3) 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, NOx sensors, and PM sensors under sections (f)(5.2.1) and (f)(5.2.2).

(5.2.4) Sensor Heaters:

(A) The OBD II system shall detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Subject to Executive Officer approval, other malfunction criteria for heater performance malfunctions may be used 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)(5.2.4)(A).

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

(5.3) Monitoring Conditions:

(5.3.1) Exhaust Gas Sensors

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(5.2.1)(A)(i), (5.2.1)(B)(i), (5.2.2)(A), and (5.2.2)(D) (e.g., sensor performance faults) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, ~~F~~for all 2010 and subsequent model year vehicles, manufacturers shall track and report the in-use performance of the exhaust gas sensor monitors under sections (f)(5.2.1)(A)(i), (5.2.1)(B)(i), and (5.2.2)(A) in accordance with section (d)(3.2.2). Further, for all 2016 and subsequent model year medium-duty vehicles (except MDPVs certified to a chassis dynamometer tailpipe emission standard) and 2019 and subsequent model year passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard, manufacturers shall track and report the in-use performance of the exhaust gas sensor monitors under section (f)(5.2.2)(D) in accordance with section (d)(3.2.2). ~~f~~For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (f)(5.2.1)(A)(i), (5.2.1)(B)(i), (5.2.2)(A), and ~~for 2016 and subsequent model year medium-duty vehicles, section (f)~~(5.2.2)(D) 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 (f)(5.2.1)(A)(iv) and (5.2.1)(B)(iv) (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 (f)(5.3.1)(D), monitoring for malfunctions identified in sections (f)(5.2.1)(A)(ii), (5.2.1)(A)(iii), (5.2.1)(B)(ii), (5.2.1)(B)(iii), (5.2.2)(B), and (5.2.2)(C) (i.e., circuit continuity, out-of-range, 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.

(5.3.2) Sensor Heaters

(A) Manufacturers shall define monitoring conditions for malfunctions identified in section (f)(5.2.4)(A) (i.e., sensor heater performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Monitoring for malfunctions identified in section (f)(5.2.4)(B) (i.e., circuit malfunctions) shall be conducted continuously.

(5.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2). To the extent feasible, the OBD II system shall separately detect lack of circuit continuity and out-of-range faults as required under sections (f)(5.2.1)(A)(ii), (f)(5.2.1)(B)(ii), and (f)(5.2.2)(B) and store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit). For sensors with sensing elements externally connected to a sensor control module, manufacturers are not required to store different fault codes for lack of circuit continuity and out-of-range faults if: (1) the sensing element (i.e., probe or sensor externally connected to the sensor control module) is a subcomponent integral to the function of the complete sensor unit; (2) the sensing element is permanently attached to the sensor control module with wires or one-time connectors; (3) the complete sensor unit is designed, manufactured, installed, and serviced per manufacturer published procedures as a single component; and (4) the sensor control module and sensing element are calibrated together during the manufacturing process such that neither can be individually replaced in a repair scenario. Additionally, manufacturers are not required to store separate fault codes for lack of circuit continuity faults that cannot be distinguished from other out-of-range or circuit faults.

(6) *Exhaust Gas Recirculation (EGR) System Monitoring*

(6.1) Requirement:

(6.1.1) The OBD II system shall monitor the EGR system on vehicles so-equipped for low flow rate, high flow rate, and slow response malfunctions. For vehicles equipped with EGR coolers (e.g., heat exchangers), the OBD II system shall monitor the cooler system 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 (f)(15).

(6.1.2) For vehicles with other charge control strategies that affect EGR flow (e.g., systems that modify EGR flow to achieve a desired fresh air flow rate instead of a desired EGR flow rate), 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 EGR systems under section (f)(6).

(6.2) Malfunction Criteria:

(6.2.1) Low Flow:

(A) The OBD II system shall detect a malfunction of the EGR system at or prior to a decrease from the manufacturer's specified EGR flow rate that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. For non-Low Emission Vehicle III applications:

~~a.~~1. 3.0 times the applicable FTP standards for 2004 through 2009 model year vehicles;

~~b.~~2. 2.5 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

~~c.~~3. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 1.5 times the applicable FTP standards for 2004 through 2006 model year vehicles;

b. 1.5 times the applicable NMHC, CO, and NOx standards or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of greater than 0.50 g/bhp-hr NOx;

c. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2012 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx; and

d. 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx.

(B) For vehicles in which no failure or deterioration of the EGR system that causes a decrease in flow could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(6.2.1)(A), the OBD II system shall detect a malfunction when either the EGR system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate or, for non-feedback controlled EGR systems, the EGR system has no detectable amount of EGR flow when EGR flow is expected.

(6.2.2) High Flow:

(A) The OBD II 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), at or prior to an increase from the

manufacturer's specified EGR flow rate that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(6.2.1)(A):

(B) For vehicles in which no failure or deterioration of the EGR system that causes an increase in flow could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(6.2.2)(A), the OBD II system shall detect a malfunction when either the EGR system has reached its control limits such that it cannot reduce EGR flow to achieve the commanded flow rate or, for non-feedback controlled EGR systems, the EGR system has maximum detectable EGR flow when little or no EGR flow is expected.

(6.2.3) Slow Response. Additionally, for 2010 and subsequent model year vehicles, the EGR system shall be monitored for slow response:

(A) The OBD II system shall detect a malfunction of the EGR system at or prior to any failure or deterioration in the EGR system response (e.g., capability to achieve the specified flow rate within a manufacturer-specified time) that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(6.2.1)(A).

(B) The OBD II system shall monitor the EGR system response under both increasing and decreasing EGR flow rates. For vehicles in which no failure or deterioration of the EGR system response could result in an engine's emissions exceeding the levels specified in section (f)(6.2.1)(A), the OBD II system shall detect a malfunction of the EGR system when no detectable response to a change in commanded or expected flow rate occurs

(6.2.4) Feedback control:

(A) Except as provided for in section (f)(6.2.4)(B), if the vehicle is equipped with feedback or feed-forward 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 II system shall detect a malfunction:

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

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

(iii) If the control system has used up all of the adjustment allowed by the manufacturer or reached its maximum authority and cannot achieve the target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(6.2.4)(A)(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 a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(6.2.4)(A)(i) and (ii) with an EGR system-specific monitor, the OBD II 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 (f)(6.2.4)(A)(i) and (ii).

(6.2.5) EGR Cooler Performance:

(A) The OBD II system shall detect a malfunction of the EGR cooler system at or prior to a reduction from the manufacturer's specified cooling performance that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(6.2.1)(A).

(B) For vehicles in which no failure or deterioration of the EGR cooler system could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(6.2.5)(A), the OBD II system shall detect a malfunction when the system has no detectable amount of EGR cooling.

(C) For purposes of determining the EGR cooler performance malfunction criteria in section (f)(6.2.5)(A) for EGR cooler systems that consist of more than one cooler (e.g., a pre-cooler and a main cooler, two or more coolers in series), the manufacturer shall submit an EGR cooler system aging and monitoring plan to the Executive Officer for review and approval. The plan shall include the description and location of each component, the monitoring strategy for each component and combination of components, and the method for determining the malfunction criteria of section (f)(6.2.5)(A) including the deterioration/aging process. Executive Officer approval of the plan shall be based on the representativeness of the aging to real world EGR cooler system component deterioration under normal and malfunctioning engine operating conditions and the effectiveness of the method used to determine the malfunction criteria of section (f)(6.2.5)(A).

(6.2.6) EGR Catalyst Performance: For catalysts located in the EGR system and used to convert constituents to reduce emissions or protect or extend the durability of other emission-related components (e.g., to reduce fouling of an EGR cooler or valve):

(A) For 2004 through 2012 model year vehicles, the catalyst shall be monitored in accordance with the other emission control or source system monitoring requirements under section (f)(16).

(B) For 2013 and subsequent model year vehicles, except as provided for in section (f)(6.2.6)(C) below, the OBD II system shall detect a malfunction when the catalyst has no detectable amount of constituent (e.g., hydrocarbons, soluble organic fractions) oxidation.

(C) ~~Monitoring of the catalyst is not required if there is no measurable emission impact on the criteria pollutants (i.e., NMHC, CO, NOx, and PM) during any reasonable driving condition in which the catalyst is most likely to affect criteria pollutants~~ EGR catalysts are exempt from this monitoring if both of the following criteria are satisfied: (1) no malfunction of the EGR catalyst can cause emissions to increase by 15 percent or more of the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle; and

(2) no malfunction of the EGR catalyst can cause emissions to exceed the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle.

(6.3) Monitoring Conditions:

(6.3.1) For malfunctions identified in sections (f)(6.2.1) and (f)(6.2.2) (i.e., EGR low and high flow) manufacturers shall:

(A) Define monitoring conditions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements) for 2004 through 2009 model year vehicles. Additionally, manufacturers shall track and report the in-use performance of the EGR system monitors under sections (f)(6.2.1) and (f)(6.2.2) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (f)(6.2.1) and (f)(6.2.2) 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)(6.3.5), ensure that monitoring is conducted continuously for all 2010 and subsequent model year vehicles.

(6.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(6.2.3) (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). Additionally, manufacturers shall track and report the in-use performance of the EGR system monitors under section (f)(6.2.3) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(6.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(6.3.3) The OBD II system shall monitor continuously for malfunctions identified in section (f)(6.2.4) (i.e., EGR feedback control).

(6.3.4) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(6.2.5) and (f)(6.2.6) (i.e., cooler performance and EGR catalyst performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the EGR system monitors under section (f)(6.2.5) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(6.2.5) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(6.3.5) Manufacturers may request Executive Officer approval to temporarily disable continuous monitoring under specific conditions technically necessary to ensure robust detection of malfunctions and to avoid false passes and false indications of malfunctions (e.g., disable EGR low flow monitoring when no or very little flow is commanded, disable EGR high and low flow monitoring 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 properly operating EGR system cannot be distinguished from a malfunctioning EGR system and that the disablement interval is limited only to that which is technically necessary.

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

(7) *Boost Pressure Control System Monitoring*

(7.1) Requirement:

(7.1.1) For 2010 and subsequent model year vehicles, the OBD II system shall monitor the boost pressure control system (e.g., turbocharger) on vehicles so-equipped for under and over boost malfunctions and slow response malfunctions. For vehicles equipped with charge air cooler systems, the OBD II system shall monitor the charge air cooler system for cooling system performance malfunctions. For 2004 and subsequent model year vehicles, 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 (f)(15).

(7.1.2) For vehicles with other charge control strategies that affect boost pressure (e.g., systems that modify boost pressure to achieve a desired air-fuel ratio instead of a desired boost pressure), 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 boost pressure control systems under section (f)(7).

(7.2) Malfunction Criteria:

(7.2.1) Underboost:

(A) The OBD II system shall detect a malfunction of the boost pressure control system at or prior to a decrease from the manufacturer's commanded or expected boost pressure that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

<u>a. For non-Low Emission Vehicle III applications:</u>

~~a.~~<u>1.</u> 2.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

~~b.~~<u>2.</u> 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

<u>b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).</u>

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx

emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2010 through 2012 model year vehicles; and

b. 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(B) For vehicles in which no failure or deterioration of the boost pressure control system that causes a decrease in boost could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(7.2.1)(A), the OBD II system shall detect a malfunction when either the boost system has reached its control limits such that it cannot increase boost to achieve the commanded boost pressure or, for non-feedback controlled boost systems, the boost system has no detectable amount of boost when boost is expected.

(7.2.2) Overboost:

(A) The OBD II system shall detect a malfunction of the boost pressure control system at or prior to an increase from the manufacturer's commanded or expected boost pressure that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(7.2.1)(A).

(B) For vehicles in which no failure or deterioration of the boost pressure control system that causes an increase in boost could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(7.2.2)(A), the OBD II system shall detect a malfunction when either the boost system has reached its control limits such that it cannot decrease boost to achieve the commanded boost pressure or, for non-feedback controlled boost systems, the boost system has maximum detectable boost when little or no boost is expected.

(7.2.3) Slow response:

(A) For 2010 through 2012 model year vehicles equipped with variable geometry turbochargers (VGT)~~,~~:

(i) ~~t~~The OBD II system shall detect a malfunction at or 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 a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in section (f)(7.2.1)(A).

(ii) For vehicles in which no failure or deterioration of the VGT system response could result in a vehicle's emissions exceeding the~~se~~ levels specified in section (f)(7.2.1)(A), the OBD II system shall detect a malfunction of the VGT system when no detectable response to a change in commanded turbocharger geometry occurs.

(B) For 2013 and subsequent model year vehicles~~,~~:

(i) ~~t~~The OBD II system shall detect a malfunction prior to any failure or deterioration in the boost pressure control system response (e.g., capability to achieve the commanded or expected boost pressure within a manufacturer-specified time) that would cause vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in section (f)(7.2.1)(A).

(ii) For vehicles in which no failure or deterioration of the boost system response could result in an engine's emissions exceeding the~~se~~ levels specified in section (f)(7.2.1)(A), the OBD II system shall detect a malfunction of the boost system when no detectable response to a commanded or expected change in boost pressure occurs.

(7.2.4) Charge Air Undercooling:

(A) The OBD II system shall detect a malfunction of the charge air cooling system at or prior to a decrease from the manufacturer's specified cooling rate that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(7.2.1)(A).

(B) For vehicles in which no failure or deterioration of the charge air cooling system that causes a decrease in cooling performance could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(7.2.4)(A), the OBD II system shall detect a malfunction when the system has no detectable amount of charge air cooling.

(C) For purposes of determining the charge air cooling performance malfunction criteria in section (f)(7.2.4)(A) for charge air cooling systems that consist of more than one cooler (e.g., a pre-cooler and a main cooler, two or more coolers in series), the manufacturer shall submit a charge air cooling system aging and monitoring plan to the Executive Officer for review and approval. The plan shall include the description and location of each component, the monitoring strategy for each component and combination of components, and the method for determining the malfunction criteria of section (f)(7.2.4)(A) including the deterioration/aging process. Executive Officer approval of the plan shall be based on the representativeness of the aging to real world charge air cooling system component deterioration under normal and malfunctioning engine operating conditions and the effectiveness of the method used to determine the malfunction criteria of section (f)(7.2.4)(A).

(7.2.5) Feedback control:

(A) Except as provided for in section (f)(7.2.5)(B), if the vehicle is equipped with feedback or feed-forward control of the boost pressure system (e.g., control of VGT position, turbine speed, manifold pressure) the OBD II system shall detect a malfunction:

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

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

(iii) If the control system has used up all of the adjustment allowed by the manufacturer or reached its maximum authority and cannot achieve the target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section

(f)(7.2.5)(A)(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 a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(7.2.5)(A)(i) and (ii) with a boost pressure system-specific monitor, the OBD II 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 (f)(7.2.5)(A)(i) and (ii).

(7.3) Monitoring Conditions:

(7.3.1) Except as provided in section (f)(7.3.4), the OBD II system shall monitor continuously for malfunctions identified in sections (f)(7.2.1), (7.2.2), and (7.2.5) (i.e., over and under boost, feedback control).

(7.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(7.2.3) (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). Additionally, ~~F~~for all 2010 and subsequent model year vehicles, manufacturers shall track and report the in-use performance of the boost pressure control system monitors under section (f)(7.2.3) in accordance with section (d)(3.2.2). ~~f~~For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(7.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(7.3.3) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(7.2.4) (i.e., charge air cooler performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the boost pressure control system monitors under section (f)(7.2.4) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(7.2.4) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(7.3.4) Manufacturers may request Executive Officer approval to temporarily disable continuous monitoring under conditions technically necessary to ensure robust detection of malfunctions and to avoid false passes and false indications of malfunctions (e.g., disable monitoring of underboost when commanded or expected boost pressure is very low). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a properly operating system cannot be distinguished

from a malfunctioning system and that the disablement interval is limited only to that technically necessary.

(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) *NOx Adsorber Monitoring*

(8.1) Requirement: The OBD II system shall monitor the NOx adsorber(s) on vehicles so-equipped for proper performance. For vehicles equipped with active/intrusive injection (e.g., in-exhaust fuel and/or air injection) to achieve desorption of the NOx adsorber(s), the OBD II 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 (f)(15).

(8.2) Malfunction Criteria:

(8.2.1) NOx adsorber capability:

(A) The OBD II system shall detect a NOx adsorber system malfunction when the NOx adsorber system capability decreases to the point that would cause a vehicle's ~~NOx or NMHC~~ emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. For non-Low Emission Vehicle III applications:

~~a.~~1. 3.0 times the applicable FTP NMHC or NOx standards for 2004 through 2009 model year vehicles;

~~b.~~2. 2.5 times the applicable FTP NMHC or NOx standards for 2010 through 2012 model year vehicles; and

~~c.~~3. 1.75 times the applicable FTP NMHC or NOx standards for 2013 and subsequent model year vehicles.

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. the applicable NOx standard by more than 0.5 g/bhp-hr (e.g., cause NOx emissions to exceed 0.7 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 3.5 times the applicable NMHC standard for 2007 through 2009 model year vehicles;

b. the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.5 times the applicable NMHC standard for 2010 through 2012 model year vehicles; and

c. the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.0 times the applicable NMHC standard for 2013 and subsequent model year vehicles.

(B) If no failure or deterioration of the NOx adsorber system capability could result in a vehicle's ~~NOx or NMHC~~ emissions exceeding the applicable malfunction criteria specified in section (f)(8.2.1)(A), the OBD II system shall detect a malfunction when the system has no detectable amount of NOx adsorber capability.

(8.2.2) 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 II 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.

(8.2.3) Feedback control:

(A) Except as provided for in section (f)(8.2.3)(B), if the vehicle is equipped with feedback or feed-forward control of the NOx adsorber or active/intrusive injection system (e.g., feedback control of injection quantity, time), the OBD II system shall detect a malfunction:

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

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

(iii) If the control system has used up all of the adjustment allowed by the manufacturer or reached its maximum authority and cannot achieve the target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(8.2.3)(A)(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 a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(8.2.3)(A)(i) and (ii) with a NOx adsorber-specific monitor, the OBD II 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 (f)(8.2.3)(A)(i) and (ii).

(8.2.4) For purposes of determining the NOx adsorber system malfunction criteria in section (f)(8.2.1) for NOx adsorber systems that consist of more than one NOx adsorber (e.g., two or more adsorbers in series), the manufacturer shall submit a system aging and monitoring plan to the Executive Officer for review and approval. The plan shall include the description 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 (f)(8.2.1) including the deterioration/aging process. Executive Officer approval of the plan shall be based on the representativeness of the aging to real world NOx adsorber system component deterioration under normal and

malfunctioning engine operating conditions, the effectiveness of the method used to determine the malfunction criteria of section (f)(8.2.1), 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 NOx adsorber system component is functioning as designed and as required in section (f)(8.2.1).

(8.3) Monitoring Conditions:

(8.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(8.2.1) (i.e., adsorber capability) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the NOx adsorber monitors under section (f)(8.2.1) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section~~s~~ (f)(8.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(8.3.2) Except as provided in section (f)(8.3.3), the OBD II system shall monitor continuously for malfunctions identified in sections (f)(8.2.2) and (8.2.3) (e.g., injection function, feedback control).

(8.3.3) Manufacturers may request Executive Officer approval to temporarily disable continuous monitoring under conditions technically necessary to ensure robust detection of malfunctions and to avoid false passes and false indications of malfunctions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a properly operating system cannot be distinguished from a malfunctioning system and that the disablement interval is limited only to that which is technically necessary.

(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) *Particulate Matter (PM) Filter Monitoring*

(9.1) Requirement: The OBD II system shall monitor the PM filter on vehicles so-equipped for proper performance. For vehicles equipped with active regeneration systems that utilize an active/intrusive injection (e.g., in-exhaust fuel injection, in-exhaust fuel/air burner), the OBD II 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 (f)(15).

(9.2) Malfunction Criteria:

(9.2.1) Filtering Performance:

(A) The OBD II system shall detect a malfunction prior to a decrease in the filtering capability of the PM filter that would cause a vehicle's ~~PM~~ emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. For non-Low Emission Vehicle III applications:

~~a.~~1. 5.0 times the applicable FTP PM standard for 2004 through 2009 model year vehicles;

~~b.~~2. 4.0 times the applicable FTP PM standard for 2010 through 2012 model year vehicles; and

~~c.~~3. 1.75 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 3 in the beginning of section (f).

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 0.09 g/bhp-hr PM as measured from an applicable cycle emission test for 2004 through 2009 model year vehicles;

b. 0.07 g/bhp-hr PM as measured from an applicable cycle emission test for 2010 through 2012 model year vehicles; and

c. 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(iii) For 2014 through 2015 model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the manufacturer shall use the malfunction criteria in section (f)(9.2.1)(A)(ii)c. above without using the provisions of section (f)(17.1) to exclude specific failure modes on vehicles under one of the following two options below:

a. At least 20 percent of 2014 model year vehicles and at least 20 percent of 2015 model year vehicles (percentage based on the manufacturer's projected California sales volume for all medium-duty diesel vehicles except MDPVs certified to a chassis dynamometer tailpipe emission standard), or

b. At least 50 percent of 2015 model year vehicles (percentage based on the manufacturer's projected California sales volume for all medium-duty diesel vehicles except MDPVs certified to a chassis dynamometer tailpipe emission standard).

(iv) For the phase-in schedules described in section (f)(9.2.1)(A)(iii) above, the manufacturer may not use an alternate phase-in schedule as defined in section (c) in lieu of the required phase-in schedules.

(B) If no failure or deterioration of the PM filtering performance could result in a vehicle's ~~PM~~ emissions exceeding the applicable malfunction criteria specified in section (f)(9.2.1)(A), the OBD II system shall detect a malfunction when no detectable amount of PM filtering occurs.

(9.2.2) Frequent Regeneration:

(A) For 2010 and subsequent model year vehicles, the OBD II system shall detect a malfunction when PM filter regeneration occurs more frequently than (i.e., occurs more often than) the manufacturer's specified regeneration frequency such that it would cause a vehicle's emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. For non-Low Emission Vehicle III applications:

~~a.~~1. 3.0 times the applicable FTP NMHC, CO, or NOx standards for 2010 through 2012 model year vehicles; and

~~b.~~2. 1.5 times the applicable FTP NMHC, CO, or NOx standards for 2013 and subsequent model year vehicles.

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 2.5 times the applicable NMHC standards or the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test for 2010 through 2012 model year vehicles; and

b. 2.0 times the applicable NMHC standards or the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(B) If no failure or deterioration causes an increase in the PM filter regeneration frequency that could result in a vehicle's ~~NMHC, CO, or NOx~~ emissions exceeding the applicable malfunction criteria specified in section (f)(9.2.2)(A), the OBD II system shall detect a malfunction when the PM filter regeneration frequency exceeds the manufacturer's specified design limits for allowable regeneration frequency.

(9.2.3) Incomplete regeneration: For 2010 and subsequent model year vehicles, the OBD II system shall detect a regeneration malfunction when the PM filter does not properly regenerate under manufacturer-defined conditions where regeneration is designed to occur.

(9.2.4) Catalyzed PM Filter:

(A) NMHC conversion: For 2015 and subsequent model year passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard and 2015 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard with catalyzed PM filters that convert NMHC emissions~~,~~:

(i) ~~t~~The OBD II 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:

a. For non-Low Emission Vehicle III applications,

1. 1.75 times the applicable FTP full useful life NMHC standards for passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard; or

2. 2.0 times the applicable NMHC standards for medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard; or

b. For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f) ~~emission levels specified in section (f)(9.2.2)(A)~~.

(ii) If no failure or deterioration of the NMHC conversion capability could result in a vehicle's ~~NMHC~~ emissions exceeding the~~se~~ emission levels specified in section (f)(9.2.4)(A)(i), the OBD II system shall detect a malfunction when the system has no detectable amount of NMHC conversion capability.

(iii) PM filters are exempt from ~~this~~ the monitoring requirements of sections (f)(9.2.4)(A)(i) and (ii) if both of the following criteria are satisfied: (1) no malfunction of the PM filter's NMHC conversion capability can cause emissions to increase by 15 percent or more of the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle; and (2) no malfunction of the PM filter's NMHC conversion capability can cause emissions to exceed the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle.

(B) Feedgas generation: For 2016 and subsequent model year medium-duty vehicles (except MDPVs certified to a chassis dynamometer tailpipe emission standard) and 2019 and subsequent model year passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard with catalyzed PM filters used to generate a feedgas constituency to assist SCR systems (e.g., to increase NO_2 concentration upstream of an SCR system), the OBD II system shall detect a malfunction when the system is unable to generate the necessary feedgas constituents for proper SCR system operation. Catalyzed PM filters are exempt from this monitoring if both of the following criteria are satisfied: (1) no malfunction of the catalyzed PM filter's feedgas generation ability can cause emissions to increase by 15 percent or more of the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle; and (2) no malfunction of the catalyzed PM filter's feedgas generation ability can cause emissions to exceed the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle.

(9.2.5) Missing substrate: The OBD II 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.

(9.2.6) 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 II 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.

(9.2.7) Feedback Control:

(A) Except as provided for in section (f)(9.2.7)(B), if the vehicle is equipped with feedback or feed-forward 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 II system shall detect a malfunction:

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

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

(iii) If the control system has used up all of the adjustment allowed by the manufacturer or reached its maximum authority and cannot achieve the target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(9.2.7)(A)(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 a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(9.2.7)(A)(i) and (ii) with a PM filter-specific monitor, the OBD II 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 (f)(9.2.7)(A)(i) and (ii).

(9.3) Monitoring Conditions:

(9.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section~~s~~ (f)(9.2.1) ~~through (9.2.6)~~ in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements)~~, with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2)~~. Additionally, ~~F~~for all 2010 and subsequent model year vehicles, manufacturers shall track and report the in-use performance of the PM filter monitors under section (f)(9.2.1) in accordance with section (d)(3.2.2). ~~f~~For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(9.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(9.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(9.2.2) through (9.2.6) 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).

~~(9.3.2)~~(9.3.3) Except as provided in section (f)(9.3.~~3~~4), the OBD II system shall monitor continuously for malfunctions identified in section (f)(9.2.7) (i.e., PM filter feedback control).

~~(9.3.3)~~(9.3.4) Manufacturers may request Executive Officer approval to temporarily disable continuous monitoring under conditions technically necessary to ensure robust detection of malfunctions and to avoid false passes and false indications of malfunctions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a properly operating system cannot be distinguished from a malfunctioning system and that the disablement interval is limited only to that which is technically necessary.

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

(10) *Crankcase Ventilation (CV) System Monitoring*

(10.1) Requirement: Manufacturers shall monitor the CV system on vehicles so-equipped for system integrity. Vehicles not subject to crankcase emission control requirements shall be exempt from monitoring of the CV system.

(10.2) Malfunction Criteria:

(10.2.1) For the purposes of section (f)(10), "CV system" is defined as any form of crankcase ventilation system, regardless of whether it utilizes positive pressure or whether it vents to the atmosphere, the intake, or the exhaust. "CV valve" is defined as any form of valve, orifice, or filter/separator used to restrict, control, or alter the composition (e.g., remove oil vapor or particulate matter) of the 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 (f)(10.2.2) or (f)(10.2.3) below.

(10.2.2) For all 2004 through 2024 model year vehicles, the following criteria apply for CV system monitoring:

(A) Except as provided in sections (f)(10.2.2)(B) through (F) below, the OBD II 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 ducting.

~~(10.2.3)~~(B) If disconnection in the system results in a rapid loss of oil or other overt indication of a CV system malfunction such that the vehicle operator is certain to respond and have the vehicle repaired, the Executive Officer shall exempt the manufacturer from detection of that disconnection.

~~(10.2.4)~~(C) Detection of a disconnection is not required if the disconnection cannot be made without first disconnecting a monitored portion of the system (e.g., 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 before disconnecting the line between the valve and the intake ducting (taking aging effects into consideration) and the line between the valve and the intake ducting is monitored for disconnection).

~~(10.2.5)~~(D) Subject to Executive Officer approval, system designs that utilize tubing between the valve and the crankcase shall also be exempted from the monitoring requirement for detection of disconnection between the crankcase and the CV valve. The manufacturer shall file a request and submit data and/or engineering evaluation in support of the request. The Executive Officer shall approve the request upon determining that the connections between the valve and the crankcase are: (i) resistant to deterioration or accidental disconnection, (ii) significantly more difficult to disconnect than the line between the valve and the intake ducting, and (iii) not subject to disconnection per manufacturer's maintenance, service, and/or repair procedures for non-CV system repair work.

~~(10.2.6)~~(E) Manufacturers are not required to detect disconnections that are unlikely to occur due to a CV system design that is integral to the induction system or to the engine (e.g., internal machined passages rather than tubing or hoses).

~~(10.2.7)~~(F) For medium-duty vehicles with engines certified on an engine dynamometer having an open CV system (i.e., a system that releases crankcase emissions to the atmosphere without routing them to the intake ducting or to the exhaust upstream of the aftertreatment), 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 (i) monitor the performance of the CV system to the extent feasible with respect to the malfunction criteria in section (f)(10.2.1) through (f)(10.2.4) and the monitoring conditions required by the diagnostic, and (ii) monitor the ability of the CV system to control crankcase vapor emitted to the atmosphere relative to the manufacturer's design and performance specifications for a properly functioning system (e.g., if the system is equipped with a filter and/or separator to reduce crankcase emissions to the atmosphere, the OBD II system shall monitor the integrity of the filter and/or function of the separator).

(10.2.3) For all 2025 and subsequent model year vehicles, the following criteria apply for CV system monitoring:

(A) Except as provided below, the OBD II system shall detect a CV system malfunction of any hose, tube, or line that transports crankcase vapors when the system contains a disconnection or break equal to or greater than the smallest internal cross-sectional area of that hose, tube, or line. For the purposes of section (f)(10.2.3), "external hose, tubing, or line" includes any fittings that are used for connection such as nipples or barbs that the hoses must be placed over for proper attachment.

(B) Manufacturers are not required to detect disconnections or breaks of any CV system hose, tube, or line if said disconnection or break (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); (3) results in a rapid loss of oil or other overt indication of a CV system malfunction such

that the vehicle operator is certain to respond and have the vehicle repaired; or (4) occurs downstream of where the crankcase vapors are delivered to the air intake system.

(C) For medium-duty vehicles with engines certified on an engine dynamometer having an open CV system (i.e., a system that releases crankcase emissions to the atmosphere without routing them to the intake ducting or to the exhaust upstream of the aftertreatment), 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 (i) monitor the performance of the CV system to the extent feasible with respect to the malfunction criteria in sections (f)(10.2.3)(A) and (B) and the monitoring conditions required by the diagnostic, and (ii) monitor the ability of the CV system to control crankcase vapor emitted to the atmosphere relative to the manufacturer's design and performance specifications for a properly functioning system (e.g., if the system is equipped with a filter and/or separator to reduce crankcase emissions to the atmosphere, the OBD II system shall monitor the integrity of the filter and/or function of the separator).

(10.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(10.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(10.4) 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 EGR or intake air mass flow rationality ~~monitoring~~ faults can be stored) if the manufacturer demonstrates that additional monitoring hardware would be necessary to make this identification and provided that the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the CV system.

(11) *Engine Cooling System Monitoring*

(11.1) Requirement:

(11.1.1) The OBD II system shall monitor the thermostat on vehicles so-equipped for proper operation.

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

(11.1.3) For vehicles equipped with a component other than a thermostat that regulates the ECT (e.g., electric water pump), the manufacturer shall submit a monitoring plan to the Executive Officer for approval. The Executive Officer shall approve the plan 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 requirements specified for the thermostat under section (f)(11).

(11.1.4) Vehicles that use an engine and/or engine component temperature sensor or system (e.g. oil temperature sensor, cylinder head temperature

sensor) in lieu of or in addition to the cooling system and ECT sensor for an indication of engine operating temperature for emission control purposes (e.g., to modify fuel injection timing or quantity), the following requirements shall apply:

(A) For vehicles that use an engine and/or engine component temperature sensor or system in lieu of the cooling system and ECT sensor, 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 (f)(11).

(B) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles that use an engine and/or engine component temperature sensor or system in addition to the cooling system and ECT sensor (including systems that use more than one thermostat or flow control device to regulate different temperatures in different cooling circuits and use input from at least two temperature sensors in separate cooling circuits for an indication of engine operating temperatures for emission control purposes), 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 (f)(11).

(11.2) Malfunction Criteria:

(11.2.1) Thermostat

(A) The OBD II system shall detect a thermostat malfunction (e.g., leaking or early-to-open thermostat) if, within an Executive Officer approved time interval or time-equivalent calculated value after starting the engine, either of the following two conditions occur:

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

(ii) The coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit (or 11.1 degrees Celsius) 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, injection 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.

(B) For 2013 and subsequent model year vehicles, the OBD II system shall detect a thermostat fault if, after the coolant temperature has reached the temperatures indicated in sections (f)(11.2.1)(A)(i) and (ii), the coolant temperature drops below the temperature indicated in section (f)(11.2.1)(A)(i).

(C) Executive Officer approval of the time interval or time-equivalent calculated value after engine start under section (f)(11.2.1)(A) above shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times.

(D) For monitoring of malfunctions under section (f)(11.2.1)(A) and (B), with Executive Officer approval, a manufacturer may use alternate malfunction criteria and/or monitoring conditions (see section (f)(11.3)) that are a function of temperature at engine start on vehicles that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data that demonstrate that a properly operating system does not reach the specified temperatures, that the monitor is capable of meeting the specified malfunction criteria at engine start temperatures greater than 50 degrees Fahrenheit (or 10 degrees Celsius), and that the overall effectiveness of the monitor is comparable to a monitor meeting these thermostat monitoring requirements at lower temperatures.

(E) A manufacturer may request Executive Officer approval to be exempted from the requirements of thermostat monitoring under sections (f)(11.2.1)(A) and (B)~~With Executive Officer approval, manufacturers may omit this monitor~~. 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.

(11.2.2) ECT Sensor

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

(B) Time to Reach ~~Closed-Loop~~ Enable Temperature for Emission Control Strategies.

(i) The OBD II system shall detect a malfunction if the ECT sensor does not achieve the highest stabilized minimum temperature which is needed to begin closed-loop, ~~or~~ feedback, or feed-forward operation of all emission~~-related engine~~ control~~s~~ strategies (e.g., feedback control of fuel pressure, EGR flow, boost pressure) within an Executive Officer approved time interval after ~~starting the~~ engine start. ~~The time interval shall be a function of starting ECT and/or a function of intake or ambient temperature.~~

(ii) The time interval shall be a function of starting ECT and/or a function of intake or ambient 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) The Executive Officer shall exempt manufacturers from the requirement of section (f)(11.2.2)(B) if the manufacturer does not utilize ECT to enable closed loop, ~~or~~ feedback, or feed-forward operation of any emission~~-related engine~~ control~~s~~ strategies.

(C) Stuck in Range Below the Highest Minimum Enable Temperature. To the extent feasible when using all available information, the OBD II system

shall detect a malfunction if the ECT sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be greater than 140 degrees Fahrenheit to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature below 140 degrees Fahrenheit). Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (f)(11.2.1) or (f)(11.2.2)(B) will detect ECT sensor malfunctions as defined in section (f)(11.2.2)(C).

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

(i) To the extent feasible when using all available information, the OBD II system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be less than 90 degrees Fahrenheit at engine start to enable a diagnostic must detect malfunctions that cause the ECT sensor to 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 (f)(11.2.1), (f)(11.2.2)(B), or (f)(11.2.2)(C) (i.e., ECT sensor or thermostat malfunctions) will detect ECT sensor malfunctions as defined in section (f)(11.2.2)(D) or in which the MIL will be illuminated under the requirements of section (d)(2.2.3) for default mode operation (e.g., overtemperature protection strategies).

(iii) For 2006 and subsequent model year applications, manufacturers are also exempted from the requirements of section (f)(11.2.2)(D) for temperature regions where the temperature gauge indicates a temperature in the red zone (engine overheating zone) or an overtemperature warning light is illuminated for vehicles that have a temperature gauge or warning light on the instrument panel and utilize the same ECT sensor for input to the OBD II system and the temperature gauge/warning light.

(11.3) Monitoring Conditions:

(11.3.1) Thermostat

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(11.2.1)(A) in accordance with section (d)(3.1) except as provided for in section (f)(11.3.1)(E). Additionally, except as provided for in sections (f)(11.3.1)(~~B~~C) ~~and~~ through (~~C~~E), monitoring for malfunctions identified in section (f)(11.2.1)(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 (f)(11.2.1)(A).

(B) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(11.2.1)(B) in accordance with section (d)(3.1) 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.

(C) Manufacturers may disable thermostat monitoring at ambient temperatures below 20 degrees Fahrenheit (or -6.7 degrees Celsius).

(D) Manufacturers may request Executive Officer approval to suspend or disable thermostat monitoring required under sections (f)(11.2.1)(A) and (B) if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 percent of the warm-up time, ~~hot restart conditions, etc.~~engine block heater operation). With respect to disablement on driving cycles solely due to warm ECT at engine start conditions for thermostat monitoring under section (f)(11.2.1)(A), the manufacturer shall disable the monitor during driving cycles where the ECT at engine start is within 35 degrees Fahrenheit (or 19.4 degrees Celsius) of the thermostat malfunction threshold temperature determined under section (f)(11.2.1)(A) (e.g., if the malfunction threshold temperature is 160 degrees Fahrenheit, the monitor shall be disabled if the ECT at engine start is above 125 degrees Fahrenheit)~~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 (f)(11.2.1)(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~~.

(E) Notwithstanding section (f)(11.3.1)(D), manufacturers may request Executive Officer approval to enable thermostat monitoring required under section (f)(11.2.1)(A) during a portion of the driving cycles where the ECT at engine start is warmer than 35 degrees Fahrenheit (or 19.4 degrees Celsius) below the thermostat malfunction threshold temperature determined under section (f)(11.2.1)(A) (e.g., if the malfunction threshold temperature is 160 degrees Fahrenheit, the manufacturer may request approval to have the monitor enabled for a portion of the ECT at engine start region between 125 and 160 degrees Fahrenheit). The Executive Officer shall approve the request upon determining that the manufacturer has submitted test data and/or engineering evaluation that demonstrate that the monitor is able to robustly detect thermostat malfunctions (e.g., cannot result in false passes or false indications of malfunctions) on driving cycles where it is enabled.

~~(E)~~(F) With respect to defining enable conditions that are encountered during the FTP or Unified cycle as required in (d)(3.1.1) for malfunctions identified in section (f)(11.2.1)(A), the FTP cycle shall refer to on-road driving following the FTP cycle in lieu of testing on a chassis or engine dynamometer.

(11.3.2) ECT Sensor

(A) Except as provided below in section (f)(11.3.2)(E), monitoring for malfunctions identified in section (f)(11.2.2)(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 (f)(11.2.2)(B) in accordance with section (d)(3.1). Additionally, except as provided for in section (f)(11.3.2)(D), monitoring for

malfunctions identified in section (f)(11.2.2)(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 (f)(11.2.2)(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(s) required to detect malfunctions specified under section (f)(11.2.2)(B) 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.

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

(12) *Cold Start Emission Reduction Strategy Monitoring*

(12.1) Requirement:

(12.1.1) For all 2010 and subsequent model year vehicles~~, if a vehicle~~ that incorporate~~s~~ a specific engine control strategy to reduce cold start emissions, the OBD II system shall monitor the ~~system~~ strategy to verify ~~the strategy~~that it achieves the desired effect (e.g., to achieve accelerated catalyst light-off temperature) and monitor the commanded elements/components for proper function (e.g., injection timing, increased engine idle speed, increased engine load via intake or exhaust throttle activation) while the control strategy is active to ensure proper operation of the control strategy.

(12.1.2) For an element/component associated with the cold start emission reduction control strategy under section (f)(12) that is also required to be monitored elsewhere in section (f) (e.g., fuel injection timing), the manufacturer shall use different diagnostics to distinguish faults detected under section (f)(12) (i.e., faults associated with the cold start strategy) from faults detected under sections other than section (f)(12) (i.e., faults not associated with the cold start strategy).

(12.2) Malfunction Criteria: The OBD II system shall, to the extent feasible, detect a malfunction if either of the following occurs:

(12.2.1) Any single commanded element/component does not properly respond to the commanded action while the cold start strategy is active. For

purposes of this section, “properly respond” is defined as when the element responds:

(A) by a robustly detectable amount by the monitor; and

(B) in the direction of the desired command; and

(C) above and beyond what the element/component would achieve on start-up without the cold start strategy active (e.g., if the cold start strategy commands a higher idle engine speed, a fault must be detected if there is no detectable amount of engine speed increase above what the system would achieve without the cold start strategy active);

(12.2.2) Any failure or deterioration of the cold start emission reduction control strategy while the cold start strategy is active that would cause a vehicle’s NMHC, CO, NOx, or PM emissions to exceed:

(A) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

(i) For non-Low Emission Vehicle III applications:

~~(i)~~a. 2.5 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

~~(ii)~~b. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

(ii) For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(B) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

(i) 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(12.2.3) For section (f)(12.2.2):

(A) For 2010 through 2012 model year vehicles, the OBD II system shall either monitor the combined effect of the elements of the system as a whole or the individual elements (e.g., increased engine speed, increased engine load from restricting an exhaust throttle) for failures that cause emissions to exceed the applicable emission levels specified in section (f)(12.2.2).

(B) For 2013 and subsequent model year vehicles, to the extent feasible (without adding hardware for this purpose), the OBD II system shall monitor the ability of the system to achieve the desired effect (e.g., strategies used to accelerate catalyst light-off by increasing catalyst inlet temperature shall verify the catalyst inlet temperature actually achieves the desired temperatures within an Executive Officer approved time interval after starting the engine) for failures that cause emissions to exceed the applicable emission levels specified in section (f)(12.2.2). For strategies where it is not feasible to be monitored as a system, the OBD II system shall monitor the individual elements/components (e.g., increased

engine speed, increased engine load from restricting an exhaust throttle) for failures that cause emissions to exceed the applicable emission levels specified in section (f)(12.2.2).

(12.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(12.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

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

(13) *Variable Valve Timing, Lift, And/Or Control (VVT) System Monitoring*

(13.1) Requirement: On all 2006 and subsequent model year applications, the OBD II system shall monitor the VVT system on vehicles so-equipped for target error and slow response malfunctions. Manufacturers must perform a comprehensive failure modes and effects analysis for every reasonable hydraulic or mechanical failure (e.g., partial or complete blockage of hydraulic passages, broken return springs, a failure of a single cylinder-specific pin to move into the desired position on a lift mechanism) to identify target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors, etc.) that are used in the VVT system shall be monitored in accordance with the comprehensive components requirements in section (f)(15).

(13.2) Malfunction Criteria:

(13.2.1) Target Error: The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle or lift tolerance that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the emission thresholds in sections (f)(13.2.1)(A) or (B) below. Systems with discrete operating states (e.g., two step valve train systems) are not required to detect a malfunction prior to exceeding the threshold but are required to detect all failures that exceed the threshold.:

(A) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard, the threshold is:

(i) For non-Low Emission Vehicle III applications:

(i)a. 3.0 times the applicable FTP standards for 2006 through 2009 model year vehicles;

(ii)b. 2.5 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

(iii)c. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

(ii) For Low Emission Vehicle III applications, any of the applicable NMOG+NOx, CO, or PM emission thresholds set forth in Table 2 in the beginning of section (f).

(B) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the threshold is:

(i) 1.5 times the applicable NMHC, CO, and NOx standards or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2006 and subsequent model year vehicles certified to an engine

dynamometer tailpipe NOx emission standard of greater than 0.50 g/bhp-hr NOx;

(ii) 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2006 through 2012 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx; and

(iii) 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx.

(13.2.2) Slow Response: The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a time that would cause a vehicle's emissions to exceed the applicable emission levels specified in sections (f)(13.2.1). Systems with discrete operating states are not required to detect a malfunction prior to exceeding the threshold but are required to detect all failures that exceed the threshold.

(13.2.3) For vehicles in which no failure or deterioration of the VVT system could result in a vehicle's emissions exceeding the levels specified in sections (f)(13.2.1), the VVT system shall be monitored for proper functional response in of the electronic components accordance with the malfunction criteria in section (f)(15.2).

(13.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for VVT system malfunctions identified in section (f)(13.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). Additionally, manufacturers shall track and report the in-use performance of the VVT system monitors ~~performance~~ under section (f)(13.2) in accordance with section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(13.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

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

(14) ~~[RESERVED]~~*Air Conditioning (A/C) System Component Monitoring*

(14.1) Requirement: On all 2019 and subsequent model year Low Emission Vehicle III applications, if a vehicle incorporates an engine control strategy that is altered when the A/C system is on, the OBD II system shall monitor all

electronic air conditioning system components for malfunctions that cause the system to fail to invoke the alternate control while the A/C system is on or cause the system to invoke the alternate control while the A/C system is off. Additionally, the OBD II system shall monitor for malfunction all electronic air conditioning system components that are used as part of the diagnostic strategy for any other monitored system or component. As applicable, the A/C system shall also be subject to the comprehensive component monitoring requirements in section (f)(15.2.3)(B).

(14.2) Malfunction Criteria:

(14.2.1) The OBD II system shall detect a malfunction prior to any failure or deterioration of an electronic component of the air conditioning system that would cause a vehicle's emissions to exceed any of the applicable emission thresholds set forth in Table 2 in the beginning of section (f) or would, through software, effectively disable any other monitored system or component covered by this regulation. For malfunctions that result in the alternate control being erroneously invoked while the A/C system is off, the appropriate emission standards shall be the FTP standards. For malfunctions that result in the alternate control failing to be invoked while the A/C system is on, the appropriate emission standards shall be the SC03 emission standards.

(14.2.2) If no single electronic component failure or deterioration causes emissions to exceed the emission thresholds as defined above in section (f)(14.2.1) nor is used as part of the diagnostic strategy for any other monitored system or component, manufacturers are not required to monitor any air conditioning system component for purposes of section (f)(14).

(14.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(14.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

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

(15) *Comprehensive Component Monitoring*

(15.1) Requirement:

(15.1.1) Except as provided in sections (f)(15.1.3), (f)(15.1.4), (f)(15.1.5), and (f)(16), the OBD II system shall monitor for malfunction any electronic powertrain component/system not otherwise described in sections (f)(1) through (f)(14) that either provides input to (directly or indirectly) or receives commands from ~~the~~ an on-board computer~~(s)~~ or smart device, and: (1) can affect emissions as determined by the criteria in section (f)(15.1.2) ~~during any reasonable in-use driving condition~~, ~~or~~ (2) is used as part of the diagnostic strategy for any other monitored system or component, or (3) is used as part of an inducement strategy on 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year diesel vehicles. Each input to or output from a smart device that meets criterion (1), (2), or (3) above shall be monitored pursuant to section (f)(15). Further detection or pinpointing of faults

internal to the smart device is not required. If the vehicle compensates or adjusts for deterioration or malfunction of the component/system, manufacturers may not use the criteria under section (f)(15.1.2) and are instead subject to the default action requirements of section (d)(2.2.3) or (f)(15.4.5) as applicable.

(A) Input Components: Input components required to be monitored may include the vehicle speed sensor, crank angle sensor, pedal position sensor, mass air flow sensor, cam position sensor, fuel pressure sensor, intake air temperature sensor, exhaust temperature sensor, and transmission electronic components such as sensors, modules, and solenoids which provide signals to the powertrain control system.

(B) Output Components/Systems: Output components/systems required to be monitored may include the idle governor, fuel injectors, automatic transmission solenoids or controls, turbocharger electronic components, the wait-to-start lamp, and cold start aids (e.g., glow plugs, intake air heaters).

(15.1.2) For purposes of criteria (1) in section (f)(15.1.1) above, the manufacturer shall determine whether a powertrain input or output component/system can affect emissions when operating without any control system compensation or adjustment for deterioration or malfunction based on the following: (1) for 2004 through 2017 model year vehicles, the manufacturer shall use the criteria in section (f)(15.1.2)(G); and (2) for 2018 and subsequent model year vehicles, the manufacturer shall use the criteria in sections (f)(15.1.2) (A) through (F). ~~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. The Executive Officer may request emission data for any reasonable driving condition.~~

(A) The OBD II system shall monitor an electronic powertrain component or system in accordance with the monitoring requirements of section (f)(15) if any condition (e.g., deterioration, failure) of the component or the system could cause:

(i) Vehicle emissions to exceed any applicable standard, or

(ii) An increase in vehicle emissions greater than 15 percent of the standard on the following test cycles: FTP test, 50°F FTP, HWFET, SC03, US06 cycle, Unified cycle. The emissions impact of the failure shall be determined by taking the mean of three or more emission measurements on a vehicle aged to represent full useful life with the component or system malfunctioning compared to the same testing without a malfunction present.

a. For cycles without standards (e.g., Unified cycle), 15 percent of the SFTP Composite Emission Standard shall be used.

b. Additionally, if function of the component or system would not necessarily occur during any of the test cycles specified (e.g., global positioning system components that control engine start/stop operation based on battery state of charge, cruise control), the

manufacturer shall request Executive Officer approval of an added alternate test cycle or vehicle operating conditions for which the emission increase will also be evaluated. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the testing conditions proposed represent in-use driving conditions under which the component or system will function and where emissions are likely to be most affected by the malfunctioning component. The component or system is required to meet the monitoring requirements under section (f)(15) if any condition (e.g., deterioration, failure) of the component or the system could cause an increase in vehicle emissions greater than 15 percent of SFTP Composite Emission Standard.

(B) Manufacturers that have determined that a component or system is not subject to monitoring because a malfunction would not cause emissions to exceed the criteria specified in section (f)(15.1.2)(A) above shall demonstrate for purposes of OBD II system approval that the criteria are satisfied by meeting the requirements in either section (f)(15.1.2)(B)(i) or (f)(15.1.2)(B)(ii) below:

(i) The manufacturer shall conduct an engineering evaluation demonstrating that no malfunction of the component/system could cause an increase in vehicle emissions greater than 15 percent of the standard on any of the test cycles listed in section (f)(15.1.2)(A) above, or

(ii) The manufacturer shall meet the following testing requirements:

a. The manufacturer shall conduct an FTP test with the component or system malfunctioning, and provide test data to show that no applicable standard has been exceeded, and

b. The manufacturer shall conduct testing using the component condition causing the largest emission impact during the worst case test cycle or in-use driving condition specified in section (f)(15.1.2)(A)(ii) (as determined by the manufacturer based on sound engineering judgment), and provide test data to show that the difference between the mean emission values do not exceed 15 percent of any standard.

(iii) The Executive Officer may request one additional test cycle for either section (f)(15.1.2)(B)(i) or (ii) above if the Executive Officer reasonably believes, based on the component being tested, that the engineering evaluation is insufficient or the cycle chosen by the manufacturer was not the worst case for demonstration of the malfunction.

(C) Notwithstanding successfully demonstrating that no malfunction would cause emissions to exceed the criteria specified in section (f)(15.1.2)(A)(ii) under the manufacturer-selected worst case test cycle, the manufacturer's determination that the component or system is not subject to monitoring under section (f)(15) is subject to Executive Officer review. If additional testing under any of the other conditions specified in section (f)(15.1.2)(A)(ii) demonstrate that the component or system meets the criteria of that section (i.e., that the component or system can affect

emissions), the ARB may deny certification of test groups for which the component or system is not monitored by the OBD II system, and any vehicles produced with OBD II systems that do not monitor the component or system are subject to corrective action, up to and including recall.

(D) For purposes of verifying a manufacturer's determination that a component or system does not affect emissions under section (f)(15.1.2)(A), within six weeks of a request by the Executive Officer, the manufacturer shall make available all test equipment (e.g. malfunction simulators, deteriorated components) used to for the demonstration conducted pursuant to section (f)(15.1.2)(B) above.

(E) Components described in sections (f)(1) through (f)(14) (including components described in sections (f)(1) through (f)(14) that are required to meet the monitoring requirements of section (f)(15)) may not be exempted from any of the monitoring requirements of sections (f)(1) through (f)(15) regardless of any demonstration of compliance with the criteria specified in section (f)(15.1.2)(A).

(F) For 2018 and 2019 model year vehicles carried over from 2017 or earlier model year vehicles, a component/system is determined to not affect emissions and the manufacturer is not required to use the criteria in sections (f)(15.1.2)(A) through (E) if the Executive Officer determined that the component/system does not affect emissions on the vehicles in question in the 2017 or earlier model year in accordance with section (f)(15.1.2)(G).

(G) For 2004 through 2017 model year vehicles, in lieu of the criteria in sections (f)(15.1.2)(A) through (E) above, the manufacturer shall determine whether a powertrain input or output component/system can affect emissions during any reasonable in-use driving condition. 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. The Executive Officer may request emission data for any reasonable driving condition. Alternatively, for 2017 model year vehicles, manufacturers may use the criteria in sections (f)(15.1.2)(A) through (E) in lieu of the criteria stated above in section (f)(15.1.2)(G).

(15.1.3) A manufacturer may request Executive Officer approval to exempt safety-only components or systems from the monitoring requirements of section (f)(15). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the component or system (1) meets the definition of a "safety-only component or system" in section (c), and (2) is not used as part of the diagnostic strategy for any other monitored system or component.

~~(15.1.3)~~(15.1.4) Manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with an electronic transfer case, electronic power steering system, two speed axle, or other components that are driven by the engine and not related to the control of

fueling, air handling, or emissions only if the component or system is used as part of the diagnostic strategy for any other monitored system or component.

~~(15.1.4)~~(15.1.5) Except as specified for hybrid~~s~~ vehicles in section (f)(15.1.~~5~~6), manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with components that only affect emissions by causing additional electrical load to the engine and are not related to the control of fueling, air handling, or emissions only if the component or system is used as part of the diagnostic strategy for any other monitored system or component.

~~(15.1.5)~~(15.1.6) For hybrid~~s~~ vehicles, manufacturers shall submit a plan to the Executive Officer for approval of the hybrid components determined by the manufacturer to be subject to monitoring in section (f)(15.1.1). In general, the Executive Officer shall approve the plan if it includes monitoring of all components/systems that affect emissions or are used as part of the diagnostic strategy for any other monitored system or component, monitoring of all energy input devices to the electrical propulsion system, monitoring of battery and charging system performance, monitoring of electric motor performance, and monitoring of regenerative braking performance. For 2019 and subsequent model year mild hybrid electric, strong hybrid electric, and plug-in hybrid electric vehicles , manufacturers are subject to the applicable requirements specified in (f)(15.2.3).

(15.2) Malfunction Criteria:

(15.2.1) Input Components:

(A) The OBD II system shall detect malfunctions of input components caused by ~~a lack of~~ circuit ~~continuity~~ faults (or for digital inputs, lack of communication to the on-board computer), out-of-range values, and, where feasible, rationality faults. To the extent feasible, the rationality fault diagnostics shall verify that a sensor output is neither inappropriately high nor inappropriately low (e.g., “two-sided” diagnostics).

(B) ~~To the extent feasible,~~ Except for input components monitored solely by emissions neutral diagnostics, rationality faults shall be separately detected and store different fault codes than the respective ~~lack of~~ circuit ~~continuity~~ fault and out of range diagnostics. Two-sided rationality diagnostics are not required to set separate fault codes for each side. Additionally:~~,~~

(i) For computer encoded digital inputs: lack of communication from the input to the on-board computer shall be separately detected and store a separate fault code. Separate fault codes are not required for each distinct out-of-range fault.

(ii) For all other inputs: component ~~lack of~~ circuit ~~continuity~~ and out of range faults shall be separately detected and store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit, etc.). Notwithstanding, ~~M~~manufacturers are not required to store separate fault codes for lack of circuit continuity faults that cannot be distinguished from other out-of-range ~~circuit~~ faults. For sensors that are fixed to a circuit board within a diagnostic

or emission critical control unit, as defined in section (c), manufacturers may combine circuit and out-of-range value faults into a single fault code that identifies the malfunctioning sensor.

(C) For input components that are directly or indirectly used for any emission control strategies that are not covered under sections (f)(1) through (f)(13) (e.g., exhaust temperature sensors used for a control strategy that regulates SCR catalyst inlet temperature within a target window), the OBD II system shall detect rationality malfunctions that prevent the component from correctly sensing any condition necessary for the strategy to operate in its intended manner. These malfunctions include faults that inappropriately prevent or delay the activation of the emission control strategy, cause the system to erroneously exit the emission control strategy, or where the control strategy has used up all of the adjustments or authority allowed by the manufacturer and is still unable to achieve the desired condition. The Executive Officer may waive detection of specific malfunctions upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that reliable detection of the malfunction is technically infeasible or would require additional hardware.

(15.2.2) Output Components/Systems:

(A) The OBD II system shall detect a malfunction of an output component/system when proper functional response of the component and system to computer commands does not occur. If a functional check is not feasible, the OBD II system shall detect malfunctions of output components/systems caused by a lack of circuit continuity or circuit fault (e.g., short to ground or high voltage), or communication errors or the lack of communication if the signal to the output component is digital. For output component lack of circuit continuity faults and circuit faults, manufacturers are not required to store different fault codes for each distinct malfunction (e.g., open circuit, shorted low, etc.). Manufacturers are not required to activate an output component/system when it would not normally be active for the purposes of performing a functional ~~monitoring~~ check of the output component~~s~~/system~~s~~ as required in section (f)(15).

(B) The idle fuel control system shall be monitored for proper functional response to computer commands. A malfunction shall be detected when any of the following conditions occur:

(i) The idle control system cannot achieve or maintain the idle speed within +/- 30 percent of the manufacturer-specified target or desired engine speed.

(ii) The idle control system cannot achieve the target idle speed within the smallest engine speed tolerance range required by the OBD II system to enable any other monitor.

(iii) For 2013 and subsequent model year vehicles, the idle control system cannot achieve the fuel injection quantity within the smallest fueling quantity tolerance range required by the OBD II system to enable any other monitor.

(iv) For 2013 and subsequent model year vehicles, the idle control system cannot achieve the target idle speed with a fuel injection quantity within +/-50 percent of the fuel quantity necessary to achieve the target idle speed for a properly functioning vehicle and the ~~given~~ known operating conditions.

(C) Glow plugs/intake air heaters shall be monitored for proper functional response to computer commands. 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. If a manufacturer demonstrates that a single glow plug failure cannot cause a measurable increase in emissions during any reasonable driving condition, the manufacturer shall detect a malfunction for the minimum number of glow plugs needed to cause an emission increase. Further, to the extent feasible on existing engine designs (without adding additional hardware for this purpose) and on all new design engines, the stored fault code shall identify the specific malfunctioning glow plug(s). For 2010 and subsequent model year vehicles, manufacturers shall detect a malfunction when a single glow plug/intake air heater no longer operates within the manufacturer's specified limits for normal operation (e.g., within specifications established by the manufacturer with the part supplier for acceptable part performance at high mileage).

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

(E) For output components/systems that are directly or indirectly used for any emission control strategies that are not covered under sections (f)(1) through (f)(13) (e.g., an intake throttle used for a control strategy that adjusts intake throttle position to regulate SCR catalyst inlet temperature within a target window), the OBD II system shall detect functional malfunctions that prevent the component/system from achieving the desired functional response necessary for the strategy to operate in its intended manner. These malfunctions include faults that inappropriately prevent or delay the activation of the emission control strategy, cause the system to erroneously exit the emission control strategy, or where the control strategy has used up all of the adjustments or authority allowed by the manufacturer and is still unable to achieve the desired condition. The Executive Officer may waive detection of specific malfunctions upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that reliable detection of the malfunction is technically infeasible or would require additional hardware.

(F) For 2015 and subsequent model year vehicles that utilize fuel control system components (e.g., injectors, fuel pump) that have tolerance compensation features implemented in hardware or software during production or repair procedures (e.g., individually coded injectors for flow characteristics that are programmed into an electronic control unit to compensate for injector to injector tolerances, fuel pumps that use in-line

resistors to correct for differences in fuel pump volume output), the components shall be monitored to ensure the proper compensation is being used.

(i) The system shall detect a fault if the compensation being used by the control system does not match the compensation designated for the installed component (e.g., the flow characteristic coding designated on a specific injector does not match the compensation being used by the fuel control system for that injector). If a manufacturer demonstrates that a single component (e.g., injector) using the wrong compensation cannot cause a measurable increase in emissions during any reasonable driving condition, the manufacturer shall detect a malfunction for the minimum number of components using the wrong compensation needed to cause an emission increase. ~~Further~~To the extent feasible, the stored fault code shall identify the specific component(s) for which the control system is using the wrong ~~that does not match the~~ compensation.

(ii) Monitoring of the fuel control system components under section (f)(15.2.2)(F)(i) is not required if the manufacturer demonstrates that both of the following criteria are satisfied: (1) no fault of the components' tolerance compensation features (e.g., wrong compensation being used) could cause emissions to increase by 15 percent or more of the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle; and (2) no fault of the components' tolerance compensation features could cause emissions to exceed the applicable full useful life NMHC, NOx (or NMOG+NOx, if applicable), CO, or PM standard as measured from an applicable emission test cycle. For purposes of determining if the emission criteria above are met, the manufacturers shall request Executive Officer approval of the test plan for which the emission impact will be determined. The test plan shall include the worst case component or combination of failed components and the degree of mismatch (e.g., wrong compensation) used as well as the test procedure and emission test cycles used to demonstrate the emission impact, including the necessary preconditioning cycles used by the system to correct or adapt for any mismatch and mitigate the emission impact. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering analysis that demonstrate that the conditions necessary for the system to correct or adapt will readily occur in a timely manner during in-use operation, ~~and~~ that the test conditions represent worst case emissions from typical in-use service actions when considering the distribution and variance of the compensation values and parts (e.g., replacement of one or more plus-one-sigma injectors with minus-one-sigma injectors without updating of the compensation value), and that the data and/or engineering analysis support the selection of the worst case failure mode (e.g., demonstration of the single-cylinder minus-one-sigma and

single-cylinder plus-one-sigma failure modes versus the all-cylinder demonstration of minus-one-sigma and plus-one sigma).

(15.2.3) Hybrid Components

(A) Energy Storage System (ESS)

(i) Manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions for monitoring of the hybrid ESS state of health. The Executive Officer shall approve the plan upon determining that the manufacturer has demonstrated the monitor properly detects malfunctions and that the monitor is able to detect any hybrid ESS state of health fault that prevents any of the following: (1) activating and maintaining emission control strategies, (2) operation of the vehicle to meet or exceed the minimum acceptable in-use monitor performance ratio requirements specified in section (d)(3.2.1), or (3) utilization of the ESS in movement of the vehicle (e.g. the engine cannot be started, the motor is unable to move the vehicle or provide motor assist due to ESS deterioration).

(ii) The OBD II system shall monitor the ESS state of charge for malfunctions that result in any of the following:

a. The state of charge cannot be controlled within the normal manufacturer-defined useable range intended for hybrid vehicle operation.

b. The hybrid system is not able to maintain the state of charge required by the OBD II system to enable other diagnostics.

(iii) The OBD II system shall monitor the ESS cell balancing system for proper functional response to computer commands. The OBD II system shall detect a malfunction when the ESS cell balancing system can no longer maintain the individual cell voltages desired. In lieu of monitoring individual cell voltages, manufacturers may monitor the individual switches used to command cell balancing for proper functional response. If the OBD II system does not determine cell balance using individual cell voltages, manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions for monitoring the ESS cell balancing system. In general, the Executive Officer will approve the plan if it includes functional monitoring of components used for cell balancing.

(iv) The individual electronic components that are used as inputs or outputs for the ESS (e.g., battery temperature sensors, battery voltage sensors, battery cells) shall be monitored in accordance with the requirements of sections (f)(15.2.1) and (15.2.2).

(v) For monitors of malfunctions specified under sections (f)(15.2.3)(iii) and (iv), manufacturers at a minimum shall store separate fault codes relating to hybrid ESS malfunctions pinpointing the smallest replaceable unit for in-use repair as defined by the manufacturer. Manufacturers may further pinpoint components and/or failure modes.

(B) Hybrid Thermal Management Systems

(i) ESS Thermal Management Systems

a. The individual electronic input and output components that are used for ESS thermal management (i.e., heating or cooling) shall be monitored in accordance with the requirements of sections (f)(15.2.1) and (15.2.2). Electronic components used for hybrid battery thermal management and commanded solely by driver demand are exempt from this monitoring requirement.

b. To the extent feasible, the OBD II system shall perform a functional check of the cooling performance and, if applicable, heating performance.

(ii) Inverter Thermal Management Systems

a. The individual electronic input and output components that are used for inverter thermal management (i.e., heating or cooling) shall be monitored in accordance with the requirements of sections (f)(15.2.1) and (15.2.2). Electronic components used for inverter thermal management and commanded solely by driver demand are exempt from this monitoring requirement.

b. To the extent feasible, the OBD II system shall perform a functional check of the cooling performance and, if applicable, heating performance.

(C) Regenerative Braking: The OBD II system shall detect a malfunction of a component when a failure disables the regenerative braking function or affects regenerative braking performance.

(D) Drive Motor: Manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions for the drive motor system. The Executive Officer shall approve the plan upon determining that the manufacturer has demonstrated that the monitor properly detects malfunctions, and that the monitor is able to detect any drive motor fault that prevents any of the following: (1) activating and maintaining emission control strategies, (2) operation of the vehicle to meet or exceed the minimum acceptable in-use monitor performance ratio requirements specified in section (d)(3.2.1), or (3) utilization of the motor in movement of the vehicle (e.g. the motor can no longer be used to move the vehicle or provide assist, the engine cannot be started).

(E) Generator: Manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions for the generator system. The Executive Officer shall approve the plan upon determining that the manufacturer has demonstrated that the monitor properly detects malfunctions, and that the monitor is able to detect any generator fault that prevents any of the following: (1) activating and maintaining emission control strategies, (2) operation of the vehicle to meet or exceed the minimum acceptable in-use monitor performance ratio requirements specified in section (d)(3.2.1), or (3) proper functional response in accordance with the malfunction criteria in section (f)(15.2).

(F) Plug-in Hybrid Electric Vehicle ESS Charger: For plug-in hybrid electric vehicles, the OBD II system shall detect malfunctions of the on-board ESS charger when a failure disables ESS charging or affects charging performance (e.g., preventing the ESS from fully charging or limits

charging rate). Detection of indeterminate ESS charging failures that cannot be distinguished from failures originating outside the vehicle (e.g., same symptom could be caused by a malfunction of a vehicle component or the off-board power supply) or charging failures originating outside the vehicle (e.g., malfunction of the electric vehicle supply equipment, poor electrical service) is not required.

(G) For hybrid components that are not addressed in sections (f)(15.2.3)(A) through (F) above, manufacturers shall monitor those hybrid components determined by the manufacturer to be subject to monitoring in section (f)(15.1.1) in accordance with the input component and output component requirements in sections (f)(15.2.1) and (f)(15.2.2).

(H) Monitoring of hybrid components as specified in sections (f)(15.2.3)(A) through (G) above on mild hybrid electric vehicles and strong hybrid electric vehicles is not required if manufacturers can demonstrate:

(i) The component is not used as part of the diagnostic strategy for any other monitored system or component,

(ii) Is not used as part of an inducement strategy, and

(iii) No malfunction of the component or system can affect emissions as determined by the criteria in section (f)(15.1.2).

(I) Monitoring of hybrid components as specified in sections (f)(15.2.3)(A) through (G) above on plug-in hybrid electric vehicles is not required if manufacturers can demonstrate:

(i) The component is not used as part of the diagnostic strategy for any other monitored system or component, and

(ii) In lieu of the criteria in section (f)(15.1.2), except as specified in (f)(15.2.3)(I)(iii) and (iv),no malfunction of the component or system could cause:

a. An engine in a vehicle with a fully charged ESS to start over any of the following test cycles where a properly-functioning fully charged vehicle does not start its engine during a single test cycle: FTP test, HWFET, Unified cycle, and US06 cycle; and

b. An increase greater than 15 percent of the integrated net energy used for a mean of three or more tests conducted with a malfunction compared to testing without a malfunction for any of the following test cycles where a properly-functioning fully charged vehicle does not start its engine during a single test cycle: FTP test, US06 cycle, HWFET, and Unified cycle. All tests shall be run with a fully charged high voltage battery, with integrated net energy measured at the electric drive system inlet. If measuring the electric drive system's inlet net energy is not feasible, the Executive Officer may approve an alternative method based on the ability of that method to measure net energy delivered to the powertrain.

(iii) For hybrid thermal management systems, in lieu of the test procedure specified in section (f)(15.2.3)(I)(ii) above, manufacturers shall submit a plan for Executive Officer approval for an alternate test cycle/vehicle operating conditions for the purposes of determining whether a malfunction would cause an engine in a vehicle with a fully-charged ESS to start where a properly-functioning fully charged vehicle does

not and a 15 percent reduction of all electric range if the component/system is malfunctioning. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that considers all conditions under which the thermal management system may be activated (e.g., high ambient temperatures, ESS charging, high load driving) and demonstrates that the chosen test cycle and operating conditions are representative of in-use conditions where all electric range is likely to be most affected by the malfunctioning component/system.

(iv) If function of the hybrid component or system would not necessarily occur during any of the test cycles specified in section (f)(15.2.3)(I)(ii) above (e.g., global positioning system components that control plug-in hybrid operation based on battery state of charge), the manufacturer shall request Executive Officer approval of an added alternate test cycle or vehicle operating conditions for which the determination of vehicle engine starts and increase in integrated net energy will be evaluated. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the testing conditions proposed represent in-use driving conditions under which the component or system will function and where energy usage is likely to be most affected by the malfunctioning component. The component or system is required to meet the monitoring requirements under section (f)(15) if any condition (e.g., deterioration, failure) of the component or the system could cause the vehicle's engine to start when it otherwise would not, or an increase greater than 15 percent of the integrated net energy used for a mean of three or more tests conducted with a malfunction compared to testing without a malfunction.

(15.3) Monitoring Conditions:

(15.3.1) Input Components:

(A) Except as provided in section (f)(15.3.1)(C), input components shall be monitored continuously for proper range of values and circuit continuity.

(B) For rationality ~~monitoring~~ fault diagnostics (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~~ fault diagnostics 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.

(15.3.2) Output Components/Systems:

(A) Except as provided in section (f)(15.3.2)(D), monitoring for circuit continuity and circuit faults shall be conducted continuously.

(B) Except as provided in section (f)(15.3.2)(C), for functional ~~monitoring~~checks, 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 fuel control system, manufacturers shall define the monitoring conditions for functional ~~monitoring~~ checks in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that functional ~~monitoring~~ checks 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.

(15.3.3) Hybrid Components

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(15.2.3)(A)(i) through (iii), (f)(15.2.3)(B)(i)b., (f)(15.2.3)(B)(ii)b., and (f)(15.2.3)(C) through (F) 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).

(15.4) MIL Illumination and Fault Code Storage:

(15.4.1) Except as provided in sections (f)(15.4.2), ~~and~~ (f)(15.4.4), and (f)(15.4.5) below, general requirements for MIL illumination and fault code storage are set forth in section (d)(2). Additional fault code storage requirements are provided in sections (f)(15.2.1)(B) for input components and in section (f)(15.2.2)(A) for output components/systems, and section (f)(15.2.3)(A)(v) for hybrid components.

(15.4.2) Exceptions to general requirements for MIL illumination. For applications that are not using the criteria of sections (f)(15.1.2)(A) through (E) to determine if a component/system can affect emissions, MIL illumination is not required in conjunction with storing a confirmed fault code for any comprehensive component if both conditions (A) and (B) below are met:

(A) the component or system, when malfunctioning, could not cause vehicle emissions to increase by:

(i) 25 percent or more for PC/LDT SULEV II vehicles, or

(ii) 15 percent or more for all other vehicles, and

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

(15.4.3) For purposes of determining the emission increase in section (f)(15.4.2)(A), the manufacturer shall request Executive Officer approval of the test cycle/vehicle operating conditions for which the emission increase will be determined. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the testing conditions represent in-use driving conditions where emissions are likely to be most affected by the malfunctioning component. For purposes of determining whether the specified percentages in section (f)(15.4.2)(A) are exceeded, if the approved testing conditions are comprised of an emission test cycle with an exhaust emission standard, the measured increase shall be compared to a percentage of the exhaust emission standard (e.g., if the increase is equal to or more than 15 percent of the exhaust emission standard for that test cycle). If the approved testing conditions are comprised of a test cycle or vehicle operating condition that does not have an exhaust emission standard, the measured increase shall be calculated as a percentage of the baseline test (e.g., if the increase from a back-to-back test sequence between normal and malfunctioning condition is equal to or more than 15 percent of the baseline test results from the normal condition).

(15.4.4) For malfunctions required to be detected by section (f)(15.2.2)(B)(iii) (idle control fuel injection quantity faults), the stored fault code is not required to specifically identify the idle control system (e.g., a fault code for cylinder fuel injection quantity imbalance or combustion quality monitoring can be stored).

(15.4.5) Exceptions to general requirements for MIL illumination and fault code storage. MIL illumination and fault code storage is not required for faults of components/systems monitored solely by emissions neutral diagnostics. Executive Officer approval is required for the emissions neutral default action activated by the emissions neutral diagnostic. The Executive Officer shall approve the emissions neutral default action upon determining that the manufacturer has submitted data and/or engineering evaluation adequately demonstrating that the action meets the conditions described under the definition of “emissions neutral default action” in section (c).

(16) *Other Emission Control or Source System Monitoring*

(16.1) Requirement: For other emission control or source systems that are not identified or addressed in sections (f)(1) through (f)(15) (e.g., homogeneous charge compression ignition (HCCI) controls, hydrocarbon traps, fuel-fired passenger compartment heaters), manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production vehicle intended for sale in California. Executive Officer approval shall be based on the effectiveness of the monitoring strategy, the malfunction criteria utilized, and the monitoring conditions required by the diagnostic and, if applicable,

the determination that the requirements of section (f)(16.3) and (f)(16.4) below are satisfied.

(16.2) For purposes of section (f)(16), emission source systems are components or devices that emit pollutants subject to vehicle evaporative and exhaust emission standards (e.g., NMOG, CO, NOx, PM) and include non-electronic components and non-powertrain components (e.g., fuel-fired passenger compartment heaters, on-board reformers).

(16.3) Except as provided below in this paragraph, for 2005 and subsequent model year vehicles that utilize emission control systems that alter intake air flow or cylinder charge characteristics by actuating valve(s), flap(s), etc. in the intake air delivery system (e.g., swirl control valve systems), the manufacturers, in addition to meeting the requirements of section (f)(16.1) above, may elect to have the OBD II 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, etc.) per intake bank to meet this requirement. Vehicles utilizing these emission control systems designed and certified for 2004 or earlier model year vehicles and carried over to the 2005 through 2009 model year shall not be required to meet the provisions of section (f)(16.3) until the engine or intake air delivery system is redesigned.

(16.4) For emission control strategies that are not covered under sections (f)(1) through (f)(13) (e.g., a control strategy that regulates SCR catalyst inlet temperatures within a target window), Executive Officer approval shall be based on the effectiveness of the plan in detecting malfunctions that prevent the strategy from operating in its intended manner. These malfunctions include faults that inappropriately prevent or delay the activation of the emission control strategy, faults that cause the system to erroneously exit the emission control strategy, and faults where the control strategy has used up all of the adjustments or authority allowed by the manufacturer and is still unable to achieve the desired condition. The Executive Officer may waive detection of specific malfunctions upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that reliable detection of the malfunction is technically infeasible or would require additional hardware.

(17) *Exceptions to Monitoring Requirements*

(17.1) Except as provided in sections (f)(17.1.1) through (17.1.4) below, upon request of a manufacturer or upon the best engineering judgment of the ARB, the Executive Officer may revise the emission threshold for a malfunction on any diagnostic required in section (f) for medium-duty vehicles if the most reliable monitoring method developed requires a higher threshold to prevent false indications of a malfunction. <u>Additionally, upon the request of a manufacturer or upon the best engineering judgment of the ARB, the</u>

Executive Officer may revise the emission threshold for a malfunction on any diagnostic required in section (f) for passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard if the Executive Officer determined that (1) the most reliable monitoring method developed requires a higher threshold to prevent false indications of a malfunction; (2) a higher threshold is needed under section (e)(17.1) for a corresponding diagnostic in section (e) (e.g., EGR system, misfire, exhaust gas sensor, aftertreatment) for light-duty vehicles; and (3) the threshold for the diagnostic on the diesel vehicle is less than or equal to the threshold required for the corresponding diagnostic on the gasoline vehicle. Additionally, except as specified in section (f)(9.2.1)(A)(iii), for 2007 through 2013 model year light-duty vehicles and 2007 through 2015 model year medium-duty vehicles, the Executive Officer may revise the PM filter malfunction criteria of section (f)(9.2.1) to exclude detection of specific failure modes (e.g., combined failure of partially melted and partially cracked substrates) if the most reliable monitoring method developed requires the exclusion of specific failure modes to prevent false indications of a malfunction.

(17.1.1) For PC/LDT SULEV II vehicles, the Executive Officer shall approve a malfunction criterion of 2.5 times the applicable FTP standards in lieu of 1.5 or 1.75 wherever required in section (f).

(17.1.2) Manufacturers shall use the following malfunction criteria for vehicles certified to the Federal Tier 2 or Tier 3 emission standards:

(A) For vehicles certified to Tier 2 Federal Bin 3 or Bin 4 tailpipe emission standards (as defined in 40 CFR 86.1811-04), manufacturers shall utilize the ULEV II vehicle NMOG and CO malfunction criteria (e.g., 1.5 times the Bin 3 or Bin 4 NMOG and CO standards) and the PC/LDT SULEV II vehicle NOx malfunction criteria (e.g., 2.5 times the Bin 3 or Bin 4 NOx standards).

(B) For vehicles certified to the Tier 3 Federal Bin 85 or Bin 110 tailpipe emission standards (as defined in 40 CFR 86.1811-17), manufacturers shall utilize the following malfunction criteria in accordance with the table below (with the NMOG+NOx, CO, and PM multipliers to be used with the applicable standard (e.g., 2.0 times the NMOG+NOx standard)):

	NMOG+NOx Multiplier	CO Multiplier	PM Multiplier	PM Threshold (mg/mi)
Monitors [1]	1.85	1.50	2.00	N/A
Aftertreatment Monitors [2]	2.00	1.50[3]	2.00[3]	N/A
PM Filter Filtering Performance Monitor	1.85[3]	1.50[3]	N/A	17.50

1. Applies to (f)(3.2.5), (f)(4)-(f)(7), (f)(9.2.2), (f)(12)-(f)(13)
2. Applies to (f)(1)-(f)(2), (f)(8), and (f)(9.2.4)(A)
3. Applies to 2019 and subsequent model years

(17.1.3) For medium-duty diesel vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the Executive Officer shall approve a malfunction criteria of “the applicable PM standard plus 0.02 g/bhp-hr PM (e.g., unable to maintain PM emissions at or below 0.03 g/bhp-hr if the exhaust emission standard is 0.01 g/bhp-hr) as measured from an applicable cycle emission test” in lieu of “0.03 g/bhp-hr PM as measured from an applicable cycle emission test” wherever required in section (f). The Executive Officer shall also approve a malfunction criteria of “the applicable PM standard plus 0.04 g/bhp-hr PM (e.g., unable to maintain PM emissions at or below 0.05 g/bhp-hr if the exhaust emission standard is 0.01 g/bhp-hr) as measured from an applicable cycle emission test” in lieu of “0.05 g/bhp-hr PM as measured from an applicable cycle emission test” wherever required in section (f).

(17.1.4) For 2007 through 2009 medium-duty diesel vehicles (including MDPVs) certified to an engine dynamometer FTP tailpipe PM emission standard of greater than or equal 0.08 g/bhp-hr, the Executive Officer shall approve a malfunction of criteria of 1.5 times the applicable PM standard in lieu of the applicable PM malfunction criteria required for any monitor in section (f).

(17.1.5) For 2004 through 2015 model year medium-duty diesel vehicles (except MDPVs) certified to a chassis dynamometer tailpipe emission standard, the monitoring requirements and malfunction criteria in section (f) applicable to medium-duty diesel vehicles certified to an engine dynamometer tailpipe emission standard shall apply. However, the manufacturer shall request Executive Officer approval of manufacturer-proposed medium-duty chassis dynamometer-based malfunction criteria in lieu of the engine dynamometer-based malfunction criteria required for each monitor in section (f). The Executive Officer shall approve the request upon finding that:

(A) the manufacturer has used good engineering judgment in determining the malfunction criteria,

(B) the malfunction criteria will provide for similar timeliness in detection of malfunctioning components with respect to detection of malfunctions on medium-duty diesel vehicles certified to an engine dynamometer tailpipe emission standard,

(C) the malfunction criteria are set as stringently as technologically feasible with respect to indicating a malfunction at the lowest possible tailpipe emission levels (but not lower than 1.5 times the chassis dynamometer tailpipe emission standard the vehicle is certified to), considering the best available monitoring technology to the extent that it is known or should have been known to the manufacturer,

(D) the malfunction criteria will prevent detection of a malfunction when the monitored component is within the performance specifications for components aged to the end of the full useful life, and

(E) the manufacturer has provided emission data showing the emission levels at which the malfunctions are detected.

(17.1.6) For 2016 and subsequent model year medium-duty diesel vehicles (except MDPVs) certified to a chassis dynamometer tailpipe emission standard, the following monitoring requirements and malfunction criteria shall apply:

(A) For Low Emission Vehicle II applications:

~~(A)~~(i) Except as provided for in sections (f)(17.1.6)(~~B~~A)(ii) ~~and~~ through (~~C~~v) below, the monitoring requirements and malfunction criteria in section (f) applicable to passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard shall apply.

~~(B)~~(ii) For NMHC catalyst conversion efficiency monitoring (section (f)(1.2.2)), the manufacturer shall detect an NMHC catalyst malfunction when the catalyst conversion capability decreases to the point that emissions exceed 1.75 times the applicable FTP NMHC or NOx standards.

~~(C)~~(iii) For misfire monitoring (section (f)(3)), the manufacturer shall use the monitoring requirements and malfunction criteria applicable to medium-duty vehicles certified to an engine dynamometer tailpipe emission standard.

(iv) For section (f)(4.2.5), the manufacturer shall use the procedure for determining the fuel system malfunction criteria applicable to medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard.

(v) For the requirements in sections (f)(5.3.1)(A) and (f)(9.2.4)(B), the manufacturer shall use the requirements applicable to medium-duty vehicles (except MDPVs certified to a chassis dynamometer tailpipe emission standard).

(B) For Low Emission Vehicle III applications:

(i) Except as provided for in sections (f)(17.1.6)(B)(ii) through (v) below, the monitoring requirements and malfunction criteria in section (f) applicable to passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard shall apply but the emission thresholds set forth in Tables 2 and 3 in the beginning of the section (f) shall apply.

(ii) For misfire monitoring (section (f)(3)), except as provided for below in section (f)(17.1.6)(B)(iii), the manufacturer shall use the monitoring requirements and malfunction criteria applicable to medium-duty vehicles certified to an engine dynamometer tailpipe emission standard.

(iii) For section (f)(3.2.5), the manufacturer shall use the emission thresholds set forth in Table 2 in the beginning of the section (f).

(iv) For section (f)(4.2.5), the manufacturer shall use the procedure for determining the fuel system malfunction criteria applicable to medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard.

(v) For the requirements in sections (f)(5.3.1)(A) and (f)(9.2.4)(B), the manufacturer shall use the requirements applicable to medium-duty

vehicles (except MDPVs certified to a chassis dynamometer tailpipe emission standard).

(17.1.7) For SULEV20 vehicles, in lieu of the NMOG+NOx emission threshold set forth in Tables 2 and 3 in the beginning of section (f), manufacturers may use a malfunction criterion of 3.25 times the applicable NMOG+NOx standard for the first three model years a vehicle is certified, but no later than the 2025 model year. For example, for SULEV20 vehicles first certified to the SULEV20 standard in the 2024 model year, the manufacturer may use the 3.25 multiplier for the 2024 and 2025 model years and shall use the NMOG+NOx emission threshold set forth in Tables 2 and 3 in the beginning of section (f) for the 2026 and subsequent model years.

(17.2) Whenever the requirements in section (f) of this regulation require a manufacturer to meet a specific phase-in schedule:

(17.2.1) The phase-in percentages shall be based on the manufacturer's projected sales volume for all vehicles subject to the requirements of title 13, CCR section 1968.2 unless specifically stated otherwise in section (f).

(17.2.2) Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) except as specifically noted for the phase-in for in-use monitor performance ratio monitoring conditions in section (d)(3.2) and the PM filter monitor in section (f)(9.2.1)(A).

(17.2.3) Small volume manufacturers may use an alternate phase-in schedule in accordance with section (f)(17.2.2) in lieu of the required phase-in schedule or may use a different schedule as follows:

(A) For the diesel PM filter monitor phase-in schedule in section (f)(9.2.1)(A)(iii), the manufacturer may use the malfunction criteria in section (f)(9.2.1)(A)(ii)c. for all 2014 and 2015 model year medium-duty vehicles in lieu of the malfunction criteria and required phase-in schedule in section (f)(9.2.1)(A)(iii).

(B) For phase-in schedules not listed in section (f)(17.2.3)(A) above, the manufacturer may meet the requirement on all vehicles by the final year of the phase-in in lieu of meeting the specific phase-in requirements for each model year.

(17.3) Manufacturers may request Executive Officer approval to disable an OBD II system monitor at ambient temperatures below ~~twenty~~ 20 degrees Fahrenheit (~~20°F~~or -6.7 degrees Celsius) (low ambient temperature conditions may be determined based on intake air or engine coolant temperature) 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 II system monitor be disabled at other ambient 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).

(17.4) Manufacturers may request Executive Officer approval to disable monitoring systems that can be affected by low fuel level or running out of fuel (e.g., misfire detection) when the fuel level is 15 percent or less of the nominal capacity of the fuel tank. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring at the fuel levels would be unreliable.

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

(17.5.1) 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 II system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(17.5.2) 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~~one of the following conditions is met:

(A) ~~t~~The electrical charging system/alternator warning light is illuminated (or voltage gauge is in the “red zone”) at the voltage used to disable other monitors.

(B) The instrument cluster completely shuts down at the voltage used to disable other monitors. For purposes of this section, “instrument cluster shutdown” is defined as a lack of display or improper zero reading of, at a minimum, vehicle speed, fuel level, and engine speed, and includes information displayed on alternate duplicate displays (e.g., heads up displays).

(C) ~~or that~~ ~~t~~The OBD II system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(17.6) A manufacturer may request Executive Officer approval to disable monitors that can be affected by PTO activation on vehicles designed to accommodate the installation of PTO units (as defined in section (c)).

(17.6.1) Except as allowed in section (~~g~~f)(17.6.2) below, a manufacturer may request Executive Officer approval to disable an affected monitor provided disablement occurs only while the PTO unit is active and the OBD II readiness status (specified under section (g)(4.1)) and PTO activation

time are appropriately tracked and erased as described in this section. The Executive Officer shall approve the request for disablement based on the manufacturer's demonstration that the affected monitor cannot robustly detect malfunctions (e.g., cannot avoid false passes or false indications of malfunctions) while the PTO unit is active. The OBD II system shall track the cumulative engine runtime with PTO active and clear OBD II readiness status (i.e., set all monitors to indicate "not complete") no later than the start of the next ignition cycle if 750 minutes of cumulative engine runtime with PTO active has occurred since the last time the affected monitor has determined the component or system monitored by the affected monitor is or is not malfunctioning (i.e., has completed). The PTO timer shall pause whenever PTO changes from active to not active and resume counting when PTO is re-activated. The timer shall be reset to zero after the affected monitor has completed and no later than the start of the next ignition cycle. Once the PTO timer has reached 750 minutes and the OBD II readiness status has been cleared, the PTO timer may not cause the OBD system to clear the readiness status again until after the PTO timer has reset to zero (after the monitor has completed) and again reached 750 minutes.

(17.6.2) In lieu of requesting Executive Officer approval for disabling an affected monitor according to section (f)(17.6.1) above, a manufacturer may disable affected monitors, provided disablement occurs only while the PTO unit is active, and the OBD II readiness status is cleared by the on-board computer (i.e., all monitors set to indicate "not complete") while the PTO unit is activated. If the disablement occurs, the readiness status may be restored to its state prior to PTO activation when the disablement ends.

(17.7) The manufacturer may request to exempt a specific component from all monitoring requirements if all malfunctions of the component affect emissions or the diagnostic strategy for any other monitored component or system only when the ambient temperature is below 20 degrees Fahrenheit. The Executive Officer shall approve the request upon the manufacturer submittal of data or engineering evaluation supporting that the following criteria are met when the ambient temperature is above 20 degrees Fahrenheit (or -6.7 degrees Celsius): (1) a malfunction of the component does not affect emissions during any reasonable driving condition, (2) a malfunction of the component does not affect the diagnostic strategy for any other monitored component or system, and (3) the ambient temperature is determined based on a temperature sensor monitored by the OBD II system (e.g., IAT sensor). If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system meets these criteria, the Executive Officer shall require the manufacturer to provide emission and/or other diagnostic data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an effect on emissions or other diagnostic strategies. The Executive Officer may request emission data for any reasonable driving condition at ambient temperatures above 20 degrees Fahrenheit (or -6.7 degrees Celsius).

(17.8) The manufacturer may request to exempt a specific component from all monitoring requirements if all malfunctions of the component affect emissions

or the diagnostic strategy for any other monitored component or system only when the vehicle speed is above 82 miles-per-hour. The Executive Officer shall approve the request upon the manufacturer submittal of data or engineering evaluation supporting that the following criteria are met when the vehicle speed is below 82 miles-per-hour: (1) a malfunction of the component does not affect emissions during any reasonable driving condition, (2) a malfunction of the component does not affect the diagnostic strategy for any other monitored component or system, and (3) the vehicle speed is determined based on a sensor monitored by the OBD II system (e.g., vehicle speed sensor). If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system meets these criteria, the Executive Officer shall require the manufacturer to provide emission and/or other diagnostic data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an effect on emissions or other diagnostic strategies.

~~(17.7)~~(17.9) Whenever the requirements in section (f) of this regulation require monitoring "to the extent feasible", the manufacturer shall submit its proposed monitor(s) for Executive Officer approval. The Executive Officer shall approve the proposal upon determining that the proposed monitor(s) meets the criteria of "to the extent feasible" by considering the best available monitoring technology to the extent that it is known or should have been known to the manufacturer and given the limitations of the manufacturer's existing hardware, the extent and degree to which the monitoring requirements are met in full, the limitations of the monitoring necessary to prevent significant errors of commission and omission, and the extent to which the manufacturer has considered and pursued alternative monitoring concepts to meet the requirements in full. The manufacturer's consideration and pursuit of alternative monitoring concepts shall include evaluation of other modifications to the proposed monitor(s), the monitored components themselves, and other monitors that use the monitored components (e.g., altering other monitors to lessen the sensitivity and reliance on the component or characteristic of the component subject to the proposed monitor(s)).

(g) *Standardization Requirements*

(1) *Reference Documents*:

The following ~~Society of Automotive Engineers (~~SAE~~)~~ International and International Organization for Standardization (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", October 2008 (SAE J1930).

(1.1.1) SAE J1930-DA "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms Web Tool Spreadsheet", March 2014.

(1.2) SAE J1962:

(1.2.1) SAE J1962 "Diagnostic Connector – Equivalent to ISO/DIS 15031-

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

(1.2.2) SAE J1962 "Diagnostic Connector", September 2015 (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", ~~May 2007~~August 2014 (SAE J1979).

(1.4.1) SAE J1979-DA, "Digital Annex of E/E Diagnostic Test Modes", ~~October 2011~~June 2014.

(1.5) SAE J1850 "Class B Data Communications Network Interface", ~~May 2001~~ June 2006 (SAE 1850).

(1.6) SAE J2012 "Diagnostic Trouble Code Definitions~~ – Equivalent to ISO/DIS 15031-6~~", ~~December 2007~~March 2013 (SAE J2012).

(1.6.1) SAE J2012-DA "Digital Annex of Diagnostic Trouble Code Definitions and Failure Type Byte Definitions", January 2013.

(1.7) ISO 9141-2:1994 "Road Vehicles-Diagnostic Systems-CARB Requirements for Interchange of Digital Information", February 1994 (ISO 9141-2).

(1.8) ISO 14230-4:2000 "Road Vehicles-Diagnostic Systems-KWP 2000 Requirements for Emission-related Systems", June 2000 (ISO 14230-4).

(1.9) ISO 15765-4:2011~~05~~ "Road vehicles-Diagnostic~~s~~ communication ~~on~~ over Controller Area Network (DoCAN) - Part 4: Requirements for emissions-related systems", ~~January 2005~~February 2011 (ISO 15765-4).

(1.9.1) ISO 15765-4:"Road vehicles – Diagnostic communication over Controller Area Network (DoCAN) – Part 4: Requirements for emissions-related systems – Amendment 1," February 2013 (ISO 15765-4)

(1.10) SAE J1939 consisting of:

(1.10.1) J1939 "~~Recommended Practice for a~~ Serial Control and Communications Heavy Duty Vehicle Network – Top Level Document", ~~March 2009~~August 2013;

(1.10.2) J1939/1 "~~Recommended Practice for~~On-Highway Equipment Control and Communication~~s~~ Network~~ for On-Highway Equipment~~", ~~September 01, 2000~~November 2012;

(1.10.3) J1939/11 "Physical Layer, 250~~K~~ Kbps~~ bits/s~~, Twisted Shielded Pair", ~~September 18, 2006~~September 2012;

(1.10.4) J1939/13 "Off-Board Diagnostic Connector", ~~March 11, 2004~~October 2011;

(1.10.5) J1939/15 "~~Reduced~~ Physical Layer, 250~~K~~ Kbps~~ bits/sec~~, Un~~N~~-Shielded Twisted Pair (UTP)", ~~August 21, 2008~~May 2014;

(1.10.6) J1939/21 "Data Link Layer", December 22, ~~2006~~2010;

(1.10.7) J1939/31 "Network Layer", ~~April 02, 2004~~April 2014;

(1.10.8) J1939/71 "Vehicle Application Layer~~ (Through February 2008)~~", ~~January 20, 2009~~April 2014;

(1.10.9) J1939/73 "Application Layer - Diagnostics", ~~September 08, 2006~~July 2013;

(1.10.10) J1939/81 "Network Management", ~~May 08, 2003~~June 2011; and

(1.10.11) J1939/84 "OBD Communications Compliance Test Cases For Heavy Duty Components and Vehicles", ~~December 2008~~February 2015.

(1.11) SAE J1699-3 – "Vehicle OBD II Compliance Test Cases", ~~May 2006~~July 2015

(SAE J1699-3).

(1.12) SAE J2534-1 – "Recommended Practice for Pass-Thru Vehicle Programming", ~~December 2004~~October 2015 (SAE J2534-1).

(1.13) ISO 26262-5:2011 "Road vehicles – Functional Safety – Part 5: Product development at the hardware level", November 2011 (ISO 26262-5).

(2) *Diagnostic Connector*:

~~A standard data link connector conforming to SAE J1962 specifications (except as specified in section (g)(2.3)) shall be incorporated in each vehicle.~~

(2.1) For vehicles not included in the phase-in specified in section (g)(2.2), a standard data link connector conforming to the "Type A" specifications of SAE J1962 version April 2002 (except as specified in section (g)(2.3)) shall be incorporated in each vehicle.

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

~~(2.2)~~(2.1.2) If the connector is covered, the cover must be removable by hand without the use of any tools and be labeled to aid technicians in identifying the location of the connector. Access to the diagnostic connector may not require opening or the removal of any storage accessory (e.g., ashtray, coinbox, etc.). The label shall be submitted to the Executive Officer for review and approval, at or before the time the manufacturer submits its certification application. The Executive Officer shall approve the label 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.

(2.2) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles, a standard data link connector conforming to the "Type A" specifications and in the location specified for "Type A" connectors in SAE J1962 version September 2015 (except as specified in sections (g)(2.2.1) and (g)(2.3)) shall be incorporated in each vehicle.

(2.2.1) The vehicle connector mounting feature shall withstand a force of 220 Newtons applied to the connector mating area in the direction of the connecting and disconnecting process without mechanical and electrical failure. It shall also withstand a force of 220 Newtons applied in all other axial directions without mechanical failure.

(2.2.2) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles, the connector may not be covered in

any way (e.g., may not be covered by a removable panel, dust cap, lid, flap, door).

(2.2.3) For the required phase-in schedules specified in sections (g)(2.2) and (2.2.2), the manufacturer may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) with the exception that 100 percent of 2021 and subsequent model year vehicles shall comply with the requirements.

(2.3) Any pins in the connector that provide electrical power shall be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes and may not exceed 20.0 Volts DC regardless of the nominal vehicle system or battery voltage (e.g., 12V, 24V, 42V, etc.).

(2.4) Manufacturers may not equip vehicles with additional diagnostic connectors 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) if the additional connectors can be mated to with SAE J1962 "Type A" external test equipment.

(3) *Communications to a Scan Tool*:
Manufacturers shall use one of the following standardized protocols for communication of all required emission related messages from on-board to off-board network communications to a scan tool meeting SAE J1978 specifications:

(3.1) SAE J1850. All required emission related messages using this protocol shall use the Cyclic Redundancy Check and the three byte header, may not use inter-byte separation or checksums, and may not require a minimum delay of 100 ms between SAE J1978 scan tool requests. This protocol may not be used on any 2008 or subsequent model year vehicle.

(3.2) ISO 9141-2. This protocol may not be used on any 2008 or subsequent model year vehicle.

(3.3) ISO 14230-4. This protocol may not be used on any 2008 or subsequent model year vehicle.

(3.4) ISO 15765-4. This protocol shall be allowed on any 2003 and subsequent model year vehicle and required on all 2008 and subsequent model year vehicles. All required emission-related messages using this protocol shall use a 500 kbps baud rate.

(4) *Required Emission Related Functions*:
The following standardized functions shall be implemented in accordance with the specifications in SAE J1979 to allow for access to the required information by a scan tool meeting SAE J1978 specifications:

(4.1) Readiness Status: In accordance with SAE J1979 specifications, the OBD II system shall indicate "complete" or "not complete" since the fault memory was last cleared for each of the installed monitored components and systems identified in sections (e)(1) through (e)(8), (e)(15), (f)(1) through (f)(4), (f)(6), (f)(8), and (f)(15). All 2010 and subsequent model year diesel vehicles shall additionally indicate the appropriate readiness status for monitors identified in

sections (f)(5), (f)(7), and (f)(9). All 2010 subsequent model year vehicles equipped with VVT system monitoring and subject to the test results requirements specified in section (g)(4.5.4)(C) shall additionally indicate the appropriate readiness status for VVT system monitors identified in sections (e)(13) and (f)(13). ~~All components or systems that are monitored continuously shall always indicate "complete". Those components or systems that are not subject to continuous monitoring shall immediately indicate "complete" upon the respective diagnostic(s) being fully executed and determining that the component or system is not malfunctioning. A component or system shall also indicate "complete" if after the requisite number of decisions necessary for determining MIL status have been fully executed, the monitor indicates a malfunction for the component or system. The status for each of the monitored components or systems shall indicate "not complete" whenever fault memory has been cleared or erased by a means other than that allowed in section (d)(2). Normal vehicle shut down (i.e., key off, engine off) may not cause the status to indicate "not complete".~~

(4.1.1) The readiness status for the following component/system readiness bits shall always indicate "complete":

(A) Gasoline Misfire (section (e)(3));

(B) Diesel Misfire (section (f)(3)) for vehicles with a single monitor designed to detect both misfires identified in section (f)(3.2.1) and subject to the monitoring conditions of sections (f)(3.3.1) and (f)(3.3.2) and misfires identified in section (f)(3.2.2) and subject to the monitoring conditions of (f)(3.3.3); and

(C) Gasoline and Diesel Comprehensive Component (sections (e)(15) and (f)(15)).

(4.1.2) For 2004 through 2018 model year vehicles, for components and systems not listed in section (g)(4.1.1) above, the readiness status shall immediately indicate "complete" upon the respective monitor(s) (except those monitors specified under section (g)(4.1.8) below) determining that the component or system is not malfunctioning. The readiness status for 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.

(A) For the gasoline evaporative system:

(i) Except as provided below in section (g)(4.1.2)(A)(ii), the readiness status shall be set to "complete" when the monitors specified in section (e)(4.2.2)(A) and either section (e)(4.2.2)(B) or (e)(4.2.2)(C) meet the criteria in section (g)(4.1.2).

(ii) For vehicles that utilize a 0.090 inch (in lieu of 0.040 inch) leak detection monitor in accordance with section (e)(4.2.5), the readiness status shall be set to "complete" when the monitors specified in sections (e)(4.2.2)(A) and (e)(4.2.2)(C) meet the criteria in section (g)(4.1.2).

(4.1.3) For 2019 and subsequent model year vehicles, for components and systems not listed in section (g)(4.1.1) above, the readiness status for each component/system readiness bit listed below shall immediately

indicate “complete” if any of the following conditions occur: (1) all the respective supported monitors listed below for each component/system have fully executed and determined that the component or system is not malfunctioning, or (2) at least one of the monitors listed below for each component/system has determined that the component or system is malfunctioning after the requisite number of decisions necessary for determining the MIL status have been fully executed, regardless of whether or not the other monitors listed have been fully executed:

(A) Gasoline Catalyst: section (e)(1.2)

(B) Gasoline Evaporative System: section (e)(4.2.2)(A) and (e)(4.2.2)(C)

(C) Gasoline Secondary Air System: sections (e)(5.2.2) and (e)(5.2.3)

(D) Gasoline Fuel System: section (e)(6.2.1)(C)

(E) Gasoline Oxygen Sensor: sections (e)(7.2.1)(A), (e)(7.2.1)(D), (e)(7.2.2)(A), and (e)(7.2.2)(C)

(F) Gasoline Oxygen Sensor Heater: (e)(7.2.3)(A)

(G) Gasoline EGR/VVT: sections (e)(8.2.1), (e)(8.2.2), (e)(13.2.1), (e)(13.2.2), and (e)(13.2.3)

(H) Diesel NMHC Converting Catalyst: sections (f)(1.2.2) and (f)(1.2.3)(A)

(I) Diesel NOx Converting Catalyst: section (f)(2.2.2)

(J) Diesel Misfire: section (f)(3.2.1) for vehicles with a separate monitor designed to detect misfires identified in section (f)(3.2.1) and subject to the monitoring conditions of sections (f)(3.3.1) and (f)(3.3.2)

(K) Diesel Fuel System: sections (f)(4.2.1), (f)(4.2.2), and (f)(4.2.3)

(L) Diesel Exhaust Gas Sensor: sections (f)(5.2.1)(A)(i), (f)(5.2.1)(A)(iv), (f)(5.2.1)(B)(i), (f)(5.2.1)(B)(iv), (f)(5.2.2)(A), (f)(5.2.2)(D), (f)(5.2.3)(A), and (f)(5.2.4)(A)

(M) Diesel EGR/VVT: sections (f)(6.2.1), (f)(6.2.2), (f)(6.2.3), (f)(6.2.5), (f)(6.2.6), (f)(13.2.1), (f)(13.2.2), and (f)(13.2.3)

(N) Diesel Boost Pressure Control System: sections (f)(7.2.1), (f)(7.2.2), (f)(7.2.3), and (f)(7.2.4)

(O) Diesel NOx Aftertreatment: sections (f)(8.2.1) and (f)(8.2.2)

(P) Diesel PM Filter: sections (f)(9.2.1), (f)(9.2.2), (f)(9.2.5), and (f)(9.2.6)

(4.1.4) For 2019 and subsequent model year engines, for monitors that detect faults of more than one major emission-related component (e.g., a single monitor that is used to detect both oxygen sensor faults that are tied to the oxygen sensor readiness bit and air-fuel ratio cylinder imbalance faults that are tied to the fuel system readiness bit), the manufacturer shall include the monitor only in the readiness status for the component/system that the monitor is primarily calibrated, intended, or expected in-use to detect faults of.

(4.1.5) Except for the readiness bits under section (g)(4.1.1) above, the readiness 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 readiness status to indicate “not complete”.

~~(4.1.1)~~(4.1.6) Subject to Executive Officer approval, if monitoring is disabled for a multiple number of driving cycles due to the continued presence of

extreme operating conditions (e.g., cold ambient temperatures, high altitudes~~, etc~~), readiness status for the subject monitoring system may be set to indicate “complete” without monitoring having been completed. Executive Officer approval shall be based on the conditions for monitoring system disablement and the number of driving cycles specified without completion of monitoring before readiness is indicated as “complete”.

~~(4.1.2) For the evaporative system monitor:~~

~~(A) Except as provided below in section (g)(4.1.2)(B), the readiness status shall be set in accordance with section (g)(4.1) when both the functional check of the purge valve and the leak detection monitor of the orifice size specified in either section (e)(4.2.2)(B) or (C) (e.g., 0.040 inch or 0.020 inch) indicate that they are complete.~~

~~(B) For vehicles that utilize a 0.090 inch (in lieu of 0.040 inch) leak detection monitor in accordance with section (e)(4.2.5), the readiness status shall be set in accordance with section (g)(4.1) when both the functional check of the purge valve and the leak detection monitor of the orifice size specified in section (e)(4.2.2)(C) (e.g., 0.020 inch) indicate that they are complete.~~

~~(4.1.3)~~(4.1.7) 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 illuminate~~d~~ in the key on, engine off position for at least 15~~-20~~ seconds as required by section (d)(2.1.2). 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 as required by section (d)(2.1.2), the MIL shall blink once per second for 5-10 seconds. The data stream value for MIL status (section (g)(4.2)) shall indicate “commanded off” during this sequence unless the MIL has also been “commanded on” for a detected fault.

(4.1.8) Manufacturers are not required to use the following monitors in determining the readiness status for the specific component or system:

(A) Circuit and out-of-range monitors that are required to be continuous.

(B) Gasoline and diesel exhaust gas sensor feedback monitors specified in sections (e)(7.2.1)(C), (e)(7.2.2)(E), (f)(5.2.1)(A)(iii), (f)(5.2.1)(B)(iii), and (f)(5.2.2)(C)

(C) Gasoline fuel system monitors specified in sections (e)(6.2.1)(A), (e)(6.2.1)(B), (e)(6.2.2), and (e)(6.2.4)

(D) Diesel feedback control monitors specified in sections (f)(2.2.3)(D), (f)(4.2.4), (f)(6.2.4), (f)(7.2.5), (f)(8.2.3), and (f)(9.2.7)

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

(4.2.1) For all vehicles:

(A) ~~c~~Calculated load value, number of stored confirmed fault codes, engine coolant temperature, engine speed, absolute throttle position (if equipped with a throttle), vehicle speed, OBD requirements to which the engine is certified (e.g., California OBD II, EPA OBD, European OBD, non-OBD), and MIL status (i.e., commanded-on or commanded-off).

~~(4.2.2) For all vehicles so equipped:~~

(B) For all vehicles so equipped: F~~f~~uel control system status (e.g., open loop, closed loop, etc.), fuel trim (short term, long term, secondary), fuel pressure, ignition timing advance, intake air temperature, manifold absolute pressure, air flow rate from mass air flow sensor, secondary air status (upstream, downstream, or atmosphere), oxygen sensor output, air/fuel ratio sensor output.

(4.2.~~3~~2) Additionally, ~~F~~for all 2005 and subsequent model year vehicles using the ISO 15765-4 protocol for the standardized functions required in section (g), the following signals shall ~~also~~ be made available:

(A) ~~a~~Absolute load, fuel level (if used to enable or disable any other diagnostics), relative throttle position (if equipped with a throttle), barometric pressure (directly measured or estimated), engine control module system voltage, commanded equivalence ratio, catalyst temperature (if directly measured or estimated for purposes of enabling the catalyst monitor(s)), monitor status (i.e., disabled for the rest of this driving cycle, complete this driving cycle, or not complete this driving cycle) since last engine shut-off for each monitor used for readiness status, time elapsed since engine start, distance traveled while MIL activated, distance traveled since fault memory last cleared, and number of warm-up cycles since fault memory last cleared.

(i) For all 2015 and subsequent model year vehicles: type of fuel currently being used.

(ii) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles: engine fuel rate, vehicle fuel rate, modeled exhaust flow (mass/time), engine reference torque, engine friction – percent torque, actual engine – percent torque, odometer reading, and test group or engine family (whichever is applicable).

~~(4.2.4)~~(B) For all ~~2005 and subsequent model year vehicles so equipped and using the ISO 15765-4 protocol for the standardized functions required in section (g)~~vehicles so equipped:

(i) ambient air temperature, evaporative system vapor pressure, commanded purge valve duty cycle/position, commanded EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), redundant absolute throttle position (for electronic throttle or other systems that utilize two or more sensors), absolute pedal position, redundant absolute pedal position, and commanded throttle motor position.

(ii) For all 2013 and subsequent model year vehicles so equipped:

a. EGR temperature, variable geometry turbo control status (e.g., open loop, closed loop), reductant level (e.g., urea tank fill level), alcohol

fuel percentage, NOx adsorber regeneration status, NOx adsorber deSOx status, hybrid battery pack remaining charge; and

b. distance traveled while low/empty SCR reductant driver warning/inducement active.

(iii) For all 2019 and subsequent model year vehicles so equipped: NOx sensor corrected.

(C) For 2019 and subsequent model year gasoline vehicles so equipped: NOx sensor output.

(D) For 2019 and subsequent model year hybrid vehicles, hybrid/EV charging state, hybrid/EV battery system voltage, and hybrid/EV battery system current.

(E) For vehicles required to meet the requirements of title 13, CCR section 1976(b)(1)(G)6., distance traveled since evap monitoring decision.

(4.2.~~5~~3) Additionally, for all 2010 and subsequent model year vehicles with a diesel engine:

(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), engine oil temperature (if used for emission control or any OBD diagnostics), time elapsed since engine start; and

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

(C) 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; and

(D) For all engines so equipped: absolute throttle position, relative throttle position, fuel injection timing, ~~intake~~ manifold surface temperature, ~~intercooler~~ charge air cooler temperature, ambient air temperature, commanded EGR valve duty cycle/position, actual EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), 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, PM sensor output, and NOx sensor output;

(i) For all 2019 and subsequent model year vehicles so equipped: diesel exhaust fluid (DEF) sensor output (concentration and temperature), commanded DEF dosing, DEF usage for the current driving cycle, and DEF dosing rate;

(E) ~~Additionally, f~~For all 2010 and subsequent model year medium-duty vehicles with a diesel engine certified on an engine dynamometer: NOx NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific NOx NTE carve-out area, or NTE deficiency for NOx 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 NTE deficiency for PM active area);

(F) For all 2013 and subsequent model year vehicles, normalized trigger for PM filter regeneration, PM filter regeneration status; ~~and~~

(G) For all 2013 and subsequent model year vehicles, average distance (or engine run time for engines not utilizing vehicle speed information) between PM filter regenerations~~.~~, and

(H) For all 2019 and subsequent model year vehicles, cylinder fuel rate.

~~(4.2.6) Additionally, for all 2013 and subsequent model year vehicles so equipped:~~

~~(A) EGR temperature, variable geometry turbo control status (e.g., open loop, closed loop), reductant level (e.g., urea tank fill level), alcohol fuel percentage, NOx adsorber regeneration status, NOx adsorber deSOx status, hybrid battery pack remaining charge; and~~

~~(B) distance traveled while low/empty SCR reductant driver warning/inducement active.~~

~~(4.2.7) Additionally, for all 2015 and subsequent model year vehicles: type of fuel currently being used.~~

(4.2.4) For purposes of the calculated load, torque, fuel rate, and modeled exhaust flow parameters in sections (g)(4.2.1)(A), (g)(4.2.2)(A)(ii), (g)(4.2.3)(A), and (g)(4.2.3)(H), manufacturers shall report the most accurate values that are calculated within the applicable electronic control unit (e.g., the engine control module).

(4.3) Freeze Frame.

(4.3.1) “Freeze frame” information required to be stored pursuant to sections (d)(2.2.7), (e)(3.4.~~3~~4), (e)(6.4.4), (f)(3.4.2)(B), and (f)(4.4.2)(D) shall be made available on demand through the standardized data link connector in accordance with SAE J1979 specifications.

(4.3.2) “Freeze frame” conditions must include the fault code which caused the data to be stored and all of the signals required in section (g)(4.2.1)(A) except number of stored confirmed fault codes, OBD requirements to which the engine is certified, MIL status, and absolute throttle position in accordance with (g)(4.3.3). Freeze frame conditions shall also include all of the signals required on the vehicle in sections ~~(g)(4.2.2) through (g)(4.2.5)(D), (g)(4.2.5)(F), (g)(4.2.6)(A), and (g)(4.2.7)~~ (g)(4.2.1)(B), (g)(4.2.2)(A) through (g)(4.2.2)(A)(i), (g)(4.2.2)(B)(i) through

(g)(4.2.2)(B)(ii)a., (g)(4.2.3)(A) through (g)(4.2.3)(D), and (g)(4.2.3)(F) that are used for diagnostic or control purposes in the specific diagnostic or emission-critical powertrain control unit that stored the fault code except: oxygen sensor output, air/fuel ratio sensor output, catalyst temperature, evaporative system vapor pressure, glow plug lamp status, PM sensor output, NOx sensor output, monitor status since last engine shut off, distance traveled while MIL activated, distance traveled since fault memory last cleared, ~~and~~ number of warm-up cycles since fault memory last cleared, DEF sensor output, commanded DEF dosing, DEF usage for the current driving cycle, and DEF dosing rate.

(4.3.3) In lieu of including the absolute throttle position data specified in (g)(4.2.1)(A) in the freeze frame data, diagnostic or emission-critical powertrain control units that do not use the absolute throttle position data may include the relative throttle position data specified in (g)(4.2.~~3~~2)(A) or pedal position data specified in (g)~~(4.2.4)~~(4.2.2)(B).

(4.3.4) Only one frame of data is required to be recorded. Manufacturers may choose to store additional frames provided that at least the required frame can be read by a scan tool meeting SAE J1978 specifications.

(4.4) Fault Codes

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

(4.4.2) Except as otherwise specified in sections (e) and (f), ~~T~~the stored fault code shall, to the fullest extent possible, pinpoint the likely cause of the malfunction. To the extent feasible on all 2005 and subsequent model year vehicles, manufacturers shall use separate fault codes for every diagnostic where the diagnostic and repair procedure or likely cause of the failure is different. ~~In general, rationality and functional diagnostics shall use different fault codes than the respective circuit continuity diagnostics. Additionally, input component circuit continuity diagnostics shall use different fault codes for distinct malfunctions (e.g., out-of-range low, out-of-range high, open circuit, etc.).~~

(4.4.3) Manufacturers shall use appropriate SAE-defined fault codes of 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.

(4.4.4) A fault code (pending and/or confirmed, as required in sections (d) (e), and (f)) 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 (including electronic control unit shutdown) in which the corresponding confirmed fault code causing the MIL to be illuminated has been stored.

(4.4.5) Pending fault codes:

(A) On all 2005 and subsequent model year vehicles, pending fault codes for all components and systems (including continuously and non-continuously monitored components) shall be made available through the diagnostic connector in accordance with SAE J1979 specifications (e.g., Mode/Service $07).

(B) On all 2005 and subsequent model year vehicles, a pending fault code(s) shall be stored and available through the diagnostic connector for all currently malfunctioning monitored component(s) or system(s), regardless of the MIL illumination status or confirmed fault code status (e.g., even after a pending fault has matured to a confirmed fault code and the MIL is illuminated, a pending fault code shall be stored and available if the most recent monitoring event indicates the component is malfunctioning).

(C) Manufacturers using alternate statistical protocols for MIL illumination as allowed in section (d)(2.2.6) 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 (g)(4.4.5)(A) and (B) and that it effectively provides service technicians with a quick and accurate indication of a pending failure.

(4.4.6) Permanent fault codes:

(A) 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.

(B) 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)(2.4)).

(C) 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.

(D) Permanent fault codes may not be erased when the control module containing the permanent fault codes is reprogrammed unless the following occur:

(i) For vehicles not included in the phase-in specified in section (g)(4.4.6)(D)(ii) below, the readiness status (refer to section (g)(4.1)) for all monitored components and systems is set to “not complete” in conjunction with the reprogramming event.

(ii) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles, the readiness bits (refer to section (g)(4.1)) for all monitored components and systems in all modules that reported supported readiness for a readiness bit other

than the comprehensive components readiness bit are set to "not complete" in conjunction with the reprogramming event.

(E) The OBD II 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 II 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 II system may not replace any existing permanent fault code with the additional confirmed fault codes.

(4.5) Test Results

(4.5.1) Except as provided for in section (g)(4.5.5), ~~F~~for all monitored components and systems for gasoline ~~engine~~ vehicles identified in sections (e)(1) through (e)(8) and (e)(13) ~~except misfire detection, fuel system monitoring, and oxygen sensor circuit and out-of-range monitoring,~~ and ~~for all monitored components and systems~~ for diesel engine vehicles identified in sections (f)(1) through (f)(9) and (f)(13) ~~except those required to be monitored continuously~~, results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems shall be stored and available through the data link in accordance with SAE J1979 specifications. For the monitors identified in sections (e)(3), (e)(6.2.1)(C), (e)(13), (f)(3), and (f)(13) (i.e., misfire monitors, VVT system monitors, fuel system air-fuel ratio cylinder imbalance monitors), the manufacturer shall meet the requirements of section (g)(4.5.4)(C) below.

(4.5.2) The test results shall be reported such that properly functioning components and systems (e.g., "passing" systems) do not store test values outside of the established test limits.

(4.5.3) Except as required under sections (g)(4.5.4)(D) and (E) below, ~~T~~the test results shall be stored until updated by a more recent valid test result or the fault memory of the OBD II system computer is cleared. Upon fault memory being cleared, test results reported for monitors that have not yet completed since the last time the fault memory was cleared shall report values that do not indicate a failure (i.e., a test value which is outside of the test limits).

(4.5.4) Additionally, for vehicles using ISO 15765-4 (see section (g)(3.4)) as the communication protocol:

(A) The test results and limits shall be made available in the standardized format specified in SAE J1979 for the ISO 15765-4 protocol. Test results using vehicle manufacturer-defined monitor identifications (i.e., SAE J1979 OBDMIDs in the range of $E1-$FF) may not be used.

(B) Test limits shall include both minimum and maximum acceptable values and shall be reported for all test results required in section (g)(4.5.1). The test limits shall be defined so that a test result equal to either test limit is a "passing" value, not a "failing" value.

(C) The test results for the following monitors shall be calculated and reported in the standardized format specified in SAE J1979:

(i) For 2005 and subsequent model year vehicles, the misfire monitors (section (e)(3) or (f)(3))ing ~~test results shall be calculated and reported in the standardized format specified in SAE J1979~~.

(ii) For 25 percent of 2009, 50 percent of 2010, and 100 percent of 2011 and subsequent model year vehicles equipped with VVT systems, the VVT monitors (section (e)(13) or (f)(13))ing ~~test results and limits shall be stored and available in the standardized format specified in SAE J1979~~.

(iii) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year gasoline vehicles, dedicated monitors used to detect fuel system air-fuel ratio cylinder imbalance malfunctions (section (e)(6.2.1)(C)).

(D) Monitors that have not yet completed since the last time the fault memory was cleared shall report values of zero for the test result and test limits.

(E) All test results and test limits shall always be reported and the test results shall be stored until updated by a more recent valid test result or the fault memory of the OBD II system computer is cleared. For monitors with multiple pass/fail criteria (e.g., a purge flow diagnostic that can pass upon seeing a rich shift, lean shift, or engine speed change), on 25 percent of 2009, 50 percent of 2010, and 100 percent of 2011 and subsequent model year vehicles, only the test results used in the most recent decision shall be reported with valid results and limits while test results not used in the most recent decision shall report values of zero for the test results and limits (e.g., a purge flow monitoring event that passed based on seeing a rich shift shall report the results and the limits of the rich shift test and shall report values of zero for the results and limits of the lean shift and engine speed change tests).

(F) The OBD II system shall store and report unique test results for each separate diagnostic (e.g., an OBD II system with individual evaporative system diagnostics for 0.040 inch and 0.020 inch leaks shall separately report 0.040 inch and 0.020 inch test results).

(4.5.5) The requirements of section (g)(4.5) do not apply to the following monitors:

(A) For gasoline vehicles:

(i) Misfire monitors, fuel system monitors, and VVT system monitors unless otherwise specified in section (g)(4.5.4)(C); and

(ii) Oxygen sensor circuit and out-of-range monitors on 2004 through 2018 model year vehicles.

(B) For diesel vehicles:

(i) VVT system monitors unless otherwise specified in section (g)(4.5.4)(C); and

(ii) Monitored components and systems identified in sections (f)(1) through (f)(9) that are required to be monitored continuously on 2004 through 2018 model year vehicles.

(C) For all 2019 and subsequent model year vehicles:

(i) Circuit and out-of-range monitors that are required to be continuous;

(ii) Gasoline and diesel exhaust gas sensor feedback monitors specified in sections (e)(7.2.1)(C), (e)(7.2.2)(E), (f)(5.2.1)(A)(iii), (f)(5.2.1)(B)(iii), and (f)(5.2.2)(C);

(iii) Gasoline fuel system monitors specified in sections (e)(6.2.1)(A), (e)(6.2.1)(B), (e)(6.2.2), and (e)(6.2.4); and

(iv) Diesel feedback control monitors specified in sections (f)(2.2.3)(D), (f)(4.2.4), (f)(6.2.4), (f)(7.2.5), (f)(8.2.3), and (f)(9.2.7).

(4.6) Software Calibration Identification

(4.6.1) On all vehicles, a software calibration identification number (CAL ID) for the diagnostic or emission critical powertrain control unit(s) shall be made available through the standardized data link connector in accordance with the SAE J1979 specifications. Except as provided for in section (g)(4.6.3), for 2009 and subsequent model year vehicles, the OBD II system shall use a single software calibration identification number (CAL ID) for each diagnostic or emission critical powertrain control unit(s) that replies to a generic scan tool with a unique module address.

(4.6.2) 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.

(4.6.3) For 2009 and subsequent model year vehicles, manufacturers may request Executive Officer approval to respond with more than one CAL ID per diagnostic or emission critical powertrain control unit. Executive Officer approval of the request shall be based on the method used by the manufacturer to ensure each control unit will respond to a SAE J1978 scan tool with the CAL IDs in order of highest to lowest priority with regards to areas of the software most critical to emission and OBD II system performance.

(4.7) Software Calibration Verification Number

(4.7.1) All 2005[2] and subsequent model year vehicles shall use an algorithm to calculate a calibration verification number (CVN) that verifies the on-board computer software integrity in diagnostic or emission critical ~~electronically reprogrammable~~ powertrain control units. The CVN shall be made available through the standardized data link connector in accordance with the SAE J1979 specifications. The CVN shall be capable of being used to determine if the emission-related software and/or calibration data are valid and applicable for that vehicle and CAL ID. For 50 percent of 2010 and 100 percent of 2011 and subsequent model year vehicles, one CVN shall

2 The requirements of section (g)(4.7) shall supercede the requirements set forth in title 13, CCR section 1968.1(l)(4.0).

be made available for each CAL ID made available and each CVN shall be output to a generic scan tool in the same order as the CAL IDs are output to the scan tool to allow the scan tool to match each CVN to the corresponding CAL ID.

(4.7.2) Manufacturers shall request Executive Officer approval of the algorithm used to calculate the CVN. Executive Officer approval of the algorithm shall be based on the complexity of the algorithm and the difficulty in achieving the same CVN with modified calibration values.

(4.7.3) The CVN shall be calculated at least once per driving cycle and stored until the CVN is subsequently updated. ~~Except for immediately after a reprogramming event or a non-volatile memory clear 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 specifications.~~ The stored CVN value may not be erased when fault memory is erased by a generic scan tool in accordance with SAE J1979 specifications or during normal vehicle shut down (i.e., key off, engine off).

(4.7.4) When a CVN request message is received by the on-board computer, the stored CVN value shall be made available through the data link connector to a generic scan tool.

(A) Except as provided below in sections (g)(4.7.4)(B) and (C), when a CVN request is received, the on-board computer may not respond with negative response codes (i.e., may not use delayed timing in sending the CVN and may not respond with a message indicating the CVN value is not currently available) and may not respond with a default value. Default value is defined as any value or space holder that is not a valid CVN value.

(B) If the CVN request message is received within the first 120 seconds of vehicle operation after a reprogramming event or a non-volatile memory clear or within the first 120 seconds of vehicle operation after a volatile memory clear or battery disconnect, the on-board computer may respond with a negative response code directing the scan tool to wait or resend the request message after the delay. Such responses and delays shall conform to the specifications for transmitting CVN data contained in SAE J1979.

(C) If a communication malfunction is preventing access to a CVN value for reporting in response to a scan tool request, a default CVN value may be reported in lieu of a valid CVN value provided that:

(i) a pending fault code is stored or a confirmed fault code is stored with the MIL commanded on pinpointing a communication fault for the module that is unable to report a valid CVN, and

(ii) the default CVN value used cannot be mistaken for a valid CVN (e.g., all zeros or all question marks for the default value).

~~(4.7.4)~~(4.7.5) For purposes of Inspection and Maintenance (I/M) testing, manufacturers shall make the CVN and CAL ID combination information available for all 2008 and subsequent model year 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. The manufacturer shall use the most recent standardized electronic format ~~is~~

detailed in Attachment E: CAL ID and CVN Data of ARB Mail-Out #MSC 06-23, December 21, 2006, incorporated by reference. Manufacturers shall submit the CVN and CAL ID information to the Executive Officer not more than 25 days after the close of a calendar quarter.

(4.8) Vehicle Identification Number:

(4.8.1) All 2005 and subsequent model year vehicles shall have the vehicle identification number (VIN) available in a standardized format through the standardized data link connector in accordance with SAE J1979 specifications. Only one electronic control unit per vehicle shall report the VIN to an SAE J1978 scan tool.

(4.8.2) If the VIN is reprogrammable:

(A) For 2012 and subsequent model year vehicles not included in the phase-in specified in section (g)(4.8.2)(B) below, ~~if the VIN is reprogrammable,~~ all emission-related diagnostic information (i.e., all information required to be erased in accordance with SAE J1979 specifications when a Mode/Service $04 clear/reset emission-related diagnostic information command is received) shall be erased in conjunction with the reprogramming of the VIN.

(B) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles, if the VIN is reprogrammable, in conjunction with reprogramming of the VIN, the OBD II system shall erase all emission-related diagnostic information identified in section (g)(4.10.1) in all control modules that reported supported readiness for a readiness bit other than the comprehensive components readiness bit.

(4.9) ECU Name: The name of each electronic control unit that responds to an SAE J1978 scan tool with a unique address or identifier shall be communicated in a standardized format in accordance with SAE J1979 (i.e., ECUNAME in Service/Mode $09, InfoType $0A). Except as specified for vehicles with more than one engine control unit, communication of the ECU name in a standardized format is required on 50 percent of 2010, 75 percent of 2011, and 100 percent of 2012 and subsequent model year vehicles. For vehicles with more than one engine control unit (e.g., a 12 cylinder engine with two engine control units, each of which controls six cylinders), communication of the ECU name is required on all 2010 and subsequent model year vehicles.

(4.10) Erasure of Emission-Related Diagnostic Information:

(4.10.1) For purposes of section (g)(4.10), “emission-related diagnostic information” includes at least all the following:

(A) Readiness status (section (g)(4.1))

(B) Data stream information (section (g)(4.2)) including MIL status, number of stored confirmed fault codes, distance traveled (or engine run time for engines not utilizing vehicle speed information) while MIL activated, number of warm-up cycles since fault memory last cleared, distance traveled (or engine run time for engines not utilizing vehicle speed information) since fault memory last cleared, and monitor status.

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

(D) Pending and confirmed fault codes (section (g)(4.4))

(E) Test results (section (g)(4.5))

(4.10.2) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles, the emission-related diagnostic information shall be erased as a result of a command by any scan tool (generic or enhanced) and may be erased if the power to the on-board computer is disconnected. At a minimum, the emission-related diagnostic information shall be erased as a result of a command by a scan tool while in the key on, engine off position. Further, except as provided for in sections (g)(4.4.6)(D), (g)(4.8.2), and (g)(4.10.4), if any of the emission-related diagnostic information is erased as a result of a command by a scan tool, all emission-related diagnostic information shall be erased from all control units that reported supported readiness for a readiness bit other than the comprehensive component readiness bit. For these control units, the OBD II system may not erase a subset of the emission-related diagnostic information in response to a scan tool command (e.g., in such cases, the OBD II system may not erase only one of three stored fault codes or only information from one control unit without erasing information from the other control unit(s)).

(4.10.3) A manufacturer may request Executive Officer approval to be exempt from erasing all emission-related diagnostic information from all control units while in the key on, engine off position for the purposes of safety or component protection. The manufacturer shall propose alternate conditions (i.e., conditions other than or in addition to the key on, engine off position) to erase the emission-related diagnostic information. The Executive Officer shall approve the alternate conditions upon determining that the manufacturer has demonstrated all of the following:

(A) The alternate erasure conditions are required for safety or component protection,

(B) The manufacturer defines conditions that can be reasonably satisfied in the vehicle service environment in which all emission-related diagnostic information from control units shall be erased. The OBD II system may not allow a scan tool to erase a subset of the emission-related diagnostic information, and

(C) All details of the erasure protocol during these alternate conditions are reported pursuant to title 13, CCR, section 1969.

(4.10.4) A manufacturer may request Executive Officer approval for an alternate erasure protocol in cases where a malfunction activates a component-protection or safety-related default mode. The Executive Officer shall approve the request for an alternate erasure protocol upon determining that the manufacturer has demonstrated all of the following:

(A) The default mode is activated for component protection or safety purposes,

(B) The alternate erasure protocol applies solely to control units that report supported readiness for only the comprehensive component readiness bit. All emission-related diagnostic information from all control units that report supported readiness for readiness bits other than comprehensive components shall be erased pursuant to (g)(10.4.2) or (g)(10.4.3) above,

(C) There exists key on, engine off position conditions that can be reasonably satisfied in the vehicle service environment in which all emission-related diagnostic information in these control module(s) can be erased, and

(D) All details of the alternate erasure protocol are reported pursuant to title 13, CCR, section 1969.

(5) *In-use Performance Ratio Tracking Requirements*:

(5.1) For each monitor required in sections (e) and (f) 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 specifications.

(5.2) Numerical Value Specifications:

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

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

(B) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event, etc.) 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, etc.). 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.

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

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

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

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

(5.2.2) For the ratio:

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

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

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

(6) ~~*Engine Run Time*~~ *Vehicle Operation Tracking Requirements*:

(6.1) For all 2010 and subsequent model year medium-duty vehicles equipped with 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:

(6.1.1) Total engine run time;

(6.1.2) Total idle run time (with "idle" defined as accelerator pedal released by driver, engine speed greater than or equal to 50 to 150 rpm below the normal warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission), PTO not active, and either vehicle speed less than or equal to one mile per hour or engine speed less than or equal to 200 rpm above normal warmed-up idle);

(6.1.3) Total run time with PTO active.

(6.1.4) Total run time with EI-AECD #1 active;

(6.1.5) Total run time with EI-AECD #2 active; and so on up to

(6.1.6) Total run time with EI-AECD #n active.

(6.1.7) For 2010 through 2012 model year vehicles, manufacturers may define "idle" in section (g)(6.1.2) above as accelerator pedal released by driver, vehicle speed less than or equal to one mile per hour, and PTO not active.

(6.2) For all 2010 and subsequent model year light-duty vehicles equipped with 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:

(6.2.1) Total engine run time;

(6.2.2) Total run time with EI-AECD #1 active;

(6.2.3) Total run time with EI-AECD #2 active; and so on up to

(6.2.4) Total run time with EI-AECD #n active.

(6.3) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles with gasoline, diesel, or alternate-fueled engines, manufacturers shall implement software algorithms to individually track and report in a standardized format the following:

(6.3.1) Total engine run time

(6.3.2) Total engine idle run time

(6.3.3) Total distance traveled

(6.3.4) Total fuel consumed

(6.3.5) Total positive kinetic energy

(6.3.6) Total engine output energy

(6.3.7) Total propulsion system active time

(6.3.8) Total idle propulsion system active time

(6.3.9) Total city propulsion system active time

(6.4) For 25 percent of 2019, 50 percent of 2020, and 100 percent of 2021 and subsequent model year plug-in hybrid electric vehicles, manufacturers shall implement software algorithms to individually track and report in a standardized format the following:

(6.4.1) Total distance traveled in charge depleting operation with engine off

(6.4.2) Total distance traveled in charge depleting operation with engine running

(6.4.3) Total distance traveled in driver-selectable charge increasing operation

(6.4.4) Total fuel consumed in charge depleting operation
(6.4.5) Total fuel consumed in driver-selectable charge increasing operation
(6.4.6) Total grid energy consumed in charge depleting operation with engine off
(6.4.7) Total grid energy consumed in charge depleting operation with engine running
(6.4.8) Total grid energy into the battery

(6.5) For 30 percent of 2019, 60 percent of 2020, and 100 percent of 2021 and subsequent model year vehicles equipped with active off-cycle credit technologies, manufacturers shall submit a plan for Executive Officer approval in accordance with (g)(6.8) to implement software algorithms to individually track and report in a standardized format the following:
(6.5.1) Active Off-Cycle Credit Technology #1;
(6.5.2) Active Off-Cycle Credit Technology #2; and so on up to
(6.5.3) Active Off-Cycle Credit Technology #n.

(6.~~3~~6) Numerical Value Specifications:
(6.~~3~~6.1) For each counter specified in section (g)(6.1) and (g)(6.2):
(A) Each number shall conform to the standardized format specified in SAE J1979.
(B) 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.
(C) 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.
(6.6.2) For each counter specified in section (g)(6.3) through (g)(6.5):
(A) Each number shall be stored twice, one representing the lifetime of the vehicle and the second representing recent operation.
(i) For the lifetime counters, each number shall be reset to zero only when data stored for the in-use performance tracking is reset to zero, as specified in section (g)(5.2.1)(B).
(ii) For the recent operation counters, each number shall be reset to zero when the recent operation counter for cumulative propulsion system active time reaches 50 hours or a scan tool command to clear fault codes is received.
(B) If any of the individual lifetime counters reach the maximum value, all lifetime counters shall be divided by two before any are incremented again to avoid overflow problems.
(C) The counters shall be made available to a generic scan tool in accordance with the SAE J1979 specifications and may be rescaled when displayed, if required by the SAE specifications (e.g., seconds to hours, minutes, and seconds).

(6.~~4~~7) Specifications of EI-AECDs
(6.~~4~~7.1) For purposes of section (g)(6.~~4~~7), the following terms shall be defined as follows:
(A) “Purpose” is defined as the objective of the EI-AECD when it is activated (e.g., EGR valve protection);

(B) “Action” is defined as a specific component/element act that is commanded when the EI-AECD is activated (e.g., EGR system is derated);

(C) “Parameter” is defined as a component/element (e.g., ECT, oil temperature) used to determine when to activate the EI-AECD; and

(D) “Condition” is defined as the specific characteristic/state exhibited by the parameter (e.g., ECT above 100 degrees Celsius) that triggers activation of the EI-AECD.

(6.~~4~~7.2) Each unique combination of action, parameter, and condition within a purpose shall be tracked as a separate EI-AECD and increment the timer(s) at all times the condition necessary to activate the EI-AECD is present.

(A) For EI-AECDs that implement an action of variable degree based on the varying characteristics of a parameter (e.g., derate EGR more aggressively as engine oil temperature continues to increase), the EI-AECD shall be tracked by incrementing two separate timers within a single EI-AECD (e.g., EI-AECD #1 timer 1 and EI-AECD #1 timer 2) as follows:

(i) The first of the two timers shall be incremented whenever the EI-AECD is commanding some amount of reduced emission control effectiveness up to but not including 75 percent of the maximum reduced emission control effectiveness that the EI-AECD is capable of commanding during in-use vehicle or engine operation. For example, an overheat protection strategy that progressively derates EGR and eventually shuts off EGR as oil temperature increases would accumulate time for the first timer from the time derating of EGR begins up to the time that EGR is derated 75 percent. As a second example, an overheat protection strategy that advances fuel injection timing progressively up to a maximum advance of 15 degrees crank angle as the engine coolant temperature increases would accumulate time for the first timer from the time advance is applied up to the time that advance reaches 11.25 degrees (75 percent of the maximum 15 degrees).

(ii) The second of the two timers shall be incremented whenever the EI-AECD is commanding 75 percent or more of the maximum reduced emission control effectiveness that the EI-AECD is capable of commanding during in-use vehicle or engine operation. For example, the second timer for the first example EI-AECD identified in section (g)(6.~~4~~7.2)(A)(i) would accumulate time from the time that EGR is derated 75 percent up to and including when EGR is completely shut off. For the second example EI-AECD identified in section (g)(6.~~4~~7.2)(A)(i), the second timer would accumulate time from the time fuel injection timing advance is at 11.25 degrees up to and including the maximum advance of 15 degrees.

(6.~~4~~7.3) A manufacturer may request Executive Officer approval to combine multiple unique actions, parameters, and/or conditions to be tracked within a single EI-AECD. The manufacturer shall submit a plan for combining, tracking, and incrementing the EI-AECD to the Executive Officer for

approval. Executive Officer approval of the plan shall be based on the effectiveness and the equivalence of the incrementing plan to determine the amount of EI-AECD activity per condition relative to the measure of EI-AECD activity under section (g)(6.47.2).

(6.47.4) For EI-AECDs that are activated solely due to elevation, the timer shall be incremented only for the portion of EI-AECD activation when the elevation is below 8000 feet (e.g., the timer for an EI-AECD that is activated when the elevation is above 5000 feet shall be incremented only when the EI-AECD is active and the elevation is below 8000 feet).

(6.47.5) For EI-AECDs that are initially activated due to engine warm-up and are subsequently reactivated after the engine has warmed up, the timer shall be incremented only when the EI-AECD is active after the initial engine warm-up (e.g., an EI-AECD that turns off an emission control at low engine coolant temperature would not increment the timer during initial warm-up but would increment the timer if coolant temperature subsequently dropped below the low temperature and reactivated the EI-AECD later in the drive cycle).

(6.47.6) If more than one EI-AECD is currently active, the timers for both EI-AECDs shall accumulate time, regardless if there is overlap or redundancy in the commanded action (e.g., two different EI-AECDs independently but simultaneously commanding EGR off shall both accumulate time in their respective timers).

(6.8) Specifications of Active Off-Cycle Credit Technologies: Manufacturers shall submit a plan for Executive Officer approval of tracking of active off-cycle credit technologies. Executive Officer approval of the plan shall be granted upon determination that the manufacturer has developed counters that will accurately track the off-cycle technology usage per the criteria in subsections (g)(6.8.1) or (g)(6.8.2) below. Each active off-cycle credit technology shall be tracked with two separate counters within a single active off-cycle credit technology (e.g., Active Off-Cycle Credit Technology #1 counter 1 and Active Off-Cycle Credit Technology #1 counter 2) as follows:

(6.8.1) For active off-cycle credit technologies where the driver has no direct control over the activation of the technology (e.g., active grill shutters), counter 1 shall increment (time) whenever the technology is active (i.e., in a state intended to reduce CO_2 emissions). For technologies that can have a varying amount of action (e.g., an active ride height system that progressively decreases the ride height based on increasing vehicle speed), counter 1 shall increment (time) when the system is active at a level representing less than 75 percent of the maximum adjustment or authority and counter 2 shall increment (time) when the system is active at a level representing 75 percent or more of its maximum adjustment or authority.

(6.8.2) For active off-cycle credit technologies where the driver must take action to achieve the CO_2 reduction benefits of the technology (e.g., driver coaching or feedback-based systems alerting the driver to take action to avoid unnecessary braking or acceleration), counter 1 shall increment (time) when the technology is enabled and counter 2 shall increment

(counts) when system prompts the driver and the driver positively responds to the prompt such that the benefits of the technology are achieved. As an example, a vehicle may have a driver selectable 'eco' mode that prompts the driver to release the accelerator pedal earlier than normal when the vehicle senses an upcoming braking event is needed, therefore encouraging the driver to coast down instead of maintaining speed and braking later. In such a case, counter 1 would identify the cumulative time the 'eco' mode was selected and counter 2 would count the number of occurrences where the driver was alerted to an upcoming need for braking and the driver positively responded by releasing the accelerator and coasting rather than maintaining speed and then transitioning directly to braking.

(6.9) For data parameters specified in sections (g)(6.3) through (g)(6.5), all data directly collected from vehicles owned by a private individual by either ARB or by a third party contracted directly by ARB shall be:

(6.9.1) Obtained with the voluntary and informed consent of the vehicle operator; and

(6.9.2) Collected and stored in a manner in accordance with required data security and record keeping policies applicable to ARB to protect the data from: (a) unauthorized access; or (b) being used to identify the individual vehicle (i.e., vehicle identification number or license plate number) or registered owner.

(6.10) Nothing in section (g)(6) obligates a vehicle manufacturer to collect the data specified in sections (g)(6.3) through (g)(6.5) from individual vehicles or make the data available to any party other than ARB.

(6.11) The data specified in sections (g)(6.3) through (g)(6.5) reflect vehicle operation in various real world conditions including different driving, environmental, and vehicle weight conditions that may not correspond to regulated test procedures. Vehicle fuel consumption and greenhouse gas (GHG) emission levels will vary based on such conditions and as a result, this data may not correspond to the test conditions and/or test procedures associated with California's GHG emission standards specified in title 13 CCR §1961.3. Compliance with the GHG emission standards applicable to 2017 and subsequent model year passenger cars, light-duty trucks, and medium-duty passenger vehicles is determined in accordance with the standards and test procedures specified in title 13, CCR §1961.3.

(7) *Exceptions to Standardization Requirements*.

(7.1) For medium-duty vehicles equipped with a diesel engine certified on an engine dynamometer, a manufacturer may request Executive Officer approval to use both: (1) an alternate diagnostic connector, and emission-related message structure and format in lieu of the standardization requirements in sections (g)(2) and (4) that refer to SAE J1962, SAE J1978, and SAE J1979, and (2) an alternate communication protocol in lieu of the identified protocols in section (g)(3). The Executive Officer shall approve the request if the alternate diagnostic connector, communication protocol, and emission-related message format and structure requested by the

manufacturer meet the standardization requirements in title 13, CCR section 1971.1 applicable for 2013 and subsequent model year heavy-duty diesel engines and the information required to be made available in section (g)(4.1) through (g)(6) (e.g., readiness status, data stream parameters, permanent fault codes, ~~engine run time~~vehicle operation tracking data) is available in a standardized format through the alternate emission-related message format.

(7.2) For 2004 model year vehicles only, wherever the requirements of sections (g)(2) and (g)(4) reflect a substantive change from the requirements of title 13, CCR sections 1968.1(e), (f), (k), or (l) for the 2003 model year vehicles, the manufacturer may request Executive Officer approval to continue to use the requirements of section 1968.1 in lieu of the requirements of sections (g)(2) and (g)(4). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that software or hardware changes would be required to comply with the requirements of sections (g)(2) and (g)(4) and that the system complies with the requirements of sections 1968.1(e), (f), (k), and (l).

(7.3) Whenever the requirements in section (g) of this regulation require a manufacturer to meet a specific phase-in schedule:

(7.3.1) The phase-in percentages shall be based on the manufacturer's projected sales volume for all vehicles subject to the requirements of title 13, CCR section 1968.2 unless specifically stated otherwise in section (g).

(7.3.2) Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) except as specifically noted elsewhere in section (g).

(7.3.3) Small volume manufacturers may use an alternate phase-in schedule in accordance with section (g)(7.3.2) in lieu of the required phase-in schedule or may meet the requirement on all vehicles by the final year of the phase-in in lieu of meeting the specific phase-in requirements for each model year.

(7.4) Emissions neutral diagnostics are exempt from the requirements of section (g) for fault code storage, freeze frame information, and test results.

(7.5) Small volume manufacturers may meet the requirement of section (g)(4.2.2)(E) on all 2022 and subsequent model year vehicles in lieu of the phase-in schedule described in section (g)(4.2.2)(E).

(h) *Monitoring System Demonstration Requirements For Certification*

(1) *General*.

(1.1) Certification requires that manufacturers submit emission test data from one or more durability demonstration test vehicles (test vehicles). For applications certified on engine dynamometers, engines may be used instead of vehicles.

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

requirements.

(1.3) For alternate-fueled vehicles, 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 that the appropriate monitors are tested with respect to the components and systems on the vehicle and that the monitors are tested on the appropriate fuel or fuel combinations.

~~(1.3)~~(1.4) For flexible fuel vehicles capable of operating on more than one fuel or fuel combinations, the manufacturer shall submit a plan for providing emission test data to the Executive Officer for approval. The Executive Officer shall approve the plan if it is determined to be representative of expected in-use fuel or fuel combinations and provides accurate and timely evaluation of the monitored systems.

(1.5) For vehicles that are equipped with components/systems defined by any of the monitoring requirements in section (e) and components/systems defined by any of the monitoring requirements in section (f) (e.g., vehicles with gasoline lean-burn systems that utilize both gasoline and diesel emission control technologies), 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 that the appropriate monitors are tested with respect to the components and systems on the vehicle and to the monitoring plan approved by the Executive Officer in accordance section (d)(7.2).

(2) *Selection of Test Vehicles*:

(2.1) Prior to submitting any applications for certification for a model year, a manufacturer shall notify the Executive Officer of the test groups planned for that model year. The Executive Officer will then select the test group(s) that the manufacturer shall use as demonstration test vehicles to provide emission test data. The selection of test vehicles for production vehicle evaluation, as specified in section (j), may take place during this selection process.

(2.2) A manufacturer certifying one to five test groups in a model year shall provide emission test data from a test vehicle from one test group. A manufacturer certifying six to fifteen test groups in a model year shall provide emission test data from test vehicles from two test groups. A manufacturer certifying sixteen or more test groups in a model year shall provide emission test data from test vehicles from three test groups. The Executive Officer may waive the requirement for submittal of data from one or more of the test groups if data have been previously submitted for all of the test groups.

(2.3) For the test vehicle(s), a manufacturer shall use a certification emission durability test vehicle(s), a representative high mileage vehicle(s), or a vehicle(s) aged to the end of the full useful life using an ARB-approved alternative durability procedure (ADP). For the gasoline evaporative system monitor testing, a manufacturer may use a production-representative vehicle in lieu of the vehicles specified above.

(3) *Required Testing for Gasoline/Spark-~~i~~Ignited ~~v~~Vehicles*:

Except as provided below, the manufacturer shall perform single-fault testing

based on the applicable FTP test with the following components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the requirements of section (e):

(3.1) Exhaust Gas Sensors:

(3.1.1) The manufacturer shall perform a test with all primary oxygen sensors (conventional switching sensors and wide range or universal sensors) used for fuel control simultaneously possessing a response rate deteriorated to the malfunction ~~criteria~~ limit calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) in section (e)(7.2.1)(A). For conventional switching sensors, the manufacturer shall perform a test for each of the following malfunctions: (1) the single worst case response rate malfunction among all symmetric and asymmetric patterns required by section (e)(7.2.1)(A), and (2) the worst case asymmetric response rate malfunction that results in slower transitions from rich-to-lean or lean-to-rich sensor output (i.e., asymmetric slow response malfunction). For wide range or universal sensors, the manufacturer shall perform a test for each of the following malfunctions: (1) the single worst case response rate malfunction among all symmetric and asymmetric patterns required by section (e)(7.2.1)(A), and (2) the symmetric response rate malfunction that results in slower transitions from rich-to-lean and lean-to-rich sensor output (i.e., symmetric slow response malfunction). For systems where the same response rate pattern meets the criteria of (1) and (2) above, only one demonstration test is required. For the response rate patterns not tested, the manufacturer is required to provide the data and/or engineering analysis used to determine that the tested response pattern for criterion (1) will result in the worst case emissions compared to all the other response rate malfunctions. Manufacturers shall also perform a test for any other oxygen sensor parameter of the primary oxygen sensor that can cause vehicle emissions to exceed the emission threshold malfunction ~~threshold~~ criteria in section (e)(7.2.1)(A) (e.g., 1.5 times the applicable standards due to a shift in air/fuel ratio at which oxygen sensor switches, decreased amplitude~~, etc.~~). Manufacturers shall also perform a test of any oxygen sensor parameter of the secondary oxygen sensor that can cause vehicle emissions to exceed the emission threshold malfunction criteria in section (e)(7.2.2)(A). When performing additional test(s), all primary and secondary (if applicable) oxygen sensors used for fuel control shall be operating at the malfunction criteria limit for the applicable parameter only. All other primary and secondary oxygen sensor parameters shall be with normal characteristics.

(3.1.2) For vehicles utilizing sensors other than oxygen sensors for primary fuel control (e.g., hydrocarbon sensors~~, etc.~~), the manufacturer shall submit, for Executive Officer approval, a demonstration test plan for performing testing of all of the sensor parameters that can cause vehicle emissions to exceed the emission threshold malfunction ~~threshold~~ criteria (e.g., 1.5 times the applicable standards). The Executive Officer shall approve the plan if it is determined that it will provide data that will assure proper performance of the diagnostics of the sensors, consistent with the intent

of section (h).

(3.2) EGR System: ~~The manufacturer shall perform a test at the low flow limit.~~The manufacturer shall perform a test at each flow limit calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) in sections (e)(8.2.1) and (e)(8.2.2).

(3.3) VVT System: For 2006 through 2008 model year Low Emission II applications and all 2009 and subsequent model year vehicles, the manufacturer shall perform a test at each target error limit and slow response limit calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the FTP standard) in sections (e)(13.2.1) and (13.2.2). In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.4) Fuel System:

(3.4.1) For vehicles with adaptive feedback based on the primary fuel control sensor(s), the manufacturer shall perform a test with the adaptive feedback based on the primary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer and calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) in section (e)(6.2.1)(A)~~ to detect a malfunction before emissions exceed the malfunction threshold (e.g., 1.5 times the applicable standards)~~. 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.

(3.4.2) For vehicles with feedback based on a secondary fuel control sensor(s) and subject to the malfunction criteria in section (e)(6.2.1)(B), 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 and calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) in section (e)(6.2.1)(B)~~ to detect a malfunction before emissions exceed the malfunction threshold (e.g., 1.5 times the applicable standards)~~.

(3.4.3) For vehicles subject to the malfunction criteria in section (e)(6.2.1)(C) (monitoring of air-fuel ratio cylinder imbalance faults), the manufacturer shall perform a test at the malfunction limit(s) calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) in section (e)(6.2.1)(C). The manufacturer shall perform the test at the rich limit and another test at the lean limit with a fault induced on the worst case cylinder for each limit. The manufacturer shall submit data and/or analysis demonstrating that a fault of the cylinder(s) will result in the worst case emissions for each malfunction limit.

~~(3.4.3)~~(3.4.4) For other fuel metering or control systems, the manufacturer shall perform a test at the criteria limit(s).

~~(3.4.4)~~(3.4.5) ~~For purposes of fuel system testing, the fault(s) induced may result in a uniform distribution of fuel and air among the cylinders. Non-uniform~~

~~distribution of fuel and air used to induce a fault may not cause misfire.~~ In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.5) Misfire: The manufacturer shall perform a test at the malfunction ~~criteria~~ limit calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) ~~specified~~ in section (e)(3.2.2)(A). ~~The testing is not required for diesel applications.~~ For plug-in hybrid electric vehicles, the manufacturer shall perform a test at the malfunction limit calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) specified in section (e)(3.2.3)(B). A misfire monitor demonstration test is not required for plug-in hybrid electric vehicles using the malfunction criteria in section (e)(3.2.3)(A).

(3.6) Secondary Air System: The manufacturer shall perform a test at the low flow limit calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) in sections (e)(5.2.2)(A), (e)(5.2.3)(A), and (5.2.3)(B). ~~Manufacturers performing only a functional check in accordance with the provisions of section (e)(5.2.2)(B) or (e)(5.2.4) shall perform a test at the functional check flow malfunction criteria.~~

(3.7) Catalyst System: The manufacturer shall perform a test using a catalyst system deteriorated to the applicable emission threshold malfunction criteria (e.g., 1.5 times the standard) in section (e)(1.2) using methods established by the manufacturer in accordance with sections (e)(1.2.~~6~~7) and (1.2.~~7~~8).

(3.8) Heated Catalyst Systems: The manufacturer shall perform a test at the malfunction ~~criteria~~ limit established by the manufacturer and calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) in section (e)(2.2.1).

(3.9) Cold Start Emission Reduction Strategy: The manufacturer shall perform a test at the malfunction limit calibrated to the emission threshold malfunction criteria (e.g., 1.5 times the standard) for each component monitored according to section (e)(11.2.1)(A) or (e)(11.2.2)(B). In conducting the cold start emission reduction strategy demonstration tests, the manufacturer may use computer modifications to cause the cold start emission reduction strategy to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

~~(3.9)~~(3.10) Other Emission Control or Source ~~s~~Systems: The manufacturer shall conduct demonstration tests for all other emission control components designed and calibrated to an emission threshold malfunction criteria (e.g., 1.5 times any of the applicable emission standards) (e.g., hydrocarbon traps, adsorbers~~, etc.~~) under the provisions of section (e)(16).

(3.11) Evaporative System: For 2017 and subsequent model year vehicles, the manufacturer shall perform a test of the evaporative system monitor with a leak size specified in section (e)(4.2.2)(C) (i.e., leak caused by a 0.020” inch diameter orifice) or an alternate orifice diameter, if approved, under section

(e)(4.2.3) or (e)(4.2.4). The manufacturer shall use an orifice of this leak size described in section (e)(4.2.1) to conduct the testing. The manufacturer shall perform at least two tests, with the leak implanted at the following locations: (1) near the fuel fill pipe, either at the fuel cap or between the fuel cap and the fuel tank, and (2) near the canister, either in the vapor line between canister and fuel tank or between the canister and purge valve. If the vehicle has multiple canisters or fuel fill pipes, the manufacturer must perform the required tests above for each canister and fuel fill pipe. The manufacturer may propose to implant a leak at a different location (e.g., near the purge valve), with Executive Officer approval based on data and/or information submitted by the manufacturer showing the location more effectively demonstrates leaks for that particular evaporative system design.

(3.12) For each of the testing requirements of section (h)(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 threshold malfunction criteria, 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 check of the system(s) is required.

(3.13) For each of the testing requirements of section (h)(3) except sections (h)(3.4.3) and (h)(3.5), when performing a test, all components or systems used in parallel for the same purpose (e.g., separate VVT actuators on the intake valves for Bank 1 and Bank 2) shall be simultaneously deteriorated to the malfunction criteria limit. Components or systems in series or used for different purposes (e.g., upstream and downstream exhaust gas sensors in a single exhaust bank) may not be simultaneously deteriorated to the malfunction criteria limit.

~~(3.10)~~(3.14) The manufacturer may electronically simulate deteriorated components if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction but may not make any vehicle control unit modifications (unless otherwise excepted above or exempted pursuant to this section) when performing demonstration tests. All equipment necessary to duplicate the demonstration test must be made available to the ARB upon request. A manufacturer may request Executive Officer approval to electronically simulate a deteriorated component with engine control unit modifications. The Executive Officer shall approve the request upon determining the manufacturer has submitted data and/or engineering analysis demonstrating that is technically infeasible, very difficult, and/or resource intensive to implant the fault with modifications external to the engine control unit.

(3.15) Small volume manufacturers may meet the requirement of section (h)(3.11) on all 2022 and subsequent model year vehicles in lieu of the 2017 and subsequent model year vehicles.

(4) *Required Testing for Diesel/Compression-~~i~~Ignition ~~v~~Vehicles*:
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 section (f).

(4.1) NMHC Catalyst: The manufacturer shall perform a separate test for each monitored NMHC catalyst(s) that is used for a different purpose (e.g., oxidation catalyst upstream of a PM filter, NMHC catalyst used downstream of an SCR catalyst). The catalyst(s) being evaluated shall be deteriorated to the applicable malfunction ~~criteria~~ limit(s) established by the manufacturer and calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) in section (f)(1.2.2)(A) using methods established by the manufacturer in accordance with section (f)(1.2.4). For each monitored NMHC catalyst(s), the manufacturer shall also demonstrate that the OBD II 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.

(4.2) NOx Catalyst: The manufacturer shall perform a separate test for each monitored NOx catalyst(s) that is used for a different purpose (e.g., passive lean NOx catalyst, SCR catalyst). The catalyst(s) being evaluated shall be deteriorated to the applicable malfunction ~~criteria~~ limit(s) established by the manufacturer and calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) in sections (f)(2.2.2)(A) and (f)(2.2.3)(A)(i) using methods established by the manufacturer in accordance with section (f)(2.2.4). For each monitored NOx catalyst(s), the manufacturer shall also demonstrate that the OBD II 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.

(4.3) Misfire Monitoring: For 2010 and subsequent model year vehicles subject to section ~~(f)(3.2.2)(A)(i) or~~ (f)(3.2.5), the manufacturer shall perform a test at the malfunction ~~criteria~~ limit calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) ~~specified~~ in section ~~(f)(3.2.2)(A)(i) or~~ (f)(3.2.5). A misfire monitor demonstration test is not required for vehicles not subject to ~~section (f)(3.2.2)(A)(i) and not subject to~~ section (f)(3.2.5).

(4.4) Fuel System: The manufacturer shall perform a separate test for each applicable malfunction limit established by the manufacturer for the fuel system parameters (e.g., fuel pressure, injection timing, injection quantity~~)~~) and calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) ~~specified~~ in sections (f)(4.2.1)(A), (f)(4.2.2)(A), ~~through~~ and (f)(4.2.3)(A). 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. For testing of the malfunction limits in section (f)(4.2.1) on vehicles required to meet section (f)(4.2.5)(B), the manufacturer shall perform a test for each of the following that is applicable: (1) with a high side fault (i.e., fault that causes too much pressure) that affects all injectors equally, (2) with a low side fault (i.e., fault that causes too little pressure) that affects all injectors equally, and (3) for systems that have single component failures which could affect a single injector, with a fault that affects the worst case injector (i.e., a fault on the injector that will result in the worst case emissions). For testing of the

malfunction limits in sections (f)(4.2.2) and (f)(4.2.3) on vehicles required to meet section (f)(4.2.5)(C), the manufacturer shall perform a test for each of the following: (1) with a high side fault (e.g., too much fuel quantity, too advanced timing) that affects all injectors equally, (2) with a low side fault (e.g., too little fuel quantity, too retarded timing) that affects all injectors equally, and (3) with a fault that affects the worst case injector (i.e., a fault on the injector that will result in the worst case emissions). 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.

(4.5) Exhaust Gas Sensor: The manufacturer shall perform a test for each exhaust gas sensor parameter at each malfunction limit calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) in sections (f)(5.2.1)(A)(i), (f)(5.2.1)(B)(i), and (f)(5.2.2)(A). 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.

(4.6) EGR System: The manufacturer shall perform a test at each flow, slow response, and cooling limit calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) in sections (f)(6.2.1)(A), (f)(6.2.2)(A), ~~through~~ (f)(6.2.3)(A), and (f)(6.2.5)(A). In conducting the EGR cooler performance demonstration test, the EGR cooler(s) being evaluated shall be deteriorated to the applicable malfunction criteria using methods established by the manufacturer in accordance with section (f)(6.2.5)(C). 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 or that there is no reasonably feasible method to induce a hardware malfunction.

(4.7) Boost Pressure Control System: The manufacturer shall perform a test at each boost, response, and cooling limit calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) in sections (f)(7.2.1)(A), (f)(7.2.2)(A), (f)(7.2.3)(A)(i), (f)(7.2.3)(B)(i), ~~through~~ and (f)(7.2.4)(A). In conducting the charge air undercooling demonstration test, the charge air cooler(s) being evaluated shall be deteriorated to the applicable malfunction ~~criteria~~ limit established by the manufacturer in section (f)(7.2.4)(A) using methods established by the manufacturer in accordance with section (f)(7.2.4)(C).

(4.8) NOx Adsorber: The manufacturer shall perform a test using a NOx adsorber(s) deteriorated to the malfunction ~~criteria~~ limit calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) in section (f)(8.2.1)(A). The manufacturer shall also demonstrate that the OBD II 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.

(4.9) PM Filter: The manufacturer shall perform a test using a PM filter(s) deteriorated to each applicable malfunction ~~criteria~~ limit calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) in sections (f)(9.2.1)(A), (f)(9.2.2)(A), and (f)(9.2.4)(A)(i). The manufacturer shall also demonstrate that the OBD II 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.

(4.10) Cold Start Emission Reduction Strategy: The manufacturer shall perform a test at the malfunction limit calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) for the system or for each component monitored according to section (f)(12.2.2). In conducting the cold start emission reduction strategy demonstration tests, the manufacturer may use computer modifications to cause the cold start emission reduction strategy to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(4.11) VVT System: The manufacturer shall perform a test at each target error limit and slow response limit calibrated to the emission threshold malfunction criteria (e.g., 2.0 times the standard) in sections (f)(13.2.1) and (f)(13.2.2). In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction.

(4.12) Other Emission Control or Source Systems: The manufacturer shall conduct demonstration tests for all other emission control components designed and calibrated to an emission threshold malfunction criteria (e.g., 1.5 times any of the applicable emission standards) (e.g., hydrocarbon traps, adsorbers) under the provisions of section (f)(16).

~~(4.12)~~(4.13) For each of the testing requirements of section (h)(4), 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 threshold malfunction criteria, 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~~ check of the system(s) is required.

~~(4.13)~~(4.14) For each of the testing requirements of section (h)(4) except sections (h)(4.3) and (h)(4.4), when performing a test, all components or systems used in parallel for the same purpose (e.g., separate VVT actuators on the intake valves for Bank 1 and Bank 2, separate NOx converting catalysts on parallel exhaust banks) shall be simultaneously deteriorated to the malfunction criteria limit. Components or systems in series or used for different purposes (e.g., upstream and downstream exhaust gas sensors in a single exhaust bank, separate high pressure and low pressure EGR systems) may not be

simultaneously deteriorated to the malfunction criteria limit.

~~(4.14)~~(4.15) The manufacturer may electronically simulate deteriorated components if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction but may not make any engine control unit modifications (unless otherwise provided above or exempted pursuant to this section) when performing demonstration tests. All equipment necessary to duplicate the demonstration test must be made available to ARB upon request. A manufacturer may request Executive Officer approval to electronically simulate a deteriorated component with engine control unit modifications. The Executive Officer shall approve the request upon determining the manufacturer has submitted data and/or engineering analysis demonstrating that it is technically infeasible, very difficult, and/or resource intensive to implant the fault with modifications external to the engine control unit.

(5) *Testing Protocol*:

(5.1) Preconditioning:

(5.1.1) Implanting of malfunction: The manufacturer shall set the system or component on the test vehicle for which detection is to be tested at the criteria limit(s) prior to conducting the first preconditioning cycle in section (h)(5.1.2) below. If a second preconditioning cycle is permitted in accordance with section (h)(5.1.3) below, 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.

(5.1.2) Preconditioning cycle: The manufacturer shall use an applicable cycle (i.e., FTP cycle, SET cycle, or Unified ~~C~~cycle) for preconditioning test vehicles prior to conducting ~~each of the above emission~~the tests under section (h)(5.2) below. The manufacturer may not require the test vehicle to be cold soaked prior to conducting preconditioning cycles in order for the monitoring system testing to be successful.

(5.1.3) Optional second preconditioning cycle: A manufacturer may request Executive Officer approval to use a second preconditioning cycle. Upon determining that a manufacturer has provided data and/or an 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, either identical to the ~~initial~~ first preconditioning cycle under section (h)(5.1.2)~~,~~ or a ~~F~~federal Highway Fuel Economy Driving Cycle, following a ten minute (20 minutes for medium duty engines certified on an engine dynamometer) hot soak after the ~~initial~~ first preconditioning cycle. ~~The manufacturer may not require the test vehicle to be cold soaked prior to conducting preconditioning cycles in order for the monitoring system testing to be successful.~~

(5.1.4) Exceptions for testing of gasoline evaporative system monitor: Manufacturers are not required to meet the requirements of section (h)(5.1) for testing of the gasoline evaporative system monitor under

section (h)(3.11).

(5.2) Demonstration Test Sequence:

~~(5.2.1) The manufacturer shall set the system or component on the test vehicle for which detection is to be tested at the criteria limit(s) prior to conducting the applicable preconditioning cycle(s). If a second preconditioning cycle is permitted in accordance with section (h)(5.1) 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.~~

~~(5.2.2)~~(5.2.1) Demonstration test cycle: After the manufacturer has met the preconditioning requirements under section (h)(5.1), the test vehicle shall be operated over the applicable cycle (i.e., the FTP cycle, Unified cycle, or alternate monitoring conditions approved under section (d)(3.1.3)) to allow for the initial detection of the tested system or component malfunction (i.e., storage of a pending fault code). ~~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 ~~driving~~ test cycle. The manufacturer is not required to run this demonstration test cycle if initial detection of the tested system or component malfunction was achieved during preconditioning under section (h)(5.1) above.

(5.2.2) Optional second demonstration test cycle: If the monitor is designed to run during conditions other than the FTP cycle (i.e., the Unified cycle or alternate monitoring conditions approved under section (d)(3.1.3)), the manufacturer may operate the test vehicle over those conditions (e.g., operate the vehicle over a second Unified cycle) prior to the exhaust emission test required in section (h)(5.2.3) below to allow for the OBD II system to store the confirmed fault code and illuminate the MIL.

(5.2.3) Exhaust emission test: The manufacturer shall operate the test vehicle over the applicable exhaust emission test. Except with Executive Officer approval, the “applicable exhaust emission test” may not include any other test cycle (e.g., any test cycle used to precondition the vehicle specifically for demonstrating compliance with the tailpipe emission standards) prior to running the exhaust emission test cycle. The manufacturer may request Executive Officer approval to operate the vehicle on an additional test cycle or other driving conditions prior to implantation of the fault. Executive Officer approval shall be granted upon determining that a manufacturer has provided data and/or an engineering evaluation that demonstrate that additional test cycle/conditions is necessary to stabilize the emission control system. ~~The test vehicle shall then be operated over the applicable exhaust emission test. If monitoring is designed to run during the Unified Cycle, a second Unified Cycle may be conducted prior to the exhaust emission test.~~

(5.2.4) Exceptions for testing of gasoline evaporative system monitor: For testing of the gasoline evaporative system monitor under section (h)(3.11), in lieu of the requirements of sections (h)(5.2.1) through (h)(5.2.3) above, the

manufacturer shall operate the vehicle in a manner such that the monitoring conditions necessary to run and complete the evaporative system monitor are satisfied, the appropriate confirmed fault code is stored, and the MIL illuminated. The testing may be done in a laboratory, with or without a dynamometer, or on an outdoor road surface.

(5.3) Test Data Collection:

(5.3.1) For 2004 through 2018 model year vehicles, during the test sequence of section (h)(5.2), the manufacturer shall collect the following data: emission test data, approximate time (in seconds) of MIL illumination during the test, fault code(s) and freeze frame information stored at the time of detection, and the corresponding SAE J1979 test results (e.g., Mode/Service $06) stored during the test.

(A) For 2004 through 2016 model year gasoline vehicles, the emission test data shall include NMOG, CO (as applicable), and NOx emission data.

(B) For 2017 through 2018 model year gasoline vehicles, the emission test data shall include NMOG, CO, NOx, and for those vehicles meeting the LEVIII 3 mg/mi PM standard (as specified in title 13, CCR section 1961.2 (a)(2)(A)), PM emission data.

(C) For all diesel vehicles, the emission test data shall include NMOG, CO, NOx, and PM emission data, as applicable.

(D) For all 2018 model year gasoline and diesel vehicles, the emission test data shall also include CO_2 emission data.

(5.3.2) For 2019 and subsequent model year vehicles, during the test sequence of section (h)(5.2):

(A) The manufacturer shall collect the following data:

(i) Approximate time on the test cycle (in seconds after engine start) when the MIL illuminates (e.g., MIL illuminated at 402 seconds into the cold start FTP cycle);

(ii) All data required by sections (g)(4.1) through (g)(4.9), (g)(5), and (g)(6) which includes readiness status, current data stream values, fault code(s), freeze frame data, test results, CAL ID, CVN, VIN, ECU Name, in-use performance ratios, and vehicle operation tracking data; and

(iii) Emission test data: For all vehicles, the emission test data shall include NMOG, CO, NOx, PM, and CO_2 emission data.

(B) The manufacturer shall collect the data described in section (h)(5.3.2)(A)(ii) above immediately prior to each engine shut-down. The engine shutdown shall include the shutdown at the end of each preconditioning cycle in section (h)(5.1), the shutdown at the end of each demonstration test cycle in section (h)(5.2.1) and (h)(5.2.2) (if applicable), and each shutdown during the exhaust emission test in section (h)(5.2.3) (e.g., the end of the FTP cycle (i.e., end of Bag 2) and the end of the complete FTP test (i.e., end of Bag 3) for passenger vehicles, light-duty trucks, and medium-duty vehicles certified on a chassis dynamometer). If the data cannot be collected immediately prior to engine shut-down, the data shall be collected immediately after engine shut-down. The manufacturer shall collect the emission data specified in section (h)(5.3.2)(A)(iii) during the exhaust emission test in section (h)(5.2.3).

(5.3.3) Exceptions for gasoline evaporative system monitor: For testing of the gasoline evaporative system monitor under section (h)(3.11), in lieu of the requirements in sections (h)(5.3.1) and (h)(5.3.2) above, the manufacturer shall collect the following data specified in sections (h)(5.3.3)(A) through (B) below. The manufacturer shall collect the data after the monitor has completed and the MIL is illuminated.

(A) Approximate time (in seconds after engine start) and distance driven before the MIL is illuminated.

(B) All data required by sections (g)(4.1) through (g)(4.9), (g)(5), and (g)(6) which includes readiness status, current data stream values, fault code(s), freeze frame data, test results, CAL ID, CVN, VIN, ECU Name, in-use performance ratios, and vehicle operation time tracking data.

~~(5.3)~~(5.4) A manufacturer required to test more than one test vehicle (section (h)(2.2)) may utilize internal calibration sign-off test procedures (e.g., forced cool downs, less frequently calibrated emission analyzers, etc.) instead of official exhaust emission test procedures to obtain the emission test data required in section (h) for all but one of the required test vehicles. The manufacturer may elect this option if the data from the alternative test procedure are representative of official exhaust emission test results. Manufacturers using this option are still responsible for meeting the malfunction criteria specified in sections (e) and (f) when emission tests are performed in accordance with official exhaust emission test procedures.

~~(5.4)~~(5.5) For medium-duty vehicles certified to an engine dynamometer exhaust emission standard, 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.

(6) *Evaluation Protocol*:

(6.1) For all tests conducted under section (h), 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 emission test (or before the hot start portion of the last Unified Cycle, if applicable) in accordance with requirements of sections (e) and (f).

(6.2) For all tests conducted under section (h), manufacturers may use ~~Non-Methane Hydrocarbon (~~NMHC~~)~~ emission results in lieu of ~~Non-Methane Organic Gas (~~NMOG~~)~~ emission results for comparison to the applicable standards or malfunction criteria (e.g., 1.5 times the FTP standards). If NMHC emission results are used in lieu of NMOG, the emission result shall be multiplied by ~~1.04 to generate an equivalent NMOG result before comparison to the applicable standards~~the adjustment factor specified in 40 CFR 1066.635 or Part I, section D. of the "California 2015 and Subsequent

Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as incorporated by reference in section 1961.2, title 13, CCR.

(6.3) If the MIL illuminates prior to emissions exceeding the applicable malfunction criteria specified in sections (e) and (f), 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)(3.2.2)(A) and (f)(3.2.2)(B), no further demonstration is required if the MIL illuminates with misfire implanted at the malfunction criteria limit.

(6.4) If the MIL does not illuminate when the systems or components are set at their limit(s), the criteria limit or the OBD II system is not acceptable.

(6.4.1) ~~Except for testing of the catalyst (i.e., components monitored under (e)(1), (f)(2) or (f)(8)) or PM filter system, i~~If the MIL first illuminates after emissions exceed the applicable emission threshold malfunction criteria specified in sections (e) and (f), the test vehicle shall be retested with the tested system or component adjusted so that the MIL will illuminate ~~before~~ without emissions exceeding the applicable emission threshold malfunction criteria specified in sections (e) and (f). If the system or component cannot be adjusted to meet this criterion because a default fuel or emission control strategy is used when a malfunction is detected (e.g., open loop fuel control used after an O2 sensor malfunction is determined, etc.), the test vehicle shall be retested with the system or component adjusted to the worst acceptable limit (i.e., the applicable monitor indicates the system or component's ~~is~~ perform~~ing~~ance is passing but at the closest possible value relative to the monitor threshold value at which a fault would be detected that would invoke the default strategy and illuminate the MIL~~or slightly better than the malfunction criteria~~). The manufacturer may request the Executive Officer to accept test data when the system or component's performance is at the worst acceptable limit within a margin of error necessary to accommodate testing variability and/or other practical limitations in setting the performance at the absolute worst acceptable limit. The Executive Officer shall accept the test data upon determining that the test data adequately demonstrate that emissions do not exceed the applicable malfunction criteria at the tested worst acceptable limit and that emissions will not exceed the applicable emission threshold malfunction criteria before performance exceeds the monitor threshold for fault detection. These provisions shall only apply to testing of the catalyst (i.e., components monitored under sections (e)(1.2), (f)(1.2.2), (f)(2.2.2), and (f)(8.2.1)) or PM filter system (i.e., (f)(9.2.1) and (f)(9.2.4)(A)) if the on-board computer invokes a default fuel or emission control strategy upon detection of the relevant catalyst malfunction. Otherwise, the provisions of section (h)(6.4.2) shall apply to testing of the catalyst or PM filter system. ~~For the OBD II system to be approved, the MIL must not illuminate during this test and the vehicle emissions must be below the applicable malfunction criteria specified in sections (e) and (f).~~

(6.4.2) Except as provided for in section (h)(6.4.1), ~~I~~in testing the catalyst (i.e., components monitored under (e)(1), (f)(2) or (f)(8)) or PM filter system, if the MIL first illuminates after emissions exceed the applicable emission threshold~~(s)~~ malfunction criteria specified in sections (e) and (f), the tested vehicle shall be retested with a less deteriorated catalyst or PM filter system (i.e., more of the applicable engine out pollutants are converted or trapped). Adjustment and testing of the catalyst or PM filter system's performance may be repeated until successful results are obtained. For the OBD II system to be approved, ~~testing shall be continued until~~ either of the following conditions ~~are~~ must be satisfied by the test results:

(A) The MIL is illuminated and emissions do not exceed the emission threshold~~s~~ malfunction criteria specified in sections (e) and (f); or

(B) The manufacturer demonstrates that the MIL illuminates within acceptable upper and lower limits of the ~~threshold~~ malfunction criteria specified in sections (e) and (f) for MIL illumination. ~~The manufacturer shall demonstrate acceptable limits by continuing testing until~~The demonstration shall be deemed appropriate when the test results show:

(i) The MIL is illuminated and emissions exceed the emission threshold~~s~~ malfunction criteria specified in sections (e) and (f) by 25 percent or less of the applicable standard (e.g., emissions are less than 2.0 times the applicable standard for an emission threshold malfunction criterion of 1.75 times the standard); and

(ii) The MIL is not illuminated and emissions are below the emission threshold~~s~~ malfunction criteria specified in sections (e) and (f) by no more than 25 percent of the standard (e.g., emissions are between 1.5 and 1.75 times the applicable standard for an emission threshold malfunction criterion of 1.75 times the standard).

(6.5) If an OBD II system is determined unacceptable by the above criteria, the manufacturer may recalibrate and retest the system on the same test vehicle. In such a case, the manufacturer must confirm, by retesting, that all systems and components that were tested prior to recalibration and are affected by the recalibration function properly under the OBD II system as recalibrated.

(6.6) Where applicable for diesel vehicles, the emission test results shall be adjusted as required under section (d)(6.2).

(6.7) Manufacturers are not required to meet the requirements of section (h)(6) for testing of the gasoline evaporative system monitor under section (h)(3.11).

(7) *Confirmatory Testing*:

(7.1) The ARB may perform confirmatory testing to verify the emission test data submitted by the manufacturer under the requirements of section (h) comply with the requirements of section (h) and the malfunction criteria identified in sections (e) and (f). This confirmatory testing is limited to the vehicle configuration represented by the demonstration vehicle(s). For purposes of section (h)(7), vehicle configuration shall have the same meaning as the term used in 40 CFR 86.082-2.

(7.2) The ARB or its designee may install appropriately deteriorated or malfunctioning components in an otherwise properly functioning test vehicle of a test group represented by the demonstration test vehicle(s) (or simulate a deteriorated or malfunctioning component) in order to test any of the

components or systems required to be tested in section (h). Upon request by the Executive Officer, the manufacturer shall make available a vehicle and all test equipment (e.g., malfunction simulators, deteriorated components, etc.) necessary to duplicate the manufacturer's testing. The Executive Officer shall make the request within six months of reviewing and approving the demonstration test vehicle data submitted by the manufacturer for the specific test group.

(7.3) Vehicles with OBD II systems represented by the demonstration vehicle(s) may be recalled for corrective action if a representative sample of vehicles uniformly fails to meet the requirements of section (h).

(i) *Certification Documentation*

(1) When submitting an application for certification of a test group, the manufacturer shall submit the following documentation. If any of the items listed below are standardized for all of a manufacturer's test groups, the manufacturer may, for each model year, submit one set of documents covering the standardized items for all of its test groups.

(1.1) For the required documentation not standardized across all test groups, the manufacturer may propose to the Executive Officer that documentation covering a specified combination of test groups be used. These combinations shall be known as "OBD II groups". Executive Officer approval shall be granted for those groupings that include test groups using the same OBD II strategies and similar calibrations. If approved by the Executive Officer, the manufacturer may submit one set of documentation from one or more representative test group(s) that are a part of the OBD II group. The Executive Officer shall determine whether a selected test group(s) is representative of the OBD II group as a whole. To be approved as representative, the test group(s) must possess the most stringent exhaust emission standards and OBD II monitoring requirements and cover all of the emission control devices within the OBD II group.

(1.2) With Executive Officer approval, one or more of the documentation requirements of section (i) may be waived or modified if the information required would be redundant or unnecessarily burdensome to generate.

(1.3) To the extent possible, the certification documentation shall use SAE J1930 terms, abbreviations, and acronyms.

(2) The following information shall be submitted as "Part 1" of the certification application. Except as provided below for demonstration data, the Executive Officer will not issue an Executive Order certifying the covered vehicles without the information having been provided. The information must include:

(2.1) A description of the functional operation of the OBD II system including a complete written description for each monitoring strategy, including those carried out by a smart device, 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 most recent standardized format detailed in Attachment ~~A~~ C of ARB Mail-Out #~~95-20,~~MSC 06-23, ~~May 22, 1995~~December 21, 2006, 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, including those monitored by a smart device:

(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~~fault diagnostics

(J) for emissions neutral diagnostics, a description of the corresponding emissions neutral default action activated upon detection of a failure under the "monitor strategy description" column

(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)

(G) Voltage (V) for all absolute throttle position criteria (as defined in SAE J1979)

(H) Milligrams per stroke (mg/stroke) for all fuel quantity-based per ignition event criteria, and ~~P~~per ~~crankshaft revolution~~stroke (/~~rev~~stroke) for all other changes per ignition event based criteria (e.g., airflow in g/~~rev~~ stroke instead of g/~~stroke~~ rev 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~~A description of the testing sequence (e.g., the number and types of preconditioning cycles) for each tested monitor, ~~approximate time (in seconds) of MIL illumination during the test, fault code(s) and freeze frame information stored at the time of detection, corresponding SAE J1979 test results (e.g. Mode/Service $06) stored during the test,~~ the data required to be collected in section (h)(5.3), and a description of the modified or deteriorated components used for fault simulation with respect to the demonstration tests specified in section (h). The manufacturer shall also include a summary of any issues that were found during testing under section (h), including issues where the vehicle does not meet one or more of the

requirements in section 1968.2 (e.g., a monitor does not detect a malfunction before emissions exceed the emission threshold malfunction criteria in section (e) or (f)). The Executive Officer may approve conditional certification of a test group prior to the submittal of this data for ARB review and approval. Factors to be considered by the Executive Officer in approving the late submission of information identified in section (i)(2.4) shall include the reason for the delay in the data collection, the length of time until data will be available, and the demonstrated previous success of the manufacturer in submitting the data prior to certification.

(2.5) Data supporting the misfire monitor:

(2.5.1) For gasoline vehicles, data supporting the misfire monitor shall include:

(A) The established percentage of misfire that can be tolerated without damaging the catalyst over the full range of engine speed and load conditions.

(B) Data demonstrating the probability of detection of misfire events of the misfire monitoring system over the full engine speed and load operating range as detailed in ARB Mail-Out MSC #06-23 for the following misfire patterns: random cylinders misfiring at the malfunction criteria established in section (e)(3.2.2), one cylinder continuously misfiring, and paired cylinders continuously misfiring.

(C) Data identifying all disablement of misfire monitoring that occurs during the FTP and US06 cycles. For every disablement that occurs during the cycles, the data ~~should~~ shall 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. The number of 1000-revolution intervals completed and the number of 1000-revolution intervals in which the FTP misfire threshold was exceeded shall also be identified. The data shall be submitted in the most recent standardized format detailed in Attachment A: Misfire Disablement and Detection Chart of ARB Mail-Out #06-23, December 21, 2006, incorporated by reference. For manufacturers certifying an OBD II group in accordance with section (i)(1.1), the manufacturer shall provide these data in section (i)(2.5.1)(C) for the representative test group(s) and any plug-in hybrid electric vehicle subject to the requirements of section (e)(3.2.3)(A).

(D) Manufacturers are not required to use the durability demonstration vehicle to collect the misfire data for sections (i)(2.5.1)(A) through (C).

(2.5.2) For diesel ~~medium-duty~~ vehicles subject to the monitoring requirements of section (f)(3.2.2), data supporting the misfire monitor shall include:

(A) Data demonstrating the probability of detection of misfire events of the misfire monitoring system over the required engine speed and load operating range for the following misfire patterns: random cylinders misfiring at the malfunction criteria established in section (f)(3.2.2), one cylinder continuously misfiring, and paired cylinders continuously misfiring.

(B) Data identifying all disablement of misfire monitoring that occurs during the chassis dynamometer FTP and Unified cycles. For every disablement that occurs during the cycles, the data shall 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. The number of 1000-revolution intervals completed and the number of 1000-revolu~~a~~tion intervals in which the misfire threshold was exceeded shall also be identified. The data shall be submitted in the most recent standardized format detailed in Attachment A: Misfire Disablement and Detection Chart of ARB Mail-Out #06-23. For manufacturers certifying an OBD II group in accordance with section (i)(1.1), the manufacturer shall provide these data in section (i)(2.5.2)(B) for the representative test group(s) and any diesel vehicle subject to the requirements of section (f)(3.2.2).

(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) For diesel vehicle monitors in section (f) 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) and the adjustment factors determined by the manufacturer for each applicable monitor in accordance with section (d)(6.2).

(2.8) A listing of all electronic powertrain input and output signals (including those not monitored by the OBD II system) that identifies which signals are monitored by the OBD II system.

(2.9) A written description of all parameters and conditions necessary to begin closed loop operation.

(2.10) A summary table identifying every test group and each of the OBD II phase-in requirements that apply to each test group.

(2.11) A written identification of the communication protocol utilized by each test group for communication with an SAE J1978 scan tool.

(2.12) A pictorial representation or written description (including any covers or labels) of the diagnostic connector and its location ~~including any covers or labels~~representative of every model covered by the application. The manufacturer may submit one set of information for a group of models whose diagnostic connectors have the same design, orientation, and location.

(2.13) A written description of the method used by the manufacturer to meet the requirements of sections (e)(9) and (f)(10) for PCV and CV system monitoring including diagrams or pictures of valve and/or hose connections.

(2.14) A cover letter identifying all concerns and deficiencies applicable to the equivalent previous model year test group, ~~and~~ the changes and/or resolution of each concern or deficiency for the current model year test group, and all other known issues that apply to the current model year test group (e.g., concerns or deficiencies of another test group that also apply to this test group, issues found during demonstration testing under section (h)).

(2.15) For diesel engine vehicles, a written description of each AECD utilized by the manufacturer including the identification of each EI-AECD relative to the data required to be tracked and reported in the standardized format specified in section (g)(6) (e.g., EI-AECD #1 is “engine overheat protection as determined by coolant temperature greater than…”), 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.

(2.16) A checklist of all the malfunction criteria in sections (e) or (f) and the corresponding diagnostic noted by fault code for each malfunction criterion. The manufacturer shall use ~~T~~the most recent formats of the checklists ~~are~~ detailed in Attachments F and G of ARB Mail-Out #MSC 06-23, December 21, 2006, incorporated by reference.

(2.17) A list of all components/systems required to track and report in-use performance under section (d)(3.2.2), the corresponding diagnostic(s) noted by fault code used to increment the numerator for each component/system, and a description of the incrementing specifications for the in-use monitor performance numerator and denominator for each diagnostic.

(2.18) A list of the test results required to be made available under section (g)(4.5) and the corresponding diagnostic(s) noted by fault code for each test result.

(2.19) A timeline showing the start of normal production and the time the vehicles will be first introduced into commerce for each test group, and the required deadlines for production vehicle evaluation testing of the standardized requirements (according to section (j)(1.2)), the monitoring requirements (according to section (j)(2.1)), and in-use monitoring performance requirements (according to section (j)(3.1)).

(2.20) For emissions neutral diagnostics:

(2.20.1) A description of the component or system being diagnosed, including its function, under what conditions it is used, and what diagnostics (if any) are affected by the component/system or the component/system diagnostic.

(2.20.2) A description of how a component/system failure would affect emissions or the OBD II system if the emission neutral default action was not activated.

(2.20.3) A description of the emissions neutral default action activated upon detection of a failure, including data and information supporting the conditions described under the definition of “emissions neutral default action” in section (c).

(2.20.4) For a diagnostic that is located within a control unit meeting the automotive safety integrity level C or D specifications, the name of the control unit (e.g., SAE J1979 controller name and supplier name, if applicable).

(2.21) A list of all safety-only components/systems (as defined in section (c)) on the vehicle, their corresponding function, and a statement of compliance indicating that the listed safety components are used only for safety and have no other function.

(2.22) A statement of compliance indicating that the test groups in the application comply with the requirements of section 1968.2, with the exception of issues indicated under section (i)(2.14) if applicable, and indicating that the manufacturer will comply with the required deadlines for submission of

results/data for production vehicle evaluation testing under section (j)(1) through (j)(3).

(2.23) For gasoline vehicles with emission controls that experience infrequent regeneration events (e.g., NOx adsorber desulfation), the adjustment factor(s) established for tailpipe certification, including any data and information used to determine the adjustment factor(s).

(2.24) For 2019 and subsequent model year medium-duty diesel vehicles certified to an engine dynamometer tailpipe emission standard, data demonstrating the net brake torque reported by the engine dynamometer and the "calculated net brake torque" during the FTP and SET cycles. Manufacturers shall determine the "calculated net brake torque" using data stream parameters "engine reference torque," "engine friction – percent torque," and "actual engine – percent torque," and the following equation:
"Calculated net brake torque" = (engine reference torque) x [(actual engine – percent torque) – (engine friction – percent torque)]

(2.25) A description of all inducement strategies, including all inputs to each inducement strategy.

(2.26) A list of comprehensive components that are not OBD II monitored due to meeting the criteria under section (e)(15.1.2), (e)(15.2.3)(I), (f)(15.1.2), or (f)(15.2.3)(I), and the engineering evaluation analysis or associated data for each component, including all emission data, a description of how the worst case configuration was determined, and test cycles used to stabilize the system.

(2.27) A list of electronic powertrain components/systems that are not OBD II monitored due to meeting the criteria under section (e)(17.8), (e)(17.9), (f)(17.7), or (f)(17.8).

(2.28) For vehicles equipped with active off-cycle credit technologies, a written description of each technology utilized by the manufacturer including the identification of each technology relative to the data required to be tracked and reported in the standardized format specified in section (g)(6) (e.g., Active Off-Cycle Credit Tech #1 is "haptic-feedback accelerator pedal"), the sensor signals and/or calculated values used to activate each technology (e.g., the tip-in rate of accelerator pedal is greater than a certain value), and the driver action (if any) required to activate the technology (e.g., driver tipped out within 1 second of feedback).

(2.29) A list of monitors that run during conditions that are not encountered during the FTP cycle or Unified cycle as allowed under section (d)(3.1.3), and, if applicable, the alternate test cycle during which the monitor runs.

~~(2.17)~~(2.30) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this regulation.

(3) "Part 2". The following information shall be submitted by January 1st of the applicable model year:

(3.1) A listing and block diagram of the input parameters used to calculate or determine calculated load values and the input parameters used to calculate or determine fuel trim values.

(3.2) A scale drawing of the MIL and the fuel cap indicator light, if present, which specifies location in the instrument panel, wording, color, and intensity.

(4) "Part 3". The following information shall be submitted upon request of the Executive Officer:

(4.1) Data supporting the criteria used to detect a malfunction when catalyst deterioration causes emissions to exceed the applicable malfunction criteria specified in sections (e) and (f).

(4.2) Data supporting the criteria used to detect evaporative system leaks.

(4.3) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this regulation.

(j) *Production Vehicle Evaluation Testing.*

(1) *Verification of Standardized Requirements*.

(1.1) Requirement: For 2005 and subsequent model year vehicles, manufacturers shall perform testing to verify that all vehicles meet the requirements of section (g)(3) and (g)(4) relevant to proper communication of required emission-related messages to an SAE J1978 scan tool.

(1.2) Selection of Test Vehicles: Manufacturers shall perform this testing every model year on one production vehicle from every unique calibration ~~within~~ no later than two months ~~of~~ after the start of normal production for that calibration. Manufacturers may request Executive Officer approval to group multiple calibrations together and test one representative calibration per group. The Executive Officer shall approve the request upon finding that the software designed to comply with the standardization requirements of section (g) in the representative calibration vehicle is identical (e.g., communication protocol message timing, number of supported data stream parameters, etc.) to all others in the group and that any differences in the calibrations are not relevant with respect to meeting the criteria in section (j)(1.4).

(1.3) Test Equipment: For the testing required in section (j)(1), manufacturers shall utilize an off-board device to conduct the testing. Prior to conducting testing, manufacturers are required to request and receive Executive Officer approval of the off-board device that the manufacturer will use to perform the testing. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data, specifications, and/or engineering analysis that demonstrate that the off-board device meets the minimum requirements to conduct testing according to SAE J1699-3 using the software developed and maintained for the SAE J1699-3 committee and available through www.sourceforge.net and SAE J2534 compliant hardware configured specifically for SAE J1699-3 testing.

(1.4) Required Testing (i.e., "static" testing portion of SAE J1699-3):

(1.4.1) The testing shall verify that the vehicle can properly establish communications between all emission-related on-board computers and any SAE J1978 scan tool designed to adhere strictly to the communication protocols allowed in section (g)(3);

(1.4.2) The testing shall further verify that the vehicle can properly communicate to any SAE J1978 scan tool:

(A) The current readiness status from all on-board computers required to support readiness status in accordance with SAE J1979 and section (g)(4.1) while the engine is running;

(B) The MIL command status while the MIL is commanded off and while the MIL is commanded on in accordance with SAE J1979 and section (g)(4.2) while the engine is running, and in accordance with SAE J1979 and sections (d)(2.1.2) during the MIL functional check and, if applicable, (g)(4.1.3) during the MIL readiness status check while the engine is off;

(C) All data stream parameters required in section (g)(4.2) in accordance with SAE J1979 including the 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 (if applicable), and ECU Name (if applicable) in accordance with SAE J1979 and sections (g)(4.6) through (4.8);

(E) Any emission-related fault code (permanent, confirmed, and pending) in accordance with SAE J1979 (including correctly indicating the number of stored fault codes and MIL command status (e.g., Mode/Service $01, PID $01, Data A)) and section (g)(4.4) for each diagnostic and emission critical electronic powertrain control unit;

(1.4.3) The testing shall also verify that the vehicle can properly respond to any SAE J1978 scan tool request to clear emission-related fault codes and reset readiness status.

(1.5) Reporting of Results:

(1.5.1) The manufacturer shall notify the Executive Officer within one month of identifying any vehicle that does not meet the requirements of section (j)(1.4). The manufacturer shall submit a written report of the problem(s) identified and propose corrective action (if any) to remedy the problem(s) to the Executive Officer for approval. Factors to be considered by the Executive Officer in approving the proposed corrective action shall include the severity of the problem(s), the ability of the vehicle to be tested in an I/M program, the ability of service technicians to access the required diagnostic information, the impact on equipment and tool manufacturers, and the amount of time prior to implementation of the proposed corrective action.

(1.5.2) Within three months of any passing testing conducted pursuant to section (j)(1), a manufacturer shall submit a report of the results and the test log file 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.

(2) *Verification of Monitoring Requirements*.

(2.1) For 2004 and subsequent model year vehicles, ~~within the first~~ no later than six months after the start of normal production ~~begins~~, manufacturers shall conduct a complete evaluation of the OBD II 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) Prior to submitting any applications for certification for a model year, a manufacturer shall notify the Executive Officer of the test groups planned for that model year. The Executive Officer will then select the test group(s), in accordance with sections (j)(2.2.2) and (j)(2.2.3) below, that the manufacturer shall use as test vehicles to provide evaluation test results. This selection process may take place during durability demonstration test vehicle selection specified in section (h).

(2.2.2) A manufacturer shall evaluate one production vehicle per test group selected for monitoring system demonstration in section (h).

(2.2.3) In addition to the vehicles selected in section (j)(2.2.2) above, a manufacturer shall evaluate vehicles chosen from test groups that are not selected for monitoring system demonstration testing under section (h). The number of additional vehicles to be tested shall be equal to the number of vehicles selected for monitoring system demonstration in section (h).

(2.2.4) The Executive Officer may waive the requirements for submittal of evaluation results from one or more of the test groups if data has been previously submitted for all of the test groups.

(2.3) Evaluation requirements:

(2.3.1) Except as provided for emissions neutral diagnostics in section (j)(2.3.1)(A) below, ~~T~~the evaluation shall demonstrate the ability of the OBD II system on the selected production vehicle to detect a malfunction, illuminate the MIL, and store ~~a~~ confirmed and permanent fault codes when a malfunction is present, and the monitoring conditions have been satisfied for each individual diagnostic required by title 13, CCR section 1968.2. The manufacturer shall also verify the ability of the OBD II system to erase all permanent fault codes stored during testing under section (j)(2) by the end of testing all diagnostics.

(A) For an emissions neutral diagnostic, in lieu of the requirement in section (j)(2.3.1) above, the manufacturer shall demonstrate that the diagnostic is able to detect a malfunction and activate the applicable emissions neutral default action.

(2.3.2) The evaluation shall verify that malfunctions detected by non-MIL illuminating diagnostics of components used to enable any other OBD II system diagnostic (e.g., fuel level sensor) will not inhibit the ability of other OBD II system diagnostics to properly detect malfunctions.

(2.3.3) On vehicles so equipped, the evaluation shall verify that the software used to track the numerator and denominator for purposes of determining in-use monitoring frequency correctly increments as required in section (d)(4)(i.e., the “dynamic” testing portion of SAE J1699-3).

(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. Emission testing to confirm that the malfunction is detected before the appropriate malfunction threshold (e.g., 1.5 times the applicable standards) is exceeded is not required. For an emissions neutral diagnostic located within a control unit meeting the automotive safety integrity level C or D specifications, the manufacturer may request Executive Officer approval to modify the evaluation

procedure or conduct an engineering evaluation in lieu of a physical evaluation if the standard evaluation would result in unsafe or hazardous conditions.

(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 in each diagnostic. If the Executive Officer determines that the requirements of section (j)(2) are satisfied, the proposed test plan shall be approved.

(2.3.6) Subject to Executive Officer approval, manufacturers may omit demonstration of specific diagnostics. The Executive Officer shall approve a manufacturer's request if the demonstration cannot be reasonably performed without causing physical damage to the vehicle (e.g., on-board computer internal circuit faults) or jeopardizing the safety of personnel performing the demonstration.

(2.3.7) For evaluation of test vehicles selected in accordance with section (j)(2.2.2), manufacturers are not required to demonstrate diagnostics that were previously demonstrated prior to certification as required in section (h).

(2.4) Manufacturers shall submit a report of the results of all testing conducted pursuant to section (j)(2) to the Executive Officer for review. This report shall identify the method used to induce a malfunction in each diagnostic, the MIL illumination status, and the confirmed fault code(s) stored. The report shall also include a summary of any problems identified during testing (e.g., a monitor that is unable to detect a fault, a monitor that is unable to store a fault code or illuminate the MIL when a fault is detected).

(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 every test group certified by the manufacturer and equipped with in-use monitoring performance tracking software in accordance with section (d)(4) to the ARB ~~within~~ no later than twelve months ~~from~~ after either the time vehicles in the test group were first introduced into commerce or the start of normal production for such vehicles, whichever is later. The manufacturer may propose to the Executive Officer that multiple test groups be combined to collect representative data. Executive Officer approval shall be granted upon determining that the proposed groupings include test groups using the same OBD II strategies and similar calibrations and that 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.

(3.2) For each test group or combination of test groups, the data must include all of the in-use performance tracking data reported through SAE J1979 (i.e., all numerators, denominators, and the ignition cycle counter(s)), the model year, the manufacturer, the vehicle model, the test group, the date the data was collected, the odometer reading, the ~~vehicle~~ VIN, and the ECM software

calibration identification number and be in the most recent standardized format detailed in Attachment D: Rate Based Data of ARB Mail-Out #MSC 06-23, December 21, 2006, incorporated by reference. The manufacturer shall also submit a report that includes a summary of any problems identified in the data (e.g., a monitor where the average in-use monitor performance ratio is less than the minimum acceptable ratio under section (d)(3.2.1)).

(3.3) Manufacturers shall submit a plan to the Executive Officer for review and approval of the sampling method, number of vehicles to be sampled, time line to collect the data, and reporting format. The Executive Officer shall approve the plan upon determining that it provides for effective collection of data from a representative sample of vehicles that, at a minimum, is fifteen vehicles, will likely result in the collection and submittal of data within the required twelve month 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.

(3.4) Upon request of the manufacturer, the Executive Officer may reduce the minimum sample size of fifteen vehicles set forth in section (j)(3.3) for test groups with low sales volume. In granting approval of a sampling plan with a reduced minimum sample size, the Executive Officer shall consider, among other things, information submitted by the manufacturer to justify the smaller sample size, sales volume of the test group(s), and the sampling mechanism utilized by the manufacturer to procure vehicles. In lieu of defining a fixed minimum sample size for low sales volume test groups, sampling plans approved for collection of data on higher sales volume test groups under section (j)(3.3) shall also be approved by the Executive Officer for low sales test groups if they use the identical sampling mechanism to procure vehicles from the low sales volume test groups.

(k) *Deficiencies.*

(1) For 2004 and subsequent model year vehicles, the Executive Officer, upon receipt of an application from the manufacturer, may certify vehicles even though said vehicles may not comply with one or more of the requirements of title 13, CCR section 1968.2. In granting the certification, the Executive Officer shall consider the following factors: the extent to which the requirements of section 1968.2 are satisfied overall based on a review of the vehicle applications in question, the relative performance of the resultant OBD II system compared to systems fully compliant with the requirements of title 13, CCR section 1968.2, and a demonstrated good-faith effort on the part of the manufacturer to: (1) meet the requirements in full by evaluating and considering the best available monitoring technology; and (2) come into compliance as expeditiously as possible. The Executive Officer may not grant certification to a vehicle in which the reported noncompliance for which a deficiency is sought would be subject to ordered recall pursuant to section 1968.5 (c)(3)(A).

(2) Manufacturers of non-complying systems are subject to fines pursuant to section 43016 of the California Health and Safety Code. Except as allowed in section (k)(7) for light-duty and medium-duty diesel vehicles, the specified fines apply to the third and subsequently identified deficiencies, with the exception that fines

shall apply to all monitoring system deficiencies wherein a required monitoring strategy is completely absent from the OBD system.

(3) The fines are in the amount of $50 per deficiency per vehicle for non-compliance with any of the monitoring requirements specified in sections (e)(1) through (e)(8), (e)(11), (e)(13), (e)(14), (e)(16), (f)(1) through (f)(9), (f)(12), (f)(13), and (f)(16) and $25 per deficiency per vehicle for non-compliance with any other requirement of section 1968.2. In determining the identified order of deficiencies, deficiencies subject to a $50 fine are identified first. Total fines per vehicle under section (k) may not exceed $500 per vehicle and are payable to the State Treasurer for deposit in the Air Pollution Control Fund.

(4) Deficiency Provisions:

(4.1) 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. For all deficiencies except for deficiencies associated with PM filter monitoring section (f)(9.2.1)(A), the Executive Officer may not allow manufacturers to carry over monitoring system deficiencies for more than two model years unless ~~it~~ the manufacturer can ~~be~~ demonstrate~~d~~ that substantial vehicle hardware modifications and additional lead time beyond two years would be necessary to correct the deficiency, in which case the Executive Officer shall allow the deficiency to be carried over for three model years (e.g., if the deficiency was first certified in the 2010 model year, the deficiency may be carried over up to and including the 2013 model year).

(4.2) For deficiencies associated with PM filter monitoring section (f)(9.2.1)(A), if the manufacturer can demonstrate that substantial vehicle hardware modifications and additional lead time would be necessary to correct the deficiency, the Executive shall allow the deficiency to be carried over up to and including the 2013 model year.

(4.3) For monitors in section (e) or (f) that are required to indicate a malfunction before emissions exceed an interim emission threshold(s) during specified interim model years and a final emission threshold(s) starting in a later model year (e.g., a monitor that is required to detect a malfunction before emissions exceed 3.0 times the applicable standards during the 2015 through 2017 model years and before emissions exceed 1.5 times the applicable standards during the 2018 and subsequent model years), a deficiency for a monitor that does not meet the required emission threshold in a specific model year is considered a new and different deficiency in another model year when the required emission threshold is different. For example, for a monitor that is required to detect a malfunction before emissions exceed 3.0 times the applicable standards during the 2015 through 2017 model years and before emissions exceed 1.5 times the applicable standards during the 2018 and subsequent model years, a deficiency granted during the 2015 through 2017 model years is separate from a deficiency granted during the 2018 and subsequent 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) Manufacturers may request that the Executive Officer grant a deficiency and amend a vehicle's certification to conform to the granting of the deficiencies during the first 6 months after commencement of normal production for each aspect of the monitoring system: (a) identified by the manufacturer (during testing required by section (j)(2) or any other testing) to be functioning different than the certified system or otherwise not meeting the requirements of any aspect of section 1968.2; and (b) reported to the Executive Officer. If the Executive Officer grants the deficiency(ies) and amend~~ed~~s the certification, the~~ir~~ approval would be retroactive to ~~the start of production~~include all affected vehicles within the model year.

(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).

(7) Exceptions to Fines Requirements.

(7.1) For 2007 through 2009 model year light-duty and 2007 through 2012 model year medium-duty diesel vehicles, in cases where one or more of the deficiencies is for the aftertreatment monitoring requirements of sections (f)(1), (2), (8), or (9) and the deficient monitor is properly able to detect all malfunctions prior to emissions exceeding twice the required monitor threshold (e.g., before emissions exceed 10 times the standard for NMHC if the threshold is 5.0 times the standard for NMHC), the specified fines shall apply to the fourth and subsequently identified deficiencies in lieu of the third and subsequently identified deficiencies. If none of the deficiencies are for the requirements of sections (f)(1), (2), (8), or (9) or if the deficient aftertreatment monitor exceeds twice the required monitor threshold, the specified fines shall apply to the third and subsequently identified deficiencies. In all cases, the exception that fines shall apply to all monitoring system deficiencies wherein a required monitoring strategy is completely absent from the OBD system still applies.

(7.2) For 2013 through 2014 model year light-duty and medium-duty diesel vehicles that utilize PM sensors for PM filter filtering performance monitoring (section (f)(9.2.1)(A)), in cases where the deficiency is for a monitor required to detect malfunctions of the PM filter filtering performance (section (f)(9.2.1)(A)), the PM sensor (section (f)(5.2.2)), or the PM sensor heater (section (f)(5.2.4)), the deficiency shall be exempt from the specified fines of section (k)(3) and the deficiency shall not be included in the count of deficiencies used in (k)(2) to determine the number of deficiencies subject to fines.

(8) Any OBD II system installed on a production vehicle that fails to conform with the certified OBD II system for that vehicle or otherwise fails to meet the requirements of section 1968.2 and has not been granted a deficiency pursuant to the provisions of section (k)(1) through (k)(7) are considered non-compliant.

The vehicles are subject to enforcement pursuant to applicable provisions of the Health and Safety Code and title 13, CCR section 1968.5.

NOTE: Authority cited: Sections 38501, 38505, 38510, 39010, 39600, 39601, 39602.5, 43000.5, 43013, 43018, 43100, 43101, 43104, 43105, 43105.5 and 43106, Health and Safety Code; and *Engine Manufacturers Association v. California Air Resources Board* (2014) 231 Cal.App.4th 1022. Reference: Sections 38501, 38505, 38510, 39002, 39003, 39010, 39018, 39021.5, 39024, 39024.5, 39027, 39027.3, 39028, 39029, 39031, 39032, 39032.5, 39033, 39035, 39037.05, 39037.5, 39038, 39039, 39040, 39042, 39042.5, 39046, 39047, 39053, 39054, 39058, 39059, 39060, 39515, 39600, 39601, 39602.5, 43000, 43000.5, 43004, 43006, 43013, 43016, 43018, 43100, 43101, 43102, 43104, 43105, 43105.5, 43106, 43150, 43151, 43152, 43153, 43154, 43155, 43156, 43204, 43211 and 43212, Health and Safety Code.