Appendix C

Proposed Regulation Order, HD OBD Regulation Title 13, California Code of Regulations, Section 1971.1, On-Board Diagnostic System Requirements--2010 and Subsequent Model-Year Heavy-Duty Engines

Proposed Revisions to the On-Board Diagnostic System Requirements and Associated Enforcement Provisions for Passenger Cars, Light-Duty Trucks, Medium-Duty Vehicles and Engines, and Heavy-Duty Engines

Date of Release: June 1, 2021
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Appendix C

Proposed Regulation Order

Amend section 1971.1, 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. Various portions of the regulations that are not modified by the proposed amendments are omitted from the text shown and indicated with "* * * *".)

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

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(c) *Definitions.*

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"Calculated load value" refers to the percent of engine capacity being used and is defined in SAE International (SAE) J1979 "E/E Diagnostic Test Modes," (SAE J1979), incorporated by reference (section (h)(1.4)), or SAE J1979-2 "E/E Diagnostic Test Modes – OBDonUDS", incorporated by reference (section (h)(1.4.2)). For diesel applications, the calculated load value is determined by the ratio of current engine output torque to maximum engine output torque at current engine speed as defined by suspect parameter number (SPN) 92 of SAE J1939-71 "Vehicle Application Layer," incorporated by reference (section (h)(1.7.8)).

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"Chassis odometer" refers to lifetime vehicle distance.

"Cold start emission reduction strategy (CSERS) cold start criteria" is defined as a set of criteria that meet all the following conditions in a single driving cycle:

(1) at least 6 hours of engine-off time before the initial combustion engine start for non-hybrid vehicles, or the continuous time the vehicle is not in a state of "propulsion system active" during the period immediately preceding the start of "propulsion system active" is at least 6 hours for hybrid vehicles,

(2) the ambient temperature is greater than or equal to 19.4 degrees Fahrenheit (or -7 degrees Celsius), and

(3) the engine coolant temperature is less than or equal to 27 degrees Fahrenheit (or 15 degrees Celsius) higher than the ambient temperature.

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(d) *General Requirements.*

Section (d) sets forth the general requirements of the OBD system. Specific performance requirements for components and systems that shall be monitored are set forth in sections (e) through (g) below. The OBD system is required to

detect all malfunctions specified in sections (e) through (g). However, except as specified elsewhere, the OBD system is not required to use a unique monitor to detect each malfunction specified.

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(2) MIL and Fault Code Requirements.

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(2.1) MIL Specifications.

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(2.1.3) At the manufacturer's option, the MIL may be used to indicate readiness status in a standardized format (see section (h)(4.1.~~6~~1)(G) or (h)(4.1.2)(E)) in the key on, engine off position.

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(2.2) MIL Illumination and Fault Code Storage Protocol.

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

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(D) Storage and erasure of freeze frame conditions.

(i) For engines using SAE J1979:

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

~~(ii)~~b. For 2010 through 2015 model year engines, the OBD system shall store and erase freeze frame conditions in conjunction with the storage and erasure of either pending or confirmed fault codes as required elsewhere in section (d)(2.2).

~~(iii)~~c. For 2016 and subsequent model year engines, except as provided for in section (d)(2.2.1)(D)(iv), the OBD system shall store freeze frame conditions in conjunction with the storage of a pending fault code.

~~a.~~1. If the pending fault code is erased in the next driving cycle in which monitoring occurs and a malfunction is not detected (as described in section (d)(2.2.1)(B)), the OBD system may erase the corresponding freeze frame conditions.

~~b.~~2. If the pending fault code matures to a confirmed fault code (as described in section (d)(2.2.1)(B)), the OBD system shall either retain the currently stored freeze frame conditions or replace the stored freeze frame conditions with freeze frame conditions regarding the confirmed fault code. The OBD system shall erase the freeze frame information in conjunction with the erasure of the confirmed fault code (as described under section (d)(2.3.1)(B)).

~~(iv)~~d. For alternate strategies that store both a pending fault code and confirmed fault code and illuminate the MIL upon the first detection of a malfunction (i.e., monitors using alternate statistical

strategies described in section (d)(2.2.1)(C)), the OBD system shall store and erase freeze frame conditions in conjunction with the storage and erasure of the confirmed fault code.

~~(v)~~e. 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 confirmed fault codes in sections (d)(2.2.1)(D)(ii) and (iii) above, and for gasoline and diesel misfire and fuel system monitors under sections (e)(1.4.2)(D), (e)(2.4.2)(B), (f)(1.4.4), and (f)(2.4.3).

(ii) For engines using SAE J1979-2:

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

b. The OBD system shall store freeze frame conditions on two frames of data (referred to as the "first frame" and "second frame") for a given fault code in conjunction with the storage of a pending fault code. After storage of the pending fault code and freeze frame conditions, if the malfunction is again detected within the same driving cycle, the OBD II system may replace the stored freeze frame conditions on the second frame with freeze frame conditions for the redetected malfunction anytime the malfunction is redetected.

1. If the pending fault code is erased in the next driving cycle in which monitoring occurs and a malfunction is not detected (as described in section (d)(2.2.1)(B)), the OBD system shall erase the corresponding freeze frame conditions on the first and second frames for the fault code.

2. If the pending fault code matures to a confirmed fault code (as described in section (d)(2.2.1)(B)), the OBD system shall retain the freeze frame conditions stored with the pending fault code on the first frame and replace the stored freeze frame conditions on the second frame with freeze frame conditions of the confirmed fault code. After storage of the confirmed fault code and freeze frame conditions, if the malfunction is again detected within the same driving cycle, the OBD system may replace the stored freeze frame conditions on the second frame with freeze frame conditions for the redetected malfunction anytime the malfunction is redetected.

3. If the malfunction is detected during a driving cycle after the driving cycle in which the confirmed fault code was first stored, the OBD system shall replace the stored freeze frame conditions on the second frame with freeze frame conditions of the redetected malfunction. If the malfunction is again detected within the same driving cycle, the OBD system may replace the stored freeze frame conditions on the second

frame with freeze frame conditions for the redetected malfunction anytime the malfunction is redetected.

4. The OBD system shall erase the freeze frame conditions on the first and second frames in conjunction with the erasure of the confirmed fault code as described under section (d)(2.3.1)(B).

c. For alternate strategies that store both a pending fault code and confirmed fault code and illuminate the MIL upon the first detection of a malfunction (i.e., monitors using alternate statistical strategies described in section (d)(2.2.1)(C)), the OBD system shall store and erase freeze frame conditions in conjunction with the storage and erasure of the confirmed fault code.

d. Except as provided below in section (d)(2.2.1)(D)(ii)d.1., if a fault code is stored when the maximum number of frames of freeze frame conditions is already stored in the diagnostic or emission critical powertrain control unit, the OBD system may not replace any currently stored freeze frame conditions in the control unit with freeze frame conditions for the newly stored fault code.

1. For 2023 through 2026 model year engines, if a misfire or fuel system fault code is stored when the maximum number of frames of freeze frame conditions is already stored in the diagnostic or emission critical powertrain control unit, the OBD system may replace any of the currently stored freeze frame conditions for a fault code in the control unit with freeze frame conditions for the newly stored fault code as allowed for gasoline and diesel misfire and fuel system monitors under sections (e)(1.4.2)(D), (e)(2.4.2)(B), (f)(1.4.4), and (f)(2.4.3).

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(3) Monitoring Conditions.

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

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

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(3.2.2) For all 2013 and subsequent model year engines, manufacturers shall define monitoring conditions that, in addition to meeting the criteria in sections (d)(3.1) (if applicable) and (d)(3.2.1), ensure that the monitor yields an in-use performance ratio (as defined in section (d)(4)) that meets or exceeds the minimum acceptable in-use monitor performance ratio for in-use vehicles. For purposes of this regulation, the following minimum acceptable in-use monitor performance ratio shall apply for monitors

specifically required in sections (e) through (g) to meet the monitoring condition requirements of section (d)(3.2):

(A) For 2013 through 2023 model year engines, 0.100 for all monitors.

(B) Except as provided below in section (d)(3.2.2)(C), for 2024 and subsequent model year engines~~,~~:

(i) 0.100 for the diesel catalyst warm-up strategy (section (e)(11.2.2))

(ii) 0.300 for all other monitors.

(C) For interim years:

(i) For 2024 through 2031 model year engines, 0.100 for crankcase ventilation (CV) system monitors specified in section (g)(2.2.3).

(ii) For 2024 through 2025 model year alternate-fueled engines, 0.100 for all monitors.

(iii) For hybrid systems on plug-in hybrid electric vehicles first certified in the 2022 through 2027 model years, 0.100 for the first three model years of hybrid system production for all monitors that are for systems or components that require engine operation. For example, the 0.100 ratio shall apply to the 2022, 2023, and 2024 model years for hybrid systems first certified in the 2022 model year and to the 2027, 2028, and 2029 model years for hybrid systems first certified in the 2027 model year. If the hybrid system is first certified in the 2028 or subsequent model year, the applicable ratios for all monitors are specified under section (d)(3.2.2)(B) above.

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(4) In-Use Monitor Performance Ratio Definition.

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(4.3) Denominator Specifications

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(4.3.2) Specifications for incrementing:

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(B) Except as provided for in sections (d)(4.3.2)(C) through (~~M~~N), the denominator for each monitor shall be incremented within 10 seconds if and only if the following criteria are satisfied on a single driving cycle:

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(M) In addition to the requirements of section (d)(4.3.2)(B) above, the denominator for the cold start emission reduction strategy catalyst warm-up strategy monitor (section (e)(11.2.2)) shall be incremented if and only if the CSERS cold start criteria (as defined in section (c)) have been met.

(~~M~~N) For a monitor designed to detect malfunctions specified under more than one section (e.g., one NMHC converting catalyst monitor to detect malfunctions under sections (e)(5.2.2) and (e)(5.2.3)(A)), if each section is subject to different denominator incrementing criteria, the manufacturer shall request Executive Officer approval of the criteria used for incrementing the monitor denominator. Executive Officer approval of the criteria shall be based manufacturer data and/or engineering evaluation demonstrating that the proposed denominator incrementing

criteria results in the lowest in-use monitor performance ratio for the monitor.

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(5) Standardized tracking and reporting of monitor performance.

(5.1) For monitors required to track and report in-use monitor performance in section (d)(3.2), the performance data shall be tracked and reported in accordance with the specifications in sections (d)(4), (d)(5), and (h)(5.1).

(5.1.1) For diesel engines using SAE J1979 or SAE J1939, the OBD system shall separately report an in-use monitor performance numerator and denominator for each of the following components: fuel system, NMHC catalyst, NOx catalyst, exhaust gas sensor, EGR/VVT system, PM filter, boost pressure control system, and NOx adsorber. The OBD system shall also report a general denominator and an ignition cycle counter in the standardized format specified in sections (d)(5.5), (d)(5.6), and (h)(5.1).

(5.1.2) For gasoline engines using SAE J1979 or SAE J1939, the OBD 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 sensor bank 1, primary oxygen sensor bank 2, secondary oxygen sensor, evaporative leak detection system, EGR/VVT system, and secondary air system. The OBD system shall also report a general denominator and an ignition cycle counter in the standardized format specified in sections (d)(5.5), (d)(5.6), and (h)(5.1).

(5.1.3) For diesel engines using SAE J1979-2, the OBD system shall separately report an in-use monitor performance numerator and denominator for each supported fault code associated with each monitor of the following components: fuel system, NMHC catalyst, NOx catalyst, exhaust gas sensor, EGR/VVT system, PM filter, boost pressure control system, and NOx adsorber. The OBD system shall also report a general denominator, an ignition cycle counter(s), and supplemental monitor activity data in the standardized format specified in sections (d)(5.5), (d)(5.6), (d)(5.7), and (h)(5.1).

(5.1.4) For gasoline engines using SAE J1979-2, the OBD system shall separately report an in-use monitor performance numerator and denominator for each supported fault code associated with each monitor of the following components: catalyst bank 1, catalyst bank 2, primary oxygen sensor bank 1, primary oxygen sensor bank 2, secondary oxygen sensor, evaporative leak detection system, EGR/VVT system, and secondary air system. The OBD system shall also report a general denominator, an ignition cycle counter(s), and supplemental monitor activity data in the standardized format specified in sections (d)(5.5), (d)(5.6), (d)(5.7), and (h)(5.1).

(5.2) Numerator

(5.2.1) For engines using SAE J1979 or SAE J1939:

~~(5.2.1)~~(A) The OBD system shall report a separate numerator for each of the

components listed in section (d)(5.1).

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

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

(5.2.2) For engines using SAE J1979-2:

(A) Except as provided in section (d)(5.2.2)(B) below, the OBD system shall report a separate numerator for each supported fault code associated with each monitor of the components listed in section (d)(5.1).

(B) For specific supported fault codes that have multiple monitors that are required to be reported under sections (e) through (g), the OBD system shall separately track numerators and denominators for each of the monitors and report only the corresponding numerator and denominator for the specific supported fault code 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 supported fault code.

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

(5.3) Denominator

(5.3.1) For engines using SAE J1979 or SAE J1939:

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

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

(5.3.2) For engines using SAE J1979-2:

(A) The OBD system shall report a separate denominator for each supported fault code associated with each monitor of the components listed in section (d)(5.1).

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

(5.4) Ratio

(5.4.1) For purposes of determining which corresponding numerator and denominator to report as required in section (d)(5.2.~~2~~1)(B) and (d)(5.2.2)(B), the ratio used for the determination shall be calculated in accordance with the specifications in section (h)(5.1.2)(B).

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(5.7) Supplemental monitor activity data: For engines using SAE J1979-2, the OBD system shall track and report the following data in accordance with SAE J1979-2 specifications for each diagnostic or emission-critical powertrain control unit:

(5.7.1) Mini-Numerator

(A) Definition: The mini-numerator is defined as the counter that indicates the number of driving cycles over which a monitor ran and completed since the last time the mini-denominator (defined below in section (d)(5.7.2)), was reset to zero. The OBD system shall track and report a mini-numerator for each supported fault code that can illuminate the MIL.

(B) Specifications for incrementing:

(i) The mini-numerator, when incremented, shall be incremented by an integer of one. The mini-numerator may not be incremented more than once per driving cycle.

(ii) The mini-numerator shall be incremented at the end of a driving cycle if and only if the associated monitor ran and completed on the driving cycle.

(iii) The OBD system shall pause further incrementing of the mini-numerator on a driving cycle if a malfunction has been detected which can illuminate the MIL as described in section (d)(2.2) and the diagnostic or emission-critical powertrain control unit that tracks and reports the mini-numerator stores a pending fault code for the malfunction. Incrementing of the mini-numerator shall resume for the next driving cycle in which no such fault code is present.

(iv) The OBD system shall cease further incrementing of the mini-numerator if the mini-numerator has reached a value of 255.

(C) Specifications for resetting: The OBD system shall reset the mini-numerator to zero at the same time the OBD system resets the mini-denominator to zero as described below in section (d)(5.7.2).

(5.7.2) Mini-Denominator

(A) Definition: The mini-denominator is defined as the counter that indicates the number of general denominators that have accumulated since the last time the mini-denominator was reset to zero. The OBD system shall track and report a mini-denominator for each diagnostic or emission-critical powertrain control unit.

(B) Specifications for incrementing:

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

(ii) The mini-denominator for non-hybrid vehicles and hybrid vehicles that are not plug-in hybrid electric vehicles shall be incremented at the end of a driving cycle if and only if the general denominator increments during the driving cycle as described in section (d)(5.6.2). The mini-denominator for plug-in hybrid electric vehicles shall be

incremented at the end of a driving cycle if and only if the criteria in section (d)(4.3.2)(J)(i) through (iv) are satisfied during the driving cycle.

(iii) The OBD system shall pause further incrementing of the mini-denominator on a driving cycle if a malfunction has been detected which can illuminate the MIL as described in section (d)(2.2) and the diagnostic or emission-critical powertrain control unit that tracks and reports the mini-denominator stores a pending fault code for the malfunction. Incrementing of the mini-denominator shall resume for the next driving cycle in which no such fault code is present.

(iv) The OBD system shall cease further incrementing of the mini-denominator if the mini-denominator has reached a value of 255.

(C) Specifications for resetting: The OBD system shall reset the mini-denominator to zero after the mini-denominator has reached a value of 255 and the OBD system has updated the monitor activity ratio described below in section (d)(5.7.3). The reset shall occur before the beginning of the next driving cycle.

(5.7.3) Monitor Activity Ratio

(A) Definition: The monitor activity ratio, or MAR, is defined as the ratio of the mini-numerator to the mini-denominator when the mini-denominator reaches its maximum value of 255. The MAR has a minimum value of zero and a maximum value of one. The OBD system shall track and report a MAR for each supported fault code that can illuminate the MIL.

(B) Specifications for updating: The MAR shall be updated only at the end of the same driving cycle in which the mini-denominator reaches a value of 255. The current value for the MAR shall be replaced with the new value.

(C) Specifications for resetting: The OBD system may not reset the MAR to zero except under the conditions described below in section (d)(5.7.4).

(5.7.4) In addition to the specifications for resetting described above in sections (d)(5.7.1)(C), (d)(5.7.2)(C), and (d)(5.7.3)(C), the mini-numerator, mini-denominator, and MAR may be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event) or, if the numbers are stored in KAM, when KAM is lost due to an interruption in electrical power to the control module (e.g., battery disconnect). Numbers may not be reset to zero under any other circumstances including when a scan tool command to clear fault codes or reset KAM is received.

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(7) Implementation Schedule

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(7.6) For 2013 model year hybrid vehicles: In lieu of meeting all other requirements of section 1971.1, a manufacturer may meet the alternative requirements set forth in sections (d)(7.6.1) through (d)(7.6.5) below for 2013 model year hybrid vehicles:

(7.6.1) A California-certified 2013 model year engine shall be used as the base engine in the hybrid vehicle design.

(7.6.2) Any modifications made to the base engine's certified OBD system shall be solely for the purpose of preventing false malfunction determinations that could otherwise occur as a result of the integration of the hybrid system hardware and software, and such modifications shall only be made to the extent necessary to achieve this purpose. All modifications are subject to Executive Officer approval. The Executive Officer shall grant approval upon determining that the modifications are necessary and reasonable for the purposes of preventing false malfunction determinations on in-use hybrid vehicles.

(7.6.3) Notwithstanding section (d)(7.6.2) above, no modifications shall be made that would render the certified base engine noncompliant with the EMD plus NOx aftertreatment monitoring requirements set forth in section (d)(7.1.4).

(7.6.4) For all hybrid components, manufacturers shall be exempt from the monitoring requirements of section (g)(3).

(7.6.5) Manufacturers shall apply for certification to the requirements of this section. The application for certification shall identify and describe the certified base engine, the hybrid system mated to it, all changes made to the certified engine along with the rationale describing the need for each change, and the vehicle applications into which the hybrid system will be installed.

(7.7) SAE J1979 and SAE J1979-2 Implementation Schedule: For vehicles using the ISO 15765-4 protocol as required in section (h)(3.1), the manufacturer shall implement SAE J1979 and SAE J1979-2 as follows:

(7.2.1) SAE J1979 Implementation: Except as provided below in section (d)(7.2.2), the manufacturer shall use SAE J1979 for the standardized functions required in section 1971.1 for 2010 through 2026 model year engines.

(7.2.2) SAE J1979-2 Implementation: For 2027 and subsequent model year engines, the manufacturer shall use SAE J1979-2 for the standardized functions required in section 1971.1.

(A) For 2023 through 2026 model year engines, the manufacturer may use SAE J1979-2 in lieu of SAE J1979 for the standardized functions required in section 1971.1.

(B) The manufacturer may not use SAE 1979-2 for the standardized functions required in section 1971.1 on 2022 and earlier model year engines.

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(e) *Monitoring Requirements for Diesel/Compression-Ignition Engines.*

(1) Fuel System Monitoring

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(1.3) Monitoring Conditions:

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

ratio requirements). Additionally, for all 2013 and subsequent model year engines, manufacturers shall track and report the in-use performance of the fuel system monitors under sections (e)(1.2.2) and (e)(1.2.3) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(1.2.2) and (e)(1.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(1.2.2) and (e)(1.2.3) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(1.4) MIL Illumination and Fault Code Storage:

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(1.4.2) Additionally, for malfunctions identified in section (e)(1.2.1) (i.e., fuel pressure control) on all 2013 and subsequent model year engines:

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(D) Storage of freeze frame conditions.

(i) For engines using SAE J1979 or SAE J1939:

~~(i)~~a. For 2013 through 2015 model year engines, 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/MIL-on fault code. For 2016 and subsequent model year engines, a manufacturer shall store and erase freeze frame conditions in accordance with section (d)(2.2.1)(D)(iii) or (d)(2.2.2)(D).

~~(ii)~~b. If freeze frame conditions are stored for a malfunction other than misfire (see section (e)(2)) or fuel system malfunction when a fault code is stored as specified in section (e)(1.4.2) above, the stored freeze frame information shall be replaced with freeze frame information regarding the fuel system malfunction.

(ii) For engines using SAE J1979-2: A manufacturer shall store and erase freeze frame conditions in accordance with section (d)(2.2.1)(D)(ii).

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(2) Misfire Monitoring

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(2.2) Malfunction Criteria:

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

(2.2.2) Additionally, for 2013 through 2015 model year engines equipped with sensors that can detect combustion or combustion quality (e.g., for use in

homogeneous charge compression ignition (HCCI) control systems) and for 20 percent of 2016 model year diesel engines, 50 percent of 2017 model year diesel engines, and 100 percent of 2018 and subsequent model year diesel engines (percentage based on the manufacturer's projected California sales volume of all diesel engines subject to this regulation), the OBD system shall detect a misfire malfunction when the percentage of misfire is equal to or exceeds five percent.

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(2.3) Monitoring Conditions:

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(2.3.3) For misfires identified in section (e)(2.2.2):

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

(i) For 2013 through 2018 model year engines and 2019 and subsequent model year engines that are not included in the phase-in specified in section (e)(2.3.3)(A)(ii), under positive torque conditions between 20 percent and 75 percent of peak torque with engine speed up to 75 percent of the maximum engine speed.

(ii) For 20 percent of 2019 model year diesel engines, 50 percent of 2020 model year diesel engines, and 100 percent of 2021 and subsequent model year diesel engines (percentage based on the manufacturer's projected California sales volume of all diesel engines subject to this regulation), 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 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 100 percent of the maximum engine speed with the engine torque at 10 percent of peak torque above the positive torque line.

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(2.4) MIL Illumination and Fault Code Storage:

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

(2.4.2) Additionally, for misfires identified in section (e)(2.2.2):

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(B) Storage of freeze frame conditions.

(i) For engines using SAE J1979 or SAE J1939:

~~(i)~~a. For 2013 through 2015 model year engines, the OBD system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing a confirmed/MIL-on fault code and erasing a confirmed/previously MIL-on fault code. For 2016 and subsequent model year engines, a manufacturer shall store and erase freeze frame conditions in accordance with section (d)(2.2.1)(D)(iii) or (d)(2.2.2)(D).

~~(ii)~~b. If freeze frame conditions are stored for a malfunction other than a misfire or fuel system malfunction (see section (e)(1)) when a misfire fault code is stored as specified in section (e)(2.4.2), the stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction. Alternatively, for the 2010 through 2023 model years, if freeze frame conditions are stored and reported for a fuel system malfunction (section (e)(1)) when a misfire fault code is stored as specified in section (e)(2.4.2) above, the stored freeze frame information may be replaced with freeze frame information regarding the misfire malfunction.

(ii) For engines using SAE J1979-2: A manufacturer shall store and erase freeze frame conditions in accordance with section (d)(2.2.1)(D)(ii).

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(3) Exhaust Gas Recirculation (EGR) System Monitoring

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(3.3) Monitoring Conditions:

(3.3.1) Except as provided in section (e)(3.3.4), the OBD system shall monitor continuously for malfunctions identified in sections (e)(3.2.1), (e)(3.2.2), and (e)(3.2.4) (i.e., EGR low and high flow, feedback control). Additionally, for all 2024 and subsequent model year engines, manufacturers shall define monitoring conditions for malfunctions identified in sections (e)(3.2.1), (e)(3.2.2), and (e)(3.2.4) that are continuous and in accordance with section (d)(3.2) (i.e., the minimum ratio requirements), and manufacturers shall track and report the in-use performance of the EGR system monitors under sections (e)(3.2.1), (e)(3.2.2), and (e)(3.2.4) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(3.2.1), (e)(3.2.2), and (e)(3.2.4) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(3.2.1), (e)(3.2.2), and (e)(3.2.4) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

(3.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(3.2.3) (i.e., slow response) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). Additionally, manufacturers shall

track and report the in-use performance of the EGR system monitors under section (e)(3.2.3) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(3.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(3.2.3) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

(3.3.3) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(3.2.5) and (e)(3.2.6) (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 (e)(3.2.5) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(3.2.5) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(3.2.5) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(4) Boost Pressure Control System Monitoring

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(4.3) Monitoring Conditions:

(4.3.1) Except as provided in section (e)(4.3.4), the OBD system shall monitor continuously for malfunctions identified in sections (e)(4.2.1), (4.2.2), and (4.2.5) (i.e., over and under boost, feedback control). Additionally, for all 2024 and subsequent model year engines, manufacturers shall define monitoring conditions for malfunctions identified in sections (e)(4.2.1), (e)(4.2.2), and (e)(4.2.5) that are continuous and in accordance with section (d)(3.2) (i.e., the minimum ratio requirements), and manufacturers shall track and report the in-use performance of the boost pressure control system monitors under sections (e)(4.2.1), (e)(4.2.2), and (e)(4.2.5) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(4.2.1), (e)(4.2.2), and (e)(4.2.5) shall

be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(4.2.1), (e)(4.2.2), and (e)(4.2.5) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

(4.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(4.2.3) (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 boost pressure control system monitors under section (e)(4.2.3) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(4.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(4.2.3) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

(4.3.3) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(4.2.4) (i.e., charge air cooler performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the boost pressure control system monitors under section (e)(4.2.4) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(4.2.4) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(4.2.4) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(5) Non-Methane Hydrocarbon (NMHC) Converting Catalyst Monitoring

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(5.2) Malfunction Criteria:

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(5.2.4) Catalyst System Aging and Monitoring

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

(B) For 2025 and subsequent model year engines from engine families selected for monitoring system demonstration in section (i):

(i) In addition to the information described above in section (e)(5.2.4)(A), the catalyst system aging and monitoring plan described above in sections (e)(5.2.4)(A) shall also include the timeline for submitting the information and data described under section (e)(5.2.4)(B)(ii) below. The timeline may include several dates for data submission for new emission control system designs where the manufacturer has not achieved sufficient in-use aging to demonstrate real world deterioration prior to certification of the OBD system.

(ii) Information and data to support methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions in sections (e)(5.2.4)(A) must be submitted to the Executive Officer and shall at a minimum include an analysis of the potential failure modes and effects, highlighting the most likely cause of failure, comparison of laboratory aged versus real world aged catalysts, and include the following for a laboratory aged catalyst and a minimum of three field-returned catalysts (data for all field-returned catalysts that are collected for this aging correlation analysis must be submitted to the Executive Officer):

a. Emissions data and all data required by sections (h)(4.1) through (h)(4.9) and (h)(5) from the FTP and SET cycles,
b. Modal data during the FTP and SET cycles,
c. Catalyst conversion efficiency as a function of catalyst temperature and exhaust gas flow rate,
d. Catalyst feedgas generation as a function of catalyst temperature, and
e. All data required by sections (h)(4.1) through (h)(4.9) and (h)(5) from all catalysts collected from a wide range of monitoring conditions.

(iii) The Executive Officer shall approve the catalyst aging method upon finding the data passes each of the following "pass" criteria below. If the manufacturer is not able to locate at least one catalyst to be evaluated under pass criteria 1 through 3 below, the manufacturer may propose to include an additional catalyst described in another pass criterion (e.g., if a catalyst described in pass criterion 2 cannot be located, the manufacturer may use an additional catalyst described in either pass criterion 1 or 3 instead) as representative of the missing catalyst.

a. Pass criterion 1: High mileage or field-returned parts with FTP emission results from section (e)(5.2.4)(B)(ii)b. that are less than the OBD emission threshold (i.e., parts degraded by less than 2 sigma below the catalyst monitor malfunction threshold) are passing the NMHC catalyst conversion efficiency monitor without MIL illumination. If the engine is certified with an NMHC catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunction criteria, the emission levels at which the malfunction was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified in the regulation.
b. Pass criterion 2: Field-returned parts that have a conversion efficiency averaged over the FTP test representative of the manufacturer's durability demonstration part (i.e., parts degraded within 2 sigma of the catalyst monitor malfunction threshold) meet

the following: 1) the NMHC catalyst conversion efficiency monitor illuminates the MIL during the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and emissions are below the emission threshold, and meet the FTP emission threshold requirements in section (e)(5.2.4)(B)(ii)b., and 2) the data and analysis show robust detection of NMHC catalyst conversion efficiency malfunctions during conditions meeting the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This testing can be done on road or on a dynamometer. If the engine is certified with an NMHC catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunction criteria, the emission levels at which the malfunction was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified in the regulation.

c. Pass criterion 3: Field-returned parts that have a conversion efficiency averaged over the FTP test that is worse than the best performing unacceptable conversion efficiency (i.e., degraded by more than 2 sigma from the catalyst monitor malfunction threshold) or have catastrophically failed meet the following: 1) the NMHC catalyst conversion efficiency monitor illuminates the MIL during the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)), and 2) the data and analysis show robust detection of NMHC catalyst conversion efficiency malfunctions during conditions meeting the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This testing can be done on road or on a dynamometer. If the engine is certified with an NMHC catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunction criteria, the test cycle conversion efficiency of the manufacturer's deficient durability demonstration part for section (i)(3) testing will be used for this assessment.

(C) The Executive Officer may waive the requirements for the submittal of the plan and data under sections (e)(5.2.4)(A) and (B) above for an engine if the plan and data have been submitted for a previous model year and the calibrations and hardware of the NMHC catalyst monitor, the engine, and the emission control system for the current model year have not changed from the previous model year.

(5.3) Monitoring Conditions:

(5.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(5.2.2) and (5.2.3) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally,

manufacturers shall track and report the in-use performance of the NMHC converting catalyst monitors under sections (e)(5.2.2) and (e)(5.2.3) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(5.2.2) and (5.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(5.2.2) and (5.2.3) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(6) Oxides of Nitrogen (NOx) Converting Catalyst Monitoring

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

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(6.2.3) Catalyst System Aging and Monitoring

~~(A) For purposes of determining the catalyst malfunction criteria in section (e)(6.2.1) for individually monitored catalysts, the manufacturer shall use a catalyst deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions. If the catalyst system contains more than one catalyst in series, the manufacturer shall use a catalyst system (including all NOx converting catalysts) 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~~A) For purposes of determining the catalyst malfunction criteria in section (e)(6.2.1)~~ for catalysts monitored in combination with others~~, the manufacturer shall submit a catalyst system aging and monitoring plan to the Executive Officer for review and approval. The plan shall include the description, emission control purpose, and location of each component, the monitoring strategy for each component and/or combination of components, and the method for determining the malfunction criteria of section (e)(6.2.1) including the deterioration/aging process. 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 (e)(6.2.1), the ability of the component monitor(s) to pinpoint the likely area of malfunction and ensure the correct components are repaired/replaced in-use, and the ability of the component monitor(s) to accurately verify that each catalyst component is functioning as designed and as required in section (e)(6.2.1).

(B) For 2025 and subsequent model year engines from engine families selected for monitoring system demonstration in section (i):

(i) In addition to the information described above in section (e)(6.2.3)(A), the catalyst system aging and monitoring plan described above in section (e)(6.2.3)(A) shall also include the timeline for submitting the information and data described under section (e)(6.2.3)(B)(ii) below. The timeline may include several dates for data submission for new emission control system designs where the manufacturer has not achieved sufficient in-use aging to demonstrate real world deterioration prior to certification of the OBD system.

(ii) Information and data to support methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions in section (f)(6.2.3)(A) must be submitted to the Executive Officer and shall at a minimum include an analysis of the potential failure modes and effects, highlighting the most likely cause of failure, comparison of laboratory aged versus real world aged catalysts, and include the following for a laboratory aged catalyst and a minimum of three field-returned catalysts (data for all field-returned catalysts that are collected for this aging correlation analysis must be submitted to the Executive Officer):

a. Emissions data and all data required by sections (h)(4.1) through (h)(4.9) and (h)(5) from the FTP and SET cycles,
b. Modal data during the FTP and SET cycles,
c. Catalyst NOx conversion efficiency as a function of catalyst temperature and exhaust gas flow rate,
d. Catalyst NOx conversion efficiency as a function of catalyst temperature and NO_2 to nitric oxide (NO) ratio,
e. Catalyst NOx conversion efficiency as a function of ammonia storage (relative to the maximum ammonia storage capacity of a new catalyst), and
f. All data required by sections (h)(4.1) through (h)(4.9) and (h)(5) from all catalysts collected from a wide range of monitoring conditions.

(iii) The Executive Officer shall approve the catalyst aging method upon finding the data passes each of the following "pass" criteria below. If the manufacturer is not able to locate at least one catalyst to be evaluated under pass criteria 1 through 3 below, the manufacturer may propose to include an additional catalyst described in another pass criterion (e.g., if a catalyst described in pass criterion 2 cannot be located, the manufacturer may use an additional catalyst described in either pass criterion 1 or 3 instead) as representative of the missing catalyst.

a. Pass criterion 1: High mileage or field-returned parts with FTP emission results from section (e)(6.2.3)(B)(ii)b. that are less than the OBD emission threshold (i.e., parts degraded by less than 2 sigma below the catalyst monitor malfunction threshold) are passing the NOx catalyst conversion efficiency monitor without MIL illumination. If the engine is certified with an NOx catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunction criteria, the emission levels at which the malfunction was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified in the regulation.

b. Pass criterion 2: Field-returned parts that have a conversion efficiency averaged over the FTP test that is representative of the manufacturer's durability demonstration part (i.e., parts degraded within 2 sigma of the catalyst monitor malfunction threshold) meet the following: 1) the NOx catalyst conversion efficiency monitor illuminates the MIL during the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and emissions are below the emission threshold, and 2) the data and analysis show robust detection of NOx catalyst conversion efficiency malfunctions during conditions meeting the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This testing can be done on road or on a dynamometer. If the engine is certified with a NOx catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunction criteria, the emission levels at which the malfunction was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified in the regulation.

c. Pass criterion 3: Field-returned parts that have a conversion efficiency averaged over the FTP test that is worse than the best performing unacceptable conversion efficiency (i.e., degraded by more than 2 sigma from the catalyst monitor malfunction threshold) or have catastrophically failed meet the following: 1) the NOx catalyst conversion efficiency monitor illuminates the MIL

during the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)), and 2) the data and analysis show robust detection of NOx catalyst conversion efficiency malfunctions during conditions meeting the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This testing can be done on road or on a dynamometer. If the engine is certified with a NOx catalyst monitor deficiency, the test cycle conversion efficiency of the manufacturer's deficient durability demonstration part for section (i)(3) testing will be used for this assessment.

(C) The Executive Officer may waive the requirements for the submittal of the plan and data under sections (e)(6.2.3)(A) and (B) above for an engine if the plan and data have been submitted for a previous model year and the calibrations and hardware of the NOx catalyst monitor, the engine, and the emission control system for the current model year have not changed from the previous model year.

(6.3) Monitoring Conditions:

(6.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(6.2.1), (e)(6.2.2)(A), and (e)(6.2.2)(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 (e)(6.2.1) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(6.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(6.2.1) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(7) NOx Adsorber Monitoring

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(7.2) Malfunction Criteria:

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(7.2.6) ~~For purposes of determining the NOx adsorber system malfunction criteria in section (e)(7.2.1), the manufacturer shall meet the following requirements:~~

~~(A) For individually monitored NOx adsorbers, the manufacturer shall use a NOx adsorber deteriorated to the malfunction criteria using methods~~

~~established by the manufacturer to represent real world NOx adsorber deterioration under normal and malfunctioning engine operating conditions. If the NOx adsorber system contains NOx adsorbers in parallel (e.g., a two bank exhaust system where each bank has its own NOx adsorber), the malfunction criteria shall be determined with the "parallel" NOx adsorbers equally deteriorated.~~

(~~B~~A) For purposes of determining the NOx adsorber system malfunction criteria in section (e)(7.2.1), the manufacturer shall meet the following requirements ~~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 (e)(7.2.1) 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 (e)(7.2.1), 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 (e)(7.2.1).

(B) For 2025 and subsequent model year engines from engine families selected for monitoring system demonstration in section (i):

(i) In addition to the information described above in section (e)(7.2.6)(A), the adsorber system aging and monitoring plan described above in section (e)(7.2.6)(A) shall also include the timeline for submitting the information and data described under section (e)(7.2.6)(B) below. The timeline may include several dates for data submission for new emission control system designs where the manufacturer has not achieved sufficient in-use aging to demonstrate real world deterioration prior to certification of the OBD system.

(ii) Information and data to support methods established by the manufacturer to represent real world NOx adsorber system deterioration under normal and malfunctioning engine operating conditions in section (e)(7.2.6)(A) must be submitted to the Executive Officer and shall at a minimum include an analysis of the potential failure modes and effects, highlighting the most likely cause of failure, comparison of laboratory aged versus real world aged adsorbers, and include the following for a laboratory aged adsorber and a minimum of three field-returned NOx adsorbers (data for all field-returned adsorbers that are collected for this aging correlation analysis must

be submitted to the Executive Officer):

a. Emissions data and all data required by sections (h)(4.1) through (h)(4.9) and (h)(5) from the FTP and SET cycles,
b. Modal data during the FTP and SET cycles,
c. NOx adsorber desorption performance as a function of NOx adsorber temperature and NOx adsorber system active/intrusive injection quantity and flow rate, and
d. All data required by sections (h)(4.1) through (h)(4.9) and (h)(5) from all adsorbers collected from a wide range of monitoring conditions.

(iii) The Executive Officer shall approve the adsorber aging method upon finding the data passes each of the following "pass" criteria below. If the manufacturer is not able to locate at least one adsorber to be evaluated under pass criteria 1 through 3 below, the manufacturer may propose to include an additional adsorber described in another pass criterion (e.g., if an adsorber described in pass criterion 2 cannot be located, the manufacturer may use an additional adsorber described in either pass criterion 1 or 3 instead) as representative of the missing adsorber.

a. Pass criterion 1: High mileage or field-returned parts with FTP emission results from section (e)(7.2.6)(B)(ii)b. that are less than the OBD emission threshold (i.e., parts degraded by less than 2 sigma below the adsorber monitor malfunction threshold) are passing the NOx adsorber capability monitor without MIL illumination. If the engine is certified with NOx adsorber monitor deficiency for not detecting a malfunction before emissions exceed the malfunction criteria, the emission levels at which the malfunction was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified in the regulation.
b. Pass criterion 2: Field-returned parts that have an adsorber capability averaged over the FTP test that is representative of the manufacturer's durability demonstration part (i.e., parts degraded within 2 sigma of the adsorber monitor malfunction threshold) meet the following: 1) the NOx adsorber capability monitor illuminates the MIL during the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and emissions are below the emission threshold, and 2) the data and analysis show robust detection of NOx adsorber capability malfunctions during conditions meeting the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This testing can be done on road or on a dynamometer. If the engine is certified with NOx adsorber monitor deficiency for not detecting a malfunction before

emissions exceed the malfunction criteria, the emission levels at which the malfunction was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified in the regulation.

c. Pass criterion 3: Field-returned parts that have an adsorber capability averaged over the FTP test that is worse than the best performing unacceptable adsorber capability (i.e., degraded by more than 2 sigma from the adsorber monitor malfunction threshold) or have catastrophically failed meet the following: 1) the NOx adsorber capability monitor illuminates the MIL during the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)), and 2) the data and analysis show robust detection of NOx adsorber capability malfunctions during conditions meeting the applicable cycle (i.e., the FTP cycle or alternate monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This testing can be done on road or on a dynamometer. If the engine is certified with a NOx adsorber monitor deficiency for not detecting a malfunction before emissions exceed the malfunction criteria, the test cycle adsorber capability of the manufacturer's deficient durability demonstration part for section (i)(3) testing will be used for this assessment.

(C) The Executive Officer may waive the requirements for the submittal of the plan and data under sections (e)(7.2.6)(A) and (B) above for an engine if the plan and data have been submitted for a previous model year and the calibrations and hardware of the NOx adsorber monitor, the engine, and the emission control system for the current model year have not changed from the previous model year.

(7.3) Monitoring Conditions:

(7.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(7.2.1) (i.e., adsorber capability) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the NOx adsorber monitors under section (e)(7.2.1) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, fFor purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(7.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(5.2.2) and (5.2.3) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(8) Particulate Matter (PM) Filter Monitoring

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(8.3) Monitoring Conditions:

(8.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(8.2.1) 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 PM filter monitors under section (e)(8.2.1) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section~~s~~ (e)(8.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(8.2.1) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

(8.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(8.2.2) through (8.2.6) 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, for all 2024 and subsequent model year engines, manufacturers shall track and report the in-use performance of the PM filter monitors under sections (e)(8.2.2), (e)(8.2.5), and (e)(8.2.6) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(8.2.2), (e)(8.2.5), and (e)(8.2.6) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(8.2.2), (e)(8.2.5), and (e)(8.2.6) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(9) Exhaust Gas Sensor Monitoring

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(9.2) Malfunction Criteria:

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(9.2.2) NOx and PM sensors:

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(D) Monitoring capability: To the extent feasible, the OBD system shall detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, PM filter, SCR, or NOx adsorber monitoring). The dependent monitor (e.g., catalyst, EGR, SCR or NOx adsorber monitor) for which the sensor is used as an OBD system monitoring device must make a robust diagnostic decision (e.g., avoid false passes of a best performing unacceptable catalyst and false fails of a nominal catalyst) with a deteriorated but passing exhaust gas sensor.

(i) For the NOx sensor on 2025 and subsequent model year engines, the manufacturer shall test each applicable failure mode of the NOx sensor (e.g., sensor offset high failure mode, sensor gain low failure mode) with the component/system for the dependent monitor set at the best performing unacceptable level (e.g., with a best performing unacceptable catalyst). For each applicable NOx sensor failure mode, the manufacturer shall, at a minimum, collect one data point with the sensor performance set at the sensor monitor malfunction threshold, at least three data points with the sensor performance set above the sensor malfunction threshold, and at least three data points with the sensor performance set below the sensor malfunction threshold. The spacing between the data points shall be set at two sigma and calculated using the variance of the applicable NOx sensor monitor output (i.e., the variance calculated from the NOx sensor monitor result distribution for the malfunction threshold sensor for the sensor failure mode under consideration). The manufacturer shall also submit test data and/or engineering analysis demonstrating the NOx sensor monitor robustness against false-pass and false-fail decisions. The robustness data/analysis shall include test results from a wide range of sensor monitor enable conditions and may include data/analysis previously collected during development of the sensor monitor. For each applicable NOx sensor failure mode, the manufacturer shall perform tests of all the required data points without sending a scan tool code clear command between each data point test (e.g., for testing of the sensor offset high failure mode, the manufacturer shall perform tests of all seven data points without sending a code clear command in-between each test). The manufacturer shall send a scan tool code clear command between testing of each applicable NOx sensor failure mode (e.g., collect all seven data points for testing of the sensor offset high failure mode, then send a code clear command before testing of the sensor gain high failure mode). The NOx sensor monitor is deemed compliant if, during testing of each applicable sensor failure mode, all the following are met:

a. The NOx sensor monitor makes a fail decision during testing for each data point (except the data point at the sensor monitor malfunction threshold) in the failing region of the sensor monitor,
b. The NOx sensor monitor makes a pass decision during testing for each data point (except the data point at the sensor monitor malfunction threshold) in the passing region of the sensor monitor,
c. The dependent monitor (e.g., catalyst monitor) makes a fail decision during testing for each data point in the passing region of the sensor monitor,
d. The MIL illuminates and is commanded on for a malfunction of the NOx sensor at least once during testing of each applicable NOx sensor failure mode, and
e. The MIL illuminates and is commanded on for a malfunction of the dependent component (e.g., catalyst) at least once during testing of each applicable NOx sensor failure mode.
f. Notwithstanding, if the manufacturer data do not satisfy sections (e)(9.2.2)(D)(i)a. through e. above due to a result being in the 2 percent tail of a normal distribution, the manufacturer may submit additional data points at the same sensor performance level to support the demonstration of compliance.

(ii) The Executive Officer may waive the requirements for the submittal of the data under section (e)(9.2.2)(D)(i) above for an engine if the data have been submitted for a previous model year and the calibrations of the NOx sensor monitor and dependent monitor for the current engine have not changed from the previous model year.

(iii) The manufacturer may meet the requirements in section (e)(9.2.2)(D)(i) above on 2023 and 2024 model year engines.

* * * *

(9.3) Monitoring Conditions:

(9.3.1) Exhaust Gas Sensors

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(9.2.1)(A)(i), (9.2.1)(B)(i), (9.2.2)(A), and (9.2.2)(D) (e.g., sensor performance faults) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the exhaust gas sensor monitors under sections (e)(9.2.1)(A)(i), (9.2.1)(B)(i), and (9.2.2)(A) in accordance with section (d)(3.2.1). Further, for all 2016 and subsequent model year engines, manufacturers shall track and report the in-use performance of the exhaust gas sensor monitors under section (e)(9.2.2)(D) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(9.2.1)(A)(i), (9.2.1)(B)(i), (9.2.2)(A), and (9.2.2)(D) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(9.2.1)(A)(i), (9.2.1)(B)(i), (9.2.2)(A), and (9.2.2)(D) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

* * * *

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

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(10.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for VVT system malfunctions identified in section (e)(10.2) 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 under section (e)(10.2) in accordance with section (d)(3.2.1).

(10.3.1) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(10.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(10.3.2) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (e)(10.2) shall be tracked and reported separately as specified in section (d)(5.1.3) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(11) Cold Start Emission Reduction Strategy Monitoring

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(11.2) Malfunction Criteria:

(11.2.1) For 2013 through 2025 model year engines, t~~T~~he OBD system shall, to the extent feasible, detect a malfunction if any of the following occurs:

(~~11.2.1~~A) 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~~i)by a robustly detectable amount by the monitor; and

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

(~~C~~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);

(~~11.2.2~~B) Any failure or deterioration of the cold start emission reduction control strategy that would cause an engine's NMHC, NOx, or CO emissions to exceed 2.0 times the applicable standards or the engine's PM emissions to exceed the applicable standard plus 0.02 g/bhp-hr.

(~~11.2.3~~C) For section (e)(11.2.~~2~~1)(B), to the extent feasible (without adding hardware for this purpose), the OBD 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 (e)(11.2.~~2~~1)(B). For strategies where it is not feasible to be monitored as a system, the OBD 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 (e)(11.2.~~2~~1)(B).

(11.2.2) Catalyst warm-up strategy (CWS) monitor: For 20 percent of 2026, 50 percent of 2027, and 100 percent of 2028 and subsequent model year engines, the OBD system shall monitor the CWS while the CSERS cold start criteria (as defined in section (c)) are met by measuring the inlet temperature and/or energy to the first NOx reducing element (e.g., SCR) and comparing it with a modeled inlet temperature and/or energy to the first NOx reducing element.

(A) The OBD system shall detect a malfunction when the CWS is no longer functioning as intended.

(B) The CWS is exempt from the monitoring requirements of section (e)(11.2.2)(A) if no malfunction of the CWS can cause emissions to exceed 1.5 times the applicable NMHC and CO standards, 0.3 g/bhp-hr NOx, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test.

(11.2.3) Individual components/features:

(A) For 2026 and subsequent model year engines, the OBD system shall detect a malfunction if any of the following components and features does not properly respond to the commanded action while the CSERS cold start criteria (as defined in section (c)) are met:

(i) EGR valve position,
(ii) EGR cooler bypass control,
(iii) variable geometry turbocharger position,
(iv) swirl valve position,
(v) fuel rail pressure,
(vi) commanded injection quantity/timing,
(vii) exhaust and intake throttle, and
(viii) variable valve timing components position.

(B) If the setpoint of a component/feature is different between cold start conditions and non-cold start conditions, for purposes of section (e)(11.2.3)(A), "properly respond" is defined as when the component/feature responds:
(i) by a robustly detectable amount; and
(ii) in the direction of the desired command; and
(iii) above and beyond what the feature/component would achieve on start-up without the cold start strategy active.

(C) For features/components where feedback from a sensor is not available to monitor for proper response, the monitor may verify the final commanded action in lieu of verifying actual delivered action.

(11.2.4) For the phase-in schedule described in section (e)(11.2.2) above, 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 2028 and subsequent model year engines shall comply with the requirements.

(11.2.5) For 2023 through 2025 model year engines, the manufacturer may meet the requirements in sections (e)(11.2.2) and (e)(11.2.3) above in lieu of meeting the requirements in section (e)(11.2.1).

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

(1) Fuel System Monitoring

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(1.3) Monitoring Conditions:

(1.3.1) Except as provided in section (f)(1.3.5), the OBD system shall monitor continuously for malfunctions identified in sections (f)(1.2.1)(A), (f)(1.2.1)(B), and (f)(1.2.2) (i.e., fuel delivery system, secondary feedback control, adaptive feedback control).

(1.3.2) Manufacturers shall define monitoring conditions for malfunctions identified in section (f)(1.2.1)(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 2024 and subsequent model year engines, manufacturers shall track and report the in-use performance of the fuel system monitors under section (f)(1.2.1)(C) in accordance with section (d)(3.2.1). ~~For purposes of tracking and reporting as required in section (d)(3.2.1), all dedicated monitors used to detect malfunctions identified in section (f)(1.2.1)(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 (f)(2), fuel system monitor under section (f)(1.2.1)(A)) to detect malfunctions identified in section (f)(1.2.1)(C) are subject to the tracking and reporting requirements of the other monitors.

(A) For engines using SAE J1979 or SAE J1939, for purposes of tracking and reporting as required in section (d)(3.2.1), all dedicated monitors used to detect malfunctions identified in section (f)(1.2.1)(C) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(1.2.1)(C) shall be tracked and reported separately as specified in section (d)(5.1.4) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

* * * *

(1.4) MIL Illumination and Fault Code Storage: For malfunctions described under section (f)(1.2.1)(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 (f)(1.4.1) through (1.4.6) below.

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(1.4.4) Storage of freeze frame conditions.

(A) For engines using SAE J1979 or SAE J1939:

~~(A)~~(i) For 2010 through 2023 model year engines using the ISO 15765-4 protocol for the standardized functions in section (h), the OBD system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing and erasing a confirmed fault code. For 2024 and subsequent model year engines using the ISO 15765-4 protocol for the standardized functions in section (h), the OBD system shall store and erase freeze frame conditions in accordance with section (d)(2.2.1)(D)(iii). For engines using the SAE J1939 protocol for the standardized functions in section (h), the OBD system shall store and erase freeze frame conditions in accordance with section (d)(2.2.2)(D).

~~(B)~~(ii) If freeze frame conditions are stored for a malfunction other than a misfire (see section (f)(2)) or fuel system malfunction when a fuel system fault code is stored as specified in section (f)(1.4.1) or (f)(1.4.2) above, the stored freeze frame information shall be replaced with freeze frame information regarding the fuel system malfunction.

(B) For engines using SAE J1979-2: A manufacturer shall store and erase freeze frame conditions in accordance with section (d)(2.2.1)(D)(ii).

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(2) Misfire Monitoring

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(2.4) MIL Illumination and Fault Code Storage:

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(2.4.3) Storage of freeze frame conditions.

(A) For engines using SAE J1979 or SAE J1939:

~~(A)~~(i) For 2010 through 2023 model year engines using the ISO 15765-4 protocol for the standardized functions in section (h), the OBD system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing and erasing a confirmed fault code. For 2024 and subsequent model year engines using the ISO 15765-4 protocol for the standardized functions in section (h), the OBD system shall store and erase freeze frame conditions in accordance with section (d)(2.2.1)(D)(iii). For engines using the SAE J1939 protocol for the standardized functions in section (h), the OBD system shall store and erase freeze frame conditions in accordance with section (d)(2.2.2)(D).

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

(B) For engines using SAE J1979-2: A manufacturer shall store and erase freeze frame conditions in accordance with section (d)(2.2.1)(D)(ii).

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(3) Exhaust Gas Recirculation (EGR) System Monitoring

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(3.3) Monitoring Conditions:

(3.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(3.2) (i.e., flow rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the EGR system monitors under section (f)(3.2) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(3.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(3.2) shall be tracked and reported separately as specified in section (d)(5.1.4) or tracked separately but reported as a

single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(4) Cold Start Emission Reduction Strategy Monitoring

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(4.2) Malfunction Criteria:

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(4.2.2) For 2013 ~~and subsequent~~ through 2025 model year engines, the OBD system shall, to the extent feasible, detect a malfunction if any 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 that would cause an engine's emissions to be equal to or above 1.5 times the applicable standards. For this requirement, the OBD system shall either monitor the combined effect of the 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 engine emissions to exceed 1.5 times the applicable standards.

(4.2.3) Cold Start Catalyst Heating Monitor: For 2026 and subsequent model year engines utilizing catalyst heating through combustion inefficiency during idle at cold start, except as provided for in section (f)(4.2.3)(C), the OBD system shall monitor the commanded (or delivered, if feasible) extra cold start exhaust heat energy directed to the catalyst. The monitor shall begin when the engine starts and the conditions of the CSERS cold start criteria (as defined in section (c)) are met, and shall continue no longer than 30 seconds after engine start. Monitoring is not required if the idle operation during the first 30 seconds after engine start is less than 10 seconds.

(A) The OBD system shall detect a malfunction of the extra cold start exhaust heat energy delivery to the catalyst when any of the following occurs:

(i) The heat energy delivery fails to achieve at least 20 percent of the additional element commanded by the cold start strategy (e.g., if an additional 20 degrees of spark retard are requested to provide additional heat to the catalyst during nominal cold starts on a properly functioning engine, the monitor must detect a malfunction if the strategy fails to command at least 4 degrees of additional spark retard). The additional element commanded by the cold start strategy shall be determined by comparing the commanded value of the element in a properly functioning engine during an FTP test cold start with the commanded value of the element in a properly functioning fully warmed-up engine. A fully warmed-up engine shall be defined by operating the engine until the engine coolant and/or block temperature achieves the targeted regulated temperature for at least 2 minutes prior to shutting the engine off and then restarting the engine within 60 seconds of shut off.

(ii) The malfunction causes an engine's emissions to be equal to or above 1.5 times any of the applicable emission standards.

(B) For purposes of meeting the requirements in section (f)(4.2.3)(A) above, the OBD system must monitor the commanded (or delivered, if feasible) extra cold start exhaust heat energy directed to the catalyst during idle conditions (e.g., increasing airflow, increasing fuel flow, applying torque reserve or retarding spark timing, altering variable valve timing) by one of the methods defined below:

(i) Increased airflow into the engine: the monitor shall compare the measured or modeled airflow amount, averaged over the monitoring window, to the airflow amount required for proper heating of the catalyst, averaged over the same monitoring window.

(ii) Final commanded torque reserve/spark retard: the monitor shall compare the final commanded torque reserve/spark retard, averaged over the monitoring window, to the nominal torque reserve/spark retard required for proper heating of the catalyst over the same monitoring window.

(iii) Catalyst temperature: the monitor shall compare the increase in the measured or modeled catalyst temperature, averaged over the monitoring window, to the expected increase in catalyst temperature over the same monitoring window.

(C) Engines are exempt from the Cold Start Catalyst Heating monitoring requirements in section (f)(4.2.3)(A) if:

(i) Disabling the CSERS would not cause the engine to exceed the full useful life emission standards through the demonstration of a cold start FTP test cycle with the CSERS fully disabled (i.e., with the system configured to the fully warmed-up values as if the engine was shut off

after the engine coolant and/or block temperature achieve the targeted regulated temperature for at least 2 minutesand immediately restarted within 60 seconds), or

(ii) The engine does not use increased air, increased fuel flow, and/or combustion efficiency degradation to accelerate aftertreatment heating to reduce cold start emissions (e.g., catalyst is only electrically-heated).

(4.2.4) Individual Feature/Component Monitoring:

(A) For 2026 and subsequent model year engines, the OBD system shall detect a malfunction if any of the following components and features does not properly respond to the commanded action while the CSERS cold start criteria (as defined in section (c)) are met:

(i) Fuel Pressure

(ii) Idle Speed Control

(iii) Variable Valve Timing/Lift

(iv) Split/Multiple Injections (missing pulses)

(v) Charge motion control, intake runner, or swirl control valves

(vi) Electronic wastegate position

(B) If the setpoint of a component/feature is different between cold start conditions and non-cold start conditions, for purposes of section (f)(4.2.4)(A), "properly respond" is defined as when the feature/component responds:

(i) by a robustly detectable amount; and

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

(iii) above and beyond what the feature/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).

(C) For features/components where feedback from a sensor is not available to monitor for proper response, the monitor may verify the final commanded action in lieu of verifying actual delivered action.

(4.2.5) For 2023 through 2025 model year engines, the manufacturer may meet the requirements in sections (f)(4.2.3) and (f)(4.2.4) above in lieu of meeting the requirements in section (f)(4.2.2).

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(5) Secondary Air System Monitoring

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(5.3) Monitoring Conditions:

(5.3.1) Manufacturers shall define the monitoring conditions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the secondary air system monitors under section (f)(5.2) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(5.2) during normal operation of the secondary air system shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(5.2) shall be tracked and reported separately as specified in section (d)(5.1.4) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

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(6) Catalyst Monitoring

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(6.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(6.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the catalyst monitors under section (f)(6.2) in accordance with section (d)(3.2.1).

(6.3.1) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(6.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(6.3.2) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(6.2) shall be tracked and reported separately as specified in section (d)(5.1.4) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

* * * *

(7) Evaporative System Monitoring

* * * *

(7.3) Monitoring Conditions:

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(7.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(7.2.2)(B) (i.e., 0.150 inch leak detection) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the evaporative system monitors under section (f)(7.2.2)(B) in accordance with section (d)(3.2.1).

(A) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(7.2.2)(B) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(B) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(7.2.2)(B) shall be tracked and reported separately as specified in section (d)(5.1.4) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

* * * *

(8) Exhaust Gas Sensor Monitoring

* * * *

(8.3) Monitoring Conditions:

(8.3.1) Primary Sensors

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(8.2.1)(A) and (D) (e.g., proper response rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). Additionally, manufacturers shall track and report the in-use performance of the primary sensor monitors under sections (f)(8.2.1)(A) and (D) in accordance with section (d)(3.2.1).

(i) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (f)(8.2.1)(A) and (D) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(ii) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (f)(8.2.1)(A) and (D) shall be tracked and reported separately as specified in section (d)(5.1.4) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

* * * *

(8.3.2) Secondary Sensors

(A) Manufacturers shall define monitoring conditions for malfunctions identified in sections (f)(8.2.2)(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, for all 2013 and subsequent model year engines meeting the monitoring requirements of section (f)(8.2.2)(C)(i) or (ii), manufacturers shall track and report the in-use performance of the secondary sensor monitors under sections (f)(8.2.2)(A) and (C) in accordance with section (d)(3.2.1).

(i) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (f)(8.2.2)(A) and (C) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(ii) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect

malfunctions identified in sections (f)(8.2.2)(A) and (C) shall be tracked and reported separately as specified in section (d)(5.1.4) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

* * * *

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

* * * *

(9.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for VVT system malfunctions identified in section (f)(9.2) 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 under section (f)(9.2) in accordance with section (d)(3.2.1).

(9.3.1) For engines using SAE J1979 or SAE J1939, f~~F~~or purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(9.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.~~2~~1)(B).

(9.3.2) For engines using SAE J1979-2, for purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in section (f)(9.2) shall be tracked and reported separately as specified in section (d)(5.1.4) or tracked separately but reported as a single set of values as specified in section (d)(5.2.2)(B), whichever is applicable.

* * * *

(g) Monitoring Requirements For All Engines.

* * * *

(3) Comprehensive Component Monitoring

* * * *

(3.2) Malfunction Criteria:

* * * *

(3.2.2) Output Components/Systems:

* * * *

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

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

a. The idle speed control system cannot achieve the target idle speed within 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed. The Executive Officer shall allow larger engine speed tolerances upon determining that a manufacturer has submitted data and/or an engineering evaluation which demonstrate that the tolerances can be

exceeded without a malfunction being present.

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

c. For 20 percent of 2026, 50 percent of 2027, and 100 percent of 2028 and subsequent model year engines without manual transmissions (i.e., any transmission that relies on the vehicle operator to independently control clutch engagement/disengagement and gear selection), an engine stall occurs (where an "engine stall" refers to a drop in the engine revolutions-per-minute (rpm) to zero rpm) within 20 seconds after engine start at the beginning of a driving cycle when fuel level is 15 percent or more of the nominal capacity of the fuel tank.

1. Manufacturers are required to store different fault codes for stalls detected while the CSERS cold start criteria (defined in section (c)) are met and stalls detected while the CSERS cold start criteria are not met.
2. The manufacturer may use an alternate phase-in schedule as defined in section (c) in lieu of the required phase-in schedule for the engine stall monitor in section (g)(3.2.2)(B)(i)c. if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) with the exception that 100 percent of 2028 and subsequent model year engines shall comply with the requirements.

* * * *

(3.3) Monitoring Conditions:

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(3.3.2) Output Components/Systems:

* * * *

(C) For the idle control system:~~,~~

(i) For malfunctions identified in sections (g)(3.2.2)(B)(i)a. and b., manufacturers shall define the monitoring conditions for functional checks in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that functional 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).

(ii) For malfunctions identified in section (g)(3.2.2)(B)(i)c., monitoring shall occur after every engine start at the beginning of every driving cycle.

* * * *

(3.4) MIL Illumination and Fault Code Storage:

(3.4.1) Except as provided in sections (g)(3.4.2) and (3.4.4) 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 (g)(3.2.1)(B) for input components, section (g)(3.2.2)(A) for

output components/systems, and section (g)(3.2.3)(A)(v) for hybrid components.

* * * *

(3.4.4) For malfunctions required to be detected by section (g)(3.2.2)(B)(ii)d. (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).

(3.4.5) Exceptions to general requirements for MIL illumination and fault code storage. For monitors of malfunctions described in section (g)(3.2.2)(B)(i)c., in lieu of storing a pending fault code and a confirmed/MIL-on fault code and illuminating the MIL as described in sections (d)(2.2.1) and (d)(2.2.2), the OBD system may use the following procedures:

(A) For vehicles using the ISO 15765-4 protocol for the standardized functions required in section (h), the OBD system may use any of the following fault code storage and MIL illumination procedures:

(i) The OBD system may store a pending fault code and a confirmed fault code after 3 sequential driving cycles during which the monitor functions and detects a malfunction, or

(ii) The OBD system may store a pending fault code after initial malfunction detection and a confirmed fault code after malfunction detection in the third sequential driving cycle if a malfunction is also detected in the second and third sequential driving cycles.

(B) For vehicles using the SAE J1939 protocol for the standardized functions required in section (h), the OBD system may use any of the following fault code storage and MIL illumination procedures:

(i) The OBD system may store a MIL-on fault code after 3 sequential driving cycles during which the monitor functions and detects a malfunction, or

(ii) The OBD system may store a pending fault code after initial malfunction detection and erase the pending fault code and store a MIL-on fault code after malfunction detection in the third sequential driving cycle if a malfunction is also detected in the second and third sequential driving cycles.

* * * *

(h) *Standardization Requirements.*

(1) Reference Documents:

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

* * * *

(1.4) SAE J1979 "E/E Diagnostic Test Modes", February 2017 (SAE J1979).

(1.4.1) SAE J1979-DA “Digital Annex of E/E Diagnostic Test Modes”, ~~May 2019~~ April 2021.

(1.4.2) SAE J1979-2, “E/E Diagnostic Test Modes: OBDonUDS”, April 2021

* * * *

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

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

(3.1.2) For engines using SAE J1979-2, except as provided in sections (h)(3.1.2)(A) and (h)(3.1.2)(B), the OBD system shall respond to functional (i.e., broadcast) and physical (i.e., point-to-point) request messages from a scan tool in accordance with SAE J1979-2 specifications.

(A) The OBD system may respond to a physical Service $14 (i.e., clear/reset emission-related diagnostic information) request message from a scan tool.

(B) The OBD system may respond to functional Service $19 subfunction $56 (i.e., "Request DTCs for a ReadinessGroup") and Service $19 subfunction $1A (i.e., "Request supported DTCExtendedRecord information") request messages from a scan tool.

(3.1.3) For engines using SAE J1979-2, except as provided in sections (h)(3.1.3)(A), (h)(3.1.3)(B), and (h)(4.7.4)(B), the OBD system may not respond with a negative response code (NRC) in response to a request message from a scan tool.

(A) The OBD system may respond with NRC $22, $31, $72, or $78 in response to a Service $14 (i.e., clear/reset emission-related diagnostic information) request message from a scan tool.

(B) The OBD system may respond with NRC $78 in response to a request message for tracking data specified in sections (h)(5.3) through (h)(5.6) from a scan tool.

* * * *

(4) Required Emission Related Functions:
The following standardized functions shall be implemented in accordance with the specifications in SAE J1979, SAE J1979-2, or SAE J1939 to allow for access to the required information by a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network:

(4.1) Readiness Status:

(4.1.1) For engines using SAE J1979 or SAE J1939:

(A) In accordance with SAE J1979/J1939-73 specifications, the OBD 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 (f)(9), and (g)(3) except (e)(11) and

(f)(4).

~~(4.1.1)~~(B) The readiness status for the following component/system readiness bits shall always indicate "complete":

~~(A)~~(i) Diesel misfire (section (e)(2)) for engines with a single monitor designed to detect both misfires identified in section (e)(2.2.1) and subject to the monitoring conditions of sections (e)(2.3.1) and (e)(2.3.2) and misfires identified in section (e)(2.2.2) and subject to the monitoring conditions of (e)(2.3.3);

~~(B)~~(ii) Gasoline misfire (section (f)(2)); and

~~(C)~~(iii) Diesel and gasoline comprehensive component (section (g)(3)).

~~(4.1.2)~~(C) For 2010 through 2015 model year engines, for components and systems not listed in section (h)(4.1.1)(B) above, the readiness status shall immediately indicate "complete" upon the respective monitor(s) (except those monitors specified under section (h)(4.1.~~7~~1)(H) 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.

~~(4.1.3)~~(D) For 2016 and subsequent model year engines, for components and systems not listed in section (h)(4.1.1)(B) 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:

(i)~~(A)~~ Diesel Fuel System: sections (e)(1.2.1), (e)(1.2.2), and (e)(1.2.3)

(ii)~~(B)~~ Diesel Misfire: section (e)(2.2.1) for engines with a separate monitor designed to detect misfires identified in section (e)(2.2.1) and subject to the monitoring conditions of sections (e)(2.3.1) and (e)(2.3.2)

(iii)~~(C)~~ Diesel EGR/VVT: sections (e)(3.2.1), (e)(3.2.2), (e)(3.2.3), (e)(3.2.5), (e)(3.2.6), and (e)(10.2)

(iv)~~(D)~~ Diesel Boost Pressure Control System: sections (e)(4.2.1), (e)(4.2.2), (e)(4.2.3), and (e)(4.2.4)

(v)~~(E)~~ Diesel NMHC Converting Catalyst: sections (e)(5.2.2) and (e)(5.2.3)(A)

(vi)~~(F)~~ Diesel NOx Converting Catalyst: section (e)(6.2.1)

(vii)~~(G)~~ Diesel NOx Aftertreatment: sections (e)(7.2.1) and (e)(7.2.2)

(viii)~~(H)~~ Diesel PM Filter:

a.~~(i)~~ For 2016 through 2023 model year engines, sections (e)(8.2.1), (e)(8.2.2), (e)(8.2.5), and (e)(8.2.6)

b.~~(ii)~~ For 2024 and subsequent model year engines, sections (e)(8.2.1) and (e)(8.2.5)

(ix)~~(I)~~ Diesel Exhaust Gas Sensor:

a.~~(i)~~ For 2016 and subsequent model year engines on vehicles using the SAE J1939 protocol for the standardized functions required in section (h), and for 2016 through 2023 model year engines on vehicles using the ISO 15765-4 protocol for the standardized functions required in section (h), sections (e)(9.2.1)(A)(i), (e)(9.2.1)(A)(iv), (e)(9.2.1)(B)(i), (e)(9.2.1)(B)(iv), (e)(9.2.2)(A), (e)(9.2.2)(D), and (e)(9.2.3)(A)

b.~~(ii)~~ For 2024 and subsequent model year engines on vehicles using the ISO 15765-4 protocol for the standardized functions required in section (h), sections (e)(9.2.1)(A)(i), (e)(9.2.1)(A)(iv), (e)(9.2.1)(B)(i), (e)(9.2.1)(B)(iv), (e)(9.2.2)(A), (e)(9.2.2)(D), (e)(9.2.3)(A), and (e)(9.2.4)(A)

(x)~~(J)~~ Diesel Exhaust Gas Sensor Heater: section (e)(9.2.4)(A) for vehicles using the SAE J1939 protocol for the standardized functions required in section (h)

(xi)~~(K)~~ Gasoline Fuel System: section (f)(1.2.1)(C)

(xii)~~(L)~~ Gasoline EGR/VVT: sections (f)(3.2.1), (f)(3.2.2), (f)(9.2.1), (f)(9.2.2), and (f)(9.2.3)

(xiii)~~(M)~~ Gasoline Secondary Air System: sections (f)(5.2.1), (f)(5.2.2), (f)(5.2.3), and (f)(5.2.4)

(xiv)~~(N)~~ Gasoline Catalyst: section (f)(6.2.1)

(xv)~~(O)~~ Gasoline Evaporative System: sections (f)(7.2.2)(A) and (f)(7.2.2)(B)

(xvi)~~(P)~~ Gasoline Oxygen Sensor: sections (f)(8.2.1)(A), (f)(8.2.1)(D), (f)(8.2.2)(A), and (f)(8.2.2)(C)

(xvii)~~(Q)~~ Gasoline Oxygen/Exhaust Gas Sensor Heater: section (f)(8.2.3)(A)

~~(4.1.4)~~(E) For 2016 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)~~(F) Except for the readiness bits listed under section (h)(4.1.1)(B) 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".

~~(4.1.6)~~(G) 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 continuously illuminate in the key on, engine off position for at least 15 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 (h)(4.2)) shall indicate "commanded off" during this sequence unless the MIL has also been "commanded on" for a detected fault.

~~(4.1.7)~~(H) For 2010 through 2015 model year engines, m~~M~~anufacturers are not required to use the following monitors in determining the readiness status for the specific component or system:

~~(A)~~(i) Circuit and out-of-range monitors that are required to be continuous;

~~(B)~~(ii) Gasoline and diesel exhaust gas sensor feedback monitors specified in sections (e)(9.2.1)(A)(iii), (e)(9.2.1)(B)(iii), (e)(9.2.2)(C), (f)(8.2.1)(C), and (f)(8.2.2)(E);

~~(C)~~(iii) Diesel feedback control monitors specified in sections (e)(1.2.4), (e)(3.2.4), (e)(4.2.5), (e)(6.2.2)(D), (e)(7.2.3), and (e)(8.2.7);

~~(D)~~(iv) Gasoline fuel system monitors specified in sections (f)(1.2.1)(A), (f)(1.2.1)(B), (f)(1.2.2), and (f)(1.2.4).

(4.1.2) For engines using SAE J1979-2:

(A) In accordance with SAE J1979-2 specifications, the OBD 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 (g)(4).

(B) The readiness status for each component/system readiness bit listed below shall immediately indicate "complete" if any of the following conditions occur: (1) except for misfire (sections (h)(4.1.2)(B)(ii) and (h)(4.1.2)(B)(xvii)), all the respective supported monitors listed below for each component/system have fully executed and determined that the component or system is not malfunctioning, (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, or (3) for misfire (sections (h)(4.1.2)(B)(ii) and (h)(4.1.2)(B)(xvii)), 4,000 fueled engine revolutions have occurred and all the respective supported monitors have fully executed and determined that there is no misfire malfunction:

(i) Diesel Fuel System: sections (e)(1.2.1), (e)(1.2.2), and (e)(1.2.3)

(ii) Diesel Misfire: sections (e)(2.2.1) and (e)(2.2.2)

(iii) Diesel EGR System: sections (e)(3.2.1), (e)(3.2.2), (e)(3.2.3), (e)(3.2.4), (e)(3.2.5), and (e)(3.2.6)

(iv) Diesel Boost Pressure Control System: sections (e)(4.2.1), (e)(4.2.2), (e)(4.2.3), (e)(4.2.4), and (e)(4.2.5)
(v) Diesel NMHC Converting Catalyst: sections (e)(5.2.2) and (e)(5.2.3)
(vi) Diesel NOx Converting Catalyst: sections (e)(6.2.1), (e)(6.2.2)(A), and (e)(6.2.2)(C)
(vii) Diesel NOx Adsorber: sections (e)(7.2.1) and (e)(7.2.2)
(viii) Diesel PM Filter:
a. For 2023 model year engines, sections (e)(8.2.1), (e)(8.2.2), (e)(8.2.5), and (e)(8.2.6)
b. For 2024 and subsequent model year engines, sections (e)(8.2.1) and (e)(8.2.5)
(ix) Diesel Exhaust Gas Sensor:
a. For 2023 model year engines, sections (e)(9.2.1)(A)(i), (e)(9.2.1)(A)(iv), (e)(9.2.1)(B)(i), (e)(9.2.1)(B)(iv), (e)(9.2.2)(A), (e)(9.2.2)(D), and (e)(9.2.3)(A)
b. For 2024 and subsequent model year engines, sections (e)(9.2.1)(A)(i), (e)(9.2.1)(A)(iv), (e)(9.2.1)(B)(i), (e)(9.2.1)(B)(iv), (e)(9.2.2)(A), (e)(9.2.2)(D), (e)(9.2.3)(A), and (e)(9.2.4)(A)
(x) Diesel VVT: sections (e)(10.2.1), (e)(10.2.2), and (e)(10.2.3)
(xi) Diesel Cold Start Emission Reduction Strategy: sections (e)(11.2.1), (e)(11.2.2), and (e)(11.2.3)
(xii) Diesel Engine Cooling System: sections (g)(1.2.2)(C) and (g)(1.2.2)(D)
(xiii) Diesel CV System: sections (g)(2.2.2) and (g)(2.2.3)
(xiv) Diesel Comprehensive Component: input component rationality fault diagnostics, output component/system functional checks, sections (g)(3.2.3)(A)(i) through (iii), (g)(3.2.3)(B)(i)b., (g)(3.2.3)(B)(ii)b., and (g)(3.2.3)(C) through (F)
(xv) Diesel Other Emission Control System: section (g)(4)
(xvi) Gasoline Fuel System: section (f)(1.2.1)(C)
(xvii) Gasoline Misfire: sections (f)(2.2.1) and (f)(2.2.2)
(xviii) Gasoline EGR System: sections (f)(3.2.1) and (f)(3.2.2)
(xix) Gasoline Cold Start Emission Reduction Strategy: sections (f)(4.2.2), (f)(4.2.3), and (f)(4.2.4)
(xx) Gasoline Secondary Air System: sections (f)(5.2.1), (f)(5.2.2), (f)(5.2.3), and (f)(5.2.4)
(xxi) Gasoline Catalyst: section (f)(6.2.1)
(xxii) Gasoline Evaporative System: sections (f)(7.2.2)(A), (f)(7.2.2)(B), and (f)(7.2.2)(C)
(xxiii) Gasoline Exhaust Gas Sensor: sections (f)(8.2.1)(A), (f)(8.2.1)(D), (f)(8.2.2)(A), (f)(8.2.2)(C), and (f)(8.2.3)(A)
(xxiv) Gasoline VVT System: (f)(9.2.1), (f)(9.2.2), and (f)(9.2.3)
(xxv) Gasoline Engine Cooling System: sections (g)(1.2.2)(C) and (g)(1.2.2)(D)
(xxvi) Gasoline CV System: sections (g)(2.2.2) and (g)(2.2.3)

(xxvii) Gasoline Comprehensive Component: input component rationality fault diagnostics, output component/system functional checks, sections (g)(3.2.3)(A)(i) through (iii), (g)(3.2.3)(B)(i)b., (g)(3.2.3)(B)(ii)b., and (g)(3.2.3)(C) through (F)

(xxviii) Gasoline Other Emission Control System: (g)(4)

(C) 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.

(D) 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".

(E) 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 continuously illuminate in the key on, engine off position for at least 15 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 (h)(4.2)) shall indicate "commanded off" during this sequence unless the MIL has also been "commanded on" for a detected fault.

(4.2) Data Stream: The following signals shall be made available on demand through the standardized data link connector in accordance with SAE J1979/J1979-2/J1939 specifications. The actual signal value shall always be used instead of a default or limp home value.

(4.2.1) For all gasoline engines:

* * * *

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

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

(i) For all engines using SAE J1979 or J1939, monitor status (i.e., disabled for the rest of this driving cycle).

* * * *

(4.2.2) For all diesel engines:

* * * *

(C) Number of stored confirmed/MIL-on fault codes, monitor status (i.e., ~~disabled for the rest of this driving cycle,~~ complete this driving cycle, or not complete this driving cycle) since last engine shut-off for each monitor used for readiness status, distance traveled (or engine run time for engines not utilizing vehicle speed information) while MIL activated, distance traveled (or engine run time for engines not utilizing vehicle speed information) since fault memory last cleared, number of warm-up cycles since fault memory last cleared, OBD requirements to which the engine is certified (e.g., California OBD, California OBD-child rating (i.e., for engines subject to (d)(7.1.2) or (d)(7.2.3)) EPA OBD, European OBD, non-OBD), MIL status (i.e., commanded-on or commanded-off);

(i) For all engines using SAE J1979 or SAE J1939, monitor status (i.e., disabled for the rest of this driving cycle);

* * * *

(4.2.3) For all engines so equipped:

* * * *

(G) For 2024 and subsequent model year engines, commanded DEF dosing, DEF dosing mode (A, B, C, etc.), DEF dosing rate, DEF usage for current driving cycle, target ammonia storage level on SCR, modeled actual ammonia storage level on SCR, SCR intake temperature, SCR outlet temperature, stability of NOx sensor reading, EGR mass flow rate, engine fuel rate, vehicle fuel rate, hydrocarbon doser flow rate, hydrocarbon doser injector duty cycle, aftertreatment fuel pressure, charge air cooler outlet temperature, propulsion system active, chassis odometer reading, engine odometer reading (if available), hybrid/EV charging state, hybrid/EV battery system voltage, hybrid/EV battery system current, commanded/target fresh air flow, crankcase pressure sensor output, crankcase oil separator rotational speed, evaporative system purge pressure sensor output, and vehicle speed limiter speed limit.

(4.2.4) Additionally, for engines using SAE J1979-2:

(A) Fuel pressure from the high-pressure and low-pressure fuel system, if so equipped

(B) Cylinder-specific misfire counts

(C) EVAP system sealing status for engines with evaporative systems that can be sealed when commanded by an enhanced scan tool

(4.3) Freeze Frame:

(4.3.1) For engines using SAE J1979 or SAE J1939:

~~(4.3.1)~~(A) "Freeze frame" information required to be stored pursuant to sections (d)(2.2.1)(D), (d)(2.2.2)(D), (e)(1.4.2)(D), (e)(2.4.2)(B), (f)(1.4.4), and (f)(2.4.3) shall be made available on demand through the standardized data link connector in accordance with SAE J1979/J1939-73 specifications.

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

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

(4.3.2) For engines using SAE J1979-2:

(A) "Freeze frame" information required to be stored pursuant to sections (d)(2.2.1)(D), (d)(2.2.2)(D), (e)(1.4.2)(D), (e)(2.4.2)(B), (f)(1.4.4), and (f)(2.4.3) shall be made available on demand through the standardized data link connector in accordance with SAE J1979-2 specifications.

(B) "Freeze frame" conditions must include the fault code which caused the data to be stored and all of the signals required in sections (h)(4.2.1)(A) and (4.2.2)(A). Freeze frame conditions shall also include all of the signals required on the engine in sections (h)(4.2.1)(B), (4.2.2)(B), (4.2.2)(E), (4.2.3)(A), (4.2.3)(B), (4.2.4)(A), and (4.2.4)(B) that are used for diagnostic or control purposes in the specific diagnostic or emission-critical powertrain control unit that stored the fault code.

(C) Freeze frame conditions shall be stored on two data frames per fault code (as described in section (d)(2.2.1)(D)(ii)). The OBD system shall have the ability to store freeze frame conditions for a minimum of five fault codes per diagnostic or emission critical powertrain control unit.

(4.4) Fault Codes:

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

(A) For all monitored components and systems, stored pending, confirmed, and permanent fault codes shall be made available through the diagnostic connector in a standardized format in accordance with SAE J1979 or SAE J1979-2 specifications, whichever is applicable. Standardized fault codes conforming to SAE J2012 shall be employed. Manufacturers shall use 2-byte fault codes (in accordance with SAE J2012) for engines using SAE J1979 and use 3-byte fault codes (in accordance with SAE J2012) for engines using SAE J1979-2.

(B) Except as otherwise specified in sections (e) through (g), the stored fault code shall, to the fullest extent possible, pinpoint the likely cause of the malfunction. To the extent feasible, manufacturers shall use separate fault codes for every diagnostic where the diagnostic and repair procedure or likely cause of the failure is different.

(i) Additionally, for monitors required to support test results in accordance with section (h)(4.5) on engines using SAE J1979-2, except as provided below, a unique fault code shall be associated with each monitor. A manufacturer may request Executive Officer approval to use a specific fault code for more than one monitor. The Executive Officer shall approve the request upon determining that there is no available unique SAE-defined fault code for each of the monitors or, based on manufacturer-submitted information, it is technically not feasible to support a unique fault code for each of the monitors (e.g., it is not technically feasible to split multiple test results from a single supported fault code into single test results for multiple supported fault codes).

* * * *

(E) Pending fault codes:

(i) Pending fault codes for all components and systems (including continuously and non-continuously monitored components) shall be made available through the diagnostic connector in accordance with SAE J1979 ~~specifications~~ (e.g., Mode/Service $07) or SAE J1979-2 (e.g., Service $19 subfunction $42) specifications, whichever is applicable.

* * * *

(4.5) Test Results:

(4.5.1) Except as provided in section (h)(4.5.7), for all monitored components and systems identified in sections (e)(1) through (f)(9) and (g)(2), results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems shall be stored and available through the data link in accordance with the standardized format specified in SAE J1979 (i.e., Service/Mode $06) or

SAE J1979-2 (i.e., Service $19 subfunction $06) for the ISO 15765-4 protocol or in SAE J1939-73 for the SAE J1939 protocol.

* * * *

(4.6) Software Calibration Identification:

(4.6.1) Except as provided for in section (h)(4.6.3), on all vehicles, a single software calibration identification number (CAL ID) for each diagnostic or emission critical control unit(s) shall be made available through the standardized data link connector in accordance with the SAE J1979/J1979-2/J1939 specifications.

* * * *

(4.7) Software Calibration Verification Number:

(4.7.1) All vehicles shall use an algorithm to calculate a single calibration verification number (CVN) that verifies the on-board computer software integrity for each diagnostic or emission critical electronic control unit. The CVN shall be made available through the standardized data link connector in accordance with the SAE J1979/J1979-2/J1939 specifications. The CVN shall be capable of being used to determine if the emission-related software and/or calibration data are valid and applicable for that vehicle and CAL ID.

* * * *

(4.7.4) The CVN shall be calculated at least once per ignition cycle and stored until the CVN is subsequently updated. The stored CVN value may not be erased when fault memory is erased by a generic scan tool in accordance with SAE J1979/J1979-2/J1939 specifications or during normal vehicle shut down (i.e., key off, engine off).

(4.7.5) 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.

* * * *

(B) If the CVN request message is received within the first 120 seconds of engine operation after a reprogramming event or a non-volatile memory clear or within the first 120 seconds of engine operation after a volatile memory clear or battery disconnect, the on-board computer may respond with one or more messages directing the scan tool to wait or resend the request message after the delay (e.g., a negative response code, acknowledgement ($00E800_{16}$) parameter group number: Control Byte = 3, or a negative acknowledgement). Vehicles complying with SAE J1939 may also send such a response when the on-board computer is already sending a different multi-packet message using TP.BAM. Such messages and delays shall conform to the specifications for transmitting CVN data contained in SAE J1979, J1979-2, or J1939, whichever applies.

* * * *

(4.8) Vehicle and Engine Identification Numbers:

(4.8.1) All vehicles shall have the vehicle identification number (VIN) available in a standardized format through the standardized data link connector in

accordance with SAE J1979/J1979-2/J1939 specifications. Only one electronic control unit per vehicle shall report the VIN to an SAE J1978/J1939 scan tool.

* * * *

(4.9) ECU Name: For 2013 and subsequent model year engines, the name of each electronic control unit that responds to an SAE J1978/J1939 scan tool with a unique address or identifier shall be communicated in a standardized format in accordance with SAE J1979/J1979-2/J1939 (e.g., ECUNAME in Service/Mode $09, InfoType $0A in SAE J1979, in Service $22, InfoType $F80A in SAE J1979-2).

(4.10) Erasure of Emission-Related Diagnostic Information:

* * * *

(4.10.2) For all vehicles, the emission-related diagnostic information shall be erased as a result of a command by a 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.

(A) For engines using SAE J1979 or SAE J1939, ~~Further,~~ except as provided for in sections (h)(4.4.1)(F)(iv), (h)(4.4.2)(F)(iv), (h)(4.8.3), and (h)(4.10.4), if any of the emission-related diagnostic information is erased as a result of a command by a scan tool or during an on-board computer reprogramming event, all emission-related diagnostic information shall be erased from all diagnostic or emission critical control units. For these control units, the OBD 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 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)).

(B) For engines using SAE J1979-2, except as provided for in sections (h)(4.4.1)(F)(iv), (h)(4.4.2)(F)(iv), (h)(4.8.3), and (h)(4.10.4):

(i) If any of the emission-related diagnostic information is erased as a result of a functional Service $14 request by a scan tool, all emission-related diagnostic information shall be erased from all control units. For these control units, the OBD 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 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)).

(ii) If any of the emission-related diagnostic information is erased as a result of a physical Service $14 request by a scan tool, all emission-related diagnostic information shall be erased in only that control unit that received the physical Service $14 request (i.e., no other control unit is required to erase emission-related diagnostic information if it did not receive a physical Service $14 request). For the control units

that received the physical Service $14 request, the OBD 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 system may not erase only one of three stored fault codes).

* * * *

(4.11) Off-Board Service Request: For engines using SAE J1979-2, the engine shall have the ability to perform the following functions if commanded by a generic scan tool in accordance with SAE J1979-2 specifications:

(4.11.1) For engines with evaporative systems that can be sealed when commanded by an enhanced scan tool, seal the evaporative system for at least 30 minutes in duration as a result of a command by a generic scan tool, and

(4.12) Status Bits: For engines using SAE J1979-2, the following status bits shall be made available in accordance with SAE J1979-2 specifications:

(4.12.1) Bit 0: "TestFailed"

(4.12.2) Bit 1: "TestFailedThisOperationCycle"

(4.12.3) Bit 2: "pendingDTC"

(4.12.4) Bit 3: "confirmedDTC"

(4.12.5) Bit 4: "testNotCompletedSinceLastClear"

(4.12.6) Bit 6: "testNotCompletedThisOperationCycle"

(5) Tracking Requirements:

(5.1) In-use Performance Ratio Tracking Requirements:

(5.1.1) For each monitor required in sections (e) through (g) to separately report an in-use performance ratio, manufacturers shall implement software algorithms to report a numerator and denominator in the standardized format specified below and in accordance with the SAE J1979/J1979-2/J1939 specifications.

* * * *

(5.2) Engine Run Time Tracking Requirements:

* * * *

(5.2.2) Numerical Value Specifications: For each counter specified in section (h)(5.2.1):

(A) Each number shall conform to the standardized format specified in SAE J1979/J1979-2/J1939.

* * * *

(5.3) NOx Emission Tracking Requirements:

* * * *

(5.3.4) The engine-out and tailpipe NOx mass parameters that are calculated by the OBD system to fulfill the requirements in section (h)(5.3) and data stream requirements in section (h)(4.2) must not have an error of more than +/- 20 percent, or alternatively at the manufacturer's discretion, 0.10 g/bhp-hr when divided by the net brake work of the engine. This requirement applies only to the NOx mass parameters in sections (h)(5.3) and (h)(4.2). Manufacturers shall report the most accurate values that are

calculated within the applicable electronic control unit (e.g., the engine control module). The NOx mass values shall furthermore be calculated using the most accurate NOx concentration and exhaust flow rate values that are calculated within the applicable electronic control unit. Any negative concentrations reported by a NOx sensor must be set to zero when used in a NOx mass calculation. Any tracking and reporting of negative NOx mass data must be done separately from the parameters covered by this regulation. Manufacturers shall not include a humidity correction factor when calculating NOx mass. The Executive Officer shall determine compliance with this requirement by comparing data from the OBD system and the test facility that are submitted by the manufacturer as described in section (j)(2.26). Specifically, the Executive Officer shall compare the total tailpipe NOx mass calculated by the OBD system for the test cycle with the total NOx mass measured by the test facility and give consideration to the consistency of the behavior of the two sets of instantaneous NOx mass values over the test cycle. Notwithstanding the compliance determination based on the data submitted as described in section (j)(2.26), manufacturers may not include any calibration/software feature which adversely impacts the accuracy of the calculated NOx mass values relative to the accuracy demonstrated at the time of certification when the engine operates in conditions outside of the certification testing environment.

* * * *

(5.7) For each parameter specified in sections (h)(5.4), (h)(5.5), and (h)(5.6):

(5.7.1) Each value shall conform to the standardized format specified in SAE J1939, ~~or~~ SAE J1979, or SAE J1979-2, whichever is applicable.

* * * *

(5.8) For all 2024 and subsequent model year diesel engines, manufacturers shall implement software algorithms to track and report in a standardized format the following parameters:

(5.8.1) Engine odometer reading (or chassis odometer reading if engine odometer is not available) at the beginning and end of the last 3 PM filter regeneration events; and

(5.8.2) Lifetime counter of PM filter regeneration events.

(5.8.3) Each number in section (h)(5.8) 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.

(5.9) Cold Start Emission Reduction Strategy Tracking Requirements

(5.9.1) For purposes of section (h)(5.9), the following terms shall be defined as follows:

(A) "Catalyst light-off temperature" is defined as the SCR catalyst inlet temperature at which the SCR catalyst NOx conversion efficiency reaches 50 percent.

(B) "FTP catalyst light-off time" is defined as the time from engine start until the SCR catalyst inlet temperature reaches the light-off temperature on an FTP test. For an engine family with multiple power ratings, manufacturers may request Executive Officer approval for proposing a representative FTP catalyst light-off time for the engine family. The Executive Officer shall approve the request upon determining that, based on manufacturer-submitted data and/or information, the representative light-off time represents the FTP catalyst light-off time on the majority of the power ratings in the field.

(C) "Engine output energy", in units of Joules (J) or Watts (W)*s, is defined by integrating brake engine power output over time, with:
"Brake engine power output" = 2π x (Brake engine torque) x (Engine RPM)/60 in units of W, and
"Brake engine torque" = (engine reference torque) x [(indicated torque) – (friction torque)].

(D) "Specified FTP engine output energy" is defined as the accumulated engine output energy measured from engine start until the SCR catalyst inlet temperature reaches the light-off temperature on an FTP test. For an engine family with multiple power ratings, manufacturers may request Executive Officer approval for proposing a representative specified FTP engine output energy for the engine family. The Executive Officer shall approve the request upon determining that, based on manufacturer-submitted data and/or information, the representative energy represents the specific FTP engine output energy on the majority of the power ratings in the field.

(E) "Post-diesel oxidation catalyst (DOC) heat energy" is defined as the heat energy flow through the DOC over time, with:
"Heat energy flow through the DOC" = [heat capacity of exhaust gas (C_p)] x [exhaust mass flow ($m_{exhaust}$)] x (temperature difference between DOC outlet and ambient) /1000.

(5.9.2) For 20 percent of 2026, 50 percent of 2027, and 100 percent of 2028 and subsequent model year diesel engines, manufacturers shall implement software algorithms to individually track and report in a standardized format the following parameters. During driving cycles where the CSERS cold start criteria (as defined in section (c)) are met at engine start, each parameter shall start accumulating/incrementing from engine start until the conditions described below for each parameter are met:

(A) Heat energy release tracker #1 (kiloJoules (kJ)): accumulate post- DOC heat energy (in units of kJ) until the FTP catalyst light-off time is achieved.

(B) Heat energy release tracker #2 (kJ): accumulate post-DOC heat energy until the specified FTP engine output energy is achieved.

(C) Heat energy release tracker #3 (kJ): accumulate post-DOC heat energy until the on-road catalyst light-off temperature is achieved.

(D) Engine output energy tracker #1 (kJ): accumulate engine output energy until the FTP catalyst light-off time is achieved.

(E) Engine output energy tracker #2 (kJ): accumulate engine output energy until the on-road catalyst light-off temperature is achieved.

(F) EGR mass flow tracker #1 (kilograms (kg)): accumulate EGR mass flow until the FTP catalyst light-off time is achieved.

(G) EGR mass flow tracker #2 (kg): accumulate EGR mass flow until the specified FTP engine output energy is achieved.

(H) EGR mass flow tracker #3 (kg): accumulate EGR mass flow until the on-road catalyst light-off temperature is achieved.

(I) Engine output energy timer (seconds): increment time until the specified FTP engine output energy is achieved.

(J) Catalyst Light-Off Timer (seconds): increment time until the catalyst light-off temperature is achieved.

(5.9.3) The parameters in section (h)(5.9.2) shall be stored in the two data types described below.

(A) Current driving cycle data

(B) Historical data, using an exponentially weighted moving average (EWMA) equation with lambda (λ) = 0.2 for calculation of the historical data, with the EWMA equation as follows:

$EWMA(t) = (1-\lambda)*EWMA(t-1) + \lambda*Y(t)$ (for t = 1, 2, ..., *n*), where

EWMA(t) is the weighted mean of historical data (the current weighted moving average),

EWMA(t-1) is the weighted mean of historical data calculated one event prior to time t,

Y(t) is the observation at time t (i.e., the current driving cycle data described in section (h)(5.9.4)(A)),

n is the number of measurements, and

λ is a constant that determines the degree of weighting/filtering for the EWMA calculation.

(5.9.4) The OBD system shall set the current driving cycle data (section (g)(5.9.3)(A)) for all parameters listed in section (h)(5.9.2) to zero if any parameter had not reached the condition required to stop incrementing before the end of the driving cycle (e.g., if the FTP catalyst light-off time is not achieved before the end of the driving cycle, the current driving cycle data for all parameters shall be set to zero). The OBD system may not use the zero values in the calculation of the historical data (section (h)(5.9.3)(B)).

(5.9.5) Numerical Value Specifications: For each parameter specified in section (h)(5.9.2):

(A) For parameters stored in the data type described in section (h)(5.9.3)(A):

(i) Each number shall be reset to zero when any of the following occur:

a. A scan tool command to clear fault codes is received;

b. An NVRAM reset occurs (e.g., reprogramming event) ;or

c. If the numbers are stored in KAM, when KAM is lost due to an interruption in electrical power to the control module (e.g., battery disconnect).

(ii) The OBD system shall store each number within 10 seconds after all counters in section (h)(5.9.2) have stopped incrementing in each driving cycle.

(B) For parameters stored in the data type described in section (h)(5.9.3)(B):

(i) 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.

(ii) The OBD system shall store each number within 600 seconds after the end of a driving cycle.

(5.9.6) Pause conditions for tracking: The OBD system shall pause tracking of all parameters listed in section (h)(5.9.2) above within 10 seconds if a malfunction of a component used as an input to any of the parameters or a CSERS malfunction described in section (e)(11.2.2) or (e)(11.2.3) has been detected and the MIL is commanded on for that malfunction. When the malfunction is no longer detected and the MIL is no longer commanded on, tracking of all parameters in section (h)(5.9.2) shall resume within 10 seconds.

(5.9.7) For the phase-in schedule described in section (h)(5.9.2) above, 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 2028 and subsequent model year engines shall comply with the requirements.

(5.9.8) For 2023 through 2025 model year engines, the manufacturer may meet the requirements in section (h)(5.9).

(6) Data Reporting Requirements for Over-the-Air Reprogramming:

(6.1) For all 2024 and subsequent model year engines, if any of the data required to be stored and made available pursuant to section (h)(5) would be erased by an over-the-air reprogramming of any control module, the manufacturer shall collect all lifetime data stored in the engine pursuant to this section using the over-air-network prior to their erasure.

(~~6.2~~6.1.1) The manufacturer shall submit a report to the Executive Officer containing the average value and standard deviation of each collected parameter for each affected certified engine family. For engines using SAE J1979 or SAE J1939, the report shall meet the specifications of ~~as specified in,~~ "Data Record Reporting Procedures for Over-the-Air Reprogrammed Vehicles and Engines", dated August 16, 2018, and hereby incorporated by reference. For engines using SAE J1979-2, the report shall meet the specifications of "Data Record Reporting

Procedures for Over-the-Air Reprogrammed Vehicles and Engines Using SAE J1979-2", dated June 1, 2021, and hereby incorporated by reference. The manufacturer shall submit the report within 75 calendar days of the availability of the calibration/software update to affected engines. The manufacturer shall submit a separate report for each unique calibration/software update.

(7) Exceptions to Standardization Requirements

(7.1) For an engine that is certified for use in both medium-duty and heavy-duty vehicles, a manufacturer may request Executive Officer approval to implement the tracking requirements in title 13, CCR sections 1968.2 (g)(6.3), (6.4), (6.5), (6.6.2), and (6.8) in lieu of the tracking requirements in sections (h)(5.4) through (5.7). The Executive Officer shall approve the request upon determining based on manufacturer-submitted information that the engine will be used in both medium-duty and heavy-duty vehicles and will meet the tracking requirements in title 13, CCR sections 1968.2(g)(6.5) and (6.8) for technologies installed on the heavy-duty vehicle that are also installed (and meeting the same tracking requirements) on the medium-duty vehicle.

(7.2) For engines using SAE J1979-2:

(7.2.1) Regarding the fault code requirements in sections (h)(4.4.1)(A) and (C), the manufacturer may use SAE-defined fault codes of SAE J1939 in lieu of SAE-defined fault codes of SAE J2012.

(7.2.2) A manufacturer may request Executive Officer approval to meet the standardization requirements of section (g) using an alternate scan tool that does not meet SAE J1978. The Executive Officer shall approve the request upon determining that the SAE J1978 specifications do not adequately accommodate the SAE J1979-2 specifications, and that the manufacturer has submitted information that demonstrate the alternate scan tool is able to access all information required for SAE J1979-2 engines and is able to perform all the functions in title 13, CCR section 1971.1 required for SAE J1978 tools and applicable to engines meeting SAE J1979-2.

(i) Monitoring System Demonstration Requirements for Certification.

* * * *

(3) Required Testing:

Except as provided below, the manufacturer shall perform single-fault testing based on the applicable test with the following components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the requirements of sections (e), (f), and (g) or sections (d)(7.1.2) and (d)(7.2.3) for extrapolated OBD systems. Except as specified below, the component/system being evaluated shall be deteriorated to the applicable malfunction limit (s) established by the manufacturer and calibrated to the emission threshold malfunction criteria using methods established by the manufacturer in

accordance with section (d)(6.4).

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

* * * *

(3.1.11) 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 (e)(11.2.~~2~~1)(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.

* * * *

(3.2) Required testing for Gasoline/Spark-Ignited Engines:

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(3.2.4) 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 (f)(4.2.1)(A), ~~or~~ (f)(4.2.2)(B), or (f)(4.2.3)(A)(ii). 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.

* * * *

(5) Evaluation Protocol:

(5.1) Full OBD engine ratings subject to sections (d)(7.1.1), (d)(7.2.2), or (d)(7.3) shall be evaluated according to the following protocol.

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(5.1.2) Except as provided in section (i)(5.1.2)(A) and (B) below, if the MIL illuminates prior to emissions exceeding the applicable emission threshold malfunction criteria specified in sections (e) through (g), no further demonstration is required. With respect to the misfire monitor demonstration test, if a manufacturer has elected to use the minimum misfire malfunction criteria of five or one percent as allowed in sections (e)(2.2.2) and (f)(2.2.2)(A), respectively, no further demonstration is required if the MIL illuminates with misfire implanted at the malfunction criteria limit.

(A) If the MIL illuminates prior to emissions exceeding the applicable emission threshold malfunction criteria specified in section (e) through (g) and a default fuel or emission control strategy is used when a malfunction is detected and the strategy is an AECD that is disclosed in the application for emissions certification (as required in Part 86, Subpart I, section 21 of the "California Exhaust Emission Standards and Test

Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines And Vehicles" and Part I section 21 of the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines and Vehicles," as incorporated by reference in section 1956.8(d), title 13, CCR), the test engine 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 performance 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). 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. ~~Alternatively, the manufacturer may request Executive Officer approval to use computer modifications to disable the default fuel or emission control strategy when retesting the engine. The Executive Officer shall approve the plan upon determining that the test data and/or engineering evaluation submitted by the manufacturer demonstrate that (1) emissions do not exceed the applicable malfunction criteria with the system or component adjusted to the best performing unacceptable level of performance, and (2) the computer modifications used to disable the default fuel or emission control strategy produce emissions results equivalent to the production-level calibration.~~

(i) If a default fuel or emission control strategy is used when a malfunction is detected and the strategy is an AECD that is disclosed in the application for emissions certification, in lieu of retesting using a system/component adjusted to the worst acceptable limit as described above in section (i)(5.1.2)(A), the manufacturer may request Executive Officer approval to use computer modifications to disable the default fuel or emission control strategy when retesting the engine. Prior to retesting the engine, the manufacturer shall submit a proposed test plan for Executive Officer approval that identifies the computer modifications used to disable the default fuel or emission control strategy. The Executive Officer shall approve the plan upon determining that the test data and/or engineering evaluation submitted by the manufacturer demonstrate that testing the engine with the computer modifications used to disable the default fuel or emission control strategy produce emissions results equivalent to testing the engine with the production-level calibration (i.e.,

emissions data from back-to-back tests of an engine with no malfunctions installed are equivalent, with one test not using the computer modifications and the other test(s) using the computer modifications).

(B) For monitors of VVT systems with discrete operating states (e.g., two step valve train systems) that are not required to detect a malfunction prior to exceeding the threshold but are required to detect all failures that exceed the threshold, if the MIL illuminates, no further testing is required.

(5.1.3) If the MIL does not illuminate when the system or component is set at its limit(s), the criteria limit or the OBD system is not acceptable.

(A) Except as provided for in section (i)(5.1.3)(C), if the MIL first illuminates after emissions exceed the applicable emission threshold malfunction criteria specified in sections (e) through (g), the test engine shall be retested with the tested system or component adjusted so that the MIL will illuminate without emissions exceeding the applicable emission threshold malfunction criteria specified in sections (e) through (g). 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 oxygen sensor malfunction is determined) and the strategy is an AECD that is disclosed in the application for emissions certification (as required in Part 86, Subpart I, section 21 of the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines And Vehicles" and Part I section 21 of the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines and Vehicles," as incorporated by reference in section 1956.8(d), title 13, CCR), the test engine 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 performance 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). 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. ~~Alternatively, the manufacturer may request Executive Officer approval to use computer modifications to disable the default fuel or emission control strategy when retesting the~~

~~engine. The Executive Officer shall approve the plan upon determining that the test data and/or engineering evaluation submitted by the manufacturer demonstrate that (1) emissions do not exceed the applicable malfunction criteria with the system or component adjusted to the best performing unacceptable level of performance, and (2) the computer modifications used to disable the default fuel or emission control strategy produce emissions results equivalent to the production-level calibration.~~ For the catalyst (i.e., components monitored under sections (e)(5.2.2), (e)(6.2.1), (e)(7.2.1), and (f)(6.2.1)) and PM filter system (i.e., sections (e)(8.2.1) and (e)(8.2.4)(A)), these testing provisions under section (i)(5.1.3)(A) shall apply only if the on-board computer invokes a default fuel or emission control strategy upon detection of the relevant catalyst or PM filter malfunction. Otherwise, the provisions of section (i)(5.1.3)(B) shall apply to testing of the catalyst or PM filter system.

(i) If a default fuel or emission control strategy is used when a malfunction is detected and the strategy is an AECD that is disclosed in the application for emissions certification, in lieu of retesting using a system/component adjusted to the worst acceptable limit as described above in section (i)(5.1.3)(A), the manufacturer may request Executive Officer approval to use computer modifications to disable the default fuel or emission control strategy when retesting the engine. Prior to retesting the engine, the manufacturer shall submit a proposed test plan for Executive Officer approval that identifies the computer modifications used to disable the default fuel or emission control strategy. The Executive Officer shall approve the plan upon determining that the test data and/or engineering evaluation submitted by the manufacturer demonstrate that testing the engine with the computer modifications used to disable the default fuel or emission control strategy produce emissions results equivalent to testing the engine with the production-level calibration (i.e., emissions data from back-to-back tests of an engine with no malfunctions installed are equivalent, with one test not using the computer modifications and the other test(s) using the computer modifications).

* * * *

(j) Certification Documentation.

* * * *

(2) The following information shall be submitted as part of the certification application. Except as provided below for demonstration data, the Executive Officer will not issue an Executive Order certifying the covered engines without the information having been provided. The information must include:

* * * *

(2.2) A table, in the standardized format detailed in Attachment C of ARB Mail-Out #MSC 09-22.

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(2.2.2) Wherever possible, the table shall use the following engineering units:

* * * *

(F) Relative percent (%) for all relative throttle position criteria (as defined in SAE J1979/J1979-2/J1939)

(G) Voltage (V) for all absolute throttle position criteria (as defined in SAE J1979/J1979-2/J1939)

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(2.35) For diesel engines, the data required under section (e)(9.2.2)(D)(i) for the NOx sensor monitoring capability diagnostic.

(2.3~~5~~6) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this regulation. This includes any of the following:

(2.3~~5~~6.1) Complete software design description documentation, specifications, and source code of the engine control unit and any other on-board electronic powertrain control unit (e.g., transmission control unit, aftertreatment system control unit). The manufacturer shall provide the descriptions and specifications in English.

(2.3~~5~~6.2) A complete list and description of all control unit variables available for real-time display and data logging, as well as all calibration maps, curves, and constants used in the software.

(2.3~~5~~6.3) A data acquisition device with real-time display and data logging capability of any and all control unit variables used in calibration. These variables shall be provided in the same engineering units used during calibration (e.g., the units as documented in the AECD documentation provided to the Executive Officer). The data acquisition device shall include, but may not be limited to, an engineering and calibration tool used during control unit software development and calibration.

(2.3~~5~~6.4) A method to unlock any production or prototype control unit to allow real-time display and data logging of any and all variables used during calibration.

(k) Deficiencies.

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(4) Manufacturers must re-apply for Executive Officer approval of a deficiency each model year. In considering the request to carry-over a deficiency, the Executive Officer shall consider the factors identified in section (k)(1) including the manufacturer's progress towards correcting the deficiency. Except as provided for in sections (k)(4.1) ~~and~~ through (k)(4.~~2~~3) below, the Executive Officer may not allow manufacturers to carry over monitoring system deficiencies for more than two model years unless the manufacturer can demonstrate that substantial engine hardware modifications and additional lead time beyond two years would be necessary to correct the deficiency, in which case the Executive Officer shall allow the deficiency to be carried over for three model years (e.g., if the deficiency was first certified in the 2013 model year, the deficiency may be carried over up to and including the 2016 model year).

(4.1) For deficiencies first granted in the 2010 model year, the Executive Officer may allow manufacturers to carry over the deficiency into the 2013 model year unless it can be demonstrated that substantial engine hardware modifications and additional lead time beyond the 2013 model year would be necessary to correct the deficiency, in which case the Executive Officer shall allow the deficiency to be carried over into the 2014 model year.

(4.2) For deficiencies first granted in the 2011 model year, the Executive Officer may allow manufacturers to carry over the deficiency into the 2014 model year.

(4.3) For deficiencies associated with the cold start emission reduction strategy monitoring requirements in section (e)(11.2.1) or (f)(4.2.2) and carried over from the 2022 or earlier model year, if the OBD system has the same or more comprehensive monitors as compared to the 2022 model year to meet the CSERS monitoring requirements in section (e)(11.2.1) or (f)(4.2.2), the Executive Officer shall allow the deficiency to be carried over up to and including the 2025 model year.

(~~4.3~~4.4) For a given engine family, 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.

* * * *

(9) For deficiencies related to issues with the tracking requirements in sections (h)(5.3) through (h)(5.7) on 2022 and 2023 model year engines, two of these deficiencies shall be exempt from the specified fines of section (k)(3) and shall not be included in the count of deficiencies in section (k)(2) to determine the number of deficiencies subject to fines.

(10) For cold start emission reduction strategy monitors and tracking requirements:

(10.1) For 2023 through 2025 model year engines, the following deficiencies 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 section (k)(2) to determine the number of deficiencies subject to fine:

(10.1.1) A deficiency covered under section (k)(4.3).

(10.1.2) A deficiency for a monitor required to meet section (e)(11.2.3) for diesel engines.

(10.1.3) A deficiency for a monitor required to meet section (f)(4.2.3) or (f)(4.2.4) for gasoline engines.

(10.2) In cases where the deficiency is for the requirements of the cold start emission reduction strategy CWS system monitor in section (d)(3.2.2)(B)(i) or (e)(11.2.2) or for a tracking parameter in section (h)(5.9), the deficiency shall be exempt from the specified fines of section (k)(3) and shall not be included in the count of deficiencies used in section (k)(2) to determine the number of deficiencies subject to fines for the following model years:

(10.2.1) For engines that first implement the cold start emission reduction strategy CWS monitor or tracking parameters in the 2023 through 2026 model years, the first 3 model years of implementation. For example, a CWS monitor deficiency is not subject to fines for the 2025, 2026, and 2027 model years for engines first certified with the CWS monitor in the 2025 model year.

(10.2.2) For engines that first implement the cold start emission reduction strategy CWS monitor or tracking parameters in the 2027 model year, the 2027 and 2028 model years.

(10.2.3) For engines that first implement the cold start emission reduction strategy CWS monitor or tracking parameters in the 2028 model year, the 2028 model year.

(~~10~~11) An OBD system installed on a production engine/vehicle that fails to conform with the certified OBD system for that engine/vehicle or otherwise fails to meet the requirements of section 1971.1 and has not been granted a deficiency pursuant to the provisions of section (k)(1) through (k)(6) is considered a nonconforming OBD system subject to enforcement. Additionally, for OBD systems granted with a deficiency, if during testing under title 13, CCR section 1971.5(b), 1971.5(c), or any other testing it is confirmed that the details of the noncompliance for which the deficiency was granted are not the same as those disclosed by the manufacturer at the time the deficiency was granted, the OBD system shall be considered a nonconforming OBD system subject to enforcement. The engines/vehicles are subject to enforcement pursuant to applicable provisions of the Health and Safety Code and title 13, CCR section 1971.5.

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(l) *Production Engine/Vehicle Evaluation Testing.*

(1) Verification of Standardized Requirements.

* * * *

(1.3) Test Equipment: For the testing required in section (l)(1), manufacturers shall utilize an off-board device to conduct the testing. Prior to conducting testing, manufacturers are required to request and receive Executive Officer approval of the off-board device that the manufacturer will use to perform the testing.

(1.3.1) For vehicles using the ISO 15765-4 protocol for the standardized functions required in section (h), except as provided for in section (l)(1.3.1)(A) below, 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 J2534-1 compliant hardware configured specifically for SAE J1699-3 testing.

(A) If software developed for SAE J1699-3 testing does not verify all the required functions in section (l)(1.4) applicable for the vehicle being tested, the Executive Officer shall approve an off-board device that uses software that does not meet SAE J1699-3 upon the manufacturer submitting data, specifications, and/or engineering analysis that demonstrate that the off-board device will verify vehicles will be able to perform all of the required functions in section (l)(1.4) for the specific vehicle.

* * * *

(1.4) Required Testing:

(1.4.1) The testing shall verify that communication can be properly established between all emission-related on-board computers and any SAE J1978/J1939 scan tool designed to adhere strictly to the communication protocols allowed in section (h)(3);

(1.4.2) The testing shall verify that all emission-related information is properly communicated between all emission-related on-board computers and any SAE J1978/J1939 scan tool in accordance with the requirements of section (h) and the applicable ISO and SAE specifications including specifications for physical layer, network layer, message structure, and message content.

(1.4.3) The testing shall further verify that the following information can be properly communicated to any SAE J1978/J1939 scan tool:

(A) The current readiness status from all on-board computers required to support readiness status in accordance with SAE J1979/J1979-2/J1939-73 and section (h)(4.1) in the key on, engine off position and while the engine is running;

(B) The MIL command status while the MIL is commanded off and while the MIL is commanded on in accordance with SAE J1979/J1979-2/J1939 and section (h)(4.2) in the key on, engine off position and while the engine is running, and in accordance with SAE J1979/J1979-2/J1939 and sections (d)(2.1.2) during the MIL functional check and, if applicable, (h)(4.1.~~6~~1)(G) or (h)(4.1.2)(E) during the MIL readiness status check while the engine is off;

(C) All data stream parameters required in section (h)(4.2) in accordance with SAE J1979/J1979-2/J1939 including, if applicable, the proper

identification of each data stream parameter as supported in SAE J1979/J1979-2/J1939 (e.g., Mode/Service $01, PID $00 for SAE J1979, Service $22, PID $F400 for SAE J1979-2, or SAE J1939/73 Diagnostic Message 24);

(D) The CAL ID, CVN, ESN, VIN, and ECU Name in accordance with SAE J1979/J1979-2/J1939 and sections (h)(4.6) through (4.8);

(E) An emission-related fault code (permanent, confirmed, pending, MIL-on, and previously MIL-on) in accordance with SAE J1979/J1979-2/J1939-73 (including correctly indicating the number of stored fault codes and MIL command status (e.g., Mode/Service $01, PID $01, Data A for SAE J1979, Service $22, PID $01 for SAE J1979-2, or J1939/73 Diagnostic Message 1)) and section (h)(4.4) for each diagnostic and emission critical electronic powertrain control unit;

* * * *

(3) Verification and Reporting of In-use Monitoring Performance.

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(3.4) Required Data:

(3.4.1) For each group of vehicles using SAE J1979 or SAE J1939:~~,~~

(A) T~~t~~he data must include all of the in-use performance tracking data reported through SAE J1979/J1939 (i.e., all numerators, denominators, the general denominator, and the ignition cycle counter), the engine model year, the engine manufacturer, the engine family, the engine serial number, the engine HP rating (for diesels), the engine torque rating (for diesels), the date the data were collected, the chassis odometer reading, the vehicle/chassis VIN, the monitoring performance group, the ECM software calibration identification number, and the distance traveled and be in the standardized format detailed in Attachments D and E of ARB Mail-Out #MSC 09-22.

(B) 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)(3.2.2)).

~~(3.4.1)~~(C) For 2022 and subsequent model year engines on vehicles from which the manufacturer collects and reports in-use monitoring performance data under section (l)(3), the manufacturer shall also collect the data specified in sections (h)(4.1) through (h)(4.9) and (h)(5), as applicable.

(3.4.2) For each group of vehicles using SAE J1979-2:

(A) The data must be collected only from vehicles where the general denominator (as defined in section (d)(5.6)) has a value equal to or greater than 300.

(B) The data must include all of the in-use performance tracking data reported through SAE J1979-2 (i.e., all numerators, denominators, the general denominator, and the ignition cycle counter), the engine model year, the engine manufacturer, the engine family, the engine serial

number, the engine HP rating (for diesels), the engine torque rating (for diesels), the date the data were collected, the chassis odometer reading, the vehicle/chassis VIN, the monitoring performance group, the ECM software calibration identification number, and the distance traveled and be in the standardized format detailed in Attachments D and E of ARB Mail-Out #MSC 09-22. Additionally, the data must include the data specified in (d)(5.7), (h)(4.1) through (h)(4.9), and (h)(5).

(C) The manufacturer shall 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)(3.2.2)),

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NOTE: Authority cited: Sections 39010, 39600, 39601, 39602.5, 43000.5, 43013, 43018, 43100, 43101, 43104, 43105, 43105.5, 43106, 43154, 43211, and 43212, Health and Safety Code. Reference: Sections 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.