State of California
AIR RESOURCES BOARD

# PUBLIC HEARING TO CONSIDER PROPOSED REVISIONS TO ON-BOARD DIAGNOSTIC SYSTEM REQUIREMENTS, INCLUDING THE INTRODUCTION OF REAL EMISSIONS ASSESSMENT LOGGING (REAL), FOR HEAVY-DUTY ENGINES, PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES AND ENGINES

# STAFF REPORT: INITIAL STATEMENT OF REASONS

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**California Environmental Protection Agency**
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**Sacramento, California 95814**

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## EXECUTIVE SUMMARY

### Background

On-board diagnostic (OBD) systems are mainly comprised of software designed into the vehicle's on-board computer system to detect emission control system malfunctions as they occur by monitoring virtually every component and system that can cause increases in emissions. When the OBD system detects an emission-related malfunction, it alerts the vehicle owner by illuminating a malfunction indicator light (MIL) located on the vehicle's instrument panel, and additionally stores information that helps to identify the faulty component or system and the nature of the fault, which enables technicians to quickly and properly repair such faults. OBD systems therefore benefit vehicle owners by ensuring detected malfunctions are promptly and correctly repaired, and ensure that in-use motor vehicle and motor vehicle engine emissions are reduced through improvements in emission system durability and performance.

The California Air Resources Board (CARB or Board) initially adopted OBD regulations in 1990 that required all 1996 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines to be equipped with OBD systems (referred to as OBD II). CARB subsequently updated the OBD II regulations with the adoption of title 13, California Code of Regulations (CCR), sections 1968.2 and 1968.5, which established OBD II requirements and OBD II specific enforcement requirements for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines. In 2005, the Board adopted regulations (title 13, CCR sections 1971.1) that required OBD systems in heavy-duty engines (HD OBD) beginning in the 2010 model year, and subsequently adopted an HD OBD-specific enforcement regulation, (title 13, CCR section 1971.5) in 2009.

Since the initial adoptions of the OBD II and HD OBD regulations, the Board has requested that staff biennially update it on engine manufacturers' progress in meeting the OBD requirements and to propose such modifications as necessary to achieve maximum compliance with the regulation. In accordance with the Board's direction, CARB staff has regularly met with manufacturers and has proposed amendments several times over the years to the OBD II and HD OBD regulations which the Board adopted.

### Staff Proposal

Since the last comprehensive update to the HD OBD regulations occurred in 2012, CARB staff has identified a number of proposed amendments to the HD OBD regulations that it believes are warranted. Some of the proposed amendments address manufacturers' implementation concerns and provide clarification on existing requirements. Staff is also proposing amendments that it believes are needed to ensure the integrity of the HD OBD systems and to provide valuable information to help track real world emissions performance of heavy-duty engines.

A summary of the main issues and technical amendments are provided below, while a detailed explanation of each issue, as well as the summaries and rationales of all the proposed changes, are provided in Chapter II of this report. The proposed amendments to the HD OBD regulation include:

- Clarifying the requirements for intrusive diagnostics
- Revising the in-use monitor performance ratio (IUMPR) requirements, including adding monitors required to track and report the in-use monitor performance ratio data
- Revising the criteria manufacturers must meet to be exempt from monitoring the feedgas generation performance of the non-methane hydrocarbon (NMHC) catalyst and catalyzed particular matter (PM) filter
- Revising the gasoline and diesel crankcase ventilation (CV) system monitoring requirements
- Specifying more detailed monitoring requirements for hybrid vehicles.
- Updating the SAE International (SAE) and International Organization for Standardization (ISO) document references
- Revising the readiness status requirements for exhaust gas/oxygen sensors and sensor heaters
- Adding data stream parameters required to be reported to track real world emissions performance and assist with CARB emission compliance programs
- Revising the certification demonstration testing requirements to modify the test engine aging requirements, clarify the allowable test sequence procedure, and add more data to be collected during testing
- Adding items required to be submitted as part of the certification application
- Revising the fines applicable to deficiencies
- Revising the production engine/vehicle evaluation testing requirements to require permanent fault code erasure testing and to collect more data from in-use engines/vehicles

Staff is also proposing similar amendments to the OBD II regulation section 1968.2 (included in Appendix C), where necessary, for medium-duty diesel engines and vehicles to harmonize the requirements of the two regulations. Additionally, while staff was not planning to do an update to the OBD II regulation this year that would affect light-duty vehicles, staff has determined based on comments from manufacturers that a few additional regulation changes are needed immediately in order to ensure manufacturers are able to certify near future vehicles that comply with the OBD II regulation. Staff has also found an issue related to the definition of “active off-cycle credit technology” in the OBD II regulation and is proposing an amendment to address this.

Staff is also proposing amendments to the HD OBD enforcement regulation (section 1971.5) to align with some of the proposed changes to the HD OBD regulation and correct some oversights and errors. These include changes to the nonconforming criteria to account for the proposed revised in-use monitor performance ratios and relaxations to the mandatory recall interim thresholds for alternate-fueled engines.

In addition to the proposed amendments described above, there are a few issues where CARB staff and industry differed significantly as to the necessity or the stringency of a requirement. The requirements of concern to the affected manufacturers are described below.

*Minimum IUMPR Requirements*

OBD monitors need to run frequently in-use to ensure that emission-related malfunctions are detected in a timely manner. The HD OBD regulation currently requires the monitoring frequency of several OBD monitors to meet a minimum required IUMPR, specifically 0.100 for all monitors. A ratio of 0.100 means the OBD monitor will run and complete on 1 out of 10 CARB-defined drive cycles. When the HD OBD regulation was first adopted in 2005, the minimum IUMPR of 0.100 was meant to be just a temporary interim ratio for the beginning years of HD OBD implementation until a higher, more appropriate IUMPR could be developed by staff based on in-use data. Based on IUMPR data collected from heavy-duty engines since then, staff believes that it is appropriate to increase the minimum required IUMPR to ensure that monitors are running frequently in-use. Thus, staff is proposing to increase the minimum required IUMPR from 0.100 to 0.300 for all monitors starting in the 2022 model year. However, manufacturers have argued that the new proposed ratio is difficult to meet for some monitors. Further, they argued that the proposed ratio should be based on the same analysis used to develop the minimum required IUMPRs in the OBD II regulation, specifically the concept that a malfunction must be detected for 90 percent of vehicles in 2 weeks.

First, staff believes that an IUMPR of 0.300 is technically feasible based on the IUMPR data manufacturers are currently required to submit to CARB under the HD OBD regulation. From reviewing the data, staff determined that most monitors are currently able to meet the proposed ratio of 0.300. Monitors that staff have observed having difficulties in meeting the proposed ratio include the oxides of nitrogen (NOx) sensor monitors and the NMHC catalyst monitors. For the NOx sensor monitors, the specific NOx sensor monitor that does not meet the 0.300 ratio varied by manufacturer (i.e., the least frequent NOx sensor monitor was different for each manufacturer). Thus, staff determined that there is no specific NOx sensor monitor that all manufacturers have an issue with, and it is therefore technically feasible for all NOx sensor monitors to run frequently in-use and meet the 0.300 ratio. For the NMHC catalyst monitor, staff agrees with manufacturers that some additional changes are needed to address the difficulty in running this monitor, though staff does not agree with modifying the 0.300 ratio. Instead, staff proposed that the NMMC catalyst monitor use new denominator incrementing criteria that is specifically tied to a regeneration event occurring. This would result in the denominator incrementing less frequently, which accordingly would result in a higher IUMPR in-use. Second, staff does not agree that the proposed minimum ratio for OBD systems on heavy-duty engines and vehicles should be based on the same concept used to develop the minimum ratio for OBD II systems on light-duty vehicles. Heavy-duty truck operation is generally much longer per ignition event than light-duty vehicle operation, thus heavy-duty trucks emit emissions for a much longer time compared to light-duty vehicles in a 2-week period. Additionally, driving patterns among heavy-duty vehicles vary much more widely than light-duty vehicles due to the different vocational heavy-duty vehicles in-use (e.g., garbage trucks vs. line-haul trucks). Staff's proposal is a more appropriate and feasible metric for HD vehicles than the manufacturer suggested metric of detection of 90% in 2 weeks.

*Real Emissions Assessment Logging (REAL)*

State and federal ambient air quality standards continue to be exceeded in major regions throughout California even though there have been significant strides made to improve California's air quality. To achieve the 8-hr ozone standard set in 1997 by the attainment date in 2023, NOx emissions in the greater Los Angeles region must be reduced by an additional two-thirds beyond reductions from all of the control measures in place today. Furthermore, to achieve the more stringent 75 parts per billion (ppb) 2008 8-hr ozone standard by 2031, NOx emissions must be reduced by 80 percent from the 2012 levels. CARB is continuing to adopt increasingly stringent criteria emissions standards for vehicles and engines in order to make progress towards meeting the attainment goals, but there is uncertainty regarding the extent to which the low certified emissions are realized in-use. Simultaneously, as CARB and its partner federal agencies (U.S. EPA and the National Highway Traffic Safety Administration) have adopted increasingly stringent carbon dioxide ($CO_2$) and fuel economy standards, engine and vehicle manufacturers have started to, and will continue to, introduce new engine and vehicle technologies to reduce $CO_2$ emissions. The reductions assigned to these technologies are based on a limited set of certification test cycles that will likely differ, by varying amounts, from actual reductions achieved in the real world. If specific technologies or applications of technologies have real world benefits that are disproportionally less than represented by the results obtained during certification, California will not realize the intended greenhouse gas (GHG) emission reductions nor will consumers realize the expected fuel savings to recoup the additional money paid for the vehicle. To address both these issues, staff is proposing the introduction of REAL to characterize the engine's NOx control performance as well as the $CO_2$ emissions in the real world.

Historically, many CARB programs have been based on limited amounts of laboratory and/or on-the-road test data due to the cost and time constraints of vehicle and engine testing. However, with today's on-board sensors and computing capability, there is now the opportunity to quickly and cost effectively generate real-world emissions data from a large number of vehicles. These REAL data can be used to identify populations of vehicles for additional testing, identify the conditions in-use where vehicles are not performing as expected with regard to emissions control, and generally better inform CARB's inventory, regulatory, certification, and enforcement programs. For the proposed REAL implementation, HD OBD systems would be required to track and report data that characterize NOx and $CO_2$ emissions in-use starting in the 2022 model year. Further, staff is proposing that the manufacturer use the most accurate NOx concentration and exhaust flow rate values to calculate the NOx mass values, and that the NOx mass parameters would need to have an error of less than either 20 percent or 0.10 grams per brake horsepower-hour (g/bhp-hr). Manufacturers have argued that such data are not related to OBD systems and are beyond the scope of OBD, so CARB does not have authority to adopt such requirements in the OBD regulations.

CARB previously established the OBD regulations to ensure reductions of in-use motor vehicle and motor vehicle engine emissions through improvements of emission system durability and performance. OBD systems fulfill such objectives by requiring onboard computers to monitor engine/vehicle emission control systems for malfunctions over the actual life of the engine/vehicle, and to timely notify the vehicle operator of detected malfunctions. CARB adopted the current version of the HD OBD and OBD II regulations pursuant to statutory provisions and other provisions of law that broadly authorize CARB to perform such acts as may be necessary for the proper execution of the powers and duties granted to and imposed upon it by any provision of law, including adopting regulations which will result in a cost-effective combination of control measures on all classes of motor vehicles and motor vehicle fuel, including reductions of in-use emissions from motor vehicles through improvements in emission system durability and performance. No conflict or inconsistency exists between the provisions of law authorizing these new data parameters and the provisions of law authorizing the most recent version of the OBD II regulation. Neither the OBD regulations nor the provisions of law authorizing CARB to adopt and amend the regulation prohibit or restrict OBD systems from recording these data. Rather, CARB staff, based on its extensive knowledge of OBD systems and experience in implementing the HD OBD and OBD II regulations as well as its experience adopting and implementing tailpipe emission standards programs, determined that OBD systems are uniquely suited to acquire and record the data specified by new requirements.

The information provided by these new requirements will, among other things, inform CARB of the need to amend the OBD regulation. For example, in addition to using the GHG-related data to help improve GHG inventory models utilized by CARB and develop future $CO_2$ emission standards, CARB anticipates using the data to help develop future $CO_2$ requirements related to OBD monitors, which currently are not required by the OBD regulations to detect malfunctions that cause exceedances of GHG emissions. The new data will also assist CARB in evaluating the need to further amend the OBD regulations to ensure that OBD systems are capable of timely malfunction detection of emission control systems and to maintain continued reductions of in-use motor vehicle and motor vehicle engine emissions through improvements of emission system durability and performance. Further, the proposed tracking of data related to the engine’s NOx control performance may be viewed as the basis for a future OBD monitoring proposal. Today, manufacturers are only required to monitor the selective catalytic reduction (SCR) system conversion efficiency and dosing performance once per drive cycle. Since good SCR performance is needed virtually continuously, this limited monitoring requirement may not be sufficient to represent all in-use driving conditions. With the NOx binning and tracking data, a future proposal could be developed for an SCR target threshold for each bin, which would provide the means for a continuous SCR monitoring requirement. Therefore, staff views the NOx binning and tracking proposal as being directly relevant to the goals of the OBD program.

Further, CARB disagrees with the comments from the manufacturers regarding the inappropriateness of these new data in the OBD regulations. In the past, individual manufacturers and their respective associations have specifically requested that CARB keep all requirements for required engine/vehicle data in a single regulation to facilitate compliance on their part. Manufacturers have previously expressed concerns that specifying required data elements across different regulations would increase their risk of noncompliance, and CARB has therefore placed the new data requirements in the OBD regulation. Examples include past additions of data necessary for emission inspections, enforcement of the OBD requirements themselves (e.g., IUMPR data), verification of the limited usage of auxiliary emission control devices (AECDs) relative to manufacturer claims at the time of engine/vehicle certification, identification of tampered or modified emission control software, or diagnosis and repair of new emission control technologies. In all cases, these data have been included in the existing framework of the OBD regulations, which gives precise information to manufacturers as to how the data are to be implemented and provides a single regulation for them to refer to for all electronic data required by CARB to be reported by the vehicle or engine.

*Software Design Documentation Requirements*

The HD OBD enforcement regulation (title 13, CCR section 1971.5(b)) allows CARB staff to conduct enforcement testing of engine families to determine if the HD OBD systems comply with the requirements of the HD OBD regulation. To conduct such testing, the regulation allows CARB staff request the manufacturer to make available test equipment used by the manufacturer in the development, calibration, or demonstration testing of the emission threshold monitors. Staff is now proposing that manufacturers make available upon CARB request items such as engine control unit (ECU) software design specifications and source code to assist CARB staff in conducting the enforcement testing. Similarly, staff is proposing as part of the certification documentation section of the HD OBD regulation (1971.1(j)(2.34)) that the same types of hardware and software be made available prior to certification upon request by CARB staff. This information would not be requested as part of routine certification, but instead in cases where detailed information is needed to enable a complete understand of specific emission control diagnostics or to support pre-certification vehicle/engine screening. Although these software and hardware may currently be requested by CARB staff based on existing certification documentation regulatory language (1971.1(j)(2.21)), the staff proposal adds more specificity as to the types of information staff may request.

Manufacturers, however, have serious concerns with providing such information, considering it to be highly proprietary and confidential business information, and believes CARB does not have adequate security measures in place to review such information and thus will not be able to adequately protect such highly sensitive intellectual property (IP) from other parties. Manufacturers believe that the regulation should clearly state that such requests would only be made when CARB has a real need for such information. While staff understands manufacturers concerns, CARB handles confidential IP as a matter of routine business. In addition, CARB staff are working with internal cyber-security experts to evaluate the internal procedures in place to protect sensitive manufacturer IP and reduce the risk of exposure to the extent feasible. However, given that CARB has broad statutory authority to adopt regulations and request information for the purposes of certification and determination of compliance with these regulations, staff considers this proposal a clarification of existing requirements.

*Manufacturer Self-Testing Requirements*

The HD OBD enforcement regulation (title 13, CCR section 1971.5) currently requires heavy-duty engine manufacturers to perform testing on a limited number of their own engines after they have reached high mileage to ensure that OBD monitors are working properly. The testing involves emissions testing of all emission threshold monitors (i.e., monitors that are required to detect a malfunction before specific emission thresholds are exceeded) on 1 to 3 in-use engines per model year. If a monitor was unable to detect a fault with emissions below the required emission thresholds, then additional testing would be "triggered" and the manufacturer would be required to procure more in-use engines to test. When that proposal was adopted, CARB determined that the workload and costs associated with the testing were not expected to be significant, but added that that it was open to alternative testing suggestions that may be taken into consideration in a future regulatory update. Since testing has commenced, manufacturers have indicated that the cost to perform such testing is much more than CARB had previously calculated, especially given that manufacturers have to emissions test 20 to 30 monitors on an engine. Additionally, manufacturers have indicated difficulties in procuring test engines from the field that met the specific criteria required by the regulation. Manufacturers have thus proposed that a number of relaxations be adopted, including reducing the number of monitors tested to 25 percent of the existing emission threshold monitors, limiting or eliminating the testing to confirm the infrequent regeneration adjustment factors (IRAF), allowing manufacturers to skip testing for a specific model year if the manufacturer shows "good performance" during testing of the previous model years, and widening the criteria for selecting engines to test. For emission threshold monitors that have been granted a deficiency for detecting faults when emissions are above the required emission thresholds, manufacturers have proposed that the "trigger" for additional testing be based on the monitor performance level represented by the manufacturer at the time of OBD certification (i.e., the emission level the manufacturer indicated the monitor detected a fault at plus some margin). While staff agrees that some relaxations are needed to the testing requirements, staff does not agree it should go as far as manufacturers propose. Staff and manufacturers have since had many discussions regarding possible changes to the manufacturer self-testing requirements, and staff has developed a proposal it believes will address manufacturers' concerns about workload and cost issues while ensuring that the important emission threshold monitors are appropriately tested and working properly in the field in accordance with the HD OBD requirements.

Accordingly, staff is proposing to reduce the number of monitors required to be tested to 15 monitors, which is about a 50 percent reduction in testing for some manufacturers. For testing of deficient emission threshold monitors, staff is proposing that the trigger for additional testing would be if the monitor is unable to detect a fault with emissions below the emissions level the manufacturer indicated a fault is detected at the time of OBD system certification plus a margin of 20 percent of the standard. Staff is also proposing to reduce the number of monitors to be tested if the manufacturer had met certain “good performance” criteria during testing of the previous 3 model years, including all the tested monitors having no deficiencies, meeting all the emission threshold requirements during testing of the first engine, and meeting all the IUMPR requirements. For the engine selection criteria, staff is proposing to widen the 70 to 80 percent full useful life window to 70 to 100 percent, allow engines of a different rating to be tested if it was re-rated to the rating of the test engine, and allow engines of a different model year to be tested if they were direct carryover engines of the test engine.

**Environmental and Cost Impacts**

The proposed amendments are not expected to have an adverse impact on the environment. The learned-out incremental costs to incorporate the proposed modifications to the HD OBD regulation would be $42.46 per engine. The estimated combined costs of the HD OBD regulation and the HD OBD enforcement regulation is $207.86 per engine. Further details of the environmental impact and costs are included in Chapters IV and VI.

**Staff Recommendations**

Staff recommends that the Board adopt the amendments to the HD OBD and OBD II regulations and the associated enforcement regulations as proposed in the Initial Statement of Reasons.

## I. INTRODUCTION AND BACKGROUND

OBD systems are mainly comprised of software designed into the vehicle's on-board computer system to detect emission control system malfunctions as they occur by monitoring virtually every component and system that can cause increases in emissions. CARB adopted title 13, CCR sections 1968.2 and 1968.5, which established OBD II requirements and OBD II specific enforcement requirements for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines. In 2005, the Board adopted regulations (title 13, CCR sections 1971.1) that required OBD systems in heavy-duty engines (HD OBD) beginning in the 2010 model year, and subsequently adopted an HD OBD-specific enforcement regulation, (title 13, CCR section 1971.5) in 2009. Since the initial adoptions of the OBD II and HD OBD regulations, the Board has requested that staff provide biennial updates on engine manufacturers' progress in meeting the OBD requirements and to propose such modifications as necessary to achieve maximum compliance with the regulation. Accordingly, CARB staff has regularly met with manufacturers and has proposed amendments several times over the years to the regulations which the Board adopted, with the most recent amendments adopted in 2015.

In this rulemaking, staff is proposing amendments to the HD OBD and OBD II regulations (title 13, CCR sections 1971.1 and 1968.2) and the associated HD OBD enforcement regulation (title 13, CCR section 1971.5). CARB staff is proposing these amendments to clarify regulation language, relax some requirements, and add new requirements that would assist and help improve the implementation of the OBD program and other CARB programs. Detailed explanations of the amendments, including the purpose and rationale for each amendment, are provided in Chapter II. All proposed amendments to sections 1971.1, 1971.5, and 1968.2 are included in Appendices A, B, and C, with proposed additions to the regulation denoted by <u>underline</u> and proposed deletions denoted by ~~strikeout~~.

## II. THE SPECIFIC PURPOSE OF EACH ADOPTION, AMENDMENT, OR REPEAL, & THE RATIONALE FOR CARB'S DETERMINATION THAT EACH IS REASONABLY NECESSARY

<u>The Problem that the Proposal is Intended to Address</u>

Since the last comprehensive update to the HD OBD regulations and medium-duty OBD requirements in the OBD II regulation occurred in 2012, CARB staff has identified a number of proposed amendments to the HD OBD regulations that it believes are warranted. CARB staff had discovered through testing and discussions with manufacturers over the years that many OBD systems have not been operating as they should be. These include monitors that do not run as frequently in-use as they should in accordance with the regulation and emission-related faults that are not detected by monitors. Additionally, manufacturers have indicated concerns with specific requirements that needed to be addressed, including addressing workload issues related to the required testing of in-use engines.  There have also been confusion with some of the current regulation language that warranted revisions to make the requirements clear.

Further, State and federal ambient air quality standards continue to be exceeded in major regions throughout California even though there have been significant strides made to improve California’s air quality.  CARB is continuing to adopt increasingly stringent criteria emissions standards for vehicles and engines in order to make progress towards meeting the attainment goals, but there is uncertainty regarding the extent to which the low certified emissions are realized in-use, specifically NOx and $CO_2$ emissions.  Staff believes specific information from the on-board computer of the engine/vehicle could be used to identify populations of vehicles for additional testing, identify the conditions in-use where vehicles are not performing as expected with regard to emissions control, and generally better inform CARB’s inventory, regulatory, certification, and enforcement programs.

To address these problems, CARB staff is proposing amendments that would enhance monitoring requirements to ensure that monitors are running frequently and emission-related malfunctions are appropriately detected in-use, include new data tracking and reporting requirements to ensure the integrity of the HD OBD and OBD II systems and to provide valuable information to help track real world emissions performance of heavy-duty and medium-duty engines, address manufacturers’ implementation concerns, and provide clarification on existing requirements.  The remainder of this chapter provides a more detailed description of staff’s proposed actions.

The Specific Purpose and Rationale of Each Adoption, Amendment, or Repeal

The information in this chapter provides a summary of the provisions, including the problem the proposed amendment is intended to address, and CARB staff’s determination that each provision proposed is: (1) reasonably necessary to carry out the purpose of the regulation; and (2) reasonably necessary to address the problem for which the amendments are proposed.

Staff is proposing amendments to the following sections in title 13, CCR: section 1971.1 “On-Board Diagnostic System Requirements – 2010 and Subsequent Model-Year Heavy-Duty Engines,” 1971.5 “Enforcement of Malfunction and Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines,” and 1968.2 “Malfunction and Diagnostic System Requirements – 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines.”

## A. Proposed Amendments to HD OBD Regulation Section 1971.1

**Various sections throughout the regulation**: Wherever the regulation indicates temperature values in degrees Fahrenheit, staff is proposing to add temperature values in degrees Celsius.

Rationale: The proposed additions of temperature values in degrees Celsius are needed to accommodate manufacturers that use degrees Celsius instead of degrees Fahrenheit when dealing with temperature values.

**Section 1971.1(c): Definitions**

**"Active technology," "automatic engine shutdown technology," "charge depleting operation," "charge sustaining operation," "charge sustaining target SOC value," "driver selectable charge increasing operation," "grid energy," "non-grid energy," "start-stop technology," and "waste heat recovery (WHR) technology"**: Staff is proposing these new definitions in the regulation.

Rationale: The new proposed definitions are needed to complement the proposed new specific procedures for plug-in hybrid electric vehicles to determine the malfunction criteria for emission threshold monitors in section 1971.1(d)(8.3) and the new proposed tracking requirements in section 1971.1(h)(5.4) through (h)(5.6).

**"Auxiliary Emission Control Device (AECD)"**: Staff is proposing to add language indicating the date for the Title 40, Code of Federal Regulations (CFR) 860.082-2 referenced as "as it existed on January 26, 2018."

Rationale: The proposed addition of the date is needed to indicate the applicable date of the CFR reference cited.

**"Emission Increasing Auxiliary Emission Control Device (EI-AECD)"**: Staff is proposing to modify the definition of an EI-AECD to refer to any approved AECD that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use, and meets (1) or (2): (1) the need for the AECD is justified in terms of protecting the vehicle against damage or accident, or (2) for 2022 and subsequent model year engines, is related to adaptation or learning (e.g., SCR system adaptation).

Rationale: The current definition of EI-AECD only referred to AECDs that both (1) reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use, and (2) for which the need for the AECD is justified in terms of protecting the vehicle against damage or accident. This does not include AECDs related to adaptation and learning. Staff has discovered that there are adaptation and learning strategies that may result in an increase in emissions, but because these strategies are not needed for engine protection, they are not required to be tracked and reported as EI-AECDs. In order to better understand the extent to which emissions may be increasing during in-use operation due to these emission-increasing adaptation and learning strategies and to confirm the claimed in-use behavior of such strategies by manufacturers, staff is proposing to change the definition of EI-AECDs to include such strategies.

**<u>“Calculated load value”</u>**: Staff is proposing to change the reference of “Society of Automotive Engineers (SAE)” to “SAE International (SAE)”. Staff is also proposing to language to define the calculated load value on diesel applications as suspect parameter number (SPN) 92 instead of “parameter definition 5.2.1.7”. Finally, staff is proposing language to change the title of SAE J1939-71 from “Vehicle Application Layer (Through May 2010)” to “Vehicle Application Layer” and indicate it is “incorporated by reference.”

<u>Rationale</u>: The proposed changes to the definition are necessary to correct errors. Specifically, the name “SAE International” is the official new name, the parameter citation of SPN 92 is the correct citation, and the correct name of SAE J1939-71 is “Vehicle Application Layer.”

**<u>“Confirmed fault code”</u>**: Staff is proposing amendments to indicate that confirmed fault code storage requirements are also included in section (e) by changing sections “(d)(2), (f), (g), and (h)(4.4)” to “(d)(2), (e) through (g), and (h)(4.4).”

<u>Rationale</u>: The proposed change is needed to correct an oversight, since section 1971.1(e) also references confirmed fault code storage requirements.

**<u>“Diagnostic or emission critical” electronic control unit and “Field reprogrammable”</u>**: Staff is proposing to delete the reference to section (f)(8.2.3)(A) and change “(g)(1.1.2)” to “(g)(1.2.2)(A)” in the list of circuit or out-of-range monitors in the definition of “diagnostic or emission critical”. Staff is also proposing language indicating that for purposes of criteria (2)(a) and (b) in this definition, a hybrid component is considered an “input component” and “output component”. Finally, staff is proposing to delete the definition of “field reprogrammable” within this definition and move it to its own definition.

<u>Rationale</u>: The proposed change to delete “(f)(8.2.3)(A)” is needed since this section refers to an exhaust gas sensor heater performance monitor and was mistakenly included as an example of a “circuit or out-of-range fault monitor” in this definition. The proposed change of “(g)(1.1.2)” to “(g)(1.2.2)(A)” is needed to correctly reference the section containing the circuit and out-of-range fault monitor requirements for the engine coolant temperature (ECT) sensor. The proposed change deleting the sentence defining “field reprogrammable” is

needed since this definition is moved to its own section. The proposed change regarding hybrid components are needed to make clear that “input component” and “output component” could include hybrid components.

**“Engine family”**: Staff is proposing to change the CFR citation from 86.098-24 to 86.096-24 and to indicate the applicable date for the CFR section cited as “as it existed on January 25, 2018.”

Rationale: The proposed changes are needed to correct the CFR citation and to indicate the applicable date for the CFR section.

**“Engine misfire” and “Misfire”**: Staff is proposing to change the name “Engine misfire” to “Misfire” and to move the definition to later in section 1971.1(c).

Rationale: The proposed change from “Engine misfire” to “Misfire” is needed to account for the usage of “misfire” within the regulation. The definition of “misfire” was moved since the definitions are listed in alphabetical order.

**“FTP cycle”**: Staff is proposing to indicate the applicable date for the reference 40 CFR appendix 1 of part 86 is “as those sections existed on January 25, 2018.”

Rationale: The proposed language is needed to indicate the applicable date for the CFR section.

**“Field fix”**: Staff is proposing a new definition for “field fix.”

Rationale: This new proposed definition is needed to complement the new proposed requirements for field fixes in section 1971.1(m).

**“Gasoline engine”**: Staff is proposing to modify the definition to define “gasoline engine” as “an engine using a spark ignition thermodynamic cycle.”

Rationale: Currently, the HD OBD regulation defines “gasoline engine” as an Otto-cycle engine. The revised definition more accurately describes gasoline engines and better encompasses the gasoline engine technologies that are being implemented.

**“Heavy heavy-duty engine,” “medium heavy-duty engine,” and “light heavy-duty engine”**: Staff is proposing new definitions for heavy heavy-duty engine, medium heavy-duty engine, and light heavy-duty engine.

Rationale: These new proposed definitions are needed to complement the proposed revisions to the demonstration testing under section 1971.1(i)(2.3.4).

**“Hybrid vehicle”**: Staff is proposing to add “including a plug-in hybrid electric vehicle” to the definition of “hybrid vehicle.” Staff is also proposing language to include “hydraulic energy storage” as an example of an energy storage device.

Rationale: The proposed change to include plug-in hybrid electric vehicles is needed to complement the new proposed definition for “plug-in hybrid electric vehicle” in subsection (c). The proposed addition of “hydraulic energy storage” is needed to clarify that vehicles with these energy storage devices are considered hybrid vehicles.

**“Ignition cycle”**: Staff is proposing to change the name “Ignition Cycle” to “Ignition cycle”, is proposing to change the term “driving cycle” to “trip”, and is proposing changes to the definition to make clear how to define ignition cycle for non-hybrid vehicles, hybrid vehicles, and plug-in hybrid electric vehicles.

Rationale: The proposed change of “Cycle” to “cycle” in the name “Ignition cycle” is needed for consistency. The proposed change of “driving cycle” to “trip” is needed since “trip” is the more accurate term to use and to avoid confusion with the term “driving cycle”, which has its own definition. The other proposed changes to the definition are needed to clarify how to define “ignition cycle” for conventional vehicles, hybrid vehicles, and non-hybrid vehicles with engine start-stop systems, and to accommodate the new second ignition cycle counter proposed for plug-in hybrid electric vehicles in section 1971.1(d)(5.5) .

**“Intrusive diagnostic”**: Staff is proposing a new definition for “intrusive diagnostic.”

Rationale: The proposed new definition is needed to complement the new proposed requirements for intrusive diagnostics in section 1971.1(d)(3.1.4).

**“Key on, engine off position”**: Staff is proposing modifications to indicate that the key on, engine off position does not include conditions where the key is in the engine run position but the engine is “not in the state of propulsion system active.”

Rationale: The proposed change to this definition is needed to account for hybrid engines and vehicles with start-stop systems.

**“MIL-on fault code” and “Previously MIL-on fault code”**: Staff is proposing amendments to indicate that MIL-on and previously MIL-on fault code storage requirements are also included in section (f) by changing sections “(d)(2), (e), (g), and (h)(4.4)” to “(d)(2), (e) through (g), and (h)(4.4).”

Rationale: The proposed change is needed to complement the proposed amendment in section 1971.1(h)(3.2) that would allow gasoline engines to use the SAE J1939 protocol (and thus, MIL-on and previously MIL-on fault codes).

**<u>“Not-To-Exceed (NTE) control area”</u>**: Staff is proposing language to this definition and sub-definitions (“Manufacturer-specific NOx NTE carve-out area,” “Manufacturer-specific PM NTE carve-out area,” and “NTE deficiency”) to indicate the date of the reference to 40 CFR 86.1370 as “as it existed on January 25, 2018.” Staff is also proposing to change references of “40 CFR 86.1370-2007” to “40 CFR 86.1370.”

<u>Rationale</u>: The proposed changes are needed to indicate the applicable date of the CFR references cited and to correct an error to the CFR reference.

**<u>“Over-the-air reprogramming”</u>**: Staff is proposing a new definition for “over-the-air reprogramming.”

<u>Rationale</u>: The new proposed definition is needed to complement the newly proposed requirements in section 1971.1(h)(6).

**<u>“Percentage of misfire”</u>**: Staff is proposing to change the word “firing” to “intended combustion” in this definition.

<u>Rationale</u>: The proposed change is needed to correct an inaccuracy in how to calculate the percentage of misfire, which should be based on total number of intended combustion events, not the total firing events.

**<u>“Plug-in hybrid electric vehicle”</u>**: Staff is proposing a new definition for “plug-in hybrid electric vehicle,” defining it as “a hybrid vehicle that has the capability to charge a battery from an off-vehicle electric source, such that the off-vehicle source cannot be connected to the vehicle while the vehicle is in motion.”

<u>Rationale</u>: The new proposed definition is needed to complement the proposed amendments related to plug-in hybrid electric vehicles throughout the regulation.

**<u>“Propulsion system active”</u>**: Staff is proposing to revise the definition of “propulsion system active” to exclude remote start activations that do not cause the engine to start unless prompted by the driver.

<u>Rationale</u>: “Propulsion system active” is currently used in determining when the in-use monitor performance denominators for hybrid vehicles should be incremented (which requires more than 600 seconds of propulsion system active time to increment the denominator). The language currently defines this as the “the state where the powertrain is enabled by the driver such that the vehicle is ready to be used.” During the OBD II rulemaking update a few years ago, manufacturers expressed concern that the current language would cause OBD II systems to unnecessarily increment the denominators during driving cycles with very little driving but where the vehicle owner used remote start activations for various reasons such as conditioning the cabin prior to actually using the vehicle.

This may result in low in-use monitor performance ratios that would not meet the minimum required ratio specified in the regulation. Thus, staff revised the OBD II regulation to modify the language in the definition to address the concerns and is now proposing the same language in the HD OBD regulation.

**"Response rate"**: Staff is proposing additional language indicating that "response rate" includes delays in the sensor to initially react to a change in exhaust gas composition (i.e., delayed response) as well as slower transitions from a rich-to-lean (or lean-to-rich) sensor output (i.e., slow response).

Rationale: The proposed change to this definition is needed to clarify the difference between delayed response faults and slow response faults.

**"Running change"**: Staff is proposing a new definition for "running change", defining it as "an emission or OBD system-related calibration, software, or hardware change to an engine (family, rating, or model) or an addition of an engine (rating or model) which occurs after certification (i.e., the Executive Order has been issued) but during engine production."

Rationale: The new proposed definition is needed to complement the new proposed requirements for running changes in section 1971.1(m).

**"Similar conditions"**: Staff is proposing to include reference to sections (e)(3), (e)(4), (e)(3.4.2)(D), and (e)(4.4.2)(D) in this definition.

Rationale: The proposed changes are needed to complement the proposed changes to sections 1971.1(e)(3.4.2)(D) and (e)(4.4.2)(D).

**"Smart device"**: Staff is proposing a new definition for "smart device."

Rationale: The new proposed definition is needed to complement the proposed amendments to the comprehensive component monitoring requirements in section 1971.1(g)(3).

**"Supplemental Emission Test (SET) cycle"**: Staff is proposing language to indicate the date of the reference to 40 CFR 86.1360 as "as it existed on January 25, 2018." Staff is also proposing to change references of "40 CFR 86.1360-2007" to "40 CFR 86.1360."

Rationale: The proposed changes are needed to indicate the applicable date of the CFR reference cited and to correct an error to the CFR reference.

**"Warm-up cycle"**: Staff is proposing to change "driving cycle" to "ignition cycle" in this definition. Staff is also proposing to include reference to section (d)(2.3.1)(C)(ii)b.3.v, "if applicable," to this definition.

Rationale: The proposed change of "driving cycle" to "ignition cycle" is needed since "ignition cycle" is the more appropriate terminology to use. The proposed additions of "(or v. is applicable)" is needed to correct an error, since hybrid vehicles are currently allowed to use the criteria in subsections (d)(2.3.1)(C)(ii)b.3.v. and (d)(2.3.2)(C)(ii)b.3.v. in lieu of (d)(2.3.1)(C)(ii)b.3.i. and (d)(2.3.2)(C)(ii)b.3.i.

**Section 1971.1(d): General Requirements**

**Section 1971.1(d)(2): "MIL and Fault Code Requirements"**

**1971.1(d)(2.1.1)**: Staff is proposing language indicating that the required engine symbol for the MIL would adhere to description of symbol number F.01 in ISO 2575 "Road Vehicles – Symbols for Controls, Indicators and Tell-Tales."

Rationale: The proposed language is needed for clarification, since there have been a few concerns that manufacturers would inappropriately modify the engine symbol (e.g., add text within the engine symbol) for the MIL.

**1971.1(d)(2.1.2)**: Staff is proposing language that indicates that if there is a delay in MIL illumination for these liquid crystal display (LCD) MILs, the delay may not exceed 5 seconds starting with the 2022 model year.

Rationale: The HD OBD regulation currently requires the MIL to continuously illuminate for at least 15 seconds during the functional check (i.e., the "bulb check") at key on, engine off, which informs the operator or technician whether or not the MIL is functioning properly. When the requirement was first adopted, vehicles were using light bulbs for the MIL. Since then, instrument panel technology has evolved to where some vehicles now use LCD screens, which may result in some delay in the illumination of the MIL symbol during the functional check due to the "boot up" time.

**1971.1(d)(2.2.1)(D)(iii), (d)(2.2.1)(D)(vi), (d)(2.2.2)(D)(iv) and (d)(2.2.2)(D)(vii)**: Staff is proposing language indicating that for 2022 and subsequent model year engines, in the event a malfunction is detected and a pending fault code is stored, if all available freeze frames are filled and freeze frame conditions are currently stored for a confirmed or previously MIL-on fault code that is not currently commanding the MIL on, the freeze frame conditions would be replaced with freeze frame conditions for the pending fault code.

Rationale: The HD OBD regulation currently requires manufacturers to store freeze frame data with storage of a pending fault code. Additionally, if the fault matures to a confirmed/MIL-on fault code, the regulation requires manufacturers to erase freeze frame data in conjunction with erasing the confirmed fault code/previously MIL-on fault code, which the regulation requires to occur if certain criteria are met for at least 40 warm-up cycles. The regulation, however, also allows the manufacturers to store only one set of freeze frame data. Thus, if a confirmed/previously-MIL-on fault code is currently stored for a fault that was previously fixed (so the MIL is extinguished) and a new fault is subsequently detected, a new pending fault code would be stored but no new freeze frame data would be stored for this new fault since there are already freeze frame data stored for the confirmed/previously-MIL on fault code. This would be confusing if the pending fault code eventually matures to a confirmed/MIL-on fault code and the MIL is illuminated, and the repair technician trying to fix the fault sees freeze frame data that do not correspond to the fault that caused the MIL to be illuminated. To address this issue, staff is proposing that the freeze frame data be replaced in these cases starting with 2022 model year engine.

**1971.1(d)(2.2.1)(D)(iv)**: Staff is proposing modifications to the alternate strategies that are required to store and erase freeze frame conditions with storage and erasure of a confirmed fault code. Specifically, the proposed changes would require alternate strategies that "store both a pending fault code and confirmed fault code and illuminate the MIL upon the first detection of a malfunction" would be required to meet the requirements of this section.

Rationale: The HD OBD regulation currently requires alternate strategies that 'do not store pending fault codes" to meet the requirements of this section. The proposed change is needed to correct an error, since on vehicles using the ISO 15765-4 protocol, all strategies (including alternate statistical strategies) are required to store a pending fault code for currently malfunctioning components/systems under subsection (h)(4.4.1)(E).

**1971.1(d)(2.2.1)(D)(v) and (d)(2.2.2.)(D)(vi)**: Staff is proposing to include language indicating that if freeze frame conditions are currently stored for a fault, the manufacturer may not replace the stored freeze frame conditions with those of a subsequently detected fault unless the subsequently detected fault is a misfire or fuel system fault or if the currently stored freeze frame data are for fault codes that are not currently illuminated the MIL in accordance with section 1971.1(d)(2.2.1)(D)(vi) or (d)(2.2.2)(D)(vii).

Rationale: Currently, the HD OBD regulation requires only one set of freeze frame information to be stored (in accordance with section 1971.1(h)(4.3.3)). Although the existing regulation indicates that freeze frame information for gasoline and diesel misfire and fuel system faults can replace currently stored freeze frame information, it does not clearly specify whether freeze frame information for any other fault can replace currently stored freeze frame information. So staff is proposing language to the freeze frame storage and erasure protocol to clarify this. Details regarding the changes related to sections 1971.1(d)(2.2.1)(D)(vi) and (d)(2.2.2)(D)(vii) are described above.

**1971.1(d)(2.2.1)(E) and (d)(2.2.2)(E)**: Staff is proposing language indicating that if the default mode of operation is not recoverable, the OBD system would be required to store a pending and confirmed fault code in addition to illuminating the MIL for engines using the ISO 15765-4 protocol and store a MIL-on fault code in addition to illuminating the MIL for engines using the SAE J1939 protocol. If the default mode of operation is recoverable, the OBD system would be allowed to delay illuminating the MIL and storing a confirmed/MIL-on fault code until the next driving cycle in which the vehicle enters the default mode of operation. Additionally, staff is also proposing that the requirements in these sections are applicable "except as provided in section (d)(2.4)." Finally, staff is proposing language indicating that the MIL is required to be illuminated and a fault code stored in the event of a malfunction of "any on-board computer or its ability to successfully send or receive information to/from other on-board computers."

Rationale: The HD OBD regulation currently requires the OBD system to illuminate the MIL and store a confirmed or MIL-on fault code if the vehicle enters a default mode of operation that affects emissions or other OBD monitors. If the default mode of operation is recoverable, the OBD system may "delay illumination of the MIL" until the next driving cycle in which the vehicle again enters the default mode of operation. The current language, however, is not clear about what is required with confirmed/MIL-on fault code storage. So staff is proposing changes to the requirements to clarify this. The proposed reference to section 1971.1(d)(2.4), which describes exceptions to the MIL and fault code requirements related to default strategies, is needed to clarify that manufacturers are exempt from the requirements of sections 1971.1(d)(2.2.1)(E) and (d)(2.2.2)(E) if they meet the criteria under section 1971.1(d)(2.4). Finally, the proposed change related to illuminating the MIL when the on-board computer is unable to successfully send or receive information to/from other computers is needed for clarification to ensure that manufacturers are detecting these type of failures.

**1971.1(d)(2.3.1)(A) and (d)(2.3.2)(A)**: Regarding monitors that do not have to meet the requirements in these sections, staff is proposing to add references to sections (e)(3.4.2)(E) and (e)(4.4.2)(E) for diesel exhaust gas recirculation (EGR) and boost pressure control system monitors. Staff is also proposing that starting with the 2022 model year, OBD systems would be required to extinguish the MIL after the monitor had run and "passed" on three driving cycles, not "after at least" three driving cycles. Staff is also proposing alternate criteria for hybrid vehicles that use SAE J1939 as the communication protocol and store SPN 6810 in the hybrid control unit when a hybrid-related fault is detected. Specifically, the OBD system on these hybrid vehicles may extinguish the MIL after the monitor had run and "passed" on more than three driving cycles but no more than six driving cycles.

Rationale: The HD OBD regulation currently states that the MIL shall be extinguished after "at least" three subsequent sequential driving cycles in which the monitor responsible for illuminating the MIL determined that the malfunction is no longer present. However, the language allows manufacturers to design OBD systems that extinguish MILs if malfunctions are not detected during more than three subsequent sequential driving cycles. Staff believes that unnecessarily keeping a MIL illuminated is unwarranted, especially after an OBD system has determined the malfunction is no longer present over three separate driving cycles, and given the likelihood of unduly worrying vehicle owners and confusing technicians attempting to repair transitory malfunctions. Staff therefore recently proposed changes to the OBD II regulation to address this and is now proposing the same changes in the HD OBD regulation. This would ensure consistency among manufacturers in the timing of extinguishing the MIL for each monitor.

However, hybrid manufacturers with vehicles using the SAE J1939 protocol have indicated that they need more than three driving cycles to extinguish the MIL. Considering the horizontally-integrated heavy-duty industry, the hybrid manufacturers and the engine manufacturers often design their control units separately, which have caused an issue with meeting the HD OBD requirements. Specifically, hybrid manufacturers have indicated that when a hybrid-related fault is detected, the hybrid control unit changes its hybrid fault status message (SPN 6810), which is regularly sent to the ECU, to indicate that there is a hybrid-related fault present. The ECU then stores a hybrid system fault code and illuminates the MIL. Once the malfunction is not detected again for three driving cycles, the hybrid control unit will erase its fault code and change the status of the SPN 6810 message to indicate that no hybrid system fault is present. If the ECU, which manages the MIL illumination, sees the SPN 6810 message indicate no fault is present for three driving cycles, it will then extinguish the MIL. Therefore, staff is proposing to allow the OBD system on these hybrid vehicles to extinguish the MIL after the monitor has run and "passed" on more than three driving cycles but no more than six driving cycles.

The proposed additions of section references to the diesel EGR and boost control pressure system monitors are needed to complement the proposed changes to sections (e)(3.4.3)(E) and (e)(4.4.2)(E).

**1971.1(d)(2.3.1)(B) and (d)(2.3.2)(C)**: Starting with the 2022 model year, staff is proposing to require that the OBD system erase the confirmed/previously MIL-on fault code (1) no sooner than the end of the driving cycle in which the identified malfunction has not been again detected in at least 40 consecutive warm-up cycles and the MIL is presently not illuminated for that malfunction, and (2) no later than the end of the driving cycle in which no malfunction has been detected in 41 consecutive warm-up cycles and the MIL is presently not illuminated for any malfunction.

Rationale: For confirmed and previously MIL-on fault codes, the HD OBD regulation currently states that an OBD system "may" erase a confirmed or previously MIL-on fault code if the fault is not subsequently detected “in at least” 40 warm-up cycles and the MIL is not presently illuminated for that fault. This requirement presents similar concerns as those discussed above relating to extinguishing the MIL, and the existing language may be misinterpreted with the use of the term “may,” even though the intent was that manufacturers are not allowed to erase the confirmed/previously MIL-on fault code sooner than 40 warm-up cycles. Staff is also aware of instances where OBD systems unnecessarily store confirmed fault codes over extended periods of time, including a few manufacturers’ OBD systems that store confirmed fault codes forever, which provides no benefit and may cause confusion and issues in the field. To address this issue and to also ensure consistency among manufacturers, staff recently proposed changes to the OBD II regulation and is now proposing the same changes in the HD OBD regulation. For example, if there is only one confirmed fault code, an OBD system could erase the confirmed fault code anytime between the end of the 40$^{th}$ warm-up cycle meeting condition (1) and the end of the 41$^{st}$ warm-up cycle meeting condition (2). Thus, vehicles that power off the engine control module at the end of a driving cycle and thus cannot erase the permanent fault code at the end of the 40$^{th}$ warm-up cycle could erase the permanent fault code at the start of the next (i.e., 41$^{st}$) warm-up cycle. This amendment would allow OBD systems to erase individual confirmed/previously MIL-on fault codes or erase a subset of confirmed/previously MIL-on fault codes at the same time, and would help ensure that repair technicians focus on recently detected faults and are not misled or distracted by troubleshooting faults that have long since disappeared.

**<u>1971.1(d)(2.3.1)(C)(ii)a. and (d)(2.3.2)(D)(ii)a.</u>**: Staff is proposing to change “rationality monitors” to “rationality fault diagnostics”. Staff is also proposing language indicating that manufacturers are required to meet the requirements of these sections, which describe the requirements for erasing permanent fault codes when the fault information in the on-board computer has been cleared and the OBD system is not commanding the MIL on, except as provided in section (d)(2.3.1)(C)(ii)d. for vehicles using the ISO 15765-4 protocol and section (d)(2.3.2)(D)(ii)d. for vehicles using the SAE J1939 protocol.

<u>Rationale</u>: The proposed change of “rationality monitors” to “rationality fault diagnostics” is needed to be consistent with the terminology used in the definitions in subsection (c), which states “rationality fault diagnostic.” The other proposed changes are needed since the current language indicates the requirements in sections 1971.1(d)(2.3.2)(C)(ii)a. and (d)(2.3.2)(D)(ii)a. have to be met “except as provided for in section (d)(2.3.1)(C)(ii)c.” or “except as provided for in section (d)(2.3.2)(D)(ii)c.”, respectively, while sections 1971.1(d)(2.3.2)(C)(ii)d. and (d)(2.3.2)(D)(ii)d. are also exceptions but were mistakenly not mentioned.

**<u>1971.1(d)(2.3.1)(C)(ii)b. and (d)(2.3.2)(D)(ii)b.</u>**: Staff is proposing language indicating that manufacturers are required to meet the requirements of this section, which describe the requirements for erasing permanent fault codes when the fault information in the on-board computer has been cleared and the OBD system is not commanding the MIL on, except as provided in sections (d)(2.3.1)(C)(ii)d. and e. for vehicles using the ISO 15765-4 protocol, and sections (d)(2.3.2)(D)(ii)d. and e. for vehicles using the SAE J1939 protocol.

Rationale: The proposed changes are needed to make clear that manufacturers do not have to meet the requirements in these sections if they meet the criteria in sections 1971.1(d)(2.3.1)(C)(ii)d., (d)(2.3.1)(C)(ii)e., (d)(2.3.2)(D)(ii)d. or (d)(2.3.2)(D)(ii)e.

**1971.1(d)(2.3.1)(C)(ii)e. and (d)(2.3.2)(D)(ii)e.**: Staff is proposing amendments to clarify that the thermostat monitor and ECT sensor "time to closed-loop" monitors are required to erase the permanent fault code only if the monitor ran and passed without any indication of a malfunction (i.e., the criteria under section 1971.1(d)(2.3.1)(C)(ii)a. or (d)(2.3.2)(D)(ii)a. are met).

Rationale: Staff is proposing amendments to the erasure protocol for permanent fault codes in the event the fault information in the on-board computer has been cleared (through the use of a scan tool or battery disconnect). Currently, monitors required to meet a minimum acceptable in-use monitor performance ratio (i.e., that are "subject to the minimum ratio requirements of section 1971.1(d)(3.2)") are required to erase a permanent fault code if the monitor ran and passed without any indication of a malfunction. Those monitors that are not subject to the minimum ratio requirements of section 1971.1(d)(3.2) are required to erase a permanent fault code if the monitor has run and passed without any indication of a malfunction and the criteria similar to those for a general denominator of section 1971.1(d)(4.3.2)(B) have been satisfied (with the exception that the general denominator conditions require ambient temperatures above 20 degrees Fahrenheit or below 8000 feet in elevation). The latter requirement was aimed at monitors that are required to run continuously such as the gasoline misfire and fuel systems monitors, and are thus "not subject to the minimum ratio requirements of section 1971.1(d)(3.2)." Staff, however, inadvertently overlooked the fact that the engine cooling system thermostat monitor and ECT sensor "time to closed-loop" monitor are also not subject to the minimum ratio requirements, even though they are not continuous monitors. Thus, staff is proposing these changes to correct this.

**1971.1(d)(2.3.1)(C)(iii) or (d)(2.3.2)(D)(iii)**: Staff is proposing language clarifying that for vehicles in which multiple permanent fault codes are currently stored, the OBD system shall erase a specific permanent fault code if the monitor for that specific fault code met the required criteria for erasure. In other words, the OBD system may not wait until the monitors for "all" the stored permanent fault codes have met the required criteria before erasing any of the permanent fault codes.

Rationale: Staff is proposing this clarifying language to address manufacturer confusion regarding when to erase permanent fault codes and to prevent permanent fault codes from being stored longer than appropriate.

**1971.1(d)(2.4.1)**: Staff is proposing amendments to the exceptions to the MIL illumination and fault code storage requirements. Specifically, staff is proposing language indicating that the section applies to default modes of operation that affect emissions or the performance of the OBD system and dictates the criteria to be exempt from illuminating the MIL "and storing a fault code." Staff is also proposing amendments to indicate that the default strategy is exempt from the MIL illumination and fault code storage requirements if it, among other conditions, is not "otherwise" caused by a component required to be monitored by the OBD system under sections 1971.1(e) through (g).

Rationale: The proposed amendments to this section are needed for clarification, since this section is intended to exempt manufacturers (if certain criteria are met) from the requirements of section (d)(2.2.1)(E) or (d)(2.2.2)(E), which require illumination of the MIL and storage of fault codes if the engine enters a default mode of operation that "can affect emissions or the performance of the OBD system." The current language in section 1971.1(d)(2.4.1), however, mentions only "default mode of operation" without the emissions/OBD system performance qualifier and refers to exemption from illuminating the MIL only, not fault code storage.

**1971.1(d)(3.1.3)**: Staff is proposing that for monitors on 2022 and subsequent model year engines, the manufacturer would not be allowed to define monitoring conditions that are designed to ensure monitoring will occur during the SET cycle in lieu of the Federal Test Procedure (FTP) cycle unless the in-use monitor performance for the monitor is required to be tracked and reported under section 1971.1(d)(3.2.1).

Rationale: Currently some monitors, including those for which the in-use monitor performance data are not tracked and reported, have been designed by manufacturers to execute on the SET cycle instead of the FTP cycle, which has concerned staff. Specifically, staff do not believe the conditions on the SET cycle, which is around 40 minutes of mostly steady-state driving, are representative of real-world heavy-duty vehicle operation, and is thus concerned monitors designed to run on such cycles will not run frequently in-use. Thus, the proposal to limit manufacturers from designing monitors to run on the SET cycle to only those for which the in-use monitor performance data are tracked and reported would ensure monitors either run frequently in-use or provide CARB staff the ability to identify problematic monitors.

**1971.1(d)(3.1.4)**: Staff is proposing to require manufacturers to submit a monitoring plan for intrusive diagnostics. The intrusive diagnostics would be required to meet certain criteria:

(A) If running the diagnostic will not reduce the effectiveness of the emission control system during any reasonable in-use driving conditions, the diagnostic would be approved.
(B) If running the diagnostic reduces the effectiveness of the emission control system during any reasonable in-use driving conditions, the diagnostic would only be allowed to run once after the MIL is illuminated by a non-intrusive diagnostic for pinpointing purposes.
(C) If running the diagnostic enhances the effectiveness of the emission control system (e.g., increase catalyst conversion efficiency for a few minutes at the beginning of a driving cycle) during any reasonable in-use, the manufacturers may be required to use alternate test procedures to demonstrate emission control system performance that is representative of normal vehicle operation and use.

Rationale: CARB staff has concerns over the emissions impact of intrusive diagnostics.  Specifically, some manufacturers have designed intrusive diagnostics that perform actions that result in increased emissions (e.g., actions that stop diesel exhaust fluid (DEF) dosing in order to pinpoint SCR system malfunctions).  Some of the intrusive diagnostics do not run during standard test cycles, so emissions would not be inherently captured during emissions testing. Further, some intrusive diagnostics that do run on the standard test cycles may misrepresent and underestimate normal in-use emissions. Thus, staff is proposing that, unless the intrusive diagnostic has no impact on the effectiveness of the emissions control system, the intrusive diagnostic would only be allowed to run after the MIL is illuminated for the purposes of pinpointing.  In some instances, the intrusive diagnostic actually enhances the effectiveness of the emissions control system.  In these cases, alterations to the standard test procedures may be necessary in order to accurately demonstrate the emissions performance of the engine or vehicle.  As such, staff is proposing the ability to request that manufacturers conduct emissions demonstrations using alternate test procedures.  The objective of the alternate test procedures would be to obtain representative emission results by disabling the intrusive actions to the emission control system.

**Sections 1971.1(d)(3.2), (d)(4), and (d)(5): "In-Use Monitor Performance Ratio" Requirements**

The HD OBD regulation requires manufacturers to track OBD system monitoring performance by counting the number of monitoring events and the number of driving events.  The number of monitoring events is defined as the numerator and the number of driving events is defined as the denominator.  The ratio of these two numbers is referred to as the monitoring frequency and provides an indication of how often the monitor is operating relative to vehicle operation.  It is important to note that the denominator is a measure of vehicle activity, not a measure of "monitoring opportunities."  The regulation requires manufacturers to design monitors that meet a minimum acceptable IUMPR.

**<u>1971.1(d)(3.2.1)</u>**: Staff is proposing language indicating that monitors that are required to track and report in-use monitoring performance data are "specified in the sections referenced below for the following components/systems." Staff is also proposing to add several monitors to the list of the monitors required to track and report in-use monitor performance data. The proposed additions would include the diesel EGR system high/low flow and feedback control monitors (section 1971.1(e)(3.3.1)), boost pressure control system over/under boost and feedback control monitors (section 1971.1(e)(4.3.1)), PM filter frequent regeneration, missing substrate, and active/intrusive injection monitors (section 1971.1(e)(8.3.2)), and gasoline air-fuel ratio cylinder imbalance monitor (section 1971.1(f)(1.3.2)). Staff is also proposing to amend the sentence "The OBD system is not required to track <u>and</u> report in-use performance for monitors other than those specifically identified above" to "The OBD system is not required to track <u>or</u> report in-use performance for monitors other than those specifically identified above."

<u>Rationale</u>: The proposed additional monitors for tracking and reporting are needed so that CARB can ensure that these monitors run frequently in-use as required, since there have been issues in the past regarding their monitoring frequency in-use. Based on CARB staff's observations and discoveries during OBD application reviews and field testing, staff believes it is appropriate and necessary to require the specified monitors to be tracked and reported in order to improve the monitoring efficiency and accountability. Specifically, some diesel monitors failed to execute during CARB staff's in-use testing of heavy-duty diesel vehicles. These included several "continuous" diesel monitors, namely EGR system low flow, high flow, and feedback control monitors and boost pressure control system under boost, over boost, and feedback control monitors. The actual monitoring frequency for these monitors is less than what CARB would reasonably expect for "continuous" monitors. So although the current regulation exempts monitors that are required to run "continuously" from this tracking and reporting requirement, staff believes these specific EGR system and boost pressure control system monitors should track and report this information and is thus proposing changes to address this. There also have been concerns about the monitoring frequency of the PM filter missing substrate monitor, so staff believes the in-use monitoring performance data should also be tracked and reported for this monitor.

CARB staff had also found issues with setting PM filter readiness status to "complete" due to the PM filter frequent regeneration and active/intrusive injection monitors. Manufacturers have expressed concerns about tying the readiness status to these monitors, since they may be difficult to run. While staff does understand manufacturers' concerns, staff also believes that there should be some assurance that these monitors are running and detecting faults in-use, especially for the PM filter frequent regeneration monitor since such failures may have a high emissions impact. Thus, in conjunction with proposing to take these monitors out of the PM filter readiness status determination (section 1971.1(h)(4.1.3)(H)), staff is proposing to require these two monitors to track and report in-use monitoring performance data to address this issue.

Concerning the gasoline air-fuel ratio cylinder imbalance monitor, CARB staff has had concerns with the monitoring frequency of this monitor for many years and believes requiring the tracking and reporting of its in-use monitoring frequency would better assist staff in determining whether or not the monitor complies with the HD OBD regulation. Thus, staff is proposing to require this tracking and reporting requirement for dedicated air-fuel ratio cylinder imbalance monitors (not those that detect these faults using other existing monitors such as the misfire monitor).

Lastly, the proposed revision of "track and report" to "track or report" is needed to clarify that manufacturers are not required to track the in-use monitor performance data for monitors not listed under section 1971.1(d)(3.2.1). While the HD OBD regulation currently lists the specific monitors that the OBD system must track and report the in-use monitor performance data, manufacturers have raised questions regarding whether OBD systems must track the data for monitors that are not listed. While some of these monitors are subject to the minimum required IUMPR and have specifications in the regulation on how to increment the associated denominators, the regulation does not require that the in-use monitor performance data for these monitors be tracked. However, manufacturers may elect to track these monitors to ensure their OBD systems are meeting the required minimum IUMPR.

**1971.1(d)(3.2.2)**: Staff is proposing amendments indicating that certain monitors that, among other conditions, meet section 1971.1(d)(3.1), "if applicable," are required to meet a minimum in-use IUMPR. Staff is also proposing language indicating that the minimum IUMPR would apply to monitors "specifically required in sections (e) through (g) to meet the monitoring condition requirements of section (d)(3.2)."

Rationale: The IUMPR requirements have generally only been required for monitors that run once or multiple times per driving cycle, and thus have not been required for "continuous" monitors since such monitors are expected to run almost all the time. However, as described in more detail below, staff has had difficulties running some "continuous" diesel monitors in-use, and is thus proposing to require the in-use monitor performance data for several "continuous" diesel EGR and boost pressure control system monitors to be tracked and reported starting in the 2022 model year. The respective monitoring requirement sections mandate these monitors run "continuously" and thus do not specify that these monitors must meet the requirements of section 1971.1(d)(3.1), which require monitors to run at least once per driving cycle. Thus, the proposed addition of "if applicable" regarding meeting section 1971.1(d)(3.1) and the proposed reference to "meeting the monitoring condition requirements of section (d)(3.2)" are needed to account for these monitors and to complement the proposed changes to the diesel EGR and boost pressure control system sections in sections 1971.1(e)(3.3.1) and (e)(4.3.1).

**1971.1(d)(3.2.2)(A) and (B)**: Staff is proposing to change the minimum acceptable IUMPR for all monitors from 0.100 to 0.300 for all 2022 and subsequent model year engines.

Rationale: When the HD OBD regulation was first adopted in 2005, the minimum IUMPR of 0.100 was meant to be an interim ratio for the beginning years of HD OBD implementation until a higher, more appropriate IUMPR could be developed by staff based on in-use data. The proposed increase of the minimum IUMPR to 0.300 is needed to ensure that monitors are running frequently in-use. The proposed minimum ratios of 0.300 are also technically feasible. CARB staff evaluated existing HD OBD monitor IUMPR data from 2013 to 2016 model year engines and found that, on average, heavy-duty gasoline engines are meeting the ratio of 0.300 for all currently required tracked and reported monitors. For heavy-duty diesel engines, CARB staff found that manufacturers are, on average, achieving the ratio of 0.300 for almost all monitors with the exception of the NMHC converting catalyst monitor and exhaust gas sensor (specifically the NOx sensor) monitor. The issues with the NMHC converting catalyst monitor and exhaust gas sensor monitor and solutions are addressed below.

Manufacturers have expressed concerns regarding the proposed increase of the minimum IUMPR to 0.300. For the NMHC converting catalyst monitor, manufacturers are concerned that the increase may force manufacturers to increase the regeneration frequency in order to run their monitors more frequently, which would result in increases to fuel use and regeneration emissions. To address this, staff is proposing to allow manufacturers to increment the denominator for this monitor when a regeneration event actually occurs (please see the description under section 1971.1(d)(4.3.2)(H) for more details). With this new denominator, the proposed IUMPR of 0.300 for the NMHC converting catalyst monitor could be achieved without increasing the regeneration frequency.

For the exhaust gas sensor monitor, the 2016 model year heavy-duty diesel IUMPR data show that some manufacturers are in fact achieving the 0.300 ratio. In addition, CARB staff investigated the least frequent exhaust gas sensor monitor (which determines the IUMPR data reported) for each manufacturer and found that this monitor varied by manufacturer. Specifically, the least frequent monitor includes monitors for NOx sensor offset, stuck NOx sensor, NOx sensor gain, NOx sensor plausibility, NOx sensor slow response, oxygen sensor, and PM sensor. Therefore, there is no specific monitor that is an issue for all manufacturers, which indicates that it is technically feasible for all exhaust gas sensor monitors to run frequently in-use. In theory, manufacturers could achieve better IUMPRs if they improve their least frequent monitor. Based on current information, CARB staff concludes that the proposed minimum IUMPR of 0.300 for the exhaust gas sensor monitor can be achieved.

Manufacturers have also indicated that the proposed 0.300 ratio should be based on the same concept that the OBD II regulation used in determining its minimum IUMPRs. Specifically, manufacturers have indicated that the proposed ratio for the HD OBD regulation should be based on the concept of detecting a fault for 90 percent of vehicles in 2 weeks. CARB staff, however, believes that this light-duty concept should not be applied to heavy-duty vehicles. U.S. Federal Highway Administration data indicate heavy-duty vehicles (i.e., class 8 trucks, transient buses, and refuse trucks) have much greater vehicle miles traveled (VMT) than light-duty cars and trucks [1]. Based on these VMT data and assuming similar vehicle speeds, hours of operation for heavy-duty vehicles are greater than for light-duty vehicles, which supports the assumption that heavy-duty vehicles are operated primarily for commercial use. Similarly, from these data, staff concludes that heavy-duty vehicle operation times are much greater, specifically the driving time per ignition event and cumulative hours of operation per day, than light-duty passenger cars. Thus, heavy-duty trucks are operating and emitting emissions for a much-longer, cumulative time versus light-duty cars in 2 weeks. Allowing all those emissions to be emitted before a fault is detected on heavy-duty vehicles compared to light-duty cars does not seem reasonable.

In addition, heavy-duty driving patterns vary widely based on vocation. Vocational heavy-duty vehicle operation time and mileage are generally shorter than those of line haul heavy-duty vehicles. Staff intended to use the vocational heavy-duty vehicle activity data from real world operation as the worst case data in terms of vehicle operation time, which would provide a fairer comparison of heavy-duty vocational vehicles to light-duty passenger cars. CARB staff analyzed the activity data for heavy-duty vocational vehicles obtained from a research project[2] that was developed to better understand heavy-duty vehicle activity in California. The 84 vocational vehicles included in the study were used for various purposes (e.g., drayage, construction, delivery, refuse, beverage distribution, food distribution, shuttle, utility) in northern and southern California, and represented real world driving patterns in California. In this data set, the heavy-duty vocational vehicle operation hours varied from a few hundred hours to almost 6,000 hours, and mileage varied from close to 2,000 miles to more than 60,000 miles. This study showed that the average daily operation hours is around 6 hours which, at an average vehicle speed of 17 miles-per-hour (mph), which equates to about 105 miles of operation per day. Using these data, CARB staff then calculated the miles for each LD and HD vehicle monitoring event by using the following equation:

[1] Average Annual Vehicle Miles Traveled of Major Vehicle Categories, updated on June 2015, U.S. Department of Energy; https://www.afdc.energy.gov/data/10309

[2] Boriboonsomsin, K.; Johnson, K., Scora, G., Sandez D., Vu, A., Durbin, T., Jiang, Y., and Burnette, A., "Collection of Activity Data from On-Road Heavy-Duty Diesel Vehicles: FINAL REPORT (ARB Agreement No. 13-301)", May 2017, University of California at Riverside

$$\frac{Miles}{Monitoring\ Event} = \frac{\frac{Operation\ Hours}{Day} \times \frac{Miles}{Hour}}{\frac{General\ Den.}{Day} \times IUMPR}$$

For the equation above, “Operation Hours / Day” is vehicle operation time per day, “Miles / Hour” is the average vehicle speed during the operation time, and “General Den./ Day” is the general denominator increase per day (or called “F-trip / Day”).

Table 1 below lists all parameters needed for the calculation and results for the miles and hours per monitoring event for heavy-duty and light-duty vehicles. The heavy-duty vehicle data are from a research project [2] while the light-duty vehicle data are from staff’s estimation based on information from the U.S. Department of Transportation Bureau of Transportation Statistics [3] and U.S. EPA tri-city study[4]. The U.S. Department of Transportation Bureau of Transportation Statistics shows that the average person miles-per-day is 40 miles. Staff assumed a passenger vehicles daily operation of 2 hours with an average speed of 20 miles-per-hour. This assumption will not change any calculation result for the miles-per-monitoring event since the numerator part of the aforementioned equation is the miles-per-day.

Table 1: Light-duty (LD) and heavy-duty (HD) vehicle operation miles/hours per monitoring event

| | Daily Operation (hours) | Average Speed (mph) | General Den./day F-trip/day (10th percentile) | IUMPR | Miles per Monitoring Event | Hours per Monitoring Event |
|---|---|---|---|---|---|---|
| HD | 6.1* | 17.3* | 1.41* | 0.1 | 745 | 43.3 |
| HD | 6.1* | 17.3* | 1.41* | 0.2 | 372 | 21.6 |
| HD | 6.1* | 17.3* | 1.41* | 0.3 | 248 | 14.4 |
| LD | 2** | 20** | 0.7*** | 0.336 | 170 | 8.5 |

*Vocational data (84 vehicles in California)
** Estimation based on U.S. Department of Transportation Bureau of Transportation Statistics’ average 40 person miles-per-day
***US EPA’s tri-city study

The calculations in Table 1 show that a proposed minimum IUMPR of 0.300 for HD OBD should reduce the heavy-duty vehicle operation miles and hours per monitoring event and close the gap for amount of operation per monitoring event

[3] National Household Travel Survey Daily Travel Quick Facts, updated May 31, 2017, United States Department of Transportation; https://www.bts.gov/statistical-products/surveys/national-household-travel-survey-daily-travel-quick-facts

[4] Staff Report: Initial Statement of Reasons: Technical Status and Revisions to Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II), March 8, 2002, Appendix IV, March 8, 2002

between light-duty and heavy-duty vehicles. Increasing the minimum IUMPR would more effectively detect failed emission control devices and help technicians execute OBD monitors before and after repairs.

Hence, based on discussion above, CARB staff believes it is inappropriate to apply the concept of “detection for 90% in 2 weeks” to heavy-duty vehicles, and believes that the proposed minimum IUMPR of 0.300 is necessary and feasible.

**1971.1(d)(3.2.2)(C)**: Staff is proposing an interim minimum acceptable IUMPR of 0.100 for the following engines/monitors: 2022 through 2023 model year alternate-fueled engines, the first 3 years for hybrid systems first certified in the 2022 through 2025 model years on plug-in hybrid electric vehicles, and the CV monitors on 2022 through 2029 model year engines.

Rationale: The proposed interim minimum ratio of 0.100 for heavy-duty alternate-fueled engines is needed since these engines are not required to implement HD OBD systems until the 2018 model year, so a lower minimum required IUMPR is needed during the initial years of HD OBD system implementation until alternate-fueled engine manufacturers have more experience with such systems.

Staff is proposing an interim minimum IUMPR of 0.100 for heavy-duty plug-in hybrid electric vehicles for similar reasons. For these vehicles, the HD OBD regulation currently requires a minimum in-use ratio of 0.100 for all monitors, including monitors of components/system that require engine operation (e.g., catalyst, exhaust gas sensor). During the OBD II regulation update in 2015, manufacturers requested that the interim ratio of 0.100 be extended a few more model years due to concerns about decreasing engine runtime in-use based on several factors, including increased availability of charging stations and improved hybrid battery performance on the vehicle. Thus, staff extended the applicable model years for the 0.100 interim ratio on OBD II plug-in hybrid electric vehicles. Considering there are currently no plug-in hybrid electric vehicles in the heavy-duty industry (so there is no experience with monitoring frequency on these heavy-duty vehicles), staff believes some relief is needed for the first few years for heavy-duty plug-in hybrid electric vehicles. The proposed interim ratio would only be allowed for the first 3 model years up through the 2025 model year for the first model year. Specifically, if the plug-in hybrid electric vehicle is first certified in the 2025 model year, the 0.100 ratio is applicable for the 2025 through 2027 model years. If the plug-in hybrid electric vehicle is first certified in the 2026 model year, the monitors would be required to meet the 0.300 ratio.

Concerning the CV monitors, staff is proposing to phase-in more stringent monitoring requirements that would require manufacturers to develop new monitors to detect more failure modes of the gasoline and diesel CV systems during the 2025 through 2027 model years (see the description for sections 1971.1(g)(2.2.2) and (2.2.3) for more details). In conjunction with these proposed changes, staff is proposing that these new monitors be required to meet an interim minimum acceptable in-use monitor performance ratio of 0.100 through the 2029 model year before transitioning to the final ratio of 0.300. This would provide an adequate interim period where manufacturers could collect data on the performance of the monitors and adjust the monitoring conditions accordingly based on feedback from the field. The lead time for complying with the final ratio should be more than adequate considering the considerable lead time already provided for implementing the new monitoring requirements.

**1971.1(d)(4.2.2)(B)(iii)**: Staff is proposing changes to indicate that the requirements in this section apply to "intrusive diagnostics."

**Rationale**: The proposed change is needed to complement the newly proposed definition for "intrusive diagnostic" in section 1971.1(c).

**1971.1(d)(4.3.2)**: Throughout this section, staff is proposing amendments to add mention of section 1971.1(d)(4.3.2)(J), specifically "or (J) (whichever is applicable)" wherever section 1971.1(d)(4.3.2)(B) is referenced.

Rationale: The proposed mentions of section 1971.1(d)(4.3.2)(J) are needed for clarity, since the regulation currently allows hybrid vehicles to use the criteria in section 1971.1(d)(4.3.2)(J) in lieu of the criteria in section 1971.1(d)(4.3.2)(B).

**1971.1(d)(4.3.2)(B)**: Staff is proposing amendments to indicate that manufacturers have to meet the requirements of section 1971.1(d)(4.3.2)(B) except as provided in sections 1971.1(d)(4.3.2)(C) through (L) instead of sections 1971.1(d)(4.3.2)(F), (I), and (J).

Rationale: The proposed changes to the subsection references are needed for clarity, since not all applicable subsections were previously listed as exceptions to the incrementing criteria under this subsection.

**1971.1(d)(4.3.2)(C)**: Staff is proposing amendments to indicate that manufacturers have to meet the requirements of section 1971.1(d)(4.3.2)(C) except as provided in section 1971.1(d)(4.3.2)(K). Staff is also proposing amendments to change "rationality monitors" to "rationality fault diagnostics". Staff is proposing to add "hybrid component temperature sensor" as an example of a monitor that is required to meet the requirements of section 1971.1(d)(4.3.2)(C). Staff is also proposing to change "engine cooling system input components" to "engine cooling system input component rationality fault diagnostics."

Rationale: The proposed mention of section 1971.1(d)(4.3.2)(K) is needed to account for the new proposed requirements for plug-in hybrid electric vehicles that are contained in this section. The proposed change of "rationality monitors" to "rationality fault diagnostics" is needed to be consistent with the terminology used in the definitions in subsection (c), which states "rationality fault diagnostic."

The proposed change adding hybrid component temperature sensors to the example of comprehensive component input component temperature sensor rationality monitors is needed to account for the new hybrid component monitoring requirements in subsection (g)(3). The proposed addition of “rationality fault diagnostics” to “engine cooling system input component” is needed since the requirements of section 1971.1(d)(4.3.2)(C) apply to diagnostics, but the phrase “rationality fault diagnostics” was mistakenly left out when referring to “engine cooling system input component”.

**1971.1(d)(4.3.2)(E)**: Staff is proposing to stop allowing other emission control system monitors (section 1971.1(g)(4)) from meeting the requirements of this section. Staff is also proposing to add “idle speed control system” and “idle fuel control system” as examples of comprehensive component output components that would be required to meet this section.

Rationale: Staff is proposing amendments to this section to correct an error. The HD OBD regulation presently inappropriately allows monitors of “other emission control systems” to increment the denominator using two different set of criteria, one based on the component being commanded to function for greater than 10 seconds (section 1971.1(d)(4.3.2)(E)) and the other based on alternate criteria proposed by the manufacturer (section 1971.1(d)(4.3.2)(F)). The proposed amendments would require manufacturers to increment the denominator for these monitors using alternate criteria proposed by the manufacturer under section 1971.1(d)(4.3.2)(F), which is the less stringent of two current options. The proposed additions to the examples of comprehensive components required to meet the criteria under this section are needed to clarify which criteria these monitors are required to meet and to avoid confusion among manufacturers.

**1971.1(d)(4.3.2)(F) and (G)**: Staff is proposing to require that the diesel PM filter frequent regeneration monitor stop using the denominator incrementing criteria in section 1971.1(d)(4.3.2)(F) and start using the criteria in section 1971.1(d)(4.3.2)(G) by the 2022 model year (though provisions are also proposed to allow manufacturers to use the criteria in section 1971.1(e)(4.3.2)(G) earlier than the 2022 model year).

Rationale: The proposed changes to these sections are needed since CARB is proposing to track and report the in-use monitor performance data for the PM filter frequent regeneration monitor starting in the 2022 model year (see details in section 1971.1(d)(3.2.1)). Thus the denominator would need to be incremented in the same manner (by the criteria under section 1971.1(d)(4.3.2)(G)) on all engines to allow for a more fair comparison of the in-use monitor performance data between manufacturers (whereas section 1971.1(d)(4.3.2)(F) allows manufacturers to propose their own criteria for incrementing the denominator, which may not be consistent among manufacturers).

**1971.1(d)(4.3.2)(G) and (H)**: Staff is proposing to require that the diesel NMHC converting catalyst monitor stop using the denominator incrementing criteria in section 1971.1(d)(4.3.2)(G) by the 2021 model year and start using the criteria in section 1971.1(d)(4.3.2)(H) starting with the 2022 model year.

Rationale: As mentioned above, staff is proposing to increase the minimum required IUMPR for all monitors from 0.100 to 0.300 starting in the 2022 model year for most engines (see section 1971.1(d)(3.2.2) above). Manufacturers have expressed concern that their NMHC converting catalyst monitors would not be able to meet the 0.300 ratio, especially considering the monitors generally require a regeneration event to occur to enable monitoring and ensure robust monitoring. Therefore, staff's proposed changes would allow manufacturers to use criteria that would result in less incrementing of the denominator (and thus higher IUMPRs) for this monitor but would still give staff a fairly accurate assessment of the monitoring frequency of the monitor in-use.

**1971.1(d)(4.3.2)(G)**: Staff is proposing to require the diesel catalyzed PM filter feedgas generation monitor (section 1971.1(e)(8.2.4)(B)) to use the denominator incrementing criteria under this section starting with the 2022 model year. Staff is also proposing to add "diesel" to the phrases "catalyzed PM filter NMHC conversion" and "PM filter filtering performance", and is proposing to modify "section (e)(8.2.4)" to "section (e)(8.2.4)(A)".

Rationale: Staff is proposing amendments to correct some oversights. The HD OBD regulation currently requires the diesel catalyzed PM filter feedgas generation monitor to increment the denominator based on the general denominator criteria. However, the denominator for the NMHC converting catalyst feedgas generation monitor is incremented based on the criteria of section 1971.1(d)(4.3.2)(G), which requires at least 800 cumulative minutes of engine run time operation. Given that both these monitors are designed to detect feedgas generation malfunctions, staff believes they both should increment the denominators based on the same criteria, with the criteria under section 1971.1(d)(4.3.2)(G) being more appropriate. Thus, staff is proposing changes to address this. The proposed addition of "diesel" is needed for consistency, since the other monitors listed under this section have "diesel" in the name of the monitor. The proposed modification of "section (e)(8.2.4)" to "section (e)(8.2.4)(A)" is needed to be more specific about the section number when referring to the diesel catalyzed PM filter NMHC conversion monitor, since section (e)(8.2.4) also contains requirements for the diesel catalyzed PM filter feedgas generation monitor under section (e)(8.2.4)(B).

**1971.1(d)(4.3.2)(K)**: Staff is proposing new denominator incrementing criteria for certain monitors. Specifically, staff is proposing changes for the evaporative system monitors and the engine cooling system input component (i.e., ECT sensor) and comprehensive component input component temperature sensor rationality monitors on plug-in hybrid electric vehicles. The proposed amendments would require these monitors when the criteria under section 1971.1(d)(4.3.2)(J) are met, when specific cold ECT and ambient temperature conditions are met, and when the vehicle is not in a state of propulsion system active for at least 6 hours.

Rationale: For these monitors, the HD OBD regulation currently requires the denominators to be incremented on trips that meet a “cold start” (i.e., if the ECT and the ambient temperature are considered cold and the ECT at engine start is less than or equal to 12 degrees Fahrenheit higher than ambient temperature at start) (section 1971.1(d)(4.3.2)(C)). The criteria were set to ensure that the vehicle has had a long enough soak period such that the components/systems will have cooled down and stabilized by the beginning of the driving cycle and it would be technically feasible to run a robust monitor. The criteria, however, are not appropriate for plug-in hybrid electric vehicles, which may have long periods of operation without running the internal combustion engine. The OBD II regulation requires that for these monitors on plug-in hybrid electric vehicles, the denominator is incremented when, among other conditions, the soak period (i.e., the period when the vehicle is not in a state of “propulsion system active”) immediately preceding the driving cycle is greater than or equal to six hours. This requirement was adopted due to manufacturers’ concerns about the “cold start” criteria not being a good indicator of a long soak on plug-in hybrid electric vehicles, especially if the drive trips were all-electric, so using the “cold start” criteria could result in multiple inappropriate increments of the denominator. The 6-hour cold soak criterion for plug-in electric hybrid vehicles would better ensure a long soak period similar to that on conventional vehicles and traditional hybrids. For example, a conventional car would first look at ECT and ambient temperature at engine start, make sure they agree with each other to confirm it is a cold start of the vehicle, make sure ambient temperature is within acceptable ranges, and then look for the drive cycle to meet the rest of the criteria to count as an evaporative system denominator trip. Plug-in hybrid electric vehicles, however, would instead first look at the amount of time the vehicle has been off/not operated when the vehicle is first started, make sure that it has been at least 6 hours since the previous vehicle trip to confirm it is a cold start of the vehicle, and then make sure the ambient temperature is within range and that the drive cycle meets the rest of the criteria to count as an evaporative system denominator trip. Staff is now proposing these same criteria to the HD OBD regulation for 2022 and subsequent model year plug-in hybrid electric vehicles.

**1971.1(d)(4.3.2)(L)**: Staff is proposing language for monitors that are 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 applicable monitoring requirement section is subject to different denominator incrementing criteria in section 1971.1(d)(4.3.2), the manufacturer is required to request Executive Officer approval of the criteria used for incrementing the monitor denominator, with approval based on data demonstrating the denominator incrementing criteria used would result in the lowest IUMPR for the monitor.

Rationale: This new proposed section is needed to address confusion from manufacturers about how to incrementing the denominator for a monitor that is designed to detect faults covered under more than one subsection (and consequently may have different denominator incrementing criteria under different subsections under subsection (d)(4.3.2)).

**1971.1(d)(4.5.3)**: Staff is proposing amendments to add mention of section 1971.1(d)(4.3.2)(J), specifically "or (d)(4.3.2)(J) (whichever is applicable)" where section 1971.1(d)(4.3.2)(B) is referenced. Staff is also proposing formatting changes to the last sentence.

Rationale: The HD OBD regulation currently allows OBD systems to disable incrementing of all numerators and denominators if a fault is detected of any component used to determine any of the criteria in section 1971.1(d)(4.3.2)(B). The intent of this allowance is to disable incrementing of all numerators and denominators since the denominators for these monitors would generally be affected by the specified faults. However, hybrid vehicles are required to use the criteria in section 1971.1(d)(4.3.2)(J) in lieu of those under section 1971.1(d)(4.3.2)(B). Staff is therefore proposing changes to clarify that disablement of all numerators and denominators is allowed if a fault is detected of any component used to determine the criteria under either section 1971.1(d)(4.3.2)(B) or (d)(4.3.2)(J), whichever is applicable. The change to the last sentence is needed for better readability.

**1971.1(d)(4.5.4)**: Staff is proposing new language requiring manufacturers to disable incrementing of applicable numerators and denominators if a fault is detected for any component used to determine if any of the criteria in sections 1971.1(d)(4.3.2)(C) through (I) and (K) are satisfied starting with the 2022 model year.

Rationale: The HD OBD regulation currently does not allow OBD systems to disable incrementing of numerators and denominators for a specific monitor if a fault of any component used to determine any denominator incrementing criteria for that specific monitor is detected (e.g., does not allow disablement of the numerators and denominators for the cold start emission reduction strategy monitor if a fault is detected of any component used to determine the criteria in section 1971.1(d)(4.3.2)(D)). Staff did not intend for manufacturers to continue incrementing these numerators and denominators if such a fault occurred, since the resulting data and ratios would not be representative of actual monitor performance in-use. Thus, staff is proposing changes to address this.

**1971.1(d)(5.1), (5.1.1) and (5.1.2)**: Staff is proposing formatting changes to these sections.

Rationale: The proposed changes are needed for better readability and greater clarity.

**1971.1(d)(5.5.1), (5.5.2)(C), and (5.5.2)(D)**: Staff is proposing that 2022 and subsequent model year plug-in hybrid electric vehicles track and report an additional, separate ignition cycle counter that would be incremented when the "fueled engine operation" definition has been met (e.g., each time the vehicle is operated and the engine is started at least once). Staff is also proposing formatting changes to section 1971.1(d)(5.5.2)(D).

Rationale: Currently, manufacturers are required to track and report an ignition cycle counter, which is required to be incremented every time the vehicle is started or operated (i.e., "engine start" is met for conventional vehicles or "propulsion system active" is met for hybrid vehicles). This is basically a counter of the number of driving cycles experienced by the vehicle. These new proposed data would provide valuable information about how often all-electric driving cycles occur in-use for heavy-duty plug-in hybrid electric vehicles, which would help staff determine if further changes are needed to the in-use monitor performance requirements, including the required minimum acceptable in-use performance ratios, for these vehicles. The proposed formatting changes to section 1971.1(d)(5.5.2)(D) are needed for better readability.

**1971.1(d)(5.6.2)**: Staff is proposing amendments to the value that the OBD system is required to output as the "general denominator" on hybrid vehicles. Staff is proposing amendments to clarify that hybrid vehicles would be required to output a "general denominator" that is incremented based on the criteria specified under section 1971.1(d)(4.3.2)(J). Staff is also proposing that starting with the 2022 model year for plug-in hybrid electric vehicles, OBD systems would be required to increment the "general denominator" based on criteria under section 1971.1(d)(4.3.2)(J) except for the criterion requiring the 10 seconds of fueled engine operation. Finally, staff is proposing formatting changes to section 1971.1(d)(5.6.2)(C).

Rationale: Currently, the HD OBD regulation requires vehicles, including hybrid vehicles, to increment the "general denominator" based on criteria specified under section 1971.1(d)(4.3.2)(B). As stated in section 1971.1(d)(4.3.2)(J), however, hybrid vehicles are required to increment the denominator if another set of criteria based on "propulsion system active time" and requiring at least 10 seconds of "fueled engine operation" are met. Thus, staff is proposing amendments to clarify this. This denominator is also used for some of the monitors required to track and report in-use monitor performance data such as the catalyst monitor and oxygen sensor monitors. The new proposed general denominator definition for plug-in hybrid electric vehicles would allow staff to compare the vehicle activity reported through this denominator with the existing vehicle activity data from non-plug-in hybrid electric vehicles. Further, staff would also compare this new denominator definition with the hybrid vehicle definition (engine fueling included) to determine how many drive cycles had all-electric operation (i.e., no engine fueling occurring on the drive cycle). It should be noted, however, that while the “general denominator” value will be based on these new criteria, the denominators for monitors such as the catalyst monitor and oxygen sensor monitors would still be incremented based on the current criteria (specifically, all the criteria under section 1971.1(d)(4.3.2)(J) including the 10-second fueled engine operation criterion). Therefore, the ratios for these monitors would still be determined based on the current denominator-incrementing criteria. The proposed formatting changes to section 1971.1(d)(5.6.2)(C) are needed for better readability

**Section 1971.1(d)(6): Malfunction Criteria Determination and Adjustment Factors**

**1971.1(d)(6)**: Staff is proposing to change the name of this section from “Malfunction Criteria Determination” to “Malfunction Criteria Determination and Adjustment Factors.”

Rationale: This proposed change is needed to make clear where the requirements for the adjustment factors are located in the regulation.

**1971.1(d)(6.2), (6.2.3), and (6.2.4)**: Staff is proposing to require diesel engine manufacturers to determine IRAFs in accordance with CFR title 40, part 86.004-28(i) for 2020 and earlier model year engines, and in accordance with CFR title 40, part 1065.680 for 2021 and subsequent model year engines. Additionally, staff is proposing to require manufacturers to submit, for Executive Officer approval, a frequency factor derivation plan that would be used for calculating the IRAFs. Finally, the CFR sections referenced in this section refers to the CFR language version current as of August 21, 2018.

Rationale: Manufacturers of heavy-duty diesel engines have been establishing and using adjustment factors for certification to account for the high emissions that may be emitted during regeneration events of their emission controls (e.g., PM filters, NOx adsorbers). The HD OBD regulation currently contains requirements associated with applying IRAFs to the emission results when determining the malfunction criteria for emission threshold monitors on diesel engines (section 1971.1)(d)(6)). Some diesel emission controls effectively reduce emissions for some amount of time and then temporarily require an alternate mode of operation to renew/regenerate the component before it can resume effectively reducing emissions. When these infrequent, but periodic, events occur, emissions can increase dramatically. Accordingly, the emission certification standards and HD OBD regulation require heavy-duty diesel engine manufacturers to account for these infrequent emission increases and include them as part of their emission measurements when determining compliance with the emission certification standards and HD OBD emission thresholds. Further, a malfunction in the system can lead to an even greater increase in emissions during regeneration events while also increasing the frequency of these events. As more frequent regeneration events with high emissions can impact the system's ability to maintain compliance, staff is proposing to require manufacturers to submit, for Executive Officer approval, a frequency factor derivation plan which will be used for calculating IRAFs.

CFR title 40, part 86.004-28(i) contains a rudimentary explanation on how to calculate IRAFs. However, a detailed example for deriving the regeneration event frequency factor is not provided. The method to calculate the frequency factor has thus been open to interpretation by the heavy-duty diesel engine manufacturers. Manufacturers have derived frequency factors using test cycles that do not appropriately capture regeneration event frequency as would be experienced over recognized emission test cycles (i.e., FTP and SET cycles). Manufacturers have also utilized unofficial discount multipliers in frequency factor calculations which have reduced the impact of elevated emissions during regeneration events. These have limited the effect of increased exhaust emissions during more frequent regeneration events in the presence of a malfunction, thereby minimizing the impact of the IRAFs on adjusted emission results. CFR title 40, part 1065.680 would address ambiguities in calculating IRAFs by providing detailed sample IRAF calculations and frequency factor derivations. However, there is still an allowance for manufacturers to use their own engineering judgment to derive frequency factors. Therefore, staff believe it is necessary for manufacturers to submit a frequency factor derivation plan for Executive Officer approval to ensure the frequency factor derivation appropriately incorporates the impact of the malfunction on the regeneration event frequency.

The proposed additions of the August 21, 2018 date to the CFR sections are needed to indicate the applicable date of the CFR references cited.

**1971.1(d)(6.2.1) and (d)(6.2.2)**: Staff is proposing amendments that would indicate that "regeneration" and "infrequent," as defined in these sections, are also referenced in section (d)(6.3).

Rationale: The proposed changes are needed to account for the new proposed language in section 1971.1(d)(6.3), which also include the terms "regeneration" and "infrequent".

**1971.1(d)(6.3)**: Staff is proposing that for 2022 and subsequent model year engines, manufacturers would be required to apply IRAFs to emission test results for test-out criteria in sections 1971.1(e)(3.2.6)(B), (e)(5.2.3)(B)(i), (e)(5.2.3)(D), (e)(8.2.4)(A)(iii), (e)(8.2.4)(B)(i), (g)(3.1.2), and (3.2.2)(F)(ii). The manufacturers would be required to use the same procedure used to determine the malfunction criteria for emission threshold monitors (i.e., the procedure in CFR title 40, part 1065.680). Staff is proposing to require manufacturers to submit, for Executive Officer approval, a frequency factor derivation plan that would be used for calculating the IRAFs. Manufacturers would be required to conduct the testing using the same deteriorated component used to determine if the test-out criteria are met (i.e., using a component with a failure mode that would result in worst-case emissions).

Rationale: The HD OBD regulation currently contains requirements associated with applying IRAFs to the emission results when determining the malfunction criteria. Some diesel emission controls effectively reduce emissions for some amount of time and then temporarily require an alternate mode of operation to renew/regenerate the component before it can resume effectively reducing emissions (e.g., PM filters, NOx adsorbers). When these infrequent, but periodic, events occur, tailpipe emissions can increase dramatically. Accordingly, the tailpipe standards and OBD regulations require engine manufacturers to account for these infrequent emission increases and include them as part of their emission measurements when determining compliance with the tailpipe standards and OBD emission thresholds. By that same reasoning, staff believes the IRAFs should also be applied to "test-out" criteria (i.e., the emission results for criteria that allow manufacturers to be exempt from monitoring a component) to more accurately quantity the emissions effect of a component failure in the real world. Thus, staff is proposing that for 2022 and subsequent model year engines, manufacturers would be required to apply IRAFs to emission test results for test-out criteria using the same procedure used to determine the malfunction criteria for emission threshold monitors (i.e., the procedure in CFR title 40, part 1065.680). Manufacturers would be required to conduct the testing using the same deteriorated component used to determine if the test-out criteria are met (i.e., using a component with a failure mode that would result in worst-case emissions).

**1971.1(d)(6.4)**: Staff is proposing clarifying language indicating that for purposes of determining the malfunction criteria for all monitors under sections 1971.1(e) through (g), the manufacturer is required to use a component/system deteriorated to the malfunction criteria using methods that represent real world deterioration and failure modes under normal and malfunctioning engine and emission control system operating conditions. For monitors required under section 1971.1(g)(3) (i.e., comprehensive components monitors), manufacturers would not be required to correlate the malfunction criteria to real world deterioration/failure modes, but would be required to design monitors to detect real world deterioration and failure modes of these components.

Rationale: Staff has had concerns with manufacturers designing monitors that are not able to detect real-world failures. For example, for "functional" monitors that the HD OBD regulation requires to be implemented if no failure could cause emissions to exceed the required emission thresholds, a few manufacturers have calibrated such monitors using failed parts that are not indicative of failures that would occur in the real world (e.g., using a "straight pipe" to calibrate EGR cooler functional monitors). These "functional" monitors should detect faults when there is at least some amount of performance left in the component/system and at the same time represent a malfunction as it would occur in the real world. Thus, staff is adding clarifying language to apply to all monitors under sections 1971.1(e) through (g) to address this. Similar language currently exists for development of threshold catalysts in the respective catalyst monitoring requirement sections. This proposed language would take that concept and apply it more broadly to the other monitoring requirements in sections 1971.1(e) through (g). Manufacturers, however, have argued that comprehensive components are predominantly components of low complexity, such as sensors, pressure sensors, and actuators, and that real world correlation would require many hours of engine testing, warranty analysis, failure mode analysis, and documentation, even though the failure will always be the same (e.g., the sensor voltage or the state of the actuator is not what it should be). Staff understands manufacturers' concerns, and thus proposed that manufacturers would not be required to correlate the malfunction criteria to real world deterioration/failure modes for comprehensive components, though the manufacturer would still be required to design the monitors to detect real world deterioration/failure of these components.

**1971.1(d)(7.5.3)**: Staff is proposing to delete language concerning manufacturers proposing a monitoring plan for alternate-fueled engines to the Executive Officer for approval.

Rationale: The proposed change is needed since this language has been moved to section 1971.1(d)(8.1.2).

**Section 1971.1(d)(8): "Determination of Requirements for Applicable Engines"**

**1971.1(d)(8.1)**: Staff is proposing a specific section clarifying the section 1971.1 requirements manufacturers would be required to meet for alternate-fueled engines. The monitoring plan manufacturers would be required to submit would include descriptions of the applicable monitoring requirements, IUMPR requirements, and standardization requirements the alternate-fueled engines would meet. Approval would be based on the appropriateness of the selected requirements to the components/systems on the engine.

Rationale: Section 1971.1(d)(7.5.3) currently describes the monitoring requirements that 2018 and subsequent model year alternate-fueled engines are required to meet, specifically requiring manufacturers to propose a plan for meeting the monitoring requirements as applicable. Staff is proposing to move this language from section 1971.1(d)(7.5.3) to (d)(8.1). Further, staff is proposing modifications to the plan manufacturers are required to submit. When the requirement in section (d)(7.5.3) was first adopted, staff neglected to include requirements other than the monitoring requirements that would need to be addressed, such as the IUMPR requirements in section 1971.1(d) and the standardization requirements in section 1971.1(h). Thus, staff is proposing language to address this. Concurrently, staff is also proposing that manufacturers submit a plan for certification demonstration testing under section 1971.1(i) indicating which monitors would be tested and what fuel or fuel combinations would be used for each test.

**<u>1971.1(d)(8.2)</u>**: Staff is proposing clarifying language for engines that do not easily fall under either the gasoline or diesel requirements. Staff is proposing new language indicating the requirements for "gasoline engines equipped with components/systems that are not covered under section (f) but are analogous to components/systems covered under section (e)" and "diesel engines equipped with components/systems that are not covered under section (e) but are analogous to components/systems covered under section (f)". Manufacturers of such engines would be required to submit a plan for meeting the HD OBD requirements, with approval based on the appropriateness of the selected requirements to the components/systems on the engine.

<u>Rationale</u>: This proposed language is needed since such engines may not cleanly fit under just the gasoline requirements or just the diesel requirements. The language would give manufacturers more details on what is required for technologies that are used on a certain engines but not detailed under the requirements for such engines (e.g., a gasoline engine using a SCR system that is traditionally used on diesel engines and with specific detailed requirements in the diesel monitoring requirements). Without the proposed language, such monitoring requirements would need to be proposed by the manufacturer under the gasoline "other emission control or source system" monitoring requirements without any guidelines as to what kind of plan is acceptable. Further, the engine may neglect to output the necessary standardized parameters needed to troubleshoot failures of the technology since they are not required for such engines in the regulation (e.g., section 1971.1(h)(4.2) requires some data stream parameters related specifically to PM filters to be made available only on diesel engines, not gasoline engines). While the intent was not to necessarily impose new monitoring requirements on current gasoline and diesel engines, the expectation is that section 1971.1(d)(8.2) would provide guidance to manufacturers as to the elements required in the monitoring plan if current technology becomes OBD relevant in the future because the technology has become an important part of the emission control solution. For example, components or systems that exceed the thresholds for other required monitors would clearly be OBD relevant and need to be included in a monitoring plan.

**<u>1971.1(d)(8.3)</u>**: Staff is proposing language requiring manufacturers of plug-in hybrid electric vehicles to calibrate the malfunction criteria for each emission threshold monitor in the driving mode (i.e., charge depleting or charge sustaining operation) that would generate the highest emissions.

Rationale: Staff is proposing specific procedures for plug-in hybrid electric vehicles when determining the malfunction criteria for emission threshold monitors. On OBD II systems, there have been some concerns about whether or not previous malfunction criteria/thresholds established by the manufacturer were based on conditions that represent worst case emissions. For example, manufacturers may calibrate the malfunction criterion/threshold for a monitor based on the vehicle being driven in charge sustaining operation and demonstrate that emissions are below the malfunction thresholds, but in actuality, emissions may be above the required thresholds if the vehicle was driven in charge depleting operation. Staff previously understood that charge sustaining operation generated higher emissions than charge depleting operation. However, staff has learned that in charge depleting operation, some plug-in hybrid vehicles can incur multiple cold starts in a single drive cycle and produce higher emissions when compared to a charge sustaining drive cycle. Thus, during the OBD II rulemaking update in 2015, staff adopted language requiring manufacturers to calibrate the malfunction criteria for each emission threshold monitor in the driving mode (i.e., charge depleting or charge sustaining operation) that would generate the highest emissions. Staff is now proposing the same requirement in the HD OBD regulation. To maintain certification efficiency and timing, manufacturers could perform engineering analyses to determine the mode (charge sustaining or charge depleting operation) that generates the highest emissions and perform demonstration testing for only the worst case mode in lieu of performing and submitting test results for both operating modes. Manufacturers would be responsible for ensuring plug-in hybrid vehicles are compliant in both modes (e.g., during confirmatory testing or enforcement testing).

## Section 1971.1(e): Monitoring Requirements for Diesel/Compression-Ignition Engines

**1971.1(e)(1.2.4)(C), (3.2.4)(C), (4.2.5)(C), (6.2.2)(D), (7.2.3)(C), and (8.2.7)(C)**: Staff is proposing to modify the identical language for the diesel "feedback control" monitoring requirements in these sections to indicate that a fault is required to be detected "if the control system has used up all of the adjustment allowed by the manufacturer and cannot achieve the target, or reached its maximum authority and cannot achieve the target."

Rationale: The proposed additions of "and cannot achieve the target" to these sections are needed since manufacturers have indicated confusion in reading the language and mistakenly thought that the phrase "cannot achieve the target" did not apply to the first condition "if the control system has used up all of the adjustment allowed by the manufacturer".

**1971.1(e)(1.3.3), (3.3.2), (3.3.3), (4.3.2), (4.3.3), (5.3.1), (7.3.1), (8.3.1), (9.3.1), and (10.3)**: Staff is proposing language in these monitor sections indicating that "Additionally, manufacturers shall track and report the in-use performance of the [respective] monitors under [the applicable sections] in accordance with section (d)(3.2.1)"

Rationale: The proposed language in these sections better expresses the requirements indicating the monitors that are required to track and report the in-use performance than the current sentences in these sections (e.g., "For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(5.2.2) and (5.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2)").

**Section 1971.1(e)(1): Diesel "Fuel System Monitoring"**

**1971.1(e)(1.4.2)(C)**: Staff is proposing to change the phrase "the pending fault code may be erased" to "the pending fault code shall be erased".

Rationale: The proposed change is needed to ensure consistency among manufacturers.

**1971.1(e)(1.4.2)(D)**: Staff is proposing revisions to the section to indicate that 2016 and subsequent model year engines have to store "and erase" freeze frame conditions in accordance with section (d)(2.2.1)(D)(iii) or (d)(2.2.2)(D), and is proposing to delete mention of "in conjunction with storing and erasing a pending fault code."

Rationale: The proposed changes to this section for 2016 and subsequent model year engines are needed to correct some errors, since sections 1971.1(d)(2.2.1)(D)(iii) and (d)(2.2.2)(D), which are referenced in this section, indicate the requirements to store "and erase" freeze frame conditions in conjunction with storing and erasing pending, confirmed, MIL-on, and previously MIL-on fault codes, but section 1971.1(e)(1.4.2)(D)(i) only mentioned storing freeze frame conditions with pending fault codes.

**Section 1971.1(e)(2): Diesel "Misfire Monitoring"**

**1971.1(e)(2.3.3)(C)**: Staff is proposing to allow manufacturers to request Executive Officer approval to disable diesel misfire monitoring when the engine coolant temperature is below 70 degrees Fahrenheit (or 21.1 degrees Celsius) on driving cycles where the engine coolant temperature at engine start is below 20 degrees Fahrenheit (or -6.7 degrees Celsius).

Rationale: This section allows manufacturers to disable diesel misfire monitoring during conditions where false detections may occur. While the gasoline misfire monitor requirements (section 1971.1(f)(2.3.4)(B)) contain specific language allowing manufacturers to disable the gasoline misfire monitor until the ECT exceeds 70 degrees Fahrenheit when the ECT at start is below 20 degrees

Fahrenheit, the diesel misfire monitor requirements do not include this specific language. Manufacturers have indicated that engine roughness can be significantly higher at cold temperatures compared to warmer temperatures, which may result in false misfire detections, and that false detections may still occur when the ECT increases above 20 degrees Fahrenheit because the engine oil temperature increases slowly. Staff agrees and is proposing to revise the language to allow such a disablement for diesel misfire monitors.

**1971.1(e)(2.4.2)(A)(iii)**: Staff is proposing to change the phrase "the pending fault code may be erased" to "the pending fault code shall be erased".

Rationale: The proposed change is needed to ensure consistency among manufacturers.

**1971.1(e)(2.4.2)(B)(i)**: Staff is proposing revisions to the section to indicate that 2016 and subsequent model year engines have to store "and erase" freeze frame conditions in accordance with section (d)(2.2.1)(D)(iii) or (d)(2.2.2)(D), and is proposing to delete mention of "in conjunction with storing and erasing a pending fault code."

Rationale: The proposed changes to this section for 2016 and subsequent model year engines are needed to correct some errors, since sections 1971.1(d)(2.2.1)(D)(iii) and (d)(2.2.2)(D), which are referenced in this section, indicate the requirements to store "and erase" freeze frame conditions in conjunction with storing and erasing pending, confirmed, MIL-on, and previously MIL-on fault codes, but section 1971.1(e)(1.4.2)(D)(i) only mentioned storing freeze frame conditions with pending fault codes.

**1971.1(e)(2.4.2)(B)(ii)**: Staff is proposing to require freeze frame data for a diesel misfire fault to replace the currently stored freeze frame data only if the stored data are not for a diesel misfire fault or a diesel fuel system fault starting in the 2022 model year.

Rationale: Currently, if the diesel misfire monitor detects a fault and freeze frame data are already stored for another fault other than diesel misfire, the HD OBD regulation requires the freeze frame data related to the diesel misfire fault to replace the currently stored freeze frame data. However, for the gasoline misfire monitor, the HD OBD regulation currently prohibits the freeze frame data for a gasoline misfire fault to replace the currently stored freeze frame data if the stored data are for a gasoline fuel system fault. Staff has determined that there is no valid reason for this discrepancy and is therefore proposing changes to address this.

**Section 1971.1(e)(3): Diesel "Exhaust Gas Recirculation (EGR) System Monitoring"**

**1971.1(e)(3.2.6)(B)**: Staff is proposing changes to the exemption criteria for EGR catalyst monitoring. Specifically, staff is proposing that manufacturers be exempt from monitoring the EGR catalyst if the following criteria are met: (1) no malfunction of the EGR catalyst can cause emissions to increase by 15 percent or more of the applicable NMHC, NOx, carbon monoxide (CO), or PM standard as measured from an applicable emission test cycle; and (2) no malfunction of the EGR catalyst can cause emissions to exceed the applicable NMHC, NOx, CO, or PM standard as measured from an applicable emission test cycle.

Rationale: The proposed changes are needed to be consistent with the specific test-out criteria required for other diesel monitors (e.g., NMHC catalyst feedgas generation in section 1971.1(e)(5.2.3)(B)).

**1971.1(e)(3.3.1)**: Staff is proposing that manufacturers track and report the in-use monitoring performance data for the EGR system low flow, high flow, and feedback control monitors (sections 1971.1(e)(3.2.1), (3.2.2), and (3.2.4)) starting in the 2022 model year.

Rationale: The rationale was explained in section 1971.1(d)(3.2.1) above.

**1971.1(e)(3.4)**: Staff is proposing to change the MIL illumination and fault code storage protocol for 2022 and subsequent model year. Specifically, staff is proposing the EGR high flow and low flow monitors use the same protocol that is currently required for other continuous monitors like the diesel fuel system monitor, which stores/erases fault codes and illuminates/extinguishes the MIL based on similar conditions.

Rationale: The proposed additions of similar conditions requirements for diesel EGR system high flow and low flow monitors are needed to address concerns with the monitors. Specifically, staff has learned these monitors may pass under some conditions but fail during other conditions. The use of similar conditions provides for robust monitoring and prevents continuous monitors from false passing when a fault is detected on a drive cycle but erased on a subsequent drive cycle due to the vehicle being driven in different operation conditions. The similar conditions (e.g., engine speed, engine coolant temperature) would be stored with the pending fault code. On the next monitoring event, a fail decision would illuminate the MIL but a pass decision would only erase the pending fault code if the conditions under the pass decision were similar to those when the pending fault code was stored. As implemented on other continuous diagnostics such as fuel system and misfire, the use of similar conditions would provide protection against false passing.

**Section 1971.1(e)(4): Diesel "Boost Pressure Control System Monitoring"**

**1971.1(e)(4.3.1)**: Staff is proposing that manufacturers track and report the in-use monitoring performance data for the boost pressure control system over boost, under boost, and feedback control monitors (sections 1971.1(e)(4.2.1), (4.2.2), and (4.2.5)) starting in the 2022 model year.

Rationale: The rationale was explained in section 1971.1(d)(3.2.1) above.

**1971.1(e)(4.4)**: Staff is proposing to change the MIL illumination and fault code storage protocol for 2022 and subsequent model year. Specifically, staff is proposing the boost pressure control system over boost and under boost monitors use the same protocol that is currently required for other continuous monitors like the diesel fuel system monitor, which stores/erases fault codes and illuminates/extinguishes the MIL based on similar conditions.

Rationale: The proposed additions of similar conditions requirements for diesel boost pressure control over boost and under boost monitors are needed to address concerns with the monitors. Specifically, staff has learned these monitors may pass under some conditions but fail during other conditions. The use of similar conditions provides for robust monitoring and prevents continuous monitors from false passing when a fault is detected on a drive cycle but erased on a subsequent drive cycle due to the vehicle being driven in different operation conditions. The similar conditions (e.g., engine speed, engine coolant temperature) would be stored with the pending fault code. On the next monitoring event, a fail decision would illuminate the MIL but a pass decision would only erase the pending fault code if the conditions under the pass decision were similar to those when the pending fault code was stored. As implemented on other continuous diagnostics such as fuel system and misfire, the use of similar conditions would provide protection against false passing.

**Section 1971.1(e)(5): Diesel "NMHC Converting Catalyst Monitoring"**

**1971.1(e)(5.2.3)(B)**: Staff is proposing to increase the exemption criteria to test out of monitoring for NMHC catalyst feedgas generation performance from 15 percent to 30 percent of the applicable standard as measured from an applicable emission test cycle, and to limit the exemption criteria pollutant to only NOx emissions. Specifically, catalysts would be exempt from monitoring if (1) no malfunction of the catalyst's feedgas generation ability can cause emissions to increase 30 percent or more of the applicable NOx standard as measured from an applicable emission test cycle; and (2) no malfunction of the catalyst's feedgas generation ability can cause emissions to exceed the applicable NOx standard as measured from an applicable emission test cycle. Staff is also proposing to require manufacturers to submit a test out plan with testing conditions (e.g., performing the test out using a catalyst depleted of all platinum to remove feedgas generation capability) for Executive Officer approval. Finally, staff is making clear that manufacturers can design feedgas monitors (and test out of monitoring) on a system level (e.g., monitor all catalysts/catalyzed PM filters used to generate a feedgas constituency to assist SCR systems with one OBD diagnostic) or separately/individually.

Rationale: For catalysts used to generate a feedgas constituency to assist SCR systems (e.g., to increase nitrogen dioxide ($NO_2$) concentration upstream of an SCR system), the HD OBD regulation currently requires HD OBD systems in 2015 and subsequent model year engines to detect a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR system operation. The performance of the NMHC catalyst from a feedgas perspective is based on the feedgas constituency that the catalyst is able to achieve at its outlet, which is the net result of both production and any consumption of $NO_2$ within the catalyst. Catalysts are exempt from this monitoring if both of the following criteria are satisfied: (1) no malfunction of the catalyst's feedgas generation ability can cause emissions to increase 15 percent or more of the applicable standard as measured from an applicable emission test cycle; and (2) no malfunction of the catalyst's feedgas generation ability can cause emissions to exceed the applicable standard as measured from an applicable emission test cycle.

Presently manufacturers are having difficulty developing a diagnostic which can detect a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR operation. Attempts have been made at correlating a loss of feedgas generation capability to a loss in hydrocarbon conversion efficiency. However, manufacturers have been unable to robustly detect a malfunction in hydrocarbon conversion performance before feedgas generation becomes completely deteriorated. Furthermore, manufacturers' SCR systems rely on feedgas generation performance to such an extent that they experience difficulty in testing out of the feedgas generation diagnostic requirement. In addition, even when a manufacturer has been able to test out of NOx criteria pollutants with a catalyst depleted of all platinum, the resultant loss in hydrocarbon conversion performance led to an increase in NMHC criteria pollutants exceeding the 15 percent test out limit. As the main function of feedgas generation is to assist the SCR system's ability to convert NOx, OBD staff deem it acceptable to limit the feedgas generation test out demonstration to NOx criteria pollutants and revise the NOx test out criteria from no more than 15 percent to no more than 30 percent of the applicable NOx standard as measured from an applicable emission test cycle. Manufacturers would be responsible for submitting a feedgas generation monitoring test out plan detailing the testing conditions for Executive Officer approval. Approval would be granted based upon manufacturers submitting data and/or engineering evaluation that show testing would be performed in the absence of feedgas generation capability of the catalyst.

As mentioned above, presently manufacturers are having difficulty developing a diagnostic which can detect a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR operation. Single-level diagnostics (i.e., separate monitors for NMHC catalysts and catalyzed PM filters) have proven to be problematic as manufacturers are having difficulty robustly detecting a malfunction in hydrocarbon conversion performance before the loss of necessary feedgas generation. In allowing a system-level diagnostic, feedgas generation monitoring would be easier because distinguished separation between a healthy system and a system with a feedgas generation malfunction could be established for monitor resolution. System-level test-out also would make it easier for manufacturers to be exempt from such monitoring requirements.

**1971.1(e)(5.2.3)(D)**: Staff is proposing to amend the existing "test-out" provisions for NMHC catalysts located downstream of the SCR system (e.g., catalysts used to prevent ammonia slip). Specifically, staff is proposing that such catalysts would be exempt from the monitoring requirements if the catalyst is monitored as part of the SCR system under section 1971.1(e)(6.2.1) and the catalyst is aged as part of the SCR system for the purposes of determining the SCR system malfunction criteria under section 1971.1(e)(6.2.1). Additionally, staff is proposing language clarifying that for catalysts located outside the SCR system, the manufacturer is exempt from monitoring the catalyst if there is no measurable emission impact on the criteria pollutants during any reasonable driving condition.

Rationale: Currently, the regulation exempts monitoring of such catalysts if complete failure of the catalyst results in "no measurable emission impact on the criteria pollutants (i.e., NMHC, CO, NOx, and PM) during any reasonable driving condition in which the catalyst is most likely to affect criteria pollutants." With staff's proposal, the manufacturer would not need to perform emission testing to see if there is any measurable emission impact if the ammonia slip catalyst is monitored as part of the SCR system by the SCR catalyst conversion efficiency diagnostic and the ammonia slip catalyst is aged to the same deterioration level as the SCR catalyst when determining the malfunction criteria for the SCR catalyst conversion efficiency monitor. The proposed change is needed since staff has accepted that the SCR catalyst conversion efficiency monitor sufficiently covers deterioration of the ammonia slip catalyst, and is therefore an adequate "surrogate" monitor for the ammonia clip catalyst. If the ammonia slip catalyst is not monitored as part of the SCR system by the SCR catalyst conversion efficiency diagnostic, manufacturers would be required to either implemented a dedicated monitor for the catalyst or perform emission testing to show that a fault of the catalyst would not cause a measurable emission impact during any reasonable driving condition.

**Section 1971.1(e)(6) "Oxides of Nitrogen (NOx) Converting Catalyst Monitoring"**

**1971.1(e)(6.2.2)(B), (C), (G), and (H)**: Staff is proposing an option that manufacturers may elect to use in lieu of meeting the existing OBD requirements for monitoring low or no reductant levels and the presence of the correct reductant. Specifically, to meet the monitoring requirements for low or no reductant, manufacturers could elect to implement inducement strategies that adequately prevent sustained vehicle operation with no reductant and additionally monitor the inputs to the inducement strategy (e.g., reductant level sensing system) in accordance with the comprehensive component monitoring requirements. To meet the monitoring requirements for the presence of improper reductant, manufacturers could elect to implement an inducement strategy that adequately prevents sustained vehicle operation with improper reductant and additionally monitor the inputs to the inducement strategy (e.g., reductant quality sensor) in accordance with the comprehensive component monitoring requirements.

<u>Rationale</u>: For diesel vehicles with SCR systems that use a reductant other than fuel, the OBD regulation currently requires manufacturers to detect a malfunction when the reductant level is too low or if the wrong reductant is present in the tank. Manufacturers have argued that low reductant levels or no reductant do not constitute actual malfunctions since the driver can simply fill the tank with reductant to “fix” the malfunction. Manufacturers have also argued that the presence of an improper reductant is not an actual malfunction since the driver can simply replace the improper reductant in the tank with the correct reductant. Therefore, they believe that the OBD system should not consider these situations to constitute malfunctions and thus should not turn on the MIL when these problems are detected. Manufacturers have also stated that their SCR systems are already subject to other non-OBD-related requirements that would cover such issues, given the importance of SCR systems in controlling emissions from diesel vehicles. Specifically, manufacturers are required to implement strategies (i.e., inducement strategies) to limit vehicle operation when the SCR system is not working properly. These could be for reasons such as someone tampering with the system (e.g., disconnecting the reductant dosing valve, disconnecting sensors such as the reductant quality sensor) or no reductant in the tank. Inducement strategies could include derating the engine or any other condition that would limit operation of the vehicle and therefore ensure that drivers will get the SCR system fixed, either by actually fixing of the failure or refilling the tank with proper reductant. To address these manufacturer concerns, staff adopted language in the OBD II regulation in 2015, and is now proposing the same language in the HD OBD regulation.

It should be noted that staff is also proposing amendments to the comprehensive component monitoring requirements (section 1971.1(g)(3)) requiring that for all vehicles with inducement strategies, manufacturers would be required to monitor all components used as part of the inducement strategies. Details about this amendment are provided below in section (g)(3.1.1).

**<u>1971.1(e)(6.2.2)(D)</u>**: Staff is proposing to add “dosing quantity” as an example of a reductant injection system feedback/feed-forward control that is required to meet the requirements in this section.

Rationale: The proposed addition of the example is needed to ensure these controls are monitored, since there have been confusion about whether or not dosing quantity control was considered a feedback/feed-forward control of the reductant injection and thus subject to this monitoring requirement.

**1971.1(e)(6.2.3)(A):** Staff is proposing to add language indicating that manufacturers would be required to use real world aging methods to establish the malfunction criteria for the NOx converting catalyst conversion efficiency monitor under scenarios where the catalysts are monitored independently and the catalyst system contains more than one catalyst in series.

Rationale: Currently, for catalyst systems with more than one catalyst in series, manufacturers are allowed to age the SCR catalysts independently when employing individual catalyst monitors. This independent aging procedure could lead to exhaust systems that do not represent real world aging because, during calibration and OBD demonstration testing, the other catalyst(s) may be aged to full useful life and only the monitored catalyst aged to the malfunction criteria. The result is an imbalance in NOx conversion efficiency between the catalysts that could lead to higher than anticipated in-use NOx emissions before the MIL is illuminated. The proposal would require a more comprehensive aging plan such that in-use NOx emissions would be closer to the required OBD emission threshold to which the manufacturer calibrated the monitor.

**Section 1971.1(e)(7) "NOx Adsorber Monitoring"**

**1971.1(e)(7.2.6)**: Staff is proposing language indicating that for individually monitored NOx adsorbers, manufacturers would be required to use a NOx adsorber deteriorated to the malfunction criteria using methods that represent real world deteriorating of the adsorber under normal and malfunctioning engine operating conditions. The language would also indicate that for NOx adsorbers used in parallel, manufacturers would be required to determine the malfunction criteria with the "parallel" NOx adsorbers equally deteriorated.

Rationale: The proposed changes to this section are needed to correct an oversight where staff forgot to include language that currently exist in the other diesel catalyst sections. Specifically, this section mistakenly only described the requirements for determining the NOx adsorber system malfunction criteria for systems with more than one NOx adsorbers, with no requirements mentioned for systems with only one NOx adsorber, and this section did not mention the deterioration requirement for NOx adsorbers used in parallel.

**Section 1971.1(e)(8) "PM Filter Monitoring"**

**1971.1(e)(8.2.1)(D), (8.2.1)(E), and (8.2.4)(A)**: Staff is proposing to require new NOx emission thresholds to the diesel PM filter filtering performance monitors and the catalyzed PM filter NMHC conversion monitor. Specifically, for 2022 and subsequent model year engines, these monitors would be required to detect a malfunction before emissions exceed the applicable NOx standard by more than 0.2 g/bhp-hr.

Rationale: PM filters can be designed (e.g., SCR is integrated into the PM filter) such that they provide a significant contribution to the overall tailpipe NOx control and NOx conversion efficiency of the aftertreatment system. Adding a NOx threshold to the diesel PM filter filtering performance monitors and the catalyzed PM filter NMHC conversion monitor ensures NOx impacts of failures of those components are adequately monitored by the OBD system.

**1971.1(e)(8.2.4)(A)(ii)**: Staff is proposing to add language clarifying the emissions related to the monitor exemption criteria specified in this section are specifically for NMHC, NOx, CO, and PM emissions.

Rationale: The proposed clarifying language is needed to avoid confusion, since some manufacturers mistakenly believed this test-out criteria applied to only one criteria pollutant (e.g., only NMHC emissions).

**1971.1(e)(8.2.4)(B)**: Similar to the proposal for NMHC catalyst feedgas generation monitoring, staff is proposing amendments to increase the maximum test out criteria for catalyzed PM filter feedgas generation monitoring, limit the test out criteria pollutant to NOx emissions, require manufacturers to submit a test out plan with proposed testing conditions (e.g., using a catalyst depleted of all platinum to remove feedgas generation capability) for Executive Officer approval, and give manufacturers the option of implementing feedgas generation detection monitors (or testing out of monitoring) on a system level or individually.

Rationale: Details of the rationale for the proposed amendments were detailed above for NMHC catalysts in section 1971.1(e)(5.2.3)(B).

**1971.1(e)(8.2.5)**: Staff is proposing to delete the word “either”.

Rationale: The proposed deletion is needed for clarity, since manufacturers may mistakenly believe the use of “either” allows them to choose which failure mode (if the PM filter substrate is completely destroyed, removed, or missing, or if the PM filter assembly is replaced with a muffler or straight pipe) the monitor will detect malfunctions of, whereas the requirement is to detect if any of the failure modes occur.

**1971.1(e)(8.3.1) and (8.3.2)**: Staff is proposing to amend the monitoring conditions for PM filter performance monitoring, specifically requiring the monitor to run once per driving cycle instead of every time the monitoring conditions are met.

Rationale: Currently, the HD OBD regulation requires this monitor to run every time the monitoring conditions are met. During the OBD II rulemaking update in 2015, manufacturers indicated that requiring the monitor to run multiple times in a driving cycle may affect the PM sensor durability due to the multiple heating cycles per driving cycle, and also indicated that the PM filter would not be expected to fail over one driving cycle but not another driving cycle. To accommodate these concerns, staff adopted amendments to now only require the PM filter filtering performance monitor to run once per driving cycle, and is now proposing the same amendments to the HD OBD regulation.

**1971.1(e)(8.3.2)**: Staff is proposing that manufacturers track and report the in-use monitoring performance data for the PM filter frequent regeneration, missing substrate, and active/intrusive injection monitors (sections 1971.1(e)(8.2.2), (8.2.5), and (8.2.6)) starting in the 2022 model year.

Rationale: The proposed additional monitors for tracking and reporting are needed so that CARB can ensure that these monitors run frequently in-use as required, since there have been issues in the past regarding their monitoring frequency in-use. Based on CARB staff's observations and discoveries during OBD application reviews and field testing, staff believes it is appropriate and necessary to require the specified monitors to be tracked and reported in order to improve the monitoring efficiency and accountability. Specifically, there have been concerns about the monitoring frequency of the PM filter missing substrate monitor, so staff believes the in-use monitoring performance data should be tracked and reported for this monitor.

CARB staff had also found issues with setting PM filter readiness status to "complete" due to the PM filter frequent regeneration and active/intrusive injection monitors. Manufacturers have expressed concerns about tying the readiness status to these monitors, since they may be difficult to run. While staff does understand manufacturers' concerns, staff also believes that there should be some assurance that these monitors are running and detecting faults in-use, especially for the PM filter frequent regeneration monitor since such failures may have a high emissions impact. Thus, in conjunction with proposing to take these monitors out of the PM filter readiness status determination (section 1971.1(h)(4.1.3)(H)), staff is proposing to require these two monitors to track and report in-use monitoring performance data to address this issue.

**1971.1(e)(8.3.3) and (e)(8.3.4)**: Staff is proposing to change "OBD II system" to "OBD system." Staff is also proposing to renumber (8.3.2) to (8.3.3) and renumber (8.3.3) to (8.3.4).

Rationale: The proposed change to "OBD system" is needed to correct an error, since "OBD II system" refers to an OBD system that meets the requirements of title 13, CCR section 1968.2, not section 1971.1. The proposed renumbering changes are needed since the requirements of section 1971.1(e)(8.3.1) have been split up into sections 1971.1(e)(8.3.1) and (8.3.2).

**Sections 1971.1(e)(9): Diesel "Exhaust Gas Sensor Monitoring"**

**1971.1(e)(9.2.1)(A)(ii), (9.2.1)(B)(ii), and (9.2.2)(B)**: Staff is proposing to delete the word "either".

Rationale: The proposed deletion is needed for clarity, since manufacturers may mistakenly believe the use of "either" allows them to choose which failure mode (a lack of circuit continuity or out-of-range values) the monitor will detect malfunctions of, whereas the requirement is to detect if any of the failure modes occur.

**1971.1(e)(9.2.2)(E) and (9.3.1)(C)**: Staff is proposing that starting with the 2022 model year, the OBD system is required to detect NOx sensor activity faults that cause the NOx sensor to not actively report NOx concentration data under conditions when it is technically feasible for a properly-working NOx sensor to be actively reporting NOx concentration data. Staff is also proposing language indicating that if the fault is caused by a component other than the NOx sensor, the OBD system would be required to monitor the other component for such faults. The monitor would be required to run continuously.

Rationale: The NOx sensors used in a diesel engine's emission control system play a key role in its ability to effectively control NOx emissions. With staff's proposal, their role would be expanded to include supporting the NOx tracking functions described in section 1971.1(h)(5.3). The goal is to have each engine track its own NOx emission control performance over all forms of real-world activity. As such, it is important to minimize any blind spots in engine operation by having functional NOx sensors that actively report data as often as possible. Staff is therefore proposing that manufacturers implement NOx sensor activity diagnostics that would be able to detect a malfunction when a sensor is not reporting NOx data under conditions when it is technically feasible for the sensor to be doing so.

In addition to the reasons cited for NOx tracking, it is important to have the NOx sensor reporting as often as is technically feasible because there are many stakeholders that are and will continue to look at NOx sensor data to gain an understanding of real-world NOx control performance. As inspection and maintenance programs are being developed for these vehicles, inspection mechanisms including HD OBD are being considered to ensure vehicles with high NOx emissions are identified and corrected. Having the NOx sensor reporting data as often as is technically feasible will facilitate such efforts.

The proposed NOx sensor activity diagnostics would be based on the conditions defined by the manufacturer that determine when it is technically feasible for a

NOx sensor to be reporting concentration data. As described in section 1971.1(j)(2.24), staff's proposal includes a requirement for manufacturers to clearly document these conditions and criteria, which are largely motivated by avoiding damage to the sensor from liquid water. In addition to physical conditions, however, a NOx sensor's activity status can also be affected by malfunctions of other components. A tailpipe exhaust temperature sensor with a negative offset, for example, could cause the engine control unit to wait for an unnecessarily long period of time before commanding the tailpipe NOx sensor to turn on. All such components that are relied on for activation of a NOx sensor must therefore also be monitored for malfunctions.

**1971.1(e)(9.4)**: Staff is proposing to exempt OBD systems from storing different fault codes for lack of circuit continuity and out-of-range faults for exhaust gas sensors if: (1) the sensing element (i.e., probe or sensor externally connected to the sensor control module) is a subcomponent integral to the function of the complete sensor unit; (2) the sensing element is permanently attached to the sensor control module with wires or one-time connectors; (3) the complete sensor unit is designed, manufactured, installed, and serviced per manufacturer published procedures as a single component; and (4) the sensor control module and sensing element are calibrated together during the manufacturing process such that neither can be properly individually replaced in a repair scenario.

Rationale: Staff is proposing specific language clarifying the fault code storage requirements for exhaust gas sensor faults. The regulation currently requires OBD systems to store unique fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit) unless the circuit fault cannot be distinguished from an out-of-range fault. During the OBD II regulatory update in 2015, manufacturers expressed concerns regarding the level of pinpointing that would be required for exhaust gas sensors that have a separate control unit and sensor unit connected by multiple wires. The OBD II regulation previously required separate fault codes for each failure mode of each connecting wire, even though all elements of the sensor are permanently attached to each other and the sensor is uniquely calibrated to the controller. Manufacturers had also stated that the only proper repair action in the field is to replace the exhaust gas sensor in its entirety and have therefore requested reduced pinpointing requirements, similar to those being proposed for smart devices (explained in section 1971.1(g)(3)). Staff adopted language in the OBD II regulation to address manufacturers' concerns and is now proposing the same language in the HD OBD regulation.

**Sections 1971.1(e)(10): "Variable Valve Timing and/or Control (VVT) System Monitoring"**

**1971.1(e)(10)**: Staff is proposing amendments to the title of "Variable Valve Timing and/or Control (VVT) System Monitoring" by adding the term "lift" to the title of the section, so the title would now be “Variable Valve Timing, Lift, and/or Control (VVT) System Monitoring.”

Rationale: The HD OBD regulation currently requires monitoring of VVT systems for target error and slow response malfunctions, while the individual electronic components used in the VVT system are required to be monitored based on the comprehensive component monitoring requirements. Leading up to the OBD II rulemaking update in 2015, manufacturers were confused about what systems constituted VVT systems, and some manufacturers incorrectly determined that systems that only control valve lift or systems with discrete operating states (e.g., two-step valve train systems) were not considered VVT systems. Staff therefore adopted amendments to the title of the sections to clarify that VVT systems include systems that can infinitely vary valve actuation as well as systems that can control valve lift to two or more discrete profiles (e.g., high lift and low lift). Staff is now proposing the same changes to the HD OBD regulation.

**1971.1(e)(10.1)**: Staff is proposing amendments to specify the level of failure of a VVT system that an OBD system must detect for target error and slow response malfunctions, and these amendments would include examples of malfunctions such as a mechanical failure of a pin to move into the desired position on a lift mechanism or partial or complete blockage of hydraulic passages.

Rationale: During the 2015 OBD II rulemaking update, manufacturers raised questions regarding the specific failure modes that OBD II systems must detect for target error and slow response malfunctions in VVT systems. Thus, staff proposed changes to the regulation to clarify this and is now proposing the same amendments in the HD OBD regulation.

**1971.1(e)(10.2.1) and (e)(10.2.2)**: Staff is proposing to clarify that VVT systems with discrete operating states are not required to detect a malfunction prior to exceeding the threshold but are still required to detect all failures that exceed the threshold.

Rationale: The HD OBD regulation currently requires manufacturers to demonstrate that their OBD systems can detect target error and slow response malfunctions prior to any failure or deterioration that would cause the vehicle's emissions to exceed an emission threshold. For infinitely varying valve actuation systems, it is possible to calibrate monitors to detect a target error and/or slow response malfunction prior to exceeding the threshold. However, for VVT systems with discrete operating states (e.g., two step valve train systems) where the system is either working or failed (e.g., stuck pin) with no possible failure mode in-between, the failures may be practically impossible to detect prior to emissions exceeding the threshold. Staff is therefore proposing amendments to clarify the requirements for these VVT systems.

**1971.1(e)(10.2.3)**: Staff is proposing amendments to clarify that only the "electronic" components of VVT systems are required to meet the functional monitoring requirements.

Rationale: The HD OBD regulation currently provides that if VVT system malfunctions do not cause emissions to exceed emission malfunction thresholds, OBD systems are only required to monitor VVT systems for proper functional response to computer commands. Staff is proposing to amend these provisions to clarify that the functional monitoring requirements are for electronic components of VVT systems. Thus, hardware failures that do not cause emissions to exceed the emission malfunction threshold, even if there is an emission increase, are not required to be monitored for proper functional response.

**Section 1971.1(e)(11): Diesel "Cold Start Emission Reduction Strategy Monitoring"**

**1971.1(e)(11.2)**: Staff is proposing to change "either" to "any."

Rationale: The proposed change is needed for clarity, since manufacturers may mistakenly believe the use of "either" allows them to choose which failure mode (i.e., which of the failures modes listed under section 1971.1(e)(11.2)) the monitor will detect malfunctions of, whereas the requirement is to detect if any of the failure modes occur.

**Section 1971.1(f): Monitoring Requirements for Gasoline/Spark-Ignited Engines**

**1971.1(f)(3.3.1), (f)(5.3.1), (f)(6.3), (f)(7.3.2), (f)(8.3.1)(A), (f)(8.3.2)(A), (f)(9.3)**: Staff is proposing language in these monitor sections indicating that "Additionally, manufacturers shall track and report the in-use performance of the [respective] monitors under [the applicable sections] in accordance with section (d)(3.2.1)."

Rationale: The proposed language in these sections better expresses the requirements indicating the monitors that are required to track and report the in-use monitor performance than the current sentences in these sections (e.g., "For purposes of tracking and reporting as required in section (d)(3.2.1), all monitors used to detect malfunctions identified in sections (e)(5.2.2) and (5.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2)").

**Section 1971.1(f)(1): Gasoline "Fuel System Monitoring"**

**1971.1(f)(1.2.1)**: Staff is proposing to add the language "any of the following occurs".

Rationale: The proposed language is needed to better express the intent of the language, which is to require the OBD system to detect a malfunction of the fuel delivery system when any of the failure modes listed under section (f)(1.2.1) occur.

**1971.1(f)(1.2.4)**: Staff is proposing changes indicating that for engines that use both “stoichiometric” and “non-stoichiometric” closed-loop operation of the fuel system, manufacturers would be required to meet the requirements of this section for failures related to either “stoichiometric” or “non-stoichiometric” closed-loop operation during the 2010 through 2021 model years. Manufacturers would be required to meet the requirements of this section for failures related to only “stoichiometric” closed-loop operation starting with the 2022 model year. Staff is also proposing to move the language in section 1971.1(f)(1.2.5) into 1971.1(f)(1.2.4)(C). Staff is also proposing new language in section 1971.1(f)(1.2.4)(D) indicating that in lieu of implementing a fuel system-specific monitor, manufacturers would be allowed to monitor the individual parameters/components that are used as inputs for fuel system closed-loop operation.

Rationale: This section requires the OBD system to detect a malfunction whenever the fuel control system fails to enter closed-loop operation within an Executive Officer-approved time interval after engine start. The current language in section 1971.1(f)(1.2.5) requires the OBD systems to indicate a fault when the fuel system fails to enter closed-loop operation within a certain time for vehicles that employ engine shutoff strategies that do not require the vehicle operator to restart the engine to continue driving. Since the intent of both sections is to ensure that a fault is detected if the fuel system fails to enter closed-loop operation within a certain time, the proposed change to move the language in section 1971.1(f)(1.2.5) to 1971.1(f)(1.2.4)(C) would clarify the requirements. Further, there have been concerns that the requirements in section 1971.1(f)(1.2.4) were not reflective of the current certification allowances, specifically the ability to demonstrate compliance using a component-level monitoring strategy that is as timely in detecting faults as an overall system-level monitor. Staff believes that the language should reflect the current flexibilities in monitoring strategies and is proposing new language in section 1971.1(f)(1.2.4)(D) to clarify this. Finally, the proposed changes related to “stoichiometric” and “non-stoichiometric” closed-loop operation are needed to harmonize with the OBD II regulation, where manufacturers have expressed confusion about whether “closed-loop operation” related to “stoichiometric” or “non-stoichiometric” closed-loop operation.

**1971.1(f)(1.3.2)**: Staff is proposing that manufacturers track and report the in-use monitoring performance data for the gasoline fuel system air-fuel ratio cylinder imbalance monitors (section 1971.1(f)(1.2.1)(C)) starting in the 2022 model year.

<u>Rationale</u>: The rationale was explained in section 1971.1(d)(3.2.1) above.

<u>**1971.1(f)(1.3.3) and (1.3.4)**</u>: Staff is proposing amendments indicating that the requirements of this section apply to malfunctions identified in section 1971.1(f)(1.2.4) "(except malfunctions identified in section (f)(1.2.4)(C), which is provided for per section (f)(1.3.4) below)." Staff is also proposing to change the reference in section 1971.1(f)(1.3.4) from "section (f)(1.2.5)" to "section (f)(1.2.4)(C)." Finally, staff is proposing to change references to "sections" in both sections to "section."

<u>Rationale</u>: The proposed changes are needed to account for the change of section (f)(1.2.5) to (f)(1.2.4)(C). The proposed change of "sections" to "section" is needed to correct an error.

<u>**1971.1(f)(1.4)**</u>: Staff is proposing language that the stored fault code is required pinpoint the likely cause of the malfunction to the extent allowed by the monitoring strategy. Staff is also proposing language indicating the OBD system does not need to store a fault code that specifically identifies an air-fuel ratio cylinder imbalance fault if hardware needs to be added to achieve this and other existing monitors (e.g., the misfire monitor) detect this fault.

<u>Rationale</u>: The proposed additional language requiring the stored fault code to pinpoint the likely cause of the malfunction to the extent allowed is needed to address confusion about the fault code storage requirements. The proposed additional language related to the air-fuel ratio cylinder imbalance fault is needed for clarity, since manufacturers are allowed to detect this fault with other existing monitors (e.g., the misfire monitor).

<u>**1971.1(f)(1.4.2)**</u>: Staff is proposing to add mention of "MIL-on" fault codes in this section, which would be required to meet the same requirements as confirmed fault codes in this section. Staff is also proposing to change the word "either" to "any".

<u>Rationale</u>: The proposed addition of "MIL-on" fault codes is needed to account for the newly proposed amendment allowing gasoline vehicles to use the SAE J1939 protocol (section 1971.1(h)(3.2)). The proposed change of "either" to "any" is needed since manufacturers may mistakenly believe the use of "either" allows them to choose under which event (i.e., event listed under section 1971.1(f)(1.4.2)) the monitor will store a confirmed/MIL-on fault code for, whereas the requirement is to store the fault code if any of the events occur.

<u>**1971.1(f)(1.4.3)**</u>: Staff is proposing to change the phrase "the pending fault code may be erased" to "the pending fault code shall be erased".

<u>Rationale</u>: The proposed change is needed to ensure consistency among manufacturers.

**1971.1(f)(1.4.4)(A)**: Staff is proposing new freeze frame storage and erasure requirements for 2022 and subsequent model year engines. Specifically, for engines using the ISO 15765-4 protocol, the OBD system would be required to store and erase freeze frame conditions in accordance with section 1971.1(d)(2.2.1)(D)(iii). For engines using the SAE J1939 protocol, the OBD system would be required to store and erase freeze frame conditions in accordance with section 1971.1(d)(2.2.2)(D).

Rationale: The proposed changes related to engines using the ISO 15765-4 protocol are needed to correct an oversight, since the freeze frame storage and erasure requirements should have aligned with the requirements for 2016 and subsequent model year engines in section 1971.1(d)(2.2.1)(D)(iii). The proposed language related to engines using the SAE J1939 protocol are needed to account for the newly proposed amendment allowing gasoline vehicles to use the SAE J1939 protocol (section 1971.1(h)(3.2)).

**1971.1(f)(1.4.4)(B)**: Staff is proposing to change “fault code” to “fuel system fault code.”

Rationale: The proposed change is needed to prevent confusion and to make clear that the reference to “fault code” refers to a fuel system fault code.

**Section 1971.1(f)(2): Gasoline “Misfire Monitoring”**

**1971.1(f)(2.1.1)**: Staff is proposing to change “the OBD system shall monitor the engine for misfire causing catalyst damage and misfire causing excess emissions” to “the OBD system shall monitor the engine for misfire.”

Rationale: The proposed change is needed for simplicity to ensure all required misfire are detected. The change does not impact the current monitoring requirements, but protects for future changes in misfire requirements (e.g., misfire percentage based criteria similar to that required for diesels) by ensuring that all required misfire modes are covered by the language.

**1971.1(f)(2.2.2)(C)**: Staff is proposing language indicating that for multiple cylinder misfire situations that result in a misfire rate greater than or equal to 50 percent of all engine firings, the OBD system would be required to detect a misfire malfunction for situations that are caused by a single component failure.

Rationale: A previous CARB mail-out (Mail-Out #95-20, “Guidelines for Compliance with On-Board Diagnostic II (OBD II) Requirements,” May 22, 1995), allowed the OBD II systems to detect a misfire malfunction for situations that are caused by a single component failure for multiple cylinder misfire situations that result in a misfire rate greater than or equal to 50 percent of all engine firings. Staff determined that this allowance should also be mentioned in the OBD II regulation and amended the OBD II regulation in 2015 to include this allowance in the gasoline misfire monitoring requirements.  Staff is now proposing the same allowance to the HD OBD regulation.

**1971.1(f)(2.4.1)(B), (2.4.2)(A)(ii), and (B)(ii)**: Staff is proposing to add mention of “MIL-on” fault codes in these sections, which would be required to meet the same requirements as confirmed fault codes in these sections.

Rationale: The proposed addition of “MIL-on” fault codes is needed to account for the newly proposed amendment allowing gasoline vehicles to use the SAE J1939 protocol (section 1971.1(h)(3.2)).

**1971.1(f)(2.4.1)(B)(i)**: Staff is proposing to change “either” to “any of the two following events.”

Rationale: The proposed change is needed for clarity, since manufacturers may mistakenly believe the use of “either” allows them to choose which failure mode (i.e., failure mode listed under section 1971.1(f)(2.4.1)(B)(i)) the monitor will detect malfunctions of, whereas the requirement is to detect if any of the failure modes occur.

**1971.1(f)(2.4.1)(B)(iii)**: Staff is proposing to change “subparagraph” to “section.”

Rationale: The proposed change is needed for consistency, since “section” is used throughout the regulation.

**1971.1(f)(2.4.2)(B)(iii)**: Staff is proposing to change the phrase “the pending fault code may be erased” to “the pending fault code shall be erased”.

Rationale: The proposed change is needed to ensure consistency among manufacturers.

**1971.1(f)(2.4.3)(A)**: Staff is proposing new freeze frame storage and erasure requirements for 2022 and subsequent model year engines.  Specifically, for engines using the ISO 15765-4 protocol, the OBD system would be required to store and erase freeze frame conditions in accordance with section 1971.1(d)(2.2.1)(D)(iii).  For engines using the SAE J1939 protocol, the OBD system would be required to store and erase freeze frame conditions in accordance with section 1971.1(d)(2.2.2)(D).

Rationale: The proposed changes related to engines using the ISO 15765-4 protocol are needed to correct an oversight, since the freeze frame storage and erasure requirements should have aligned with the requirements for 2016 and subsequent model year engines in section 1971.1(d)(2.2.1)(D)(iii).  The proposed language related to engines using the SAE J1939 protocol are needed to account for the newly proposed amendment allowing gasoline vehicles to use the SAE J1939 protocol (section 1971.1(h)(3.2)).

**1971.1(f)(2.4.3)(B)**: Staff is proposing to change “fault code” to “misfire fault code.”

Rationale: The proposed change is needed to prevent confusion and to make clear that the reference to “fault code” refers to a misfire fault code.

**Section 1971.1(f)(3): Gasoline “Exhaust Gas Recirculation (EGR) System Monitoring”**

**1971.1(f)(3.2.1) and (3.2.2)**: If a fault that causes a decrease in EGR flow can never cause emissions to exceed the emission malfunction thresholds, staff is proposing that the OBD system be required to detect a fault when there is no detectable amount of EGR flow when EGR flow is expected for non-feedback controlled systems, or when the EGR system has reached its control limits such that it cannot increase the EGR flow to achieve the commanded flow rate for feedback controlled systems. Similarly, if a fault that causes an increase in EGR flow can never cause emissions to exceed the emission malfunction thresholds, staff is proposing that the OBD system would be required to detect when the EGR system has reached its control limits such that it cannot reduce the EGR flow on feedback controlled systems, or when the EGR system has maximum detectable EGR flow when little or no flow is expected for non-feedback controlled systems.

Rationale: Currently, if a fault of the EGR system that causes a decrease in flow will not cause emissions to exceed this level, OBD systems are required to detect a fault if there is no detectable amount of EGR flow. Similarly, if a fault of the EGR system that causes an increase in flow will not cause emissions to exceed this level, OBD systems are required to detect a fault if the system has reached its control limits such that it cannot reduce EGR flow. The regulation, however, does not account for the differences between feedback controlled and non-feedback controlled EGR systems. Therefore, staff is proposing changes to address this.

**1971.1(f)(3.2.2)**: Staff is proposing to allow manufacturers to request Executive Officer approval to be exempt from monitoring EGR high flow faults if the vehicle stalls at idle when the fault occurs or if the fault cannot be detected during off-idle conditions.

Rationale: During the OBD II rulemaking update in 2015, manufacturers had requested that they be exempt from monitoring this fault in the event that such an EGR fault causes the vehicle to stall. Staff agreed that in cases where the EGR failure or deterioration cannot be detected because the vehicle has immediately stalled during idle conditions, monitoring would not be required. However, manufacturers were required to demonstrate that the failure or deterioration would be detected under all other driving conditions, or provide data indicating why the failure or deterioration can only be detected under idle conditions. As such, staff adopted language to allow for this exemption. Staff is now proposing the same allowance in the HD OBD regulation.

**Section 1971.1(f)(4): Gasoline "Cold Start Emission Reduction Strategy Monitoring"**

**1971.1(f)(4.1.2)**: For the example of an element/component associated with the cold start emission reduction strategy that is also required to be monitored elsewhere in regulation, staff is proposing to change the example from "fuel injection timing" to "idle control system."

Rationale: The propose change is needed since "idle control system" is a more appropriate example to use with regards to gasoline engines.

**1971.1(f)(4.2.1)(B)**: Staff is proposing to change "components" to "elements/components."

Rationale: The proposed change is needed since "elements" as well as "components" are used throughout in section 1971.1(f)(4).

**1971.1(f)(4.2.2)**: Staff is proposing to change "either" to "any." Staff is also proposing to change "element" to "element/component" in section 1971.1(f)(4.2.2)(A).

Rationale: The proposed change of "either" to "any" is needed for clarity, since manufacturers may mistakenly believe the use of "either" allows them to choose which failure mode (i.e., failure mode listed under section 1971.1(f)(4.2.2)) the monitor will detect malfunctions of, whereas the requirement is to detect if any of the failure modes occur. The proposed change of "element" to "element/component" in section 1971.1(f)(4.2.2)(A) is needed since "component" as well as "element" are used throughout in section 1971.1(f)(4).

**Section 1971.1(f)(7): Gasoline "Evaporative System Monitoring"**

**1971.1(f)(7.2.2)(A)**: Staff is proposing language indicating that the OBD system is required to detect purge flow faults if there is no purge flow from the evaporative system to the "enclosed area of the air intake system."

Rationale: The proposed language is needed make clear the purge flow pathway that the manufacturer is required to monitor.

**1971.1(f)(7.2.5)**: Staff is proposing language regarding a "complete evaporative system" for engines with multiple fuel tanks, canisters, and/or purge valves.

Specifically, staff is proposing to allow manufacturers to request CARB approval to define multiple “complete evaporative systems” within a vehicle, provided that there are no shared vapor lines or paths between each complete system.

Rationale: The OBD systems are currently required to detect a fault if the “complete evaporative system” has a 0.150 inch leak. Vehicles may utilize much larger evaporative systems that consist of multiple fuel tanks, canisters, and/or purge valves that would increase the difficulty of detecting such leaks compared to existing evaporative systems. Staff is therefore proposing to allow manufacturers to request CARB approval to define multiple “complete evaporative systems” within a vehicle. Thus, the manufacturer would be required to detect a 0.150 inch leak in each of the “complete evaporative systems” instead of the entire evaporative system as a whole.

**1971.1(f)(7.2.6)**: Staff is proposing to allow manufacturers to design monitoring strategies that do not directly confirm evaporative purge delivery to the engine provided the manufacturer submitted data and/or engineering analysis demonstrating the monitoring strategy will have equivalent effectiveness in detecting purge flow malfunctions.

Rationale: HD OBD systems are currently required to verify purge flow to the engine on all evaporative system purge flow paths. Many engines include at least two purge flow paths to the engine, a path for low-load engine operation (i.e., lines for purging the evaporative system canister under conditions where the intake manifold pressure is less than ambient pressure) and a path for high-load engine operation (i.e., lines for purging the evaporative system canister under conditions where the intake manifold pressure is greater than ambient pressure). The most common examples are turbocharged engines that have multiple purge lines to enable purging under both low and high intake manifold pressure conditions. During the OBD II 2015 rulemaking update, staff adopted language that would allow manufacturers more flexibility in designing monitoring strategies. Staff is now proposing the same allowance in the HD OBD regulation.

**Sections 1971.1(f)(8): Gasoline “Exhaust Gas Sensor Monitoring”**

**1971.1(f)(8.2.1)(A)**: Staff is proposing changes to the language to indicate that the “response rate” faults the OBD system is required to detect includes delays in the sensor to initially react to a change in exhaust gas composition (i.e., delayed response) as well as slower transitions from a rich-to-lean (or lean-to-rich) sensor output (i.e., slow response).

Rationale: The proposed changes to the description of the response rate faults are needed to clarify the difference between delayed response faults and slow response faults.

**1971.1(f)(8.2.1)(B)**: Staff is proposing to delete the word “either”.

Rationale: The proposed deletion is needed for clarity, since manufacturers may mistakenly believe the use of “either” allows them to choose which failure mode (a lack of circuit continuity or out-of-range values) the monitor will detect malfunctions of, whereas the requirement is to detect if any of the failure modes occur.

**1971.1(f)(8.4)**: Staff is proposing to exempt OBD systems from storing different fault codes for lack of circuit continuity and out-of-range faults for exhaust gas sensors if: (1) the sensing element (i.e., probe or sensor externally connected to the sensor control module) is a subcomponent integral to the function of the complete sensor unit; (2) the sensing element is permanently attached to the sensor control module with wires or one-time connectors; (3) the complete sensor unit is designed, manufactured, installed, and serviced per manufacturer published procedures as a single component; and (4) the sensor control module and sensing element are calibrated together during the manufacturing process such that neither can be properly individually replaced in a repair scenario.

Rationale: The rationale is provided in section 1971.1(e)(9.4) above.

**Sections 1971.1(f)(9): “Variable Valve Timing and/or Control (VVT) System Monitoring”**

**1971.1(f)(9)**: Staff is proposing amendments to the title of “Variable Valve Timing and/or Control (VVT) System Monitoring” by adding the term “lift” to the title of the section, so the title would now be “Variable Valve Timing, Lift, and/or Control (VVT) System Monitoring.”

Rationale: The rationale is provided in section 1971.1(e)(10) above.

**1971.1(f)(9.1)**: Staff is proposing amendments to specify the level of failure of a VVT system that an OBD system must detect for target error and slow response malfunctions, and these amendments would include examples of malfunctions such as a mechanical failure of a pin to move into the desired position on a lift mechanism or partial or complete blockage of hydraulic passages.

Rationale: The rationale is provided in section 1971.1(e)(10.1) above.

**1971.1(f)(9.2.1) and (9.2.2)**: Staff is proposing to clarify that VVT systems with discrete operating states are not required to detect a malfunction prior to exceeding the threshold but are still required to detect all failures that exceed the threshold.

Rationale: The rationale is provided in sections 1971.1(e)(10.2.1) and (10.2.2) above.

**1971.1(f)(9.2.3)**: Staff is proposing amendments to clarify that only the "electronic" components of VVT systems are required to meet the functional monitoring requirements.

Rationale: The rationale is provided in section 1971.1(e)(10.2.3) above.

**Section 1971.1(g): Monitoring Requirements for All Engines**

**Section 1971.1(g)(1): "Engine Cooling System Monitoring"**

**1971.1(g)(1.1.3)**: Staff is proposing language to clarify that manufacturers that use components/systems "other than" the cooling system and ECT sensor refers to systems that use other engine and/or engine component temperature sensors or systems "in addition to" or "in lieu of" the cooling system and ECT sensor. Further, for engines that use sensors/systems "in addition to" the cooling system and ECT sensor, staff is proposing that manufacturers implement these monitors starting with the 2022 model year.

Rationale: The proposed additions of "engine and/or engine component temperature sensor or system" and "in lieu of or in addition to" are needed to clarify what types of alternate systems are covered under this section. The proposed separation of the requirements into sections 1971.1(g)(1.1.3)(A) and (B) is needed to allow leadtime for manufacturers to meet (B), since the original language "For engines that use a system other than the cooling system and ECT sensor" was unclear to manufacturers as to whether or not this included systems that use other temperature sensors "in addition to" the ECT sensor for these purposes.

**1971.1(g)(1.1.4)**: Staff is proposing language indicating that manufacturers of vehicles with engine cooling systems that include components modulated by a control unit to regulate ECT are required to submit a monitoring plan for Executive Officer approval, with approval based on the reliability and effectiveness of the monitoring plan compared to the thermostat monitoring requirements under section 1971.1(g)(1).

Rationale: Some manufacturers have recently utilized technologies other than or in addition to the thermostat to regulate ECT on the vehicle. For example, an electric water pump can regulate the ECT by modulating the pump on or off to achieve the desired target regulating temperature. Further, variable speed electric water pumps may be modulated to turn the pump on or off and further to achieve more flow or less flow. Since systems or devices, such as an electric water pump, can regulate the cooling system temperatures, staff is proposing language to clarify the requirements for these systems.

**1971.1(g)(1.2.1)(A) and (C)**: Staff is proposing amendments to the thermostat monitoring requirements that would allow manufacturers to detect a thermostat malfunction if a fault is detected within a “time-equivalent calculated value after engine start.”

Rationale: The OBD regulation requires OBD systems to detect thermostat malfunctions if any of the following occurs: (i) the ECT does not reach the highest temperature required by the OBD system to enable other diagnostics, or (ii) the ECT does not reach a warmed-up temperature within 20 degrees Fahrenheit of the engine manufacturer’s nominal thermostat regulating temperature. The OBD regulation currently requires detection of these failures “within an Executive Officer-approved time interval after engine start.” During the 2015 OBD II regulation update, manufacturers had requested the use of a parameter that is not specifically a “time” parameter to detect the malfunctions, indicating that other engine parameters may be more useful in determining the time and driving characteristics before deciding if there is a thermostat malfunction. Thus, staff adopted modifications that would allow manufacturers to detect a thermostat malfunction if a fault is detected within a “time-equivalent calculated value after engine start.” Staff is now proposing the same allowance in the HD OBD regulation.

**1971.1(g)(1.2.1)(D), (1.2.1)(E), (1.3.1)(D), and (1.3.1)(E)**: Staff is proposing language clarifying requirements in sections 1971.1(g)(1.2.1)(D), (1.2.1)(E), and (1.3.1)(D) apply to the thermostat monitoring requirements under sections (g)(1.2.1)(A) and (B), and that the requirements in section 1971.1(g)(1.3.1)(D) and (E) apply to the thermostat monitoring requirements under section (g)(1.2.1)(A).

Rationale: The proposed language is needed for which thermostat monitoring requirements are applicable to each section.

**1971.1(g)(1.2.2)(B)**: Staff is proposing changes indicating that the “time to reach closed-loop/feedback enable temperature” requirements of this section also apply to “feed-forward operation” of emission control system/strategies. Staff is also proposing changes to the requirement related to detection of ECT sensor faults where the sensor does not achieve the minimum temperature needed for closed-loop operation. Specifically, staff is proposing language to clarify that the minimum ECT should be based on achieving “stoichiometric” closed-loop operation across the range of engine loads observed on the FTP cycle. Staff is proposing to require this starting with the 2022 model year.

Rationale: The proposed change related to feed-forward operation is needed for clarity to ensure sensors used for such operation are appropriately monitored. The proposed change of “emission control system” to “emission control system/strategies” is needed since the term “emission control strategies” is also used by industry to refer to the “emission control systems” that this section applies to. For “closed-loop” operation of the fuel system on engines (typically gasoline engines), there could be two different conditions under which closed-loop operation is achieved (stoichiometric versus non-stoichiometric), and multiple ECT temperatures for achieving closed-loop depending on engine speed and load. Since the regulation is not clear on which closed-loop operation it is referring to, staff believes the proposed clarification to the language is needed.

**<u>1971.1(g)(1.3.2)(D)</u>**: Staff is proposing to change the reference of "time to reach closed-loop enable temperature" diagnostic to the diagnostic(s) "required to detect malfunctions specified under section (g)(1.2.2)(B)."

<u>Rationale</u>: The proposed change is needed to clarify which thermostat monitoring requirements are applicable to this section.

**<u>Section 1971.1(g)(2) "CV System Monitoring"</u>**

**<u>1971.1(g)(2.2.1)</u>**: Staff is proposing language indicating that the part of the CV system "between the crankcase and the CV valve" would be subject to the malfunction criteria in section 1971.1(g)(2.2.3) in addition to (g)(2.2.2).

<u>Rationale</u>: The proposed change is needed to account for the newly proposed section (g)(2.2.3).

**<u>1971.1(g)(2.2.2)</u>**: Staff is proposing several changes to the current CV monitoring requirements. First, staff is proposing to group the requirements under sections (g)(2.2.2) through (g)(2.2.7) under one section, section (g)(2.2.2), and is proposing to renumber these sections. In newly renumbered section (g)(2.2.2)(A), staff is proposing to delete the word "either." In newly renumbered section (g)(2.2.2)(F), staff is proposing to change "(g)(2.2.1) through (g)(2.2.4)" to "(g)(2.2.2)."

<u>Rationale</u>: Most of the proposed changes are needed to complement the newly proposed monitoring requirements under section 1971.1(g)(2.2.3). The proposed deletion of "either" is needed for clarity, since manufacturers may mistakenly believe the use of "either" allows them to choose which failure mode (a disconnection of the CV system between the crankcase and CV valve or between the CV valve and intake ducting) the monitor will detect malfunctions of, whereas the requirement is to detect if any of the failure modes occur. The rest of the changes are needed for better readability and formatting reasons.

**<u>1971.1(g)(2.2.3)</u>**: Staff is proposing that OBD systems monitor CV systems for proper performance. OBD systems would continue to be required to detect a malfunction when a disconnection of the CV system occurs between either the crankcase and the CV valve, or between the CV valve and the intake ducting. Further, OBD systems would be required to detect any disconnections of any hose, tube, or line that transports crankcase vapors or any breaks in such hoses, tubes or lines that are equal to or greater than the smallest internal cross-sectional area of that hose, tube, or line. Additionally, breaks that result in rapid oil loss, engine stall, or other overt conditions of a problem that is certain to be repaired would be exempted from monitoring. The proposal would allow manufacturers to phase-in this requirement starting with the 2025 model year, with all 2027 and subsequent model year engines required to meet the requirement. No changes are being proposed to the existing allowance that allows CV system designs that are completely internal to the engine (with no external tubing or hoses) to be exempt from the leak monitoring requirement.

Rationale: The OBD regulation currently requires OBD systems to detect disconnections in the CV system between the crankcase and the intake manifold on the CV valve side of the system. Most OBD systems utilize existing monitors such as the fuel system monitors or idle system monitors to detect disconnections of the CV system between the CV valve and the intake manifold. Detecting disconnections between the CV valve and the crankcase (e.g., between the CV valve and the fresh air intake) is generally significantly more difficult for most vehicles without the addition of hardware such as pressure sensors, and the OBD regulation therefore currently does not require OBD systems to detect this type of disconnection if the CV system is designed in a way that is resistant to deterioration or accidental disconnections and makes technicians more likely to disconnect the hose or hoses between the CV valve and the intake manifold.

Staff has identified a few issues with the existing CV monitoring requirements during certification of both OBD II and HD OBD systems. First, some of the hoses used in existing CV systems have exhibited durability issues that have not been detected by existing OBD systems, because the existing monitoring requirements are primarily focused on monitoring of connections and not on monitoring overall system integrity. Second, the existing criteria that exempt OBD systems from monitoring disconnections if robust connections are used do not detect malfunctions in the CV lines themselves, and may hinder repairs of the CV system because the connections cannot be removed without specialized tools and/or damaging the connections. Finally, the exemption criteria requires an evaluation by staff of large amounts of information, which often leads to protracted discussions with manufacturers during design reviews and certification and increases the time staff needs to evaluate and approve OBD systems. To address these issues, staff adopted amendments to the CV system requirements in the OBD II regulation in 2015 and is now proposing the same amendments to the HD OBD regulation.

Some manufacturers have already added pressure sensors and/or algorithms to their current model year systems to detect disconnected lines. With refinement, staff believes such approaches will be capable of leak detection anywhere in the system. To allow time for manufacturers to make these changes across their product lines, the proposal allows manufacturers to phase-in this requirement during the 2025 through 2027 model years. Staff believes this lead time is appropriate because some engines may comply with the requirement by incorporating internal CV passages into the base engine. The proposed lead time should provide all manufacturers sufficient time to incorporate these changes into future engines and OBD systems.

**Section 1971.1(g)(3) "Comprehensive Component Monitoring"**

**1971.1(g)(3.1.1)**: Staff is proposing language indicating that components that are mentioned under section 1971.1(g)(3.1.3) would be required to be detected if they meet the criteria under section 1971.1(g)(3.1.3) instead of the criteria under section 1971.1(g)(3.1.1).

Rationale: The proposed language is needed to correct an oversight, since section 1971.1(g)(3.1.3) contains alternate criteria than section 1971.1(g)(3.1.1) for certain components to determine if the components are required to be monitored.

**1971.1(g)(3.1.1)**: Staff is proposing to require components that are used as inputs to (directly or indirectly) inducement strategies be required to be monitored under section 1971.1(g)(3) starting with the 2022 model year. Further, staff is proposing language indicating that components used as inputs to (directly or indirectly) or outputs from an AECD strategy are also required to be monitored under section 1971.1(g)(3).

Rationale: The proposed change requiring monitoring of components used as part of an inducement strategy is necessary to ensure that the inducement strategy operates as expected in-use and that any malfunction that prevents the inducement strategy from activating properly is detected and repaired in a timely manner. Since this requirement was not clear in the current regulation, staff is proposing lead time to meet this monitoring requirements.

The proposed language requiring monitoring of components used as part of an AECD strategy is needed for clarification. The HD OBD regulation already requires such monitoring under the comprehensive component monitoring requirements, since the current language in section 1971.1(g)(3.1.1) requires monitoring of components/systems that "can affect emissions during any reasonable in-use driving condition", and AECDs by definition are involved with "activating, modulating, delaying, or deactivating the operation of any part of the emission control system." However, it is unclear if all manufacturers are indeed monitoring all these components. Thus, the language was added for further clarification.

**1971.1(g)(3.1.1) and (3.1.2)**: Staff is proposing new language indicating that if the engine control system takes action to compensate or adjust in response to detecting a deteriorated or malfunctioning component/system, then this type of response would be considered a default action subject to the requirements of either section 1971.1(d)(2.2.1)(E) or (d)(2.2.2)(E) as applicable instead of the requirements in section 1971.1(g)(3).

Rationale: Because an action is being taken in direct response to the deterioration or malfunction in order to keep emissions in check, these actions are considered default actions and thus are subject to the requirements of either 1971.1 (2)(2.2.1)(E) or (d)(2.2.2)(E). Alternate control strategies which are actuated in response to a detected malfunction that affect either emissions or the OBD system have always required MIL illumination and fault code storage. The purpose of OBD is to detect malfunctions and illuminate the MIL. Allowing fault detection and subsequent mitigation to avoid MIL illumination would require an excessive validation effort for a prohibitively large set of conditions to ensure that multiple faults and multiple emission and/or OBD mitigating default actions would always result in a compliant vehicle. Historically, all emission and/or OBD related faults have required MIL illumination and no analysis of so-called synergistic effects have been required.

**1971.1(g)(3.1.1), (g)(3.2.1)(A), (g)(3.2.1)(B), (g)(3.2.2)(A), and (g)(3.4.1)**: Staff is proposing several changes related to smart devices. Staff is proposing changes in section 1971.1(g)(3.1.1) to indicate that components that provide input to or receives commands from a smart device and that affect emissions or the OBD system would be required to be monitored under section 1971.1(g)(3), and that further detection or pinpointing of faults internal to smart devices would not be required. Staff is also proposing language in sections 1971.1(g)(3.2.1)(A) and (B) and (g)(3.2.2)(A) making clear the associated language for digital inputs/outputs. Specifically, the proposed amendments would allow for fault code consolidation for out-of-range faults when the input is transmitted digitally to the on-board computer. The proposed amendments would further clarify that communication errors that prevent digital transmission of the data must be detected and must be identified by storing a separate, failure-specific fault code. The proposed amendments would also make clear that malfunctions of outputs that cause communication failures must be detected. Finally, staff is proposing amendments in section 1971.1(g)(3.4.1) to indicate that section (g)(3.2.1)(B) contains additional fault code storage requirements.

Rationale: As technological advances in the automotive industry continue, manufacturers are increasingly using “smart devices” in place of conventional sensors and actuators to control and monitor powertrain functions. The primary difference between smart devices and similar conventional components is that smart devices incorporate microprocessors to condition or convert input and output signals so that such signals can be used more effectively and reliably. Also, smart devices most commonly communicate with the on-board computer through a digital interface instead of analog signals. In order to address the increased use of smart devices in vehicles, CARB staff is proposing to add a definition of “smart device” in section 1971.1(c), and is also proposing amendments to clarify how the HD OBD monitoring requirements apply to smart devices.

An example of a current production smart device is a smart fuel rail pressure sensor. This sensor provides temperature-corrected pressure readings of the fuel pressure at the fuel injectors in a digital format to the on-board computer. A corresponding conventional sensor design would either correct for temperature with analog circuitry or have the correction made within the on-board computer based on a separate temperature input. Smart sensors are typically less sensitive to electro-magnetic interference and can offer cost and durability improvements compared to purely analog designs.

From the perspective of CARB's OBD program, the emission-related objectives for monitoring smart devices are essentially the same as those for conventional sensor technologies. That is, if the device is an emission control device (e.g., a smart exhaust gas sensor), it needs to be monitored for malfunctions that cause emissions to exceed the emission thresholds for the corresponding major monitor requirement. Failure mode identification and the setting of corresponding fault codes must follow the specific requirements of the relevant section. If the device falls under the requirements for "Other Emission Control or Source Monitoring" (section 1971.1(g)(4)), manufacturers need to propose an appropriate monitoring strategy for the detection and identification of malfunctions that may occur, as is currently the case for devices that would not meet the definition of a smart device.

If a smart device is an emission-related powertrain device subject to monitoring under the regulation's comprehensive component monitoring category (section 1971.1(g)(3)), monitoring is required for circuit faults, out-of-range values, and rationality if it is an input to an on-board computer and for functional response to computer commands if it is an output device. To this end, the proposed modifications to section 1971.1(g)(3.1.1) would make clear that every input from a smart device to the on-board computer must be evaluated for circuit faults, out-of-range values, and to the extent feasible, rationality. Proposed amendments to section 1971.1(g)(3.2.1) would allow for fault code consolidation for out-of-range faults when the input is transmitted digitally to the on-board computer. The proposed amendments would further clarify that communication errors that prevent digital transmission of the data must be detected and must be identified by storing a separate, failure-specific fault code. These proposed requirements are essentially the digital equivalent of verifying circuit continuity between the component and the on-board computer. Designs that check for out-of-range values within the smart device may transmit an error code to the on-board computer instead of signal values when the sensor values are outside of expected bounds. The on-board computer will then translate that error code into a corresponding fault code that can be downloaded by a technician or inspection and maintenance program.

Similarly, smart output components may receive either analog or digital signals from the on-board computer. Staff believes the current language in the HD OBD regulation mostly covers the requirements for these output components. The HD OBD system is required to monitor each output for evidence (via other on-board sensors or systems) that the component is functioning in response to the computer commands. If such a functional check is not feasible, the HD OBD system must at a minimum verify the circuit continuity (or integrity of the digital communication link) of the output from the computer to the device. Since it is not clear in the regulation, staff is proposing language to indicate smart output components would be required to be monitored for communication faults. The table below (Table 2) summarizes the monitoring requirements for input and output devices (for both smart devices and traditional sensors/actuators) and the corresponding requirements regarding fault identification. It includes a provision for consolidation of circuit fault and out-of-range fault codes for components that are physically attached to the circuit board of an on-board computer because such components are generally not serviceable apart from replacement of the circuit board. A single fault code that indicates the malfunctioning component is acceptable in such cases.

**Table 2**

| Type of Component | Monitoring Required? / Fault Code Requirement | | | | |
|---|---|---|---|---|---|
| | Circuit Continuity | Communication | Out-of-Range | Rationality | Functional |
| **Analog Input** | Yes, Fault specific codes (open circuit, circuit high, circuit low) unless component is fixed to ECU | N/A | Yes, Fault Specific codes (out of range high/low) unless component is fixed to ECU | Yes, to extent feasible. Single code can cover two sided failure modes | N/A |
| **Digital Input** | N/A | Yes. Single fault code acceptable | Yes, single fault code acceptable to cover failure modes | Yes, to extent feasible. Single code can cover two sided failure modes. | N/A |
| **Analog Output** | Yes, if functional check is not feasible. Single fault code acceptable. | N/A | N/A | N/A | Yes, if feasible. Single fault code acceptable |
| **Digital Output** | N/A | Yes, if functional check is not feasible. Single fault code acceptable | N/A | N/A | Yes, if feasible. Single fault code acceptable |

Each smart device may be evaluated based solely on the input it provides to the on-board computer, or the commands that it receives from it. That is, faults internal to the smart device would not need to be separately pinpointed by the HD OBD system's monitoring strategies because they are generally not serviceable at this level. As an example, if a smart input device contains two internal sensors, Sensor A and Sensor B, that are used to create a single data parameter transmitted to the on-board computer (e.g., a temperature corrected pressure), the diagnostic strategy would not need to determine whether Sensor A or Sensor B has failed for fault code setting. The monitor would only be required to evaluate the input that the device provides to the on-board computer for circuit continuity/proper communication, out-of-range values, and rationality (and to set fault codes specific to those failure modes).

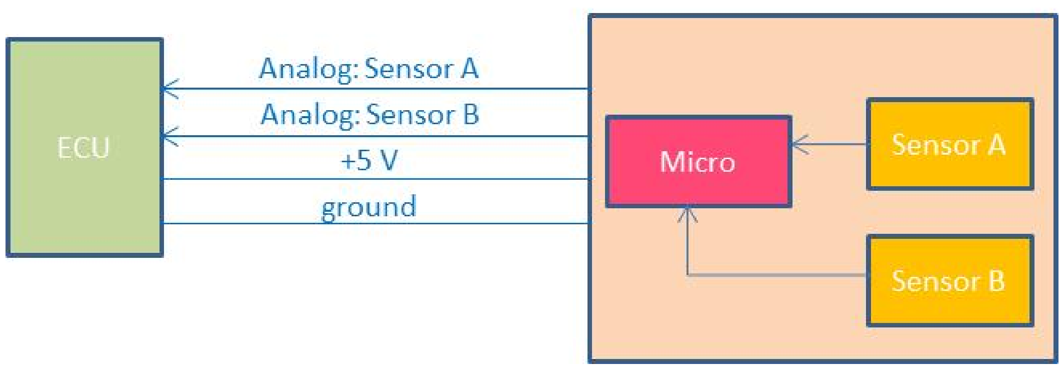
Due to the processing power contained within smart devices, there is opportunity to attach external input or output components to them with external wiring or connectors. This could be done for purposes as simple as minor conditioning of the data used or generated by the smart device, or it could include more complex calculations involving combinations of signals that used to be carried out within the on-board computer when using conventional sensor technology. In order to ensure that inputs or outputs attached to smart devices are adequately evaluated with respect to emissions and/or HD OBD system performance, the proposed smart device definition in section 1971.1(c) and amendments to section 1971.1(g)(3.1.1) would make clear that external inputs and outputs to the smart devices are considered separate components, and as such, are separately subject to the HD OBD monitoring requirements. This means that manufacturers would be required to evaluate components providing input to a smart device for circuit continuity, out-of-range values, and rationality if their failure can impact emissions and/or HD OBD system performance. Further, manufacturers would be required to monitor output components driven by smart devices for functional response to the commands they receive if feasible, and at a minimum, for circuit continuity if a functional check is not feasible. As an exception, the proposed definition of smart device would state that an external subcomponent to a smart device can be considered part of the device if it is integral to the function of the smart device (i.e., the smart device could serve no purpose without the subcomponent, nor the subcomponent without the smart device). It must be permanently attached to the smart device, and the smart device/subcomponent combination must be designed, manufactured, installed, and serviced as a single component.

The proposed amendments would exclude transmissions and hybrid battery pack controllers from the definition of smart devices for purposes of the HD OBD regulation even though they typically use microcontrollers to govern their operation. Consequently, HD OBD systems must continue to individually detect the malfunction of electronic transmission and hybrid battery system components internal to the devices that can affect emissions (in the case of the hybrid battery system components) and/or HD OBD performance and to set subcomponent and failure mode specific fault codes. The reason for staff's proposal is that these are major systems on vehicles that may be commonly repaired by technicians in the service environment (instead of being simply replaced). The staff believes that the availability of the more detailed fault information is valuable to technicians and remanufacturers, resulting in more effective repair work.

In concluding this section, four examples are provided below to illustrate how the requirements specifically apply to various smart sensor designs.

In Example 1, a smart sensor contains sensors A and B, which are conditioned within the device by a microprocessor before the sensor values are transmitted to the on-board computer using an analog interface. In this case, monitoring of the smart device is for all intents and purposes the same as for two separate analog sensors. Under the requirements, the HD OBD system would independently monitor the inputs for Sensor A and Sensor B for circuit continuity, out of range values, and rationality. Separate fault codes for each failure mode would be required. As indicated in Table 2 above, circuit continuity fault codes would be required to differentiate open circuit, circuit high, and circuit low faults, and out of range high faults must be differentiated from out of range low faults. This level of fault isolation is important to help technicians find and fix external circuit and wiring problems that can affect proper transmission of the sensor data over the analog interface. Beyond these requirements, the isolation of faults within the smart sensor itself is not required because the only reasonable repair action for an internal sensor fault is replacement of the sensor.

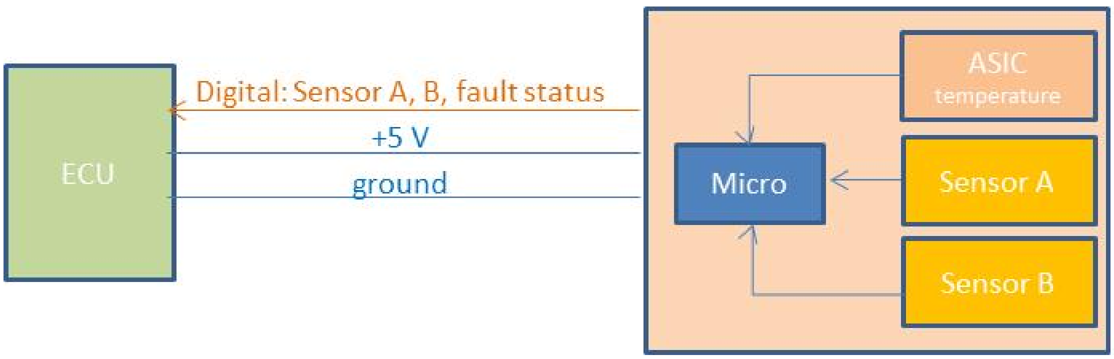
Example 1:
Smart Sensor with Analog Interface




Example 2 helps illustrate the requirements when a digital interface is used. The smart sensor contains two internal sensors that are conditioned by a microprocessor based on temperature. The temperature information is not used outside of the smart sensor and is therefore not required to be monitored. Monitoring of the digital interface between the smart sensor and the on-board computer would replace the circuit continuity checks for the analog connections between the device and the on-board computer in Example 1 above. A malfunction must be detected if the interface is unable to transmit data or fault information for either sensor. Proper digital transmission of the data ensures that the connection between the device and the on-board computer is functioning as expected.

Monitoring for out of range values and rationality can occur within either the smart device or the on-board computer. Regardless of where the monitoring takes place, the manufacturer would be required to disclose and describe the monitoring strategy, monitoring conditions, fault criteria, and fault codes used in its certification documentation. Only a single fault code would be required to indicate both out of range high and out of range low errors.

Example 2
Smart Sensor with Digital Interface

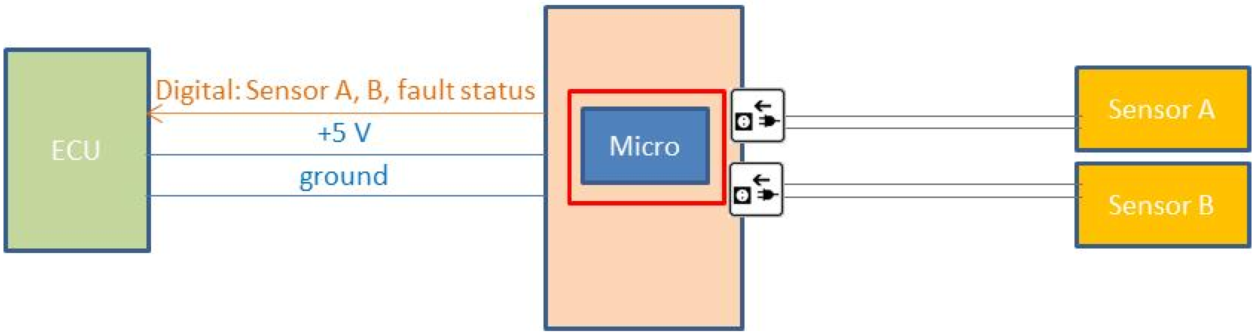



Example 3 provides a slightly more complex scenario. In this case, the smart device is a sensor interface that receives analog inputs from Sensor A and Sensor B. The interface processes the data and sends it in digital format to the on-board computer. Under the requirements, Sensors A and B, and the smart interface are all considered separate comprehensive components for which monitoring is necessary.

Because they provide analog inputs to the smart interface, Sensors A and B must be monitored for circuit continuity, out of range values, and rationality. Each failure mode must use separate fault codes to help technicians diagnose the root cause of the detected problem. Monitoring for circuit faults would occur within the interface, and the interface would be required to transmit to the on-board computer necessary fault status information to permit storage of the appropriate fault codes and MIL illumination. Monitoring for out of range values and rationality can occur within either the interface or the on-board computer. Both out of range high and out of range low would be indicated with separate fault codes because the sensors transmit their data in analog fashion to the interface. Again, regardless of where the monitoring takes place, the manufacturer would be required to disclose and describe the monitoring strategy, monitoring conditions, fault criteria, and fault codes used in its certification documentation.

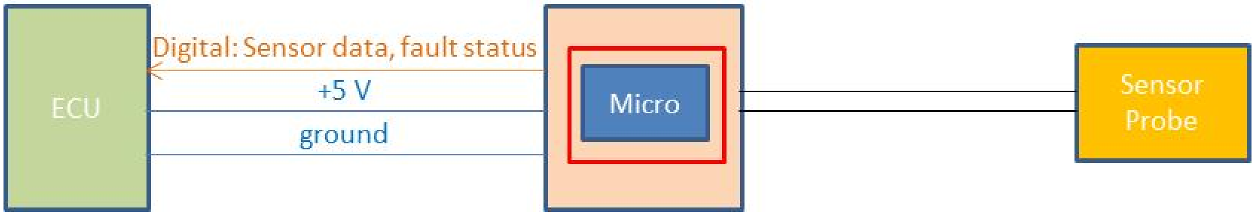
As in Example 2, the regulations would require the smart interface to be monitored for its ability to communicate the sensor information to the on-board computer. A malfunction must be detected if the interface is unable to transmit data or fault information for either sensor.

Example 3
External Analog Sensors Processed by Digital Interface




Example 4 illustrates the requirements for a similar smart device that uses a sensor probe as an integrated subcomponent. Using the provision described earlier, the sensor probe is considered part of the smart device because the probe and controller are designed, produced, and serviced as a single unit, and neither subpart can serve any purpose by itself. Therefore, even though it is externally connected to the controller, the regulation would not require each individual connection between the probe and the controller to be separately monitored for purposes of fault isolation because if a malfunction in one of the connections occurred, replacement of the whole assembly is the only reasonable and proper service action. Instead, as if the sensor probe was internal to the smart device controller, the sensor data that is transmitted to the on-board computer would evaluated for out of range values and rationality. Further, the digital communication link would be monitored for its ability to transmit data and fault status information.

Example 4
Smart Device with Permanently Attached Subcomponent




**<u>1971.1(g)(3.1.5), (3.2.3), (g)(3.3.3), and (3.4.1)</u>**: Staff is proposing specific monitoring requirements for hybrid components to apply to 2022 and subsequent model year engines. The proposed amendments focus on the major hybrid electric systems and components: the energy storage system (ESS), hybrid thermal management system, regenerative braking system, drive motor, generator, and plug-in hybrid electric vehicle ESS charger. Details of the proposed monitoring requirements are covered below. Staff is also proposing language in section 1971.1(g)(3.4.1) indicating that section 1971.1(g)(3.2.3)(A)(v) contains additional fault code storage requirements.

Rationale: While hybrid powertrain components are subject to monitoring, the current regulation does not contain specific guidelines for hybrid components but instead requires manufacturers to submit a monitoring plan to CARB for review and approval. Consequently, some manufacturers have expressed uncertainty in designing monitoring requirements for hybrid components. After many years of reviewing hybrid OBD systems, staff believes it has gained sufficient experience to clarify certain monitoring requirements for hybrid components. The proposed requirements would provide manufacturers with criteria to aid in designing malfunction thresholds for most hybrid components rather than providing specific performance and diagnostic requirements. Ultimately, the proposed amendments primarily clarify existing regulatory language and would not likely result in significant changes to the OBD system designs for most manufacturers. The proposal would promote consistency and equity in implementation. To account for manufacturers that would need to make changes to their OBD designs to comply with the proposed amendments, staff proposes the changes take effect starting with the 2022 model year to provide some lead time.

For monitoring of the ESS (e.g., battery), staff is proposing specific monitoring requirements for state of health (SOH), state of charge (SOC), and cell balancing monitoring. Staff believes these monitors are necessary for maintaining proper operation of the ESS and determining when the ESS is no longer able to perform basic functions. SOH is used to measure the deterioration of the ESS and its ability to perform as compared to a new ESS. While manufacturers would still be required to submit a monitoring plan for SOH monitoring, specific guidelines for malfunction criteria would be outlined in the regulation. Specifically, SOH monitors would be required to detect malfunctions or deterioration of the ESS system that prevent the activation and operation of emission control strategies, the ability of the vehicle to operate such that the monitoring frequencies of all other diagnostics are not adversely affected, and ESS failures that result in loss of all hybrid function or no start of the engine. Manufacturers would be required to submit proposed SOH thresholds in comparison to these levels of failure so staff would be able to determine whether the manufacturer proposed thresholds are appropriate.

SOC is the level capacity of an ESS that is readily available for use, much like a fuel level gauge. The proposed amendments would require ESS SOC monitors to detect malfunctions when the SOC is outside the manufacturer-defined usable range intended for hybrid operation. Many manufacturers control SOC to keep the battery from deteriorating too quickly. For example, a manufacturer may choose to limit hybrid operation when the SOC is below 20 percent of total battery capacity, or may choose to stop charging the battery when SOC is above 80 percent total capacity. These strategies are intended to protect the batteries and as a result, staff is proposing that manufacturers monitor the batteries for malfunctions that could potentially push them outside the usable range such that damage to the battery occurs or charging capability is limited. Additionally, if another diagnostic requires SOC to be above or below a certain level, manufacturers would be required to verify that the system is able to reach and maintain the proper SOC to enable and complete the diagnostic.

Cell balancing is another control strategy that has large effects on the hybrid ESS. Improper cell balancing can result in failure of the battery to charge correctly or increased battery deterioration. Staff is proposing that manufacturers monitor the cell balancing system for proper functional response by verifying the proper target voltages are reached or by monitoring the individual switches used to command cell balance. Staff believes these malfunction criteria would be sufficient for most manufacturers. However, if a manufacturer does not determine cell balance via voltage measurement, the manufacturer would be required to submit a monitoring plan to CARB proposing an alternate method of monitoring the ESS cell balancing system. Alternate methods that include functional monitoring of all components used for cell balancing would likely be approved.

Additionally for ESS monitoring, staff is proposing all other input and output components used as part of the ESS but not specifically named would be subject to the input and output comprehensive component monitoring requirements of sections 1971.1(g)(3.2.1) and (g)(3.2.2). ESS components that would fall under these requirements include ESS temperature sensors, ESS voltage sensors, battery cells, and pre-charge contactors. Because these components are often integrated into larger units, staff is proposing to allow manufacturers to store a fault code pinpointing the smallest replaceable unit for in-use repair. For example, the OBD system may store a single fault code for all battery cell voltage sensor out-of-range high failures if all the sensors are designed to be replaced as a single unit. This provision would also be allowed for ESS cell balancing monitors, such that manufacturers would be able to store fault codes pinpointing the smallest replaceable unit for in-use repair of the ESS (e.g., battery pack, battery module, or battery cell). If a manufacturer elects to pinpoint further, it would be allowed to do so.

Staff is also proposing hybrid ESS and motor/generator inverter thermal management system monitoring requirements to reduce confusion about what is required to be monitored for both active and passive ESS and motor/generator inverter thermal management systems. Active thermal management systems use dedicated components that are commanded by the vehicle for proper cooling and heating of the hybrid systems. When these components fail, the thermal management system is unable to properly function. Passive thermal management systems do not have solely dedicated components, and instead use air from the passenger cabin. Since passive thermal management systems do not depend on dedicated components for temperature control, manufacturers have suggested that they do not need to be monitored. The proposed language does not distinguish between components in passive and active thermal management systems; in both systems, all electronic input and output components commanded by the hybrid system would be required to be monitored. For example, if a passive cabin cooled system has a fan commanded by the vehicle in order to cool the ESS, manufacturers would be required to monitor that component. Electronic components commanded solely by driver demand and used for ESS thermal management would not be considered electronic input or output components and thus would not be required to be monitored. An example of such components that would be exempt from monitoring includes air conditioning components commanded only by the driver for purposes of cooling the cabin. To the extent feasible, manufacturers would also be required to implement a functional check on the thermal management system, which would generally involve ensuring that the thermal management system is activated when commanded. Staff is also proposing similar requirements for motor/generator inverter thermal management systems, although staff would not allow manufacturers to be exempt from monitoring components commanded solely by driver demand in the case of motor/generator inverter thermal management. Heavy-duty hybrid system manufacturers have expressed concerns about meeting these monitoring requirements, indicating that being a horizontal industry, they are not responsible for the cooling system on such vehicles. Thus, they believe that they should not be held responsible for monitoring of the motor/generator inverter thermal management system and that the existing over-temperature diagnostics should be sufficient. CARB staff, however, disagrees. While the horizontal hybrid component manufacturer may not supply the cooling system for a heavy-duty hybrid vehicle, the expectation is that the hybrid manufacturer will work directly with the fan/cooling manufacturer to design the thermal heat management system. Monitoring the active thermal cooling system components directly instead of utilizing an over-temperature diagnostic can identify which components from suppliers are failing and ensures quick effective repairs of malfunctioning components.

Regenerative braking is an important function in hybrid vehicles that allows for the recapturing of kinetic energy to be stored in the ESS. Staff is proposing that manufacturers monitor the regenerative braking function for malfunctions that cause regenerative braking performance to be reduced, or cause regenerative braking to be disabled. Any inputs used to enable regenerative braking or inputs whose failure would result in the disablement of regenerative braking would be subject to monitoring. An example of a component failure resulting in reduced performance would be an input device such as brake pedal position used for feedback into the regenerative braking system. If this component were to malfunction, regenerative braking would revert to a default mode of operation such as a flat regenerative braking percentage, look-up table values, or disablement of regenerative braking; all of which result in degraded performance.

Staff is proposing requirements for drive motor and generator monitoring similar to those proposed for ESS SOH monitoring. Manufacturers would be required to submit a plan for monitoring following specific guidelines outlined in the regulation. Specifically, the plan should include detection of malfunctions that prevent the activation and operation of emission control strategies, the ability of the vehicle to operate such that the monitoring frequencies of all other diagnostics are not adversely affected, and failures that result in loss of all hybrid function or no start of the engine. Showing these levels of deterioration in comparison to one another would greatly aid staff in understanding how the manufacturer has calibrated the diagnostic and when a failure can be detected. Instead of a single requirement for drive motor and generator monitoring (since many vehicle configurations have one system performing both functions), staff believes two separate requirements are necessary given that one system performs the two separate functions under different operating conditions, and allowing one diagnostic to monitor both functions may not be robust. Nonetheless, manufacturers would be allowed to use a single monitor to detect failures of both the drive motor and the generator if the monitor is able to fulfill the proposed monitoring requirements for both drive motor and generator fault detection.

Staff is also proposing monitoring requirements specific to plug-in hybrid electric vehicles, specifically the ESS charger. ESS chargers differentiate plug-in hybrid electric vehicles from regular hybrid vehicles and provide plug-in vehicles the ability to charge the ESS and gain all-electric range. Failing ESS chargers would prevent a plug-in hybrid electric vehicle from operating solely on electric power for propulsion, resulting in higher emissions from increased engine operation. Staff is proposing that manufacturers monitor the on-board ESS charger for malfunctions causing the disablement of battery charging or affecting charging performance. Monitoring of ESS chargers would be limited to on-board chargers; detection of indeterminate failures that cannot be distinguished from those originating from outside the vehicle such as failures of the electric vehicle supply equipment or poor electrical service would not be required.

**1971.1(g)(3.2.1)(A) and (B)**: Staff is proposing to change “a lack of circuit continuity” to “circuit faults.”

Rationale: The proposed changes are needed since “circuit faults” is the more appropriate terminology to use.

**1971.1(g)(3.2.1)(E)**: Staff is proposing amendments to the monitoring requirements for camshaft and crankshaft alignment. Specifically, staff is proposing to require manufacturers to detect either the smallest detectable level of misalignment between the camshaft and the crankshaft based on existing hardware or the minimum number of misaligned teeth/cogs that causes a measurable emissions increase.

Rationale: The HD OBD regulation currently requires engines that require precise alignment between the camshaft and the crankshaft to monitor the camshaft and crankshaft position sensors for proper alignment between the camshaft and crankshaft. Further, for vehicles equipped with VVT systems and a timing belt or chain, manufacturers are required to detect a malfunction if the alignment between the camshaft and crankshaft is off by one or more cam/crank sprocket cogs (e.g., the timing belt/chain has slipped by one or more teeth) or when the minimum number of teeth/cogs misalignment needed to cause a measurable emission increase during any reasonable driving condition has occurred. During the 2015 OBD II rulemaking update, manufacturers have indicated that vehicles with VVT systems with discrete operating states would require new trigger wheels and improved position sensors with better resolution in order to robustly detect when a single tooth/cog misalignment has occurred. Thus, staff therefore adopted amendments requiring vehicles with VVT systems to detect the smallest amount of misalignment possible using their existing hardware in lieu of one cam/crank sprocket cog misalignment. Thus, manufacturers with vehicles equipped with discrete profile VVT systems would not have to incur additional cost to improve or add hardware to meet the regulation. Staff is now proposing the same amendments to the HD OBD regulation.

**1971.1(g)(3.2.2)(A)**: Staff is proposing to change “functional monitoring” to “functional check” and to change “output components/systems” to “the output component/system.”

Rationale: The proposed changes are needed to be consistent with the terminology used in the definitions in section 1971.1(c), which states “functional check,” and for better readability.

**1971.1(g)(3.2.2)(C)**: Staff is proposing to add “intake air heater” to the requirement to detect a malfunction when a single glow plug/intake air heater no longer operated within manufacturer’s specified limits of normal operation.

Rationale: The proposed language is needed for clarity, since “intake air heater” was mistakenly not mentioned in this sentence while it was mentioned in the sentences before.

**1971.1(g)(3.2.2)(D)**: Staff is proposing that manufacturers be exempt from monitoring the wait-to-start lamp under certain circumstances: (1) if the lamp is located on the instrument cluster on an LCD screen and a fault causes the lamp, vehicle speed, engine speed, and fuel level displays to black out , or (2) the engine is prohibited from cranking until a manufacturer-determined time necessary for optimum cold start performance and emission control has been met

Rationale: Manufacturers utilize glow plugs to aid engine starting during inclement (i.e., extremely cold) ambient conditions. These glow plugs are activated when the ambient temperature is below a threshold and release thermal energy into the combustion chambers, thereby facilitating engine starting. The duration of thermal energy released into the combustion chambers increases as the ambient temperature decreases since the glow plugs must overcome a more formidable thermal sink with a colder engine. The HD OBD regulation currently requires the wait-to-start lamp circuit to be monitored for malfunctions that cause the lamp to fail to illuminate when commanded on (e.g., burned out bulb). OBD staff is proposing that manufacturers be exempt from monitoring the wait-to-start lamp under certain circumstances.

Regarding condition (1) mentioned above, as determining the proper function of an LCD screen without the use of an external detection device (e.g., human eyeballs) does not presently exist, there is no method for the OBD system to detect a wait-to-start lamp failure on an LCD screen. Vehicle speed, engine speed and fuel level are crucial information for operation of the vehicle. Therefore, the absence of this information due to a black out would be an associated overt indication of an LCD screen failure and would provide sufficient motivation for the operator to investigate and repair the instrument cluster, and thereby repair the wait-to-start lamp.

Regarding condition (2) above, the wait-to-start lamp is an indication to the operator that the combustion chambers have not been heated to a temperature conducive to better engine starting performance. Thus, cranking the engine while the wait-to-start lamp is illuminated would result in sub-par engine starting performance and negatively impact cold start emissions. Implementing an engine cranking override feature ensures that the system will achieve the elevated combustion chamber temperatures deemed necessary by the manufacturer for quicker engine starting and more stable operation after cold start. In this case, a malfunction of the wait-to-start lamp would have no negative effect on cold start emissions, and thus would not need to be monitored.

**1971.1(g)(3.2.2)(F)**: For monitoring of the fuel control system components under this section, staff is proposing language clarifying that “to the extent feasible,” the stored fault code is required to identify the specific component(s) “for which the control system is using the wrong compensation” instead of if the component “does not match the compensation.” Staff is also proposing language in the monitoring exemption criteria indicating the emissions criteria are based on the NMHC, NOx, CO, and PM standards. Finally, staff is proposing changes that would allow a manufacturer to submit an engineering analysis in support of the worst case emission demonstration (e.g., single-cylinder vs multiple-cylinder) in lieu of completing and reporting emission results for both single and multiple cylinder compensation malfunctions.

Rationale: Staff is proposing to streamline the "test out" requirements for diesel engines that utilize fuel control system components with tolerance compensation features implemented in hardware or software. Currently, manufacturers are required to submit emissions data to demonstrate that both single-cylinder and multiple-cylinder compensation failure modes meet the test out requirements if applying for an exemption from monitoring. The proposed changes would allow a manufacturer to submit an engineering analysis in support of the worst case emission demonstration (e.g., single-cylinder vs multiple-cylinder) in lieu of completing and reporting emission results for both single and multiple cylinder compensation malfunctions. The severity of malfunction for the demonstration will be maintained as described in the regulation (e.g., replacement of plus-one-sigma injectors with minus-one-sigma injectors without updating the compensation value). The proposed changes related to the emissions criteria are needed to prevent confusion about what emissions are involved.

**1971.1(g)(3.3.1)(B)**: Staff is proposing to change "rationality monitoring" to "rationality fault diagnostics."

Rationale: The proposed changes are needed to be consistent with the terminology used in the definitions in subsection (c), which states "rationality fault diagnostic."

**1971.1(g)(3.3.2)(B) and (C)**: Staff is proposing to change "functional monitoring" to "functional checks."

Rationale: The proposed changes are needed to be consistent with the terminology used in the definitions in subsection (c), which states "functional check."

**1971.1(g)(3.4.2)**: Staff is proposing to allow manufacturers to use the provision to store confirmed/MIL-on fault codes without MIL illumination up through the 2021 model year. Staff is also proposing to add the language to clarify that the provision can be applied only if "both conditions (A) and (B) below are met."

Rationale: This section describes the criteria under which a comprehensive component monitor may be exempt from illuminating the MIL. Specifically, MIL illumination is not required (but monitoring and storage of a fault code is still required) if a fault does not cause emissions to increase by more than 15 percent of the FTP standard and if the component/system is not used as part of another OBD monitor. First, the proposed addition of "both conditions (A) and (B) below are met" is needed to address confusion about which conditions need to be met in order to be exempt from illuminating the MIL. Second, the staff is proposing to end this provision altogether because it has not proven to be of significant benefit to manufacturers. Specifically, this provision would not be allowed starting with the 2022 model year. A similar provision was removed from the OBD II requirements as part of CARB's 2015 regulatory revisions. This provision to exempt a monitored component from the MIL illumination requirements was first adopted during the beginning years of OBD II program implementation as a compromise with manufacturers in determining which components and system had to be monitored. CARB wanted to ensure that all components that could have a measurable impact on emissions when malfunctioning were monitored, while manufacturers contended that monitoring was only appropriate for components and systems that had a more significant impact on emissions. After further discussion with manufacturers, CARB agreed not to require MIL illumination for components that had a minimal (but measurable) impact on emissions as long as monitoring still occurred and a fault code was stored. This was intended to give repair technicians the ability to know when such components were malfunctioning and in need of repairs when the vehicle was brought in for other types of service. However, in practice since adoption of the regulatory language, manufacturers have generally not found the provision to be of value, and its use has been very rare. Manufacturers have not seen adequate benefit in the MIL illumination exemption to undergo the testing necessary to qualify for its use when the development of a monitoring strategy capable of detecting malfunctions and storing a fault code is still required. Further, from a service perspective, most manufacturers believe it is simpler and less confusing for the OBD system to work consistently in that all detected malfunctions result in MIL illumination. CARB staff agrees that the provision did not turn out to be a meaningful option for manufacturers to use, and is instead proposing where appropriate to altogether exempt manufacturers from implementing monitoring strategies for certain component failures (e.g., NMHC feedgas monitoring, fuel system component compensation monitoring). Removing the existing provision in light of the above going forward would simplify the regulatory requirements and minimize confusion.

**1971.1(g)(5.6.1)**: Staff is proposing to add language indicating that the 750-minute timer (which tracks the cumulative engine runtime while PTO is active) mentioned in this section is not the same timer as the "total run time with PTO active" timer mentioned in section 1971.1(h)(5.2.1)(C).

Rationale: The proposed change is needed for clarification since there have been confusion about whether or not the timer mentioned in this section is the same as the timer mentioned in section 1971.1(h)(5.2.1)(C).

**1971.1(g)(5.7)**: Staff is proposing amendments to indicate that this section allows manufacturers to request to be exempt from monitoring a component if a failure only affects emissions or other diagnostics when the ambient temperature is below 20 degrees Fahrenheit (or -6.7 degrees Celsius). Staff is also proposing language indicating that manufacturer would need to submit to the Executive Officer data or engineering evaluation supporting this request, and is proposing to delete the sentence "the manufacturer shall determine whether a component/system meets the criteria."

Rationale: This section exempts OBD systems from monitoring a component if the failed component affects emissions or other diagnostics only when the ambient temperature is below 20 degrees Fahrenheit. Staff believes there is not much benefit in monitoring components that only affect emissions under these extreme ambient conditions, considering the limited amount of time vehicles are operated in these temperature ranges. During the OBD II rulemaking update in 2015, manufacturers have expressed confusion about what exactly this section is allowing, with some mistakenly believing this section allows manufacturers to "disable" monitors during these extreme conditions. Staff however intended that these sections allow a component to be exempt from all monitoring requirements (i.e., allow a component to have no monitors), not allow a required monitor for a component to be disabled during certain conditions. Staff is therefore proposing modifications to the language in this section to make this clearer. The other proposed changes requiring manufacturers to request approval of the monitoring exemption and to provide supporting data with their request is needed to ensure that Executive Officer has all the information necessary to determine if manufacturers are appropriately not monitoring a specific component and that the component indeed does not affect emissions or other monitors below 20 degrees Fahrenheit.

**Section 1971.1(h): Standardization Requirements**

**Section 1971.1(h)(1): Reference Documents**

**1971.1(h)(1)**: Staff is proposing amendments that would update the SAE and ISO documents that are incorporated by reference into the HD OBD regulation to reflect the most recently amended versions of such documents. Staff is also proposing to incorporate by reference the following documents: SAE J1939-DA "Digital Annex of Serial Control and Communication Heavy Duty Vehicle Network Data," SAE J3162 "Heavy Duty OBD IUMPR Data Collection Tool Process," and ISO 2575 "Road Vehicles – Symbols for Controls, Indicators and Tell-Tales".

Rationale: As is common practice with technical standards, industry periodically updates the standards to add specification or clarity. Thus, staff is proposing these changes to reflect these updated standards. The proposed changes also include the addition of the digital annex document SAE J1939-DA "Digital Annex of Serial Control and Communication Heavy Duty Vehicle Network Data," which was added to support the currently referenced document SAE J1939 "Serial Control and Communications Heavy Duty Vehicle Network – Top Level Document." Further, the newly added SAE J3162 "Heavy Duty OBD IUMPR Data Collection Tool Process" is needed to support the proposed "dynamic" testing requirement amendments in section 1971.1(l)(2.3.3), and the newly added ISO 2575 "Road Vehicles – Symbols for Controls, Indicators and Tell-Tales" is needed to support the proposed amendment related to the MIL in section 1971.1(d)(2.1.1).

**Section 1971.1(h)(2): Diagnostic Connector**

**1971.1(h)(2.2.1) and (2.3)**: Staff is proposing amendments that would require the diagnostic link connector (DLC) on heavy-duty vehicles with no driver's side door to be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the center console (or the vehicle centerline if the vehicle does not have a center console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position. The connector would also be required to be easily identified and accessed by a crouched technician. Further, for vehicles that do not have a steering wheel or foot pedal, staff is proposing that the manufacturer be required to get Executive Officer approval for the DLC location.

Rationale: The DLC location requirements in the current regulation do not address heavy-duty vehicles with no driver's side doors (e.g., buses) nor does it address possible future vehicles that do not have steering wheels or foot pedals (e.g., autonomous vehicles). For vehicles with no driver's side doors, manufacturers have requested that they be allowed to locate the DLC in the same area that is allowed in the OBD II regulation, which staff agreed to. Further, for vehicles such as autonomous vehicles, manufacturers have indicated that they should be allowed to locate the DLC to the right of the vehicle centerline, as they expect that future autonomous vehicles will require drivers to enter from the right side of the vehicle. Staff, however, believes that there is too much uncertainty in what the inside of the vehicle cabin will look in these vehicles. Thus, staff believes that it is not feasible to prescribe specific language for the required DLC location to cover all such vehicles, and instead is proposing that manufacturers come in with a proposal for the DLC location.

**1971.1(h)(2.6)**: Staff is proposing modifications clarifying that the requirements in section 1971.1(h)(2.6) apply to additional connectors that "can be mated with SAE J1962 "Type A" or SAE J1939-13 external test equipment" instead of "conforms to the "Type A" specifications of SAE J1962 or SAE J1939-13.

Rationale: The proposed modifications are needed for clarity, since the phrase "can be mated with SAE J1962 "Type A" or SAE J1939-13 external test equipment" is more appropriate than the current phrasing, and to ensure technicians trying to plug into the OBD diagnostic connector port are not mistakenly plugging into a different port that is similar to the OBD port, which is the intent of this section.

**Section 1971.1(h)(3): Communications to a Scan Tool**

**1971.1(h)(3.2)**: Staff is proposing to delete the requirement that would restrict the usage of the SAE J1939 communication protocol to only diesel engines, so that all engines would now be allowed to use the SAE J1939 communication protocol.

Rationale: Based on staff's experience with standardization under the OBD II regulation, it is desirable to have a single set of standards used by all vehicles due to the many issues in the field when multiple protocols were allowed in the initial years of OBD II implementation. Staff has found this is generally beneficial for the service and repair industry, inspections, diagnostic equipment and tool manufacturers, and the regulatory agencies in terms of verifying all vehicles are built in conformance with the standards. During discussions with staff members for various state inspection and maintenance (I/M) programs (outside of California), repeated requests have been made to limit the communication protocol options to avoid the problems they have faced in updating and modifying their test equipment to communicate with every variant of protocols that used to be allowed on light-duty vehicles. As stated in the 2005 Staff Report when the HD OBD regulation was first adopted, the heavy-duty industry had strongly argued against requiring only one protocol to be allowed. Thus, staff had adopted HD OBD requirements allowing manufacturers to use ISO 15765-4 (which is the protocol currently required for OBD II) or SAE J1939, but only diesel engines were allowed to use SAE J1939. Staff have since received multiple requests from industry to allow gasoline HD engines to use SAE J1939 protocol because many heavy-duty vehicles use the protocol for communications between all non-engine systems. Thus, the current requirement forces the engine manufacturer or vehicle manufacturer to supply a gateway module to allow communications between the two protocols in order to operate the vehicle. The present heavy-duty gasoline I/M program does not include a requirement to collect OBD data from the vehicle. Current staff efforts to develop a heavy-duty diesel inspection and maintenance program will require the development of program test equipment to communicate with diesel engines using the SAE J1939 protocol, which could also be used with gasoline engines in an improved gasoline program. Therefore, staff is proposing to accept the request from industry and allow both protocols for gasoline vehicles.

**Section 1971.1(h)(4): Required Emission Related Functions**

**1971.1(h)(4.1.1)(A)**: Staff is proposing modifications that change the phrase "without a separate monitor" to "with a single monitor" and add the phrase "and misfires identified in section (e)(2.2.2) and subject to the monitoring conditions of (e)(2.3.3)."

Rationale: The proposed changes to the language are needed to make the requirements easier to understand.

**1971.1(h)(4.1.3)(H)**: Staff is proposing to remove the PM filter frequent regeneration monitor (section 1971.1(e)(8.2.2)) and the PM filter active/intrusive injection monitor (section 1971.1(e)(8.2.6)) from the PM filter readiness bit starting in the 2022 model year.

Rationale: Manufacturers have expressed concern that the PM filter frequent regeneration monitor (section 1971.1(e)(8.2.2)) and the PM filter active/intrusive injection monitor (section 1971.1(e)(8.2.6)), may take too long to run and complete, which would unnecessarily delay setting of the readiness status to "complete." While staff believes it is important to include most monitors of the primary emission controls on the engine (including the monitors that require regeneration events) to ensure that any faults of these important emission controls are properly identified, even though they may require extended time periods to complete, staff understands manufacturers' concerns. Also, there are other data parameters and standardized data functions that can be used to ensure relevant monitors have been executed prior to an inspection. Thus, staff is proposing to remove these monitors from the PM filter readiness bit, but is also proposing to require that the in-use monitor performance data for these two monitors be tracked and reported starting in the 2022 model year (sections 1971.1(d)(3.2.1) and (e)(8.3.2)).

**1971.1(h)(4.1.3)(I), (K), and (Q)**: Staff is proposing to require engines on vehicles using the ISO 15765-4 protocol to include the diesel exhaust gas sensor heater monitor (section 1971.1(e)(9.2.4)(A)) in the diesel exhaust gas sensor readiness bit starting in the 2022 model year. Staff is also proposing to require manufacturers to support the readiness bits for the "diesel exhaust gas sensor heater" for vehicles using the SAE J1939 protocol and add the "gasoline oxygen/exhaust gas sensor heater" for all applicable vehicles.

Rationale: The proposal to include the diesel exhaust gas sensor heater monitor in the diesel exhaust gas sensor readiness bit is needed correct an oversight, since these heater monitors should have been included in the readiness bits. Since SAE J1979 does not require that manufacturer have a separate readiness bit for the diesel exhaust gas sensor heater, staff is proposing to include this monitor in the existing diesel exhaust gas sensor readiness bit. The proposed additions of the "diesel exhaust gas sensor heater" and "gasoline oxygen/exhaust gas sensor heater" readiness bits are needed to align the required readiness bits to the ones listed in SAE J1979 and J1939. These engines are currently supporting these readiness bits since they are required in the standards, so no lead times were added for these new readiness bits in the HD OBD regulation.

**1971.1(h)(4.1.7)**: Staff is proposing to delete the section reference "(f)(1.2.5)."

Rationale: This proposed change is needed since staff proposed to move the language under section 1971.1(f)(1.2.5) to section 1971.1(f)(1.2.4).

**1971.1(h)(4.2.1)(D), (4.2.2)(H), and (4.2.3)(F)**: For all model year 2022 and newer engines, staff proposes to add new parameters to the regulation's data stream requirements as shown in Table 3, and to modify or extend the applicability of several parameters that are already required as shown in Table 4.

The new requirements apply to engines that use hardware and control strategies for which the indicated parameters are relevant.

Table 3.  New Data Stream Parameters

| # | Proposed Parameter | Description |
|---|---|---|
| 1 | Commanded DEF dosing | Commanded DEF dosing quantity (mass based). |
| 2 | DEF dosing mode (A, B, C, etc.) | The specific mode of DEF dosing operation (e.g., fill mode, sustain mode, etc.) |
| 3 | DEF dosing rate | Actual quantity of DEF dosed into the aftertreatment system. |
| 4 | DEF usage for current driving cycle | The accumulated amount of DEF introduced into the aftertreatment system for the current driving cycle. |
| 5 | Target ammonia storage level on SCR | The target storage level of ammonia on the SCR catalyst that the DEF dosing system seeks to achieve. |
| 6 | Modeled actual ammonia storage level on SCR | The modeled actual storage level of ammonia on the SCR catalyst. |
| 7 | SCR intake temperature | Temperature of exhaust entering the SCR catalyst. |
| 8 | SCR outlet temperature | Temperature of exhaust exiting the SCR catalyst. |
| 9 | NOx mass emission rate - engine out | The rate of NOx emitted by the engine (grams per second) based on NOx concentration measurements made upstream of the NOx aftertreatment system. |
| 10 | NOx mass emission rate - tailpipe | The rate of NOx emitted by the engine (grams per second) based on NOx concentration measurements made downstream of the NOx aftertreatment system. |
| 11 | Stability of NOx sensor reading | An indicator as to whether the NOx reading of a NOx sensor is stable as determined by the manufacturer's control software. |
| 12 | EGR mass flow rate | The flow rate (mass basis) of the exhaust gas that is recirculated into the combustion air. |
| 13 | Vehicle fuel rate | The amount of fuel consumed by the engine summed with the amount of fuel injected directly into the aftertreatment system per unit of time. |
| 14 | Hydrocarbon doser flow rate | Mass flow rate of external hydrocarbon dosing into the aftertreatment system. |
| 15 | Hydrocarbon doser injector duty cycle | Percentage of the maximum hydrocarbon dosing of an external dosing system. |
| 16 | Aftertreatment fuel pressure | The measured pressure of the fuel supplied to the external hydrocarbon doser in the aftertreatment system. |
| 17 | Engine operating state | An indicator as to whether the engine is in warm-up mode. |

| # | Proposed Parameter | Description |
|---|---|---|
| 18 | Propulsion system active | An indicator as to whether the powertrain is enabled by the driver such that the vehicle is ready to be used (e.g., vehicle is ready to be driven, ready to be shifted from "park" to "drive"). |
| 19 | Odometer reading | Accumulated distance traveled by vehicle during its operation from the time it was new. |
| 20 | Engine family | Certification engine family name. |
| 21 | Hybrid/EV charging state | An indicator of whether the hybrid/EV battery is in Charge Sustaining Mode or Charge Depletion Mode. |
| 22 | Hybrid/EV battery system voltage | Voltage of the hybrid/EV battery system. |
| 23 | Hybrid/EV battery system current | Electrical current in the hybrid/EV battery system. |
| 24 | Commanded/target fresh air flow | Air mass flow rate commanded by the engine control system. |
| 25 | Crankcase pressure sensor | The gauge pressure indicated by the pressure sensor inside the engine crankcase. |
| 26 | Crankcase oil separator rotational speed | The speed of a rotating (centrifugal) crankcase oil separator. |
| 27 | Evaporative system purge pressure sensor | The pressure indicated by the purge pressure sensor in the evaporative system. |
| 28 | Vehicle speed limiter (VSL) speed limit | The speed limit to which the VSL is set. |
| 29 | Engine rated power | The rated net brake power output of the engine. |
| 30 | Engine rated speed | The engine speed that corresponds to the engine rated power. |

Table 4. Changes to Existing Data Stream Parameters

| # | Parameter | Description of Change |
|---|---|---|
| 1 | Cylinder fuel rate | Already required for diesel engines. Propose to extend to gasoline engines. |
| 2 | Modeled exhaust flow (mass/time) | Already required for diesel engines. Propose to extend to gasoline engines. |
| 3 | Engine reference torque | Already required for diesel engines. Propose to extend to gasoline engines. |
| 4 | Engine friction - percent torque | Already required for diesel engines. Propose to extend to gasoline engines. |
| 5 | Actual engine - percent torque | Already required for diesel engines. Propose to extend to gasoline engines. |

| # | Parameter | Description of Change |
|---|---|---|
| 6 | Vehicle speed | Currently required for diesels if used for emission control or any OBD diagnostics. Propose to remove this exclusion and require for all diesel engines. |
| 7 | PM sensor output | Add parenthetical clarification: "(e.g., PM sensor current for sensors that accumulate soot)" |
| 8 | Reductant quality sensor output | Add parenthetical clarification: "(e.g., DEF concentration and temperature)" |
| 9 | Engine fuel rate | Change name from "Fuel rate" to "Engine fuel rate". |
| 10 | Charge air cooler outlet temperature | Change name from "engine intercooler" to "Charge air cooler outlet temperature". |

Rationale: HD OBD systems are required to report certain "real-time" data parameters in a standardized format that a generic scan tool can process and read. Such data are used by technicians for troubleshooting malfunctions, by inspectors for making inspection pass/fail decisions, and by CARB staff in assessing compliance with CARB requirements and determining the in-use emission and OBD system performance of vehicles. Staff's proposal to add the new parameters to the data stream requirements is motivated by various reasons ranging from assisting technicians with vehicle repair to improving staff's understanding of real-world emissions. The rationale is described further below with new parameters grouped together where possible.

- 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, and SCR outlet temperature:
  - Would assist with diagnosis of SCR-related performance issues and in-use compliance test evaluation. SCR outlet temperature is also a required input for identifying NTE events during in-use compliance testing.

- NOx mass emission rate - engine out and NOx mass emission rate – tailpipe:
  - Would need to be supported to fulfill the proposed NOx tracking requirements described in section 1971.1(h)(5.3). Would also assist with diagnosis of SCR-related performance issues and in-use compliance test evaluation.

- Stability of NOx sensor reading:
  - Needed to determine when a NOx sensor's reading is valid and therefore necessary for fulfilling the proposed NOx tracking requirements. Already supported in CAN communications between the NOx sensor and the engine control unit. Would also assist with diagnosis of high tailpipe NOx emissions and SCR-related performance issues.

- EGR mass flow rate:
  - o Would assist with diagnosis of EGR-related performance issues, default action analysis, and in-use compliance test evaluation.

- Vehicle fuel rate and VSL speed limit:
  - o Would need to be supported to fulfill the GHG tracking requirements described in section 1971.1(h)(5.4). Would also assist with service and repair and in-use portable emission measurement system (PEMS) testing.

- Hydrocarbon doser flow rate, hydrocarbon doser injector duty cycle, and aftertreatment fuel pressure:
  - o Important parameters for understanding performance and fuel use of injection systems used by aftertreatment.

- Engine operating state and propulsion system active:
  - o Important factors in the operation and enablement of various monitors and possibly also in operation of start/stop mechanisms in HD diesel hybrids.

- Odometer reading, engine family, engine rated power, and engine rated speed:
  - o Would assist with future inspection and maintenance programs.

- Hybrid/EV charging state, hybrid/EV battery system voltage, and hybrid/EV battery system current:
  - o Assist technicians with diagnosing and repairing malfunctions in hybrid vehicles and assist staff in certification review and compliance testing.

- Commanded/target fresh air flow, crankcase pressure sensor, crankcase oil separator rotational speed, and evaporative system purge pressure sensor:
  - o Used by some engines as an input to various OBD monitors.

The proposed changes to data stream parameters that are already in the regulation are listed in Table 4. The changes include extending parameters to gasoline engines and making several clarifications. The rationale for these changes is described below:

- Cylinder fuel rate, modeled exhaust flow (mass/time), engine reference torque, engine friction - percent torque, and actual engine - percent torque:
  - o Extending the applicability of these parameters to gasoline vehicles would assist technicians during service and repair and also facilitate conducting valid in-use emission tests with PEMS.

- Vehicle speed:
  - o Would be required to comply with the proposed NOx tracking requirements. Already required for all gasoline engines and any diesel engines that use vehicle speed for emissions control or OBD diagnostics.

- PM sensor output and reductant quality sensor output:
    - o Adding parenthetical text of “e.g., PM sensor current for sensors that accumulate soot” and “e.g., DEF concentration and temperature” helps to clarify the kind of output that must be supported.

- Engine fuel rate:
    - o Already required for all engines. Changing the name from “fuel rate” to “engine fuel rate” to help distinguish from “vehicle fuel rate” which includes fuel used by the engine and aftertreatment system.

- Charge air cooler outlet temperature:
    - o Already required for all engines. Changing the name from “engine intercooler temperature” to “charge air cooler outlet temperature” makes it more consistent with SAE J1939 and J1979 terminology.

**1971.1(h)(4.2.3)(A)**: Staff is proposing to add the phrase “(short term, long term, and secondary)” to “fuel trim.”

Rationale: The proposed additional language is needed to address manufacturers’ confusion about the specific data stream parameter they are required to support and report for “fuel trim.”

**1971.1(h)(4.4.1)(B) and (4.4.2)(B)**: For the standardization requirements for fault codes, staff is proposing to add the phrase “Except as otherwise specified in sections (e) through (g)” to beginning of the sections and to delete the sentences “In general, rationality and functional diagnostics shall use different fault codes than the respective circuit continuity diagnostics. Additionally, input component circuit continuity diagnostics shall use different fault codes for distinct malfunctions (e.g., out-of-range low, out-of-range high, open circuit)” in these sections.

Rationale: The proposed amendments are necessary since these requirements are already described in other sections such as section 1971.1(g)(3) and are thus redundant in these sections.

**1971.1(h)(4.4.2)(C)**: Staff is proposing to change “SAE J939” to “SAE J1939.”

Rationale: The proposed change is needed to correct an error.

**1971.1(h)(4.5.1) and (h)(4.5.7)**: Staff is proposing to require CV system monitors that meet the newly proposed monitoring requirements of section 1971.1(g)(2.2.3) to store and report test results. CV system monitors that meet section 1971.1(g)(2.2.2) would not be required to meet the test results requirements of section 1971.1(h)(4.5).

Rationale: The HD OBD regulation requires OBD systems to store the most recent monitoring results for most of the major monitors and to make available to scan tools certain test information (i.e., the minimum and maximum value test limits as well as the actual test value) of the most recent monitoring event, which is intended to assist technicians in diagnosing and repairing malfunctions. The regulation currently exempts CV monitors from storing and reporting test results. However, with the newly proposed monitoring requirements for CV systems specified in section 1971.1(g)(2.2.3), staff believes that requiring these monitors to store and report test results would be beneficial to repair technicians trying to repair CV system faults.

**1971.1(h)(4.5.1)**: Staff is proposing modifications that indicate that the test results are required to be in the standardized format in SAE J1939-73 for the SAE J1939 protocol.

Rationale: The proposed changes are needed for clarity, since the current language "standardized format specified in SAE J1979 for the ISO 15765-4 protocol or SAE J1939" is confusing and seems to imply that engines using the SAE J1939 protocol are required to use the standardized format specified in SAE J1979, which is not the case.

**1971.1(h)(4.5.7)**: Staff is proposing to delete "(f)(1.2.5)" from the list of monitors exempt from meeting the test results requirements of section 1971.1(h)(4.5).

Rationale: The proposed change is needed since staff proposed to move the language under section 1971.1(f)(1.2.5) to section 1971.1(f)(1.2.4).

**1971.1(h)(4.7.5)**: Staff is proposing language indicating that examples of messages that the on-board computer are not allowed to use when a calibration verification number (CVN) request is received (except for the period after a reprogramming event or non-volatile/volatile memory clear) are negative response codes, acknowledgement ($00E800_{16}$) parameter group number: Control Byte = 3, and negative acknowledgements. Staff is also proposing language indicating that the OBD system is not allowed to report a default CVN value except in the event of a communication malfunction that prevents access to the CVN value. This would be allowed provided that a fault code is stored for the communication failure with the MIL commanded on and the default CVN value cannot be mistaken for a valid CVN.

Rationale: The HD OBD regulation currently requires the CVN to be stored at all times, calculated, and re-stored at least once per ignition cycle, and to be made immediately available at all times through the DLC to a generic scan tool in accordance with the requirements in SAE J1979. The HD OBD regulation also requires that if a CVN request message is received by the on-board computer, the stored CVN value is required to made available to the scan tool. Thus, the proposed language providing examples of messages that the on-board computer are not allowed to use and prohibiting a default CVN from being reported when a CVN request is received are needed to clarify the current requirements. The CVN should always be available in most circumstances, considering the CVN is calculated once per ignition cycle and stored until replaced by an updated CVN calculation. Messages like negative response codes create unnecessary bus traffic, which can delay CVN being made immediately available upon request by a generic scan tool. Additionally, default values would create more confusion for technicians because the default values may be mistaken for actual CVN values, or may cause technicians to mistakenly believe that CVN is not supported when in fact it is.

However, the HD OBD regulation currently does not require the CVN to be made immediately available to a scan tool if it is requested “immediately” following erasure of the stored CVN value, specifically within the first 120 seconds of engine operation after the ECU is reprogrammed or the non-volatile memory is cleared, or within 30 seconds of a volatile memory clear or battery disconnect. Additionally, the regulation allows the on-board computer to response with “one or more messages” directing the scan tool to wait or resend the request message after the delay in these cases. Thus, staff proposed language clarifying these messages include negative responses and negative acknowledgements. However, the on-board computer would still be prohibited from sending default CVN values in these cases. During the OBD II rulemaking update in 2015, manufacturers have stated that SAE J1979 provides clear direction on how a control unit should respond when data are not available from an OBD device that communicates over a network, with the general principle being that a “default” value that is easily identified as “not normal” would be reported to indicate if a device has failed (e.g., there is a communication failure with the specific control unit). They indicated that prohibiting default CVN values and requiring the control unit to report the stored valid CVN value when a communication failure occurs would confuse repair technicians. While staff understands the manufacturers’ concern, staff wants to limit the output of default CVN values. Thus, staff proposed language to allow the on-board computer to use a default CVN value only in cases of communication failures that prevent access to the actual stored CVN value.

**1971.1(h)(4.7.6)**: Staff is proposing amendments to require manufacturers to use the “most recent” standardized electronic format detailed in Attachment F of ARB Mail-Out #MSC 09-22 for the CVN and calibration identification number (CAL ID) information. Staff is also proposing amendments indicating that the “25 days” deadline for submitting the CVN and CAL ID information is now “30 calendar days.” Finally, staff is proposing language indicating that the manufacturer is required to submit the CVN and CAL ID information for every applicable vehicle, even those resulting from field fixes after the production period has ended for that engine.

Rationale: The proposed change related to the “most recent” standardized electronic format is needed to ensure that manufacturers are using the most updated format that is uploaded to the CARB website. The proposed change to “30 calendar days” was requested by manufacturers, who indicated that more time was needed to provide the CAL ID and CVN information and thus requested to align the timeline with the proposed timeline in section 1971.1(k)(3) for paying deficiency fines. Additionally, the proposed addition of “calendar” is needed to make clear the days referred to “calendar” days and not “working” days. The proposed language indicating that manufacturer has to submit CVN and CAL ID information even after the end of engine production is needed since some manufacturers have inappropriately stopped submitting this information at that time even if though changes in the field (e.g., field fixes) have resulted in new CVN/CAL IDs for those engines.

**1971.1(h)(4.8.2)**: Staff is proposing that heavy-duty engines certified to the Low Emission Vehicle III exhaust emission standards in title 13, CCR section 1961.2 be exempt from the ESN requirements of section 1971.1(h)(4.8.2).

Rationale: This proposed change is needed to address manufacturers that have heavy-duty engines that are grouped as “medium-duty engines” and meet the Low Emission Vehicle III standards, as is allowed in title 13, CCR section 1961.2.

**1971.1(h)(4.10.1)**: Staff is proposing to add language indicating that the “emission-related diagnostic information” is required to include “at least” the information described in section 1971.1(h)(4.10.1). Staff is also proposing modifications to the examples list, including alternate engine run time parameters in lieu of distance-related parameters for engines with no vehicle speed information and the addition of MIL status and monitor status. Staff is also proposing to change “section (h)(4.4.)” to “section (h)(4.4)” in section 1971.1(h)(4.10.1)(D).

Rationale: Section 1971.1(h)(4.10.1) details the information that would be required to be erased, including “data stream information (section (h)(4.2))” followed by a list of some examples of the required parameters. The proposed change to add “at least” is needed to clarify what information are required to be included. The proposed modifications to the examples list are needed to align with the lists in SAE J1979 for engines using the ISO 15765-4 protocol and SAE J1939-73 for engines using the SAE J1939 protocol. The proposed change from “(h)(4.4.)” to “(h)(4.4)” is needed to correct an error.

**1971.1(h)(4.10.2)**: Staff is proposing amendments indicating that the emission-related diagnostic information erasure requirements of section 1971.1(h)(4.10.2) also apply to on-board computer reprogramming events that erase any of the emission-related diagnostic information. Staff is also proposing several grammatical and clarifying amendments to the language in this section.

Rationale: Section 1971.1(h)(4.10.2) of the regulation currently requires all emission-related diagnostic information to be erased if any of the information is erased as a result of a command by a scan tool. The rationale for clearing all information was to reduce the opportunity for selective reprogramming events to be used to evade detection during inspections or avoid necessary repairs. Thus, this erasure should also take place during an on-board computer reprogramming event that erases any emission-related diagnostic information. So staff is proposing language to make this clear. The other changes are needed for better readability.

**1971.1(h)(4.10.2), (4.10.3), and (4.10.4)**: Staff is proposing amendments indicating that section 1971.1(h)(4.10.2) would allow for the OBD system to erase the information (in response to a scan tool command) during any driving conditions as long as the information can be erased while the vehicle is in the key on, engine-off position, while section 1971.1(h)(4.10.3) would allow manufacturers to forgo erasing the information during key on, engine-off conditions for safety or component protection reasons. Staff is also proposing amendments (section 1971.1(g)(4.10.4) to allow a manufacturer to erase the emission-related diagnostic information from some or all of the control modules that report only the comprehensive component readiness bit, provided that all emission-related diagnostic information from control units that support readiness for a readiness bit other than comprehensive components is erased and that there exist "key on, engine off" conditions in which all emission-related diagnostic information in all control units can be erased. The amendments also make clear that, except for these specific conditions, the OBD system would not allow a scan tool to erase only a subset of the information.

Rationale: During the OBD II rulemaking update in 2015, manufacturers have expressed concerns that if all the specified information were erased, it could result in a safety issue. Specifically, because some malfunctions are mitigated by remedial actions that are triggered by the detection of the malfunction and subsequent storage of a fault code, clearing of all emission-related diagnostic information while the vehicle is operated could result in loss of the remedial action and pose a safety issue to the driver or technician. To avoid these potential safety issues, manufacturers inhibit clearing of this information unless the vehicle is off or not in the propulsion system active state (i.e., in the "key on, engine off" position). To address these concerns, staff adopted two alternatives to erase fault codes and is now proposing the same amendments in the HD OBD regulation. The first alternative (section 1971.1(g)(4.10.3)) allows a manufacturer to erase all emission-related diagnostic information under conditions other than or in addition to vehicle "key on, engine off" conditions. This option would achieve staff's objectives of coordinated code clearing, while allowing manufacturers to ensure that all diagnostic information is cleared in a way that is safe for drivers and/or technicians. Thus, section 1971.1(h)(4.10.2) would allow for the OBD system to erase the information (in response to a scan tool command) during any driving conditions as long as the information can be erased while the vehicle is in the key on, engine-off position, while section 1971.1(h)(4.10.3) is intended to allow manufacturers to forgo erasing the information during key on, engine-off conditions for safety or component protection reasons. The second alternative (section 1971.1(g)(4.10.4)) allows a manufacturer to erase the emission-related diagnostic information from some or all of the control modules that report only the comprehensive component readiness bit, provided that all emission-related diagnostic information from control units that support readiness for a readiness bit other than comprehensive components is erased and that there exist “key on, engine off” conditions in which all emission-related diagnostic information in all control units can be erased. The amendments also make clear that, except for these specific conditions, the OBD system would not allow a scan tool to erase only a subset of the information. This option is necessary to ensure that safety-related default modes remain latched until it is safe to remove the default action (i.e., the malfunction is repaired and the appropriate actions have been taken to ensure that safety has been restored).

## Section 1971.1(h)(5): Tracking Requirements

**1971.1(h)(5.1.2)(A)(vi)**: Staff is proposing amendments for the in-use performance ratio tracking requirements. Specifically, staff is proposing that in the case that the engine is not equipped with a component, the corresponding numerators and denominators for that component would be required to report zero for vehicles using the ISO 15765-4 protocol and report “FFFF” for vehicles using the SAE J1939 protocol.

Rationale: The HD OBD regulation currently requires the numerators and denominators for components that are not equipped on a vehicle to report a value of zero. The proposed changes are needed to align the requirements with those specified in SAE J1939, which typically require values of “FFFF” to be reported for unsupported parameters.

**1971.1(h)(5.2.1)**: Staff is proposing to change the language from “all gasoline and diesel engines” to “all engines” when referring to the engines required to meet this section.

Rationale: The proposed changes are needed to avoid confusion, since the requirements of this section are intended to apply to all heavy-duty engines, including alternate-fueled engines. Since most of the regulation designates requirements applicable to “gasoline engines” and “diesel engines,” staff had included language in current section 1971.1(d)(7.5) and newly proposed section 1971.1(d)(8.1) that clarify that manufacturers of alternate-fueled engines would need to propose a plan for Executive Officer approval that indicate the requirements that the engines would meet, including the standardization requirements of section 1971.1(h). However, there have been confusion whether or not section 1971.1(h)(5.2.1) applied to alternate-fueled engines, since newly proposed language within section 1971.1(h)(5) refer specifically to “alternate-fueled engines.” Thus, staff is proposing the amendment to make clear that all engines, including alternate-fueled engines, are required to meet section 1971.1(h)(5.2.1).

**<u>1971.1(h)(5.2.1)(D)</u>**: Staff is proposing to require 2022 and subsequent model year gasoline and alternate-fueled engines to track and report EI-AECD active run time data. Staff is also proposing to add a space between “#1” and “active” in section 1971.1(h)(5.2.1)(D)(i).

<u>Rationale</u>: The proposed new tracking requirement is needed for these engines since this information is important and will be helpful to CARB staff in understanding EI-AECD operation on these engines. The proposed addition of the space is needed to correct an error.

**<u>1971.1(h)(5.2.1)(E)</u>**: Staff is proposing that 2022 and subsequent model year diesel engines track and report the following: total run time with no delivery of reductant used to control NOx emissions (e.g., DEF) due to insufficient exhaust temperature, and total run time with the exhaust temperature below 200 degrees Celsius as measured just upstream of the NOx converting catalyst. If an engine has more than one NOx converting catalyst, tracking would be based on the temperature upstream of the catalyst that is closest to the engine.

<u>Rationale</u>: Staff’s proposal to track engine run time under these two conditions is motivated by the need to better understand real-world behavior and performance of a diesel engine’s NOx emission control system. Together with the DEF dosing system, the SCR catalyst is the most important NOx control element in a diesel engine. Its performance is constrained, however, by the temperature of the exhaust. Conversion of NOx is very limited at exhaust temperatures that are below approximately 200 degrees Celsius and DEF dosing is curtailed under such conditions. Thermal management strategies can be employed to minimize the high NOx emissions that result when control is poor, but the degree of their implementation can vary widely from one engine make to another and is not well understood in the real-world context. By tracking engine run time when a reductant is not being used as well as when the exhaust temperature is below 200 degrees Celsius, staff can gain insight into the prevalence of engine operation under these conditions.

**<u>1971.1(h)(5.3)</u>**: Staff proposes to add NOx emission and engine activity tracking requirements to the regulation for all 2022 and subsequent model year heavy-duty diesel engines. Engine control modules will estimate the parameters listed in Table 5 and store them in the four data arrays shown. The data for each parameter in each array will be split up and stored as cumulative values in the 16 bins that are defined by Table 6 below.

**Table 5. NOx Tracking Arrays and Parameters**

| Parameter | Active 100 Hour Array | Stored 100 Hour Array | Lifetime Array | Lifetime Engine Activity Array[5] |
|---|---|---|---|---|
| NOx mass – engine out (g)[1] | x | x | x | n/a |
| NOx mass – tailpipe (g)[2] | x | x | x | n/a |
| Engine output energy (kWh)[3] | x | x | x | x |
| Distance traveled (km) | x | x | x | x |
| Engine run time (hours) | x | x | x | x |
| Vehicle fuel consumption[4] (liters) | x | x | x | x |

1. Mass of NOx emitted by the engine upstream of the NOx emission control system.
2. Mass of NOx emitted by the engine which enters the atmosphere (downstream of the NOx emission control system).
3. Brake work output of the engine.
4. The amount of fuel consumed by the engine summed with the amount of fuel injected directly into the aftertreatment system.
5. Engine activity data are recorded regardless of NOx sensor status.

**Table 6. Bin Structure For Each Parameter in Each Array**

Vehicle Speed (km/h)

| % of Rated Power | 0 | > 0 ≤ 16 | > 16 ≤ 40 | > 40 ≤ 64 | > 64 |
|---|---|---|---|---|---|
| ≤ 25% | Bin 2 | Bin 3 | Bin 4 | Bin 5 | Bin 6 |
| > 25% ≤ 50% | | Bin 7 | Bin 8 | Bin 9 | Bin 10 |
| > 50% | | Bin 11 | Bin 12 | Bin 13 | Bin 14 |

**Total** (Bin 1)

**NTE Bin** (Bin 15)

**Regen Bin** (Bin 16)

Parameter data would be stored in the Active 100 Hour, Stored 100 Hour, and Lifetime Arrays only when the NOx sensors that are used for determining the NOx mass parameters are reporting NOx concentration data. The Lifetime Engine Activity Array would store data at all times irrespective of the status of the

NOx sensors. Data would be stored in the Active 100 Hour Array until a total of 100 hours of engine operation has elapsed with both NOx sensors reporting NOx concentration data. The stored data would then be moved to the Stored 100 Hour Array and a new block of Active 100 Hour Array data would begin to accumulate. All data stored in an array would be based on signals that are sampled at a rate of at least 1 Hertz. If the MIL is commanded on because a malfunction is detected, data would continue to be tracked and reported unless the malfunction prevents one of the parameters shown in Table 5 from being determined. All tracked data would be required to be stored in a form of memory that is non-volatile. The proposal would require the stored data to not be lost in the event of loss of power to the controller(s) involved in tracking.

Bin 1 is the total value of a parameter and is equal to the sum of the values in Bins 2 through 14, which are defined by vehicle speed and percent of rated power. Together, the data contained in Bins 2 through 14 cover the full range of all possible vehicle activity. The same parameter data that are stored in these bins are stored a second time in either the NTE or Regen bins whenever the associated bin criteria are satisfied. The NTE bin is for storing data whenever all NTE zone conditions are met and none of the NTE exclusions apply. NTE bin data are not tied to the 30 second minimum which defines an NTE event and instead are updated at a frequency of 1 Hertz as with the other bins. The Regen bin's parameter data are updated whenever the engine is commanding a PM filter regeneration event. Specifically, this bin is for high-temperature active regeneration events (oxygen-based soot oxidation) and not low-temperature regeneration events (catalyst-based soot oxidation).

Rationale: Staff's proposal to add the NOx emission and engine activity tracking requirements described above is motivated by a need to better understand real-world, in-use emissions from heavy-duty vehicles and to have a screening tool for quickly identifying vehicles which may have an emissions-related problem that merits further investigation. This is part of an ongoing effort to bring REAL to the fleet for in-use emissions performance evaluation. Although late model heavy-duty diesel engines are all certified to stringent emission standards, there is concern over how well performance in the certification test cell translates to performance on the road. This new tool will not only track real world emissions performance now, but will inform future mobile source program evolution to promote the development and implementation of more effective programs to attain air quality and climate change goals.

One recent CARB project serves to highlight this concern. In the project, 68 trucks with SCR systems were equipped with data-logging devices that collected a wide range of publicly-available OBD data. Using parameters like NOx sensor concentration, air flow rate, fuel consumption, engine speed, and torque, staff estimated NOx mass emission rates. Results are shown in Figure 1, below. Each bar in the figure represents the average NOx emission rate of an engine over at least one month of operation. Many trucks appear to have NOx emissions rates that are far above the 0.2 g/bhp-hr certification standard. Although emission rates of NOx are influenced by the specific duty cycle of the engine, large discrepancies from the certification standard over substantial blocks of vehicle activity are nevertheless cause for concern.

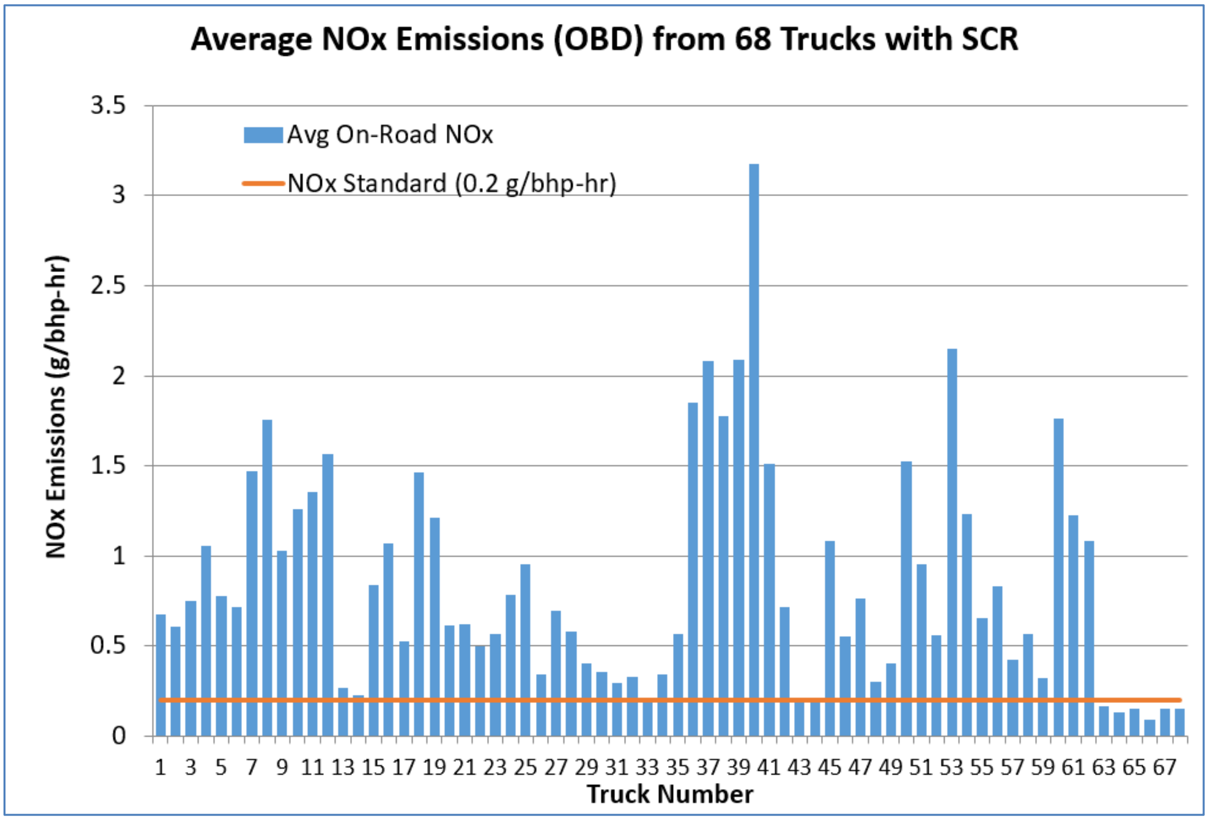



Figure 1

Having emission data of this nature on a much larger population of diesel vehicles would be of great value in CARB's efforts to understand and control real-world emissions. Such data would provide rapid feedback on the effectiveness of certification procedures and OBD systems as well as enhance the accuracy of CARB's emissions inventory. As already indicated above, the proposed data could be used by CARB staff as a screening tool. CARB will not make a determination that a vehicle does not comply with a specific regulation based only on these data. CARB, however, may use the data to conduct further investigation of a specific vehicle that may or may not lead to an enforcement case. Tracked NOx data could be used to identify patterns of high emissions that may exist in a specific engine family, thereby making possible a more targeted in-use compliance testing program. Such data would not be directly used in making compliance determinations.

Given the relative ease with which NOx mass emissions can be estimated using hardware that engines already employ and OBD data that engines already support, it is both highly feasible and reasonable to require each engine to estimate and track its own emissions. The key enabling technology, the NOx sensor, is already being used on all SCR system-equipped diesel engines as an input to both the reductant dosing system and the diagnostic system that assess the health of the SCR catalyst. Furthermore, the NOx concentration that is measured by an engine's NOx sensors and the exhaust mass flow rate are both data stream parameters that must already be supported in today's diesel engines. As shown in the rationale for section 1971.1(h)(5.3.4) below, by using these two parameters alone, it is possible to arrive at a simple estimate of NOx mass that is reasonably accurate relative to standard laboratory and PEMS measurements.

In addition to estimating and tracking the mass of NOx emitted into the atmosphere, staff's proposal includes several other parameters of interest. The mass of NOx emitted by the engine upstream of the SCR system is valuable to track because it gives insight into engine behavior and the effectiveness and health of the SCR catalyst. The engine output energy, distance traveled, engine run time, and fuel consumption are activity related parameters that provide the necessary context for the NOx mass emissions data. They allow the NOx mass to be expressed as different forms of emission rates, such as g/bhp-hr or g/mile.

The bin structure associated with staff's proposal is designed to sort emissions and activity data into different windows of vehicle operation to allow for a more detailed understanding of a vehicle's NOx emissions. Bins 2 through 14 are defined by windows of vehicle speed and engine power output that cover the full range of vehicle operation. Sorting the tracked data accordingly would, for example, allow staff to evaluate the significance of low speed, low load operation relative to high speed, high load operation. It would also help to point out areas of vehicle activity where more attention should be focused to achieve the greatest real-world benefits from further emission control efforts. The NTE bin is defined by the same criteria used for in-use compliance testing. As such, the data stored in the NTE bin would provide some indication as to whether a given vehicle may be having trouble meeting in-use standards. The Regen bin would only be used to store data when the engine commands an active PM filter regeneration event. During such events, NOx emissions tend to be significantly higher than during normal operation and they must be accounted for at the time of certification. The data in the Regen bin would provide real-world feedback on the amount of time spent in regeneration relative to overall engine operation as well as the level of NOx emissions. Such data would help staff to evaluate the usefulness and accuracy of certification procedures and potentially point out areas that need improvement.

Staff is proposing that all of these new data parameters be stored in non-volatile random access memory (NVRAM) within one of the vehicle's onboard computers used for engine control. This type of memory storage would prevent the data from being erased during routine service events and help to ensure that a useful amount of data are available at the time of request.

In response to staff's NOx tracking proposal, manufacturers have argued that such data are not related to OBD systems and are beyond the scope of OBD. As such, they believe that CARB does not have the authority to adopt these requirements in the OBD regulations. However, the NOx tracking proposal may be viewed as the basis for a possible future OBD monitor proposal. Today, manufacturers are only required to monitor the SCR conversion efficiency and dosing performance once per drive cycle. Since good SCR performance is needed virtually continuously, this limited monitoring requirement may not be sufficient to represent all in-use driving conditions. With the NOx binning and tracking data, a future proposal could be developed for an SCR target threshold for each bin, which would provide the means for a continuous SCR monitoring requirement. Therefore, staff views the NOx binning and tracking proposal as being directly relevant to the goals of the OBD program. Incidentally, staff originally adopted continuous monitoring requirements for the SCR system dosing performance when the HD OBD regulation was first adopted in 2005. However, staff had to relax the requirement during the 2012 HD OBD regulation update to a once-per-trip monitoring frequency in order to address manufacturers' concerns regarding technical feasibility. With the knowledge gained over the last decade in NOx control and SCR catalyst design, staff will be looking to improve the SCR monitoring requirements and make the SCR monitors subject to continuous monitoring conditions.

**1971.1(h)(5.3.4)**: Staff is proposing that the engine-out and tailpipe NOx mass parameters that would be calculated by the OBD system to fulfill the requirements in section 1971.1(h)(5.3) and data stream requirements in section 1971.1(h)(4.2) would be required to not have an error of more than 20 percent, or alternatively 0.10 g/bhp-hr. Manufacturers would be required to report the most accurate values that are calculated within the applicable electronic control unit. These NOx mass values must furthermore be calculated using the most accurate NOx concentration and exhaust flow rate values that are calculated within the applicable electronic control unit. Manufacturers must not include a humidity correction factor when calculating NOx mass. The Executive Officer would determine compliance with this requirement by comparing data from the OBD system and the test facility that the manufacturer would submit as described in section 1971.1(j)(2.26). Specifically, the Executive Officer would 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.

Rationale: Staff is proposing a NOx mass accuracy specification to support the NOx emission tracking proposal described above. Given the importance of the NOx mass data that each heavy-duty diesel engine will track, basic requirements need to be established to ensure that manufacturers choose NOx mass calculation methods that are accurate.

Staff's accuracy specification of an error of no more than 20 percent or alternatively 0.10 g/bhp-hr is not a technology-forcing requirement because it reflects the capability of current technology.  Presented in Table 7 below are NOx emissions test data (primarily from CARB's Truck and Bus Surveillance Program) that span 11 different engines, 3 engine makes, and 4 displacements.  The table compares NOx emission rates that were measured by laboratory instrumentation with estimates based on NOx sensor and other OBD data.  Figure 2 shows these data graphically side by side.  Test data from older trucks with no OBD systems, one engine with a NOx sensor malfunction, and two engine families with large ammonia slip problems were excluded from this analysis.  Although NOx sensors have the shortcoming of being cross-sensitive to ammonia, most heavy-duty diesel engines have low ammonia emissions owing to conservative DEF dosing calibrations and the widespread use of ammonia slip catalysts.  This is evidenced by the generally good correlation between NOx sensors and laboratory-grade analyzers that CARB staff has observed in various truck testing programs.  The results of this analysis indicate that all test runs in Table 7 comply with either the proposed 20 percent error limit or the 0.10 g/bhp-hr limit, and some test runs comply with both limits.

The NOx emission calculations based on OBD data in Table 7 relied on tailpipe NOx sensor concentration data and flow rate parameters supported by the engine control unit.  Staff used the simple equation shown below to calculate the NOx mass emission rate on a second-by-second basis over the test cycle:

$$NOx\left(\frac{g}{s}\right) = 0.001588 * [NOx]\text{ppm} * \text{Exhaust Flow}\left(\frac{\text{kg}}{\text{hr}}\right) * \frac{1}{3600}$$

Depending on the engine make, the exhaust flow was either the sum of intake air and fuel mass flow rates or, if supported by the engine, the calculated exhaust mass flow rate itself.  Only test runs 6 and 7 used exhaust flow data measured by the laboratory because flow data from the engine were not included on the log file.  The constant 0.001588 is the ratio of the molecular weight of $NO_2$ (46.01 grams per mole (g/mol)) to the molecular weight of air (28.97 g/mol) divided by 1,000 for consistency in units.  No humidity correction was made, and as such a humidity correction was not applied to the laboratory data used in this analysis.  Also, no special steps were taken for better time alignment of the NOx concentration data with the flow rate data.  Despite the simplicity of this approach, the OBD-based results tracked fairly well with the laboratory results and none of the test runs had error that exceeded both of the proposed limits.

Table 7. Comparison of Laboratory and OBD NOx Emissions Data

| **Test Run #** | **Engine Make** | **Truck or Engine #** | **Model Year** | **Test Cycle** | **Lab NOx** g/bhp-hr | **OBD NOx** g/bhp-hr | **Error** % | **Error** g/bhp-hr |
|---|---|---|---|---|---|---|---|---|
| 1 | A | 1 | 2014 | UDDS | 0.511 | 0.593 | 16% | 0.082 |
| 2 | A | 2 | 2014 | UDDS | 0.266 | 0.335 | 26% | 0.069 |
| 3 | A | 2 | 2014 | UDDS | 0.399 | 0.476 | 19% | 0.077 |
| 4 | A | 3 | 2014 | UDDS | 0.099 | 0.106 | 7% | 0.006 |
| 5 | A | 3 | 2014 | UDDS | 0.130 | 0.182 | 40% | 0.052 |
| 6 | A | 4 | 2014 | UDDS | 0.181 | 0.195 | 8% | 0.014 |
| 7 | A | 4 | 2014 | UDDS | 0.174 | 0.226 | 30% | 0.052 |
| 8 | A | 4 | 2014 | UDDS | 0.165 | 0.201 | 21% | 0.035 |
| 9 | B | 5 | 2014 | Hot FTP | 0.046 | 0.061 | 33% | 0.015 |
| 10 | B | 5 | 2014 | Cold FTP | 0.754 | 0.827 | 10% | 0.073 |
| 11 | C | 6 | 2015 | UDDS | 0.826 | 0.853 | 3% | 0.027 |
| 12 | C | 6 | 2015 | UDDS | 1.109 | 1.104 | 0% | -0.005 |
| 13 | C | 7 | 2013 | UDDS | 1.864 | 2.128 | 14% | 0.264 |
| 14 | C | 8 | 2013 | UDDS | 2.494 | 2.638 | 6% | 0.144 |
| 15 | C | 9 | 2013 | UDDS | 1.365 | 1.490 | 9% | 0.126 |
| 16 | C | 10 | 2014 | UDDS | 1.134 | 1.131 | 0% | -0.003 |
| 17 | C | 11 | 2014 | UDDS | 1.381 | 1.612 | 17% | 0.231 |

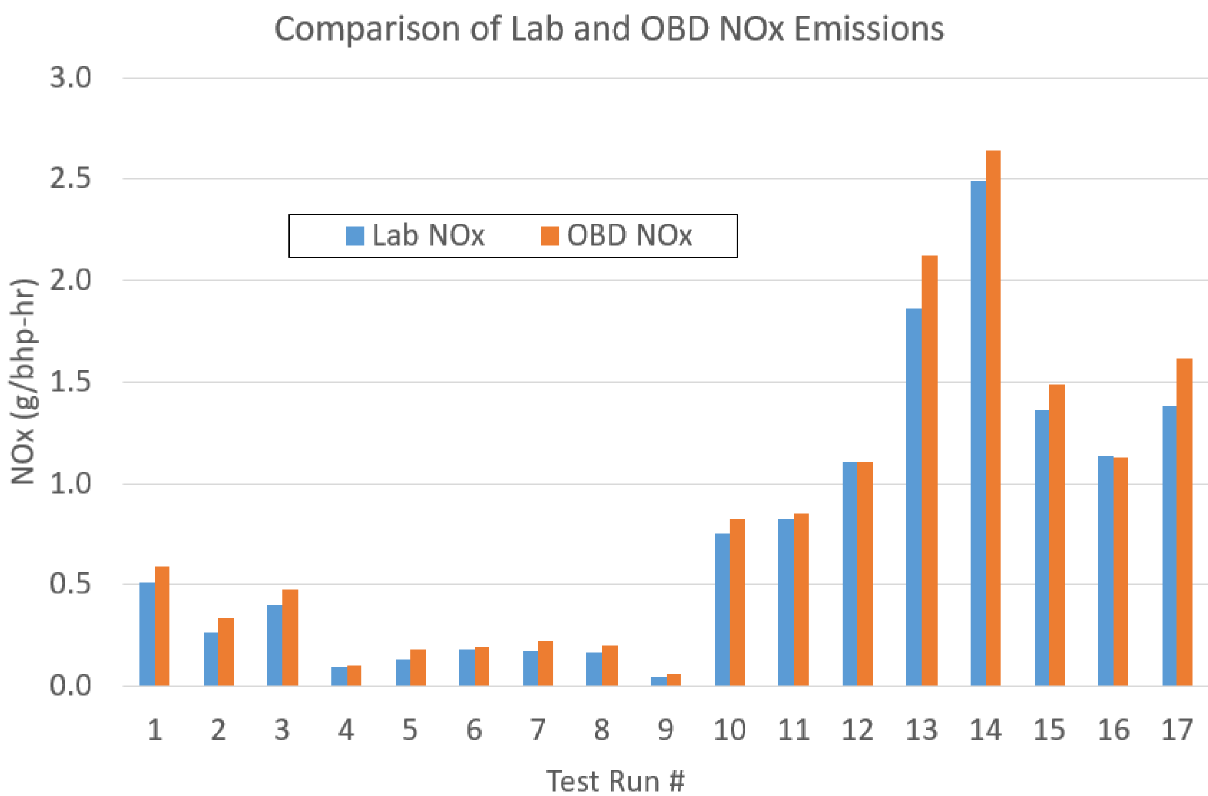



Figure 2.

The accuracy of NOx mass emissions estimates based on NOx sensors was also the subject of a recent heavy-duty diesel vehicle test program conducted by West Virginia University researchers[5]. The study compared NOx mass estimates based on simultaneous measurements using a NOx sensor, a Semtech PEMS system, and a Fourier Transform Infrared (FTIR) gas analyzer during on-road driving. Figure 3, below, shows the NOx mass emission rates determined using these three methods over 16 different NTE events. The researchers found that the NOx sensor results (represented by the red columns) differed from the FTIR results by 11.4% on average and differed from the PEMS results by 14.8% on average. This level of agreement is further evidence that OBD data can provide a meaningful estimate of real-world NOx emissions levels and that the proposed accuracy specification is representative of what today's technology can achieve.

[5] Demirgok, B., Besch, M., Ryskamp, R., Pradhan, S., Thiruvengadam, A., Carder, D., and Quiros, D. "Assessment of the Measurement Thresholds and Cross-sensitivity of On-board NOx Sensors to Evaluate Real-time NOx Emissions Rates". Presented at the 28th CRC Real World Emissions Workshop, March 18-21, 2018, Garden Grove, California.

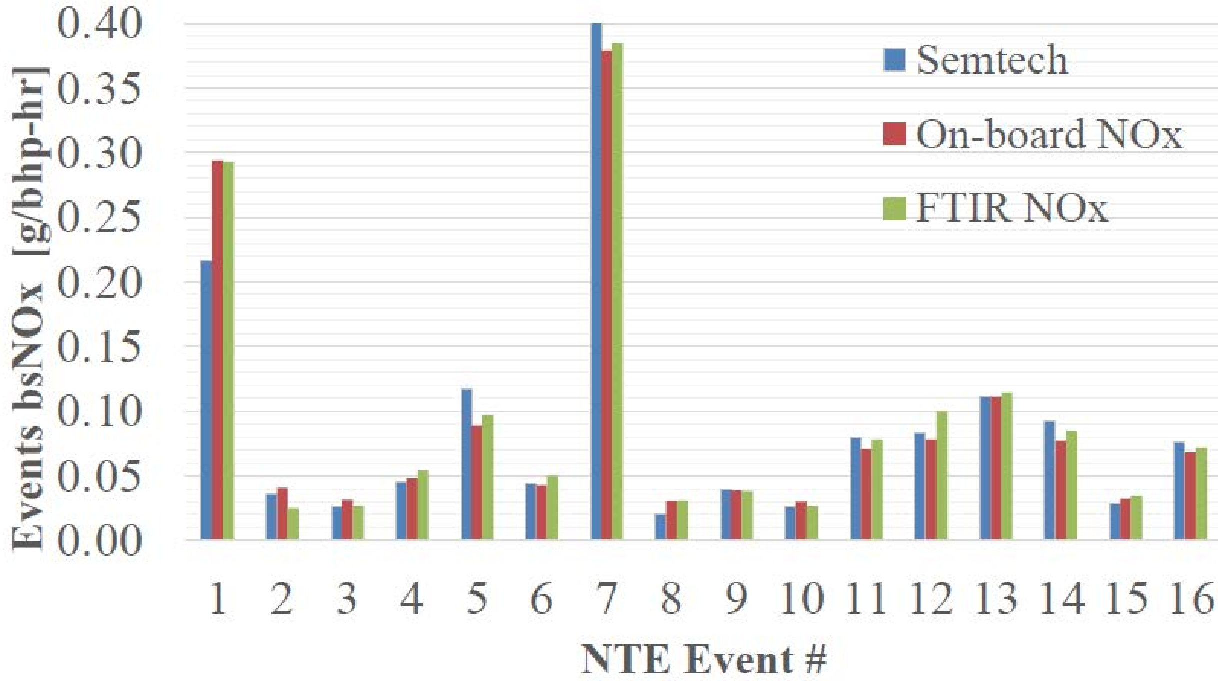



Figure 3.

Together with the proposed accuracy specification, staff is also proposing that manufacturers submit data demonstrating compliance with the specification. This part of staff's proposal is described in more detail in the section 1971.1(j)(2.26). Manufacturers would be required to submit NOx mass emission rate data generated by both the OBD system and the certification test cell over the same test run, and would have a choice of using either the hot-start FTP or UDDS cycle for engine and chassis dynamometer-based testing, respectively. The choice would be limited to these two cycles because they are both standard, transient test cycles. Steady state test cycles are not sufficiently realistic to be a good test of NOx mass calculations. To ensure that all NOx sensors are actively reporting data throughout the test cycle, the test cycle must be preceded by a warm-up cycle without cycling the ignition in between the two cycles, and manufacturers would be required to collect the data over both cycles. Staff is also proposing that instead of submitting only final emissions numbers, manufacturers would submit data for the warm-up cycle and the test cycle at a resolution of at least 1 Hertz to provide a more complete picture of the performance of the OBD-based NOx values relative to test cell numbers. Data at this resolution will also help to show the OBD system's ability to properly fulfill the NOx tracking requirements which involve storing NOx mass data in bins at a frequency of 1 Hertz.

Staff proposes to use the submitted OBD and emissions test data to determine if the OBD system complies with the proposed accuracy specification as it relates specifically to the tailpipe NOx mass parameter. Staff would sum the OBD system's instantaneous output of tailpipe NOx mass emission rate values over the test cycle and compare the total with the total NOx measured by the test facility over the test cycle to determine if the OBD system complies with the proposed specification. Staff would use the 1 Hertz data collected over the warm-up cycle to verify NOx sensor activation calibration data submitted by the manufacturer. Engine-out NOx mass is not a quantity that is normally measured during certification testing, and so staff is not proposing that manufacturers submit engine-out NOx test cell data as part of certification. Instead, manufacturers would only submit the instantaneous engine-out NOx mass emission rate data as estimated by the OBD system. This would allow staff to confirm that the OBD system supports the engine-out NOx mass emission rate parameter and that the parameter behaves logically over the transient test cycle.

**1971.1(h)(5.3.6)**: Staff is proposing language indicating the data specified in section 1971.1(h)(5.3) would reflect vehicle operation that may not correspond to regulated test procedures, thus the data cannot be used to determine compliance with other requirements such as the applicable standards for NOx. Instead, the language would indicate that compliance with the applicable standards for NOx emissions for heavy-duty diesel engines and vehicles would be determined in accordance with the applicable standards and test procedures applicable to the test cycle.

Rationale: The language is needed to address manufacturers' concerns about how the data required to be tracked and reported under section 1971.1(h)(5.3) would be used by CARB staff. Specifically, manufacturers have indicated that concerns that the data may be used to determine compliance with specific standards such as the NOx emission standards, even though the conditions under which the data were obtained differ from the official test procedures used to determine compliance with the emission standards. As mentioned above, staff's proposal to add the NOx emission and engine activity tracking requirements is motivated by a need to better understand real-world, in-use emissions and to have a screening tool for quickly identifying vehicles which may have an emissions-related problem that merits further investigation. Thus, for the initial implementation years of the NOx data tracking proposal, CARB does not intend to determine emission standard compliance or seek enforcement action based solely on these data. Therefore, staff is proposing the language in section 1971.1(h)(5.3.6) to address this. However, in the future, CARB intends to develop compliance procedures based on an evolution of the proposed NOx tracking data in a future regulatory action for implementation on 2027 and subsequent model year engines.

**1971.1(h)(5.4), (5.5), (5.6), and (5.7)**: Starting with 2022 model year heavy-duty engines, staff is proposing that manufacturers track and report data that would help characterize vehicle $CO_2$ emissions in the real world. The data stored would be aggregated over three time periods labeled: "active 100 hour," "stored 100 hour," and "lifetime." The "active 100 hour" data value would represent the parameter value over the current less-than-100 hours of operation, whereas the "stored 100 hour" data value would represent the parameter value over the last complete 100 hours of operation. Lastly, the "lifetime" data value would represent the cumulative parameter value aggregated since the engine was first operated after production. Table 8 "GHG Tracking Parameters," Table 9 "Additional GHG Tracking Parameters for Hybrids," and Table 10 "Additional GHG Tracking Parameters for Plug-in Hybrids" provide a complete listing of the data parameters staff is proposing. Appendix E provides a more complete description of each proposed parameter. The number associated with each parameter identified in Tables 8, 9, and 10 corresponds to the identification number in Appendix E. Additionally, as mentioned above in section 1971.1(h)(4.2), staff is proposing that the speed limit for the vehicle speed limiter (VSL) technology (the VSL speed limit) and the engine family be stored and reported for all vehicles. Staff is proposing that all of these new data parameters be stored in NVRAM. This type of memory storage would prevent the data from being erased during routine service events and help to ensure that a useful amount of data are available at the time of request.

Regarding Table 8, "PTO" refers to power takeoff, "WHR" refers to waste heat recovery, "Active Tech" refers to active technology, and "PKE" refers to positive kinetic energy.

Table 8: GHG Tracking Parameters

| | Fuel Consumption | Distance traveled | Energy Output | Run Time | Technology Activation Count |
|---|---|---|---|---|---|
| Active 100 Hour | (1[1] Engine)<br>(10 Idle)<br>(18 PTO)<br>(33 Vehicle) | (24 WHR)<br>(36 Vehicle)<br>(45 Active Tech) | (4 Engine)<br>(27 WHR)<br>(39 PKE) | (7 Engine)<br>(8 Idle)<br>(13 Urban)<br>(16 PTO)<br>(21 WHR)<br>(30 Stop/Start)<br>(42 Active Tech) | (48 Automatic Engine Shutdown) |
| Stored 100 Hour | (2 Engine)<br>(11 Idle)<br>(19 PTO)<br>(34 Vehicle) | (25 WHR)<br>(37 Vehicle)<br>(46 Active Tech) | (5 Engine)<br>(28 WHR)<br>(40 PKE) | (9 Idle),<br>(14 Urban)<br>(17 PTO)<br>(22 WHR)<br>(31 Stop/Start)<br>(43 Active Tech) | (49 Automatic Engine Shutdown) |
| Lifetime | (3 Engine)<br>(12 Idle)<br>(20 PTO)<br>(35 Vehicle) | (26 WHR)<br>(38 Vehicle)<br>(47 Active Tech) | (6 Engine)<br>(29 WHR)<br>(41 PKE) | (15 Urban)<br>(23 WHR)<br>(32 Stop/Start)<br>(44 Active Tech) | (50 Automatic Engine Shutdown) |

1. Number corresponds to parameter number in Appendix E

Table 9: Additional GHG Tracking Parameters for Hybrids

| | Activation Time |
|---|---|
| Active 100 Hour | (75[1] Propulsion System Active)<br>(78 Propulsion System Active Idle)<br>(81 Urban Propulsion System Active) |
| Stored 100 Hour | (76 Propulsion System Active)<br>(79 Propulsion System Active Idle)<br>(82 Urban Propulsion System Active) |
| Lifetime | (77 Propulsion System Active)<br>(80 Propulsion System Active Idle)<br>(83 Urban Propulsion System Active) |

1. Number corresponds to parameter number in Appendix E

Table 10: Additional GHG Tracking Parameters for Plug-in Hybrids

| | Fuel Consumption | Distance traveled | Energy Output |
|---|---|---|---|
| Active 100 Hour | (60[1] Charge depleting)<br>(66 Charge increasing/driver selectable) | (51 Charge depleting/Eng. Off)<br>(54 Charge depleting/Eng. On)<br>(57 Charge increasing/driver selectable) | (66 Grid Energy Consumed/Charge depleting/Eng. off)<br>(69 Grid Energy consumed/Charge depleting/Eng. on)<br>(72 Grid Energy into Battery) |
| Stored 100 Hour | (61 Charge depleting)<br>(64 Charge increasing/driver selectable) | (52 Charge depleting/Eng. Off)<br>(55 Charge depleting/Eng. On)<br>(58 Charge increasing/driver selectable) | (67 Grid Energy Consumed/Charge depleting/Eng. off)<br>(70 Grid Energy consumed/Charge depleting/Eng. on)<br>(73 Grid Energy into Battery) |
| Lifetime | (62 Charge depleting)<br>(65 Charge increasing/driver selectable) | (53 Charge depleting/Eng. Off)<br>(56 Charge depleting/Eng. On)<br>(59 Charge increasing/driver selectable) | (68 Grid Energy Consumed/Charge depleting/Eng. off)<br>(71 Grid Energy consumed/Charge depleting/Eng. on)<br>(74 Grid Energy into Battery) |

1. Number corresponds to parameter number in Appendix E

Rationale: The proposed data would be used to help verify that the advanced vehicle and powertrain technologies being deployed to meet CARB's stringent GHG emission standards actually deliver the expected GHG benefits and consumer fuel savings in the real world. As with the NOx tracking parameters, these GHG parameters are an application of the REAL concept, which aims to track and report real-world performance of emissions-control technologies. These proposed GHG parameters would be stored within the vehicle's own engine control unit in an aggregate format— not second-by-second or even trip-specific data — to allow CARB to quantify the overall $CO_2$ performance of these new engine and vehicle technologies. The data would not contain any information regarding how an individual vehicle was being operated during any given time period or during any specific trips. Further, the data would specifically not include any information that could be used, directly or indirectly, to identify a vehicle's current or past location or any data that could be used to identify current or past vehicle operation in excess of speed limits or any other traffic law. The data could either be accessed from the vehicle by physically plugging a generic scan tool into the diagnostic connector or remotely while the vehicle is on.

For all heavy-duty engines, staff is proposing that the data include the following parameters for all three time periods where specified (active 100 hour, stored 100 hour, and lifetime): vehicle distance traveled, vehicle fuel consumed, engine fuel consumed, engine idle fuel consumed, fuel consumed while PTO is active, PKE, calculated engine output energy, engine run time, idle run time, urban run time, and PTO active time. These data are specifically targeted to quantify the fuel consumption and $CO_2$ performance of the engine and vehicle and can be compared to the certified $CO_2$ emission standards. For engines, the $CO_2$ emission standard is expressed in grams ($CO_2$)/brake-horse power-hour (g($CO_2$)/bhp-hr)). By tracking engine fuel consumption and output energy, direct comparison of the engine's real-world fuel consumption and $CO_2$ performance to its certification emission limit is possible. For vehicles, $CO_2$ performance is assessed in the Greenhouse Emissions Model (GEM). GEM is a computer simulation platform that can model a wide variety of heavy-duty vehicles. For combination tractors and vocational vehicles, GEM utilizes three drive cycles including a transient cycle and two cruise speed cycles. For vocational vehicles, two additional idle cycles are used, one simulating parked idle and the other idling in traffic. The vehicle standard is expressed in g($CO_2$)/ton-mile. As such, direct comparison of $CO_2$ performance assessed by GEM to the vehicles' performance data would be limited to those vehicles with known loads.

Additionally for all hybrid vehicles (including plug-in hybrid electric vehicles), staff is proposing that the data include the following parameters over all three time periods: propulsion system active time, idle propulsion system active time, and urban propulsion system active time. Further, for plug-in hybrid electric vehicles, staff is proposing the following additional parameters over all three time periods: distance traveled in charge depleting operation with the engine off, distance traveled in charge depleting operation with the engine on, distance traveled in driver-selectable charge increasing operation, fuel consumed in charge depleting operation, fuel consumed in driver-selectable charge increasing operation, grid energy consumed in charge depleting operation with the engine off, grid energy consumed in charge depleting operation with the engine on, and grid energy into battery. Such data are essential for understanding the $CO_2$ emissions from plug-in hybrid electric vehicles as they are being used in the real world and to inform future rulemaking changes regarding their GHG benefits.

To better understand how "active" Phase 2 engine and vehicle $CO_2$ emission control technologies are impacting fuel consumption and $CO_2$ emissions, staff is proposing that the data be collected when these technologies are activated. An “active technology” is one that is either activated by the driver or the vehicle for the purpose of reducing fuel consumption and $CO_2$ emissions.  Since some active technologies may operate independent of the engine control system and may not be monitored by the OBD system, staff is proposing that data collection only be required for those active technologies that are either controlled by the engine ECU or monitored by the OBD system.  Examples include systems with cylinder deactivation controlled by the engine control unit, intelligent control technology (e.g., predictive cruise control) activated by the driver, active aerodynamic technology, vehicle speed limiter technology, and driver-selectable hybrid modes (e.g., eco mode, sport mode, mountain mode).  For engines and vehicles equipped with these technologies mentioned, staff is proposing that these vehicles include the following data over all three time periods: ”Active Technology” run time and distance traveled while “Active Technology” is active. There are three active technologies that staff has identified separate parameters for:  WHR, Stop-Start, and automatic engine shutdown.  For WHR, not only distance traveled and run time data are collected over the three time periods, as with all active technologies, but WHR energy output data is being collected as well.  For stop-start, only run time is being collected over all three time periods. Lastly for automatic engine shutdown count, only the number of times the automatic engine shutdown is activated is being tracked for over all three time periods.

For vehicles equipped with active technologies that have not been specifically identified, staff is proposing that these vehicles include data that would be structured similar to how EI-AECDs are currently logged in medium- and heavy-duty diesel vehicles, with some modifications.  For each active technology employed by a given vehicle, the manufacturer will assign a number (e.g., Active Technology #1, Active Technology #2, Active Technology #n) and report that assignment to CARB as part of the confidential information submitted at the time of certification.  These data would provide the vehicle distance traveled and run time while the active technology is active.

Staff is proposing that all of these new data parameters be stored in NVRAM within one of the vehicle’s onboard computers used for engine control.  This type of memory storage would prevent the data from being erased during routine service events and help to ensure that a useful amount of data are available at the time of request.

As noted, these proposed data would primarily be used to characterize the engine or vehicle’s $CO_2$ emissions in the real world.  As CARB and its partner federal agencies have adopted increasingly stringent $CO_2$ and fuel consumption standards, vehicle manufacturers are introducing new engine and vehicle technologies to reduce $CO_2$ emissions.  Further, manufacturers are charging higher incremental prices to consumers for these technologies and consumers are choosing these technologies based on expectations that the fuel savings will more than offset the higher incremental costs.  These data would help staff better understand how Phase 2 technologies are impacting fuel consumption and $CO_2$ emissions in the real world and could be used to identify technologies that should be explored further by CARB or its partner federal agencies for compliance with the standards.

CARB also anticipates using such data for other purposes, including the development of future $CO_2$ tailpipe standards that would better ensure real world reductions are achieved, the development of future plug-in hybrid electric vehicle regulations that more accurately represent the emission reductions these vehicles achieve, and improvement of GHG inventory models utilized by CARB to accurately project benefits from current and future regulatory measures being considered when planning for compliance with the California's GHG goals. There is a significant need for current real-world $CO_2$ data because many of the studies done previously are out of date and therefore may not accurately represent today's vehicle technology and vehicle use. Thus, ongoing survey of the real-world fuel consumption and $CO_2$ emissions of heavy-duty vehicles is of paramount importance. Once $CO_2$ data parameters are established, CARB staff anticipates establishing a voluntary program where truck fleets would use telematics to communicate $CO_2$ parameter data to CARB on a day-to-day basis. CARB staff would analyze this data and report any conclusions that can be drawn on the effectiveness of engine and vehicle technologies in reducing $CO_2$ emissions. The proposed vehicle and fuel usage parameters would make such ongoing surveys possible.

These data could also be used by vehicle owners, repair technicians, and engine/vehicle manufacturers. Vehicle owners may benefit from such data by being able to better verify the fuel consumption rates of their vehicles. Repair technicians could use the data to help diagnose and repair faults or complaints of increased fuel consumption. Engine/vehicle manufacturers could also use the data to obtain more accurate data about the fuel consumption performance of their engines/vehicles or to assist them in providing data from actual in-use engines/vehicles.

**1971.1(h)(5.8)**: Staff is proposing that for 2022 and subsequent model year diesel engines, manufacturers track and report the distance since the last 3 PM filter regeneration events and a lifetime counter of PM filter regeneration events.

Rationale: The proposed PM filter regeneration parameters would improve the ability of technicians and CARB staff alike to track the in-use activity and performance of engine manufacturers' regeneration strategies. Information on when the last 3 regeneration events occurred would shed light on the recent behavior and condition of the engine. The lifetime counter of regeneration events would provide an overall picture of regeneration frequency for the engine that could be compared to recent behavior. It would also provide CARB staff with real-world data that could be compared against manufacturers' estimated regeneration frequency factors that are part of the IRAF calculations used in the certification process.

**1971.1(h)(6)**: Staff is proposing changes related to the preservation of vehicle and engine tracking data when over-the-air (OTA) reprogramming technology is used. Specifically, if any of the data stored pursuant to section 1971.1(h)(5) would be erased as a result of an OTA reprogramming event on 2022 and subsequent model year engines, the manufacturer would be required to first collect all of the data required to be stored by the section. The manufacturer would further be required to submit a data record to CARB indicating the average value and standard deviation of each required parameter for each affected engine family. The proposal would require manufacturers to submit the report within 60 calendar days of the availability of the update. Details on how the data records are to be created, formatted, and submitted are included in a separate document incorporated by reference in section 1971.1(h)(6), entitled, “Data Record Reporting for Over-the-Air Reprogrammed Vehicles and Engines.”

Rationale: OTA reprogramming events are designed to take place remotely and automatically without the need of a technician or for the vehicle to be at a service facility. For some vehicle designs, these reprogramming events will result in the erasure of all OBD-related information stored in the reprogrammed on-board controller. Based on the relative simplicity in updating vehicle programming with OTA technology, the potential for more frequent updates of on-board computer programming clearly exists. Staff is concerned that the average vehicle designed to support OTA reprogramming might, at any given time, have accumulated only minimal vehicle activity tracking data since the last reprogramming event if the data are cleared during such events.

The staff’s proposed amendment would require manufacturers to use the OTA network to first collect the vehicle tracking data required to be stored under section 1971.1(h)(5) before the reprogramming event takes place. The manufacturer would then provide CARB with an aggregated snapshot of the data parameters from affected vehicles. This data record would include the average value and standard deviation of key data parameter combinations. The availability of these data records would assist CARB staff in analyzing the vehicle performance characteristics the parameters address when they would otherwise be lost at possibly an unacceptably high frequency. Manufacturers of vehicles that are designed to retain the accumulated data when the software is updated would not be required to compile and submit the data. CARB staff believes that the collection, compilation, and submission of the data could be largely automated within the manufacturers OTA reprogramming systems.

**Section 1971.1(i): Monitoring System Demonstration Requirements for Certification**

**1971.1(i)(1.4)**: Staff is proposing to require manufacturers of alternate-fueled engines to submit a demonstration testing plan for Executive Officer approval, indicating the monitors that manufacturers would test and the appropriate fuel or fuel combinations that manufacturers would use for each monitor test.

Rationale: This new proposed language is needed since alternate-fueled engines may utilize both gasoline and diesel emission control technologies and thus may not cleanly fit under just the gasoline requirements or just the diesel requirements. The proposal complement the proposed requirements in section 1971.1(d)(8.1) and would ensure manufacturers of these engines are meeting the correct testing requirements in the regulation.

**1971.1(i)(1.5)**: Staff is proposing to require manufacturers of engines that are equipped with components/systems defined by any of the monitoring requirements in sections (e) and (f) to submit a demonstration testing plan for Executive Officer approval, indicating the monitors that manufacturers would test with respect to the components and systems on the vehicle and the monitoring plan approved by the Executive Officer in accordance with section 1971.1(d)(8.2).

Rationale: This new proposed subsection is needed since these vehicles may utilize both gasoline and diesel emission control technologies and thus may not cleanly fit under just the gasoline requirements or just the diesel requirements. The proposal would ensure they are meeting the correct testing requirements in the regulations.

**1971.1(i)(2.3.3)**: Staff is proposing to change the applicable model year engines that would be required to meet the aging and data collection requirements of this section from 2016 and subsequent model year engines to 2016 through 2021 model year engines.

Rationale: The proposed changes are needed to complement the new proposed aging and data collection requirements for 2022 and subsequent model year engines in section 1971.1(i)(2.3.4).

**1971.1(i)(2.3.4)**: The staff is proposing specific requirements that the manufacturer-submitted accelerated aging process would be required to meet for 2022 and subsequent model year diesel engines. Specifically, staff is proposing that the accelerated aging proposals would need to, at a minimum, include the following:

1) A minimum system (engine, engine emission controls, aftertreatment) accelerated aging process aging time of 2,500 hours for heavy heavy-duty engines, 1,063 hours for medium heavy-duty engines, and 632 hours for light heavy-duty engines.
2) Operation at rated horsepower.

3) Operation at load levels greater than 80 percent of the rated torque, with sustained intervals at 100 percent of the rated torque.
4) Operation over transient conditions.
5) The calculated number of regeneration events experienced over full useful life.
6) Thermal cycling events (i.e., system shut down with a subsequent cold start). These thermal cycling events shall not be included in the minimum aging hours.

In addition, the system fuel burn rate, the calculated total fuel consumed over full useful life, and the calculated amount of reductant used by the system over full useful life would be used as metrics to determine whether the proposed accelerated aging process is sufficient in replicating a full useful life system.

Rationale: The HD OBD regulation currently requires, for testing of 2016 and subsequent model year diesel engines, a manufacturer to use a system (engine, engine emission controls, and aftertreatment) aged by an Executive Officer-approved accelerated aging process to be representative of full useful life. Manufacturers are required to collect emission and deterioration data from an actual high mileage system(s) (consisting of the engine, engine emission controls, and aftertreatment) to validate its accelerated aging process. This should include validation of all adaptation/learning parameters implemented by the manufacturer to maintain emission control performance to the applicable emission certification standard over the life of the system.

The proposed clarifications would address shortcomings found in accelerated aging proposals currently being submitted by manufacturers. Manufacturers have submitted accelerated aging proposals which they deemed to be sufficient in replicating a system (engine, emission controls, aftertreatment system) that is representative of a full useful life system. However, upon review of the proposals, staff have found that important aging conditions were absent. For example, manufacturers did not subject their systems to the same number of calculated PM filter regeneration events as those experienced over full useful life. PM filter regeneration events result in aftertreatment system temperatures higher than those experienced during operation when a PM filter regeneration event is not active. The higher temperatures degrade and deteriorate the aftertreatment system at a faster rate. Over full useful life, the accumulated effects of the degradation and deterioration result in an aftertreatment system functioning at a lower performance level than when the system was new. By excluding this degradation and deterioration in accelerated aging proposals, system emission control performance will not be as stressed and results in a system that is further removed from a full useful life system. By clarifying key aging condition requirements, manufacturers' accelerated aging proposals would better replicate a system that is representative of a full useful life system. Further, it must also be emphasized that the minimum aging time is the absolute minimum aging hours the system (engine, engine emission controls, aftertreatment system) must accumulate over the proposed accelerated aging process.

**<u>1971.1(i)(3)</u>**: Staff is proposing language indicating that except as provided elsewhere in section 1971.1(i)(3), 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 1971.1(d)(6.4).

<u>Rationale</u>: The proposed language is needed to complement the newly proposed language in section (d)(6.4), which is intended for monitors that do not have specified deterioration criteria under their respective monitoring requirement sections in sections 1971.1(e) through (g) and details the component/system deterioration criteria manufacturers would be required to use when calibrating their monitors. The testing requirements under section 1971.1(i)(3) currently detail the deterioration criteria that must be met for component/system monitors that have deterioration criteria specified in their respective monitoring requirement sections. The proposed language would clarify that those monitors for which no specific deterioration criteria are mentioned in section 1971.1(i)(3) would be required to meet the deterioration criteria set forth in section 1971.1(d)(6.4).

**<u>1971.1(i)(3.1.1)</u>**: Staff is proposing to clarify the test requirements for diesel fuel system monitors. For the fuel system pressure control monitor, the proposed amendments would require manufacturers to perform a test for each of the following that is applicable: (1) with a high side fault (i.e., fault that causes too much pressure) that affects all injectors equally, (2) with a low side fault (i.e., fault that causes too little pressure) that affects all injectors equally, and (3) for systems that have single component failures that could affect a single injector, with a fault that affects the worst case injector (i.e., a fault on the injector that will result in the worst case emissions). For the fuel system injection quantity and injection timing monitors, the proposal would require manufacturers to perform a test for each of the following: (1) with a high side fault (e.g., too much fuel quantity, too advanced timing) that affects all injectors equally, (2) with a low side fault (e.g., too little fuel quantity, too retarded timing) that affects all injectors equally, and (3) with a fault that affects the worst case injector (i.e., a fault on the injector that will result in the worst case emissions).

<u>Rationale</u>: These proposed clarifications to the test procedures would help ensure that all failure modes covered by the monitor calibration requirements under section 1971.1(e)(1.2.7) are properly detected before the required emission thresholds are exceeded.

**<u>1971.1(i)(3.1.9)</u>**: Staff is proposing to change “(e)(9.2.2)(A)(i) through (ii)” to “(e)(9.2.2)(A).”

Rationale: The proposed change is needed to correct an error.

**1971.1(i)(3.1.10) and (3.2.8)**: Staff is proposing changes to address VVT systems with discrete operating states. Specifically, manufacturers of these systems would be required to test the worst-case failure mode. Manufacturer would be required to provide supporting data that were used to determine the failure mode tested is the mode that would result in the worst case emissions compared to all the other failure modes.

Rationale: Staff proposed changes in section 1971.1(e)(10.2.1), (e)(10.2.2), (f)(9.2.1), and (f)(9.2.2) clarifying that monitors of VVT systems with discrete operating states are not required to detect a malfunction before emissions exceed the required threshold, but are required to detect all failures that exceed the threshold. The current language in sections 1971.1(i)(3.1.10) and (3.2.8), however, specifically requires testing at each malfunction limit "calibrated to the emission threshold malfunction criteria." Thus, the language is not clear as to what failure mode manufacturers are required to use to test VVT systems with discrete operating states. Thus, staff is proposing changes to address these systems.

**1971.1(i)(3.1.11) and (i)(3.2.4)**: Staff is proposing language to allow manufacturers to conduct diesel and gasoline cold start emission reduction strategy monitor demonstration tests by using computer modifications to simulate malfunctions, provided manufacturers demonstrate such modifications produce test results equivalent to an induced hardware malfunction.

Rationale: Staff is proposing this language based on manufacturers' concerns about implanting faults for cold start monitor parameters such as ignition retard and staff's past experience in reviewing these tests.

**1971.1(i)(3.2.7)**: Staff is proposing modifications to the language for gasoline exhaust gas sensor monitor testing, specifically changing references to response rate malfunctions that "results in delays during transitions from rich-to-lean or lean-to-rich output" to "results in slower transitions from rich-to-lean or lean-to-rich sensor output" and indicating that these are "slow response malfunctions."

Rationale: The proposed changes are needed to ensure that manufacturers would not mistake these slow response malfunctions for delayed response malfunctions and to align the descriptions with the definition of "response rate" in section 1971.1(c).

**1971.1(i)(3.3.3)**: Staff is proposing to require manufacturers to perform baseline emission testing of the system (engine, engine emission controls, aftertreatment) before beginning the required testing in section 1971.1(i)(3.1) for diesel/compression ignition engines, section 1971.1(i)(3.2) for gasoline/spark-ignited engines, and section 1971.1(i)(3.3.1) for all engines. For engines that experience infrequent regeneration events, the manufacturer would be required to adjust the emission results using the procedure described in CFR title 40, part 86.004-28(i) (current as of August 21, 2018) on 2020 and earlier model year engines, and part 1065.680 (current as of August 21, 2018) on 2021 and subsequent model year engines.

Rationale: The proposed testing is needed to help CARB staff determine if the engine meets the aging requirements of section 1971.1(i). Specifically, the proposed baseline emission test data would be used by CARB staff to validate the manufacturer's accelerated aging process. Further, the performance of full useful life systems procured from the field could be correlated to the performance of the accelerated aged system. Manufacturers currently perform baseline emission tests of the OBD demonstration engine to ensure the system is compliant with the applicable certification emission standards before beginning the required OBD demonstration tests.

**1971.1(i)(4.1) and (4.2)**: Staff is proposing amendments to the requirements related to the test sequence when conducting HD OBD demonstration testing as required in section 1971.1(i)(3). First, staff is proposing to clearly define each part of the test sequence and specify criteria for what is allowed during each part when testing a monitor. Specifically, the newly defined test sequence include implanting of malfunction, malfunction preconditioning cycles, malfunction detection cycles, exhaust emissions preconditioning cycle, exhaust emission test, and regeneration emission test. Figure 4 below provides an illustration of the proposed test sequence for each monitor:

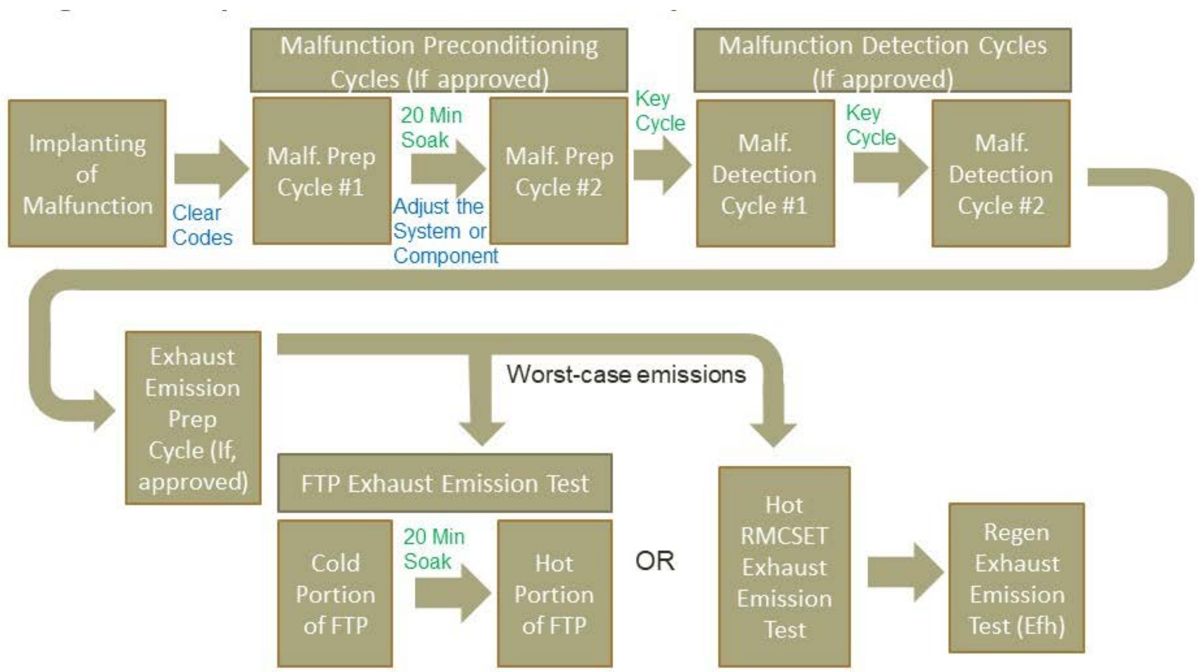



Figure 4

"Implanting of Malfunction": The proposed requirements for "implanting of malfunction" would indicate when the manufacturer is required to install the malfunctioning system or component on the test engine, and would clarify that if a second malfunction preconditioning cycle is approved, the manufacturer may adjust the system or component to be tested before conducting this cycle.

"Malfunction Preconditioning Cycles": The language would clarify that "malfunction preconditioning cycles" are only allowed for stabilization of the emission control system due to the introduction of the malfunction, and are not intended for the purpose of learning or adapting of the diagnostic (e.g., for diagnostics using exponentially weighted moving average (EWMA) strategies). Further, for engines equipped with emission controls that experience infrequent regeneration events, the language would clarify that the manufacturers are not allowed to run a manual PM filter regeneration event immediately before or any time after the malfunction is implanted, except when conducting the regeneration emission test, if the monitor requires a regeneration event to enable monitoring, or if a regeneration event is expected to occur during testing of the monitor.

"Malfunction Detection Cycles" and "Exhaust Emission Test": For diesel engines, the HD OBD regulation requires manufacturers to calibrate their emission threshold monitors using the emission test cycle and standard (the FTP or SET exhaust emission test/standard) determined to be more stringent.  However, the test cycle that the monitor can actually run on may differ from this emission test cycle/standard (e.g., the monitor may be designed to run on the SET cycle but have a malfunction threshold based on the FTP standard). Based on the test cycle the monitor is designed to run on and the applicable exhaust emission test cycle determined to be more stringent for that particular monitor, staff is proposing language to clarify how many cycles are allowed for the “malfunction detection cycle” test sequence. For example, if the monitor requires two driving cycles to illuminate the MIL, and if the monitor is designed to run on the SET cycle and the emission threshold malfunction criteria is based on the FTP cycle/standard, then the test engine would be operated over the SET cycle to allow for the initial detection of the system or component malfunction and operated over a second SET cycle to allow the OBD system to store a confirmed/MIL-on fault code and illuminate the MIL. Then the manufacturer would operate the test engine over the FTP exhaust emission test for the emissions measurements. However, if the monitor is designed to run on the FTP cycle and the emission threshold malfunction criteria is based on the FTP cycle/standard, then the manufacturer would omit the malfunction detection cycles, given that the OBD system should store a confirmed/MIL-on fault code and illuminate the MIL before the end of the FTP exhaust emission test.

“Exhaust Emission Prep Cycle”: The amendments for the exhaust emission test would clarify that manufacturers are prohibited from running additional test cycles (i.e., exhaust emission prep cycles) prior to running the exhaust emission test cycle unless the manufacturer demonstrates the additional test cycles are necessary to stabilize the emission control system.

“Regeneration Emission Test”: For engines equipped with emission controls that experience infrequent regenerations, section 1971.1(d)(6.2) requires manufacturers to adjust the emission test results to account for regeneration events. The proposed changes would clarify that for every demonstration after the exhaust emission test, manufacturers would need to collect emission results during a regeneration event and use the emission results to calculate the IRAF for that monitor. Additionally, staff is proposing to allow manufacturers to modify the test sequence such that the regeneration emission test is not immediately performed after the exhaust emission test, but instead performed at the end of section 1971.1(i) testing once all of the OBD monitor tests and exhaust emission tests have been completed.

Rationale: Currently the regulation lacks the necessary clarity in the process and allowable cycles for durability demonstration testing of a monitor. Specifically, manufacturers have posed many questions and spent a lot of time with CARB staff discussing their demonstration testing sequence proposals. Many of the demonstration testing sequence proposals included test cycles that were not approved by CARB in accordance with section 1971.1(d)(3.1.3) or too many unnecessary cycles, which typically translates to poor monitoring frequency in-use and may result in emissions that are not representative of real world operation. Thus, the proposed amendments would not only clarify and streamline the process manufacturers are required to meet when conducting demonstration testing, but would also provide greater assurance that these monitors will robustly execute and meet the minimum in-use monitor performance frequency during in-use operation.

As mentioned above, CARB staff is proposing to prohibit manufacturers from performing manual PM filter regeneration events before or after implanting the malfunctioning component/system except if the monitor requires a regeneration event to enable monitoring, if a regeneration event is expected to occur during testing of the monitor, or when conducting the regeneration emission test,. Forced regeneration events are not representative of real-world situations and may result in improved diagnostic performance immediately following a regeneration, but the OBD performance begins to diminish until the next regeneration event occurs.  An example is if the regeneration event is resetting models that are used in a specific diagnostic for detecting a failure and/or is used to better control the emission control system such that the proceeding driving cycles have improved emission performance.  Given that a majority of manufacturers have a PM filter regeneration interval greater than 500 miles, CARB staff needs to ensure that the OBD system performance is robust and emissions are below the OBD emission threshold at all times and not immediately following a regeneration event.

The amendments would also clarify that manufacturers are prohibited from running additional test cycles prior to running the exhaust emission test cycle unless the manufacturer demonstrates the additional test cycles are necessary to stabilize the emission control system.  Staff is proposing this amendment in response to manufacturers utilizing two additional preconditioning cycles (in addition to those already allowed in the HD OBD regulation) prior to running the emission exhaust test cycle because they are allowed to do so for demonstrating compliance with the tailpipe emission standards.  Staff, however, does not believe these additional test cycles should automatically be allowed for HD OBD demonstration testing, especially given that the HD OBD regulation already allows manufacturers to run preconditioning cycles to stabilize the emission control systems.

**1971.1(i)(4.3.1)**: Staff is proposing language to indicate that the data manufacturers are required to collect immediately prior to each engine shut-down are the data described in section 1971.1(i)(4.2.3)(B).  Staff is also proposing to make changes to the examples of when each engine shut-down occur, specifically deleting the references to sections (i)(4.2.1) and (i)(4.2.3) and indicating the preconditioning cycle is the “malfunction preconditioning cycle.” Staff is also proposing language indicating that the data described in section 1971.1(i)(4.3.2)(A) would be collected during the test cycle in which the MIL is illuminated, and the emission data described in section 1971.1(i)(4.3.2)(C) would be collected during the exhaust emission tests described in sections 1971.1(i)(4.2.2) and (4.2.3).

Rationale: The proposed changes to subsection (i)(4.3.1) are needed to correct an oversight, since the current language required all the data to be collected at every engine shut-down, which is not possible for the data mentioned in sections 1971.1(i)(4.3.2)(A) and (C). Concurrently, staff proposed language to make clear when the data under sections 1971.1(i)(4.3.2)(A) and (C) are required to be collected. The other proposed changes are needed for better readability.

**1971.1(i)(4.3.2)(C)**: Staff is proposing language indicating that manufacturers are required to provide emission test data for NMHC, CO, NOx, and PM as applicable (based on the applicable emission threshold malfunction criteria) for each monitor. Staff is also proposing that manufacturers report $CO_2$ emissions data for all monitors starting with 2022 model year engines.

Rationale: The proposed addition of the emission test data in section 1971.1(i)(4.3.2)(C), which is currently mentioned in the certification documentation section 1971.1(j)(2.4), is needed since section 1971.1(i)(4.3.2)(C) is the more appropriate section to mention this requirement. The proposed requirement for manufacturers to report $CO_2$ emission data, which manufacturers already have the capability of collecting in their test facilities and should already be collecting for the purpose of calculating molar flow rates and typical carbon balance verifications, is needed to assist staff in determining and proposing appropriate emission malfunction thresholds based on $CO_2$ in future rulemaking actions.

**1971.1(i)(4.3.3)**: Staff is proposing to add data collection requirements for all 2022 and subsequent model year heavy-duty diesel engines during a small portion of durability demonstration engine (DDE) testing. For baseline testing and demonstration testing of the NOx converting catalyst conversion efficiency monitor, manufacturers would be required to record the data stream parameters listed in Table 11 at 1 second intervals (i.e., 1 Hertz) and submit the data as a comma separated values file.

**Table 11. Data Stream Parameters to Collect During DDE Testing**

| Engine Parameters | Aftertreatment Parameters |
|---|---|
| Engine speed | Corrected NOx sensor output |
| Actual engine torque | Stability of NOx sensor reading |
| Engine friction – percent torque | Commanded DEF dosing |
| Reference engine maximum torque | DEF dosing rate |
| Fuel rate | DEF usage for current driving cycle |
| Fuel injection timing (all cylinders) | DEF dosing mode |
| Modeled exhaust flow | Target ammonia storage level on SCR |
| Air flow rate (from mass air flow sensor) | Modeled actual ammonia storage level on SCR |
| Commanded EGR valve duty cycle/position | Exhaust gas temperature sensor output |
| Actual EGR valve duty cycle/position | PM filter inlet temperature |
| EGR error between actual and commanded | PM filter outlet temperature |
| Commanded/target boost pressure | SCR intake temperature |
| Boost pressure | SCR outlet temperature |
| Variable geometry turbo position | - |
| Intake air/manifold temperature | - |
| Charge air cooler outlet temperature | - |
| Engine coolant temperature | - |
| Engine oil temperature | - |
| EGR mass flow rate | - |

Rationale: Staff's proposal to collect the data stream parameters shown above during DDE testing would provide staff with more detailed information about the conditions under which monitors run in the test cell environment. Nearly all monitors that are demonstrated as part of DDE testing must run and make a pass or fail decision over a standard certification test cycle. Having real-time data from the engine as it goes through the standard cycles would give staff a far more complete and detailed picture that staff can use as a reference when analyzing real-world operation of monitors. Staff's proposal includes collecting the same data during the demonstration of the NOx converting catalyst conversion efficiency monitor because it is one of the most important of all OBD monitors. Having detailed information on the conditions under which it runs and makes a fail decision would serve as a valuable reference when analyzing its real-world performance.

In addition to improving staff's understanding of the circumstances of monitor operation, the collected data would also more fully illustrate the behavior of the engine itself under test cell conditions. Again, it would serve as a valuable reference when staff tries to understand engine behavior in real-world conditions relative to test cell conditions. Instead of just having a set of average emissions data to represent an entire test cycle, staff would have real-time information on the DEF dosing rate, boost, EGR valve position, catalyst temperatures, and other elements of engine behavior that enable the engine to comply with emission standards. Any instances of high emissions observed on the road would be better understood given the context that is made possible by these data.

A third motivation behind staff's proposal is to provide material evidence that all of the data stream parameters listed in Table 11 are in fact supported by the engine as required in the regulation. Although the manufacturer may not use the public controller area network to collect the data due to speed limitations and instead access controllers with an alternate method, collecting the data still would demonstrate that all of the listed parameters are in fact supported in the controller and updated real time.

It should be pointed out that staff's proposal does not create any new testing requirements. The proposal simply takes advantage of testing that is already being conducted today. Manufacturers would only need to record data for parameters that would be part of the standard data stream requirements.

**1971.1(i)(4.6)**: Staff is proposing to allow manufacturers of heavy-duty engines certified to the Low Emission Vehicle III (LEV III) exhaust emission standards (defined in title 13, CCR section 1961.2) use an alternate testing protocol (with Executive Officer approval) similar to those required in the OBD II regulation (section 1968.2(h)(5)) for demonstration of MIL illumination.

Rationale: The proposed allowance is needed to accommodate those heavy duty vehicles optionally certified to the LEV III standards per title 13, CCR section 1956.8 (c)(3) or (h)(5). These provisions allow manufacturers to group complete or incomplete vehicles greater than 14,000 pounds GVWR with vehicles less than 14,000 pounds GVWR certifying to the LEV III exhaust emission standards and test procedures specified in title 13, CCR section 1961.2. Because manufacturers are essentially designing these heavy-duty vehicles to the standards and specifications of light- and medium-duty vehicles, which are chassis-based standards, some allowances are needed under the HD OBD engine-dynamometer based demonstration testing protocols to ensure appropriate evaluation of the OBD systems, which generally conform more closely to the requirements in title 13, CCR section 1968.2.

**1971.1(i)(5.1.1) and (i)(5.2.1)**: Staff is proposing to change the reference of "(i)(4.2.3) to "(i)(4.2.2)."

Rationale: The proposed change is needed since the requirements of the emission test were moved from section 1971.1(i)(4.2.3) to (i)(4.2.2) as part of the proposed changes to section 1971.1(i)(4.2).

**<u>1971.1(i)(5.1.2)</u>**: Staff is proposing amendments to the language related to the misfire monitor. Specifically, staff is adding reference to the "five percent" minimum misfire malfunction criterion in section (e)(2.2.2) (which was corrected from the current reference of (e)(2.2.2)(A)). Staff is also proposing that for any demonstration test in which a default fuel or emission control strategy is used when a malfunction is detected and the MIL illuminates prior to emissions exceeding the applicable emission threshold malfunction criteria, manufacturers would be required to test and collect emissions with a worst acceptable limit component or system.

<u>Rationale</u>: The proposed change adding reference to the "five percent" minimum misfire malfunction criterion is needed to correct an error, since the current language in this section only referenced the "one percent" minimum misfire malfunction criterion, which is only specified in section (f)(2.2.2)(A), not section (e)(2.2.2). The proposed change of (e)(2.2.2)(A) to (e)(2.2.2) is needed to correct an error in the section number referenced.

Concerning the proposed changes related to default fuel or emission control strategies, the regulation currently indicates that if a default action is executed when a malfunction is detected that reduces the emission control performance and the MIL illuminates after emissions exceed the applicable emission threshold, the manufacturer is required to retest the test engine with the worst acceptable limit component or system (such that the default action is not executed) over the worst-case emission test cycle. However, the regulation currently does not require testing of the worst acceptable limit component or system for default actions that improve the emission control system.

Upon detection of a malfunctioning component or system, some diagnostics trigger a default action that improves the emission control system that, in some cases, may result in emission levels below the applicable OBD emission threshold. However, if this component or system is performing better than the BPU component or system (e.g., worst acceptable limit part) such that the diagnostic does not detect any fault and thus does not trigger the default action, emissions may exceed the applicable OBD emission threshold without MIL illumination. This unfortunately is currently allowed in the HD OBD regulation to demonstrate compliance with the applicable OBD emission threshold. An example of a default action designed to improve the emission control performance may involve modulating the operation of the SCR system by commanding increased DEF dosing. With such a strategy, testing only a malfunctioning component or system would not provide assurance that the diagnostic is appropriately calibrated to detect a malfunction of the component or system prior to exceeding the applicable OBD emission threshold. The proposed additional language would ensure that these emission threshold monitors are calibrated appropriately such that they illuminate the MIL prior to emissions exceeding the applicable OBD emission thresholds.

**1971.1(h)(5.1.2) and (5.1.2)(B)**: Staff is proposing changes indicating that 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 would be required.

Rationale: Section 1971.1(i)(5.1.2) currently requires no additional testing if the monitor is able to detect a fault and illuminate the MIL with emissions below the required thresholds. These criteria do not fit the case of VVT systems with discrete operating states, which are not required to detect faults and illuminate the MIL before emissions exceed the threshold. Thus, staff is proposing changes to address these systems.

**1971.1(h)(5.1.3)(A) and (5.1.3)(C)**: Staff is proposing changes indicating that 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 does not illuminate when the VVT system is tested using the worst case failure mode, the OBD system is not acceptable.

Rationale: Section 1971.1(i)(5.1.3) currently requires additional testing if the monitor is unable to detect a fault and illuminate the MIL before emissions exceed the required thresholds. These criteria do not fit the case of VVT systems with discrete operating states, which are not required to detect faults and illuminate the MIL before emissions exceed the threshold. Thus, staff is proposing changes to address these systems

**1971.1(h)(5.1.3)**: Staff is proposing language to make clear for catalyst monitors (monitored under sections (e)(5.2.2), (e)(6.2.1), (e)(7.2.1), and (f)(6.2.1)) and PM filter system monitors (i.e., sections (e)(8.2.1) and (e)(8.2.4)(A)), the provisions described under section 1971.1(h)(5.1.3)(A) only apply if the on-board computer invokes a default fuel or emission control strategy when a fault is detected. Staff is also proposing to change “(e)(8.2.4)” to “(e)(8.2.4)(A)” in section 1971.1(h)(5.1.3)(B).

Rationale: These sections describe the procedure that must be taken when the MIL does not illuminate when the malfunction is set at the limits during demonstrating testing. The proposed changes in section 1971.1(i)(5.1.3)(A) are needed to clarify the testing procedures for catalyst and PM filter faults where default actions are taken subsequent to fault detection, since the original language is not clear on these procedures. The proposed change in section 1971.1(i)(5.1.3)(B) is needed to correct an error to the section reference.

**Section 1971.1(j): Certification Documentation**

The HD OBD regulation requires manufacturers to submit certification documentation for each engine or OBD certification documentation group. The certification documentation contains all the information needed for CARB staff to determine if the OBD system meets the requirements of the HD OBD regulation. The regulation specifies all the information that is required to be included in the certification documentation. Based on its experience in reviewing these certification packages, staff has determined changes are needed to the regulation language and that more information is needed to facilitate the review process and is therefore proposing the following amendments.

**<u>1971.1(j)(2.1) and (j)(2.2.1)</u>**: Staff is proposing amendments that would make clear that information about monitoring strategies that are carried out by smart devices would need to be included as part of the OBD certification documentation.

<u>Rationale</u>: For some smart device applications, portions of the HD OBD monitoring requirements may be carried out within the smart device itself, which would then transmit the necessary information to the on-board computer to facilitate fault handling and MIL illumination when a problem occurs. The proposed amendments would make clear that such monitoring strategies must be fully described in the manufacturer's HD OBD certification application that is reviewed and approved by CARB staff.

**<u>1971.1(j)(2.2.1)(I)</u>**: Staff is proposing to change "rationality checks" to "rationality fault diagnostics."

<u>Rationale</u>: The proposed change is needed to be consistent with the terminology used in the definitions in section 1971.1(c), which states "rationality fault diagnostic."

**<u>1971.1(j)(2.2.2)(H)</u>**: Staff is proposing changes to the engineering units required to be used in the certification application. Specifically, staff is proposing that units of" mg per stroke" be used for all fuel quantity-based ignition event criteria and units of "per stroke" be used for all other changes per ignition event based criteria for both gasoline and diesel vehicles.

<u>Rationale</u>: The regulation currently requires manufacturers to use "per crankshaft revolution" for all parameters/criteria based on changes per ignition event. During the 2015 OBD II rulemaking update, manufacturers have indicated that this is misleading and that they should be allowed to indicate ignition event-based criteria using "per stroke" because it is also used in the data stream parameter identifiers (PID) (i.e., PID uses "mg per stroke"). They also indicated "per stroke" should be used for both gasoline and diesel applications. Considering the reason for requiring specific units to be used in the application is for consistency among manufacturers, staff proposed these changes to address this.

**<u>1971.1(j)(2.4)</u>**: Staff is proposing changes to the information/data manufacturers are required to include regarding certification demonstration testing in the certification documentation. The proposal deletes reference to “emission test data,” indicates that the “description of the testing sequence” would be “for each tested monitor,” and includes language that would require manufacturers to include a summary of any issues found during demonstration testing.

<u>Rationale</u>: The proposed deletion of “emission data” is needed since this requirement was moved to the description of the test data required to be collected during certification demonstration testing in section 1971.(i)(4.3). The proposed addition of “for each tested monitor” is needed for clarity, since the testing sequence may be different for each tested monitor. The proposed additional language requiring a summary of issues found during demonstration testing is needed to assist staff during certification review.

**<u>1971.1(j)(2.6.2)</u>**: Staff is proposing amendments to the certification documentation requirements for diesel engine misfire monitor disablement data. Specifically, staff is proposing language that would indicate that the “EPA Urban Dynamometer Driving Schedule for Heavy-Duty Vehicles specified in 40 CFR Part 86, Appendix I” referenced in this section refers to the CFR language version that existed on July 1, 2012. Staff is also proposing language indicating that for manufacturers certifying an OBD certification documentation group in accordance with section 1971.1(j)(1.1), the manufacturer would be required to provide these data for the representative engine(s).

<u>Rationale</u>: These proposed changes are needed to indicate the applicable date for the CFR section cited and to clarify that the misfire disablement data is only required for the representative engine, not all engine families within the OBD certification documentation group.

**<u>1971.1(j)(2.7)</u>**: Staff is proposing amendments indicating that for diesel engines, the information regarding the manufacturer-determined adjustment factors would need to include all details of how each adjustment factor was calculated. Staff is also proposing that manufacturers provide information related to any adjustment factor(s) established in accordance to section 1971.1(d)(6.2) on gasoline vehicles with emission controls that experience infrequent regeneration events.

<u>Rationale</u>: The proposed changes to the diesel engine adjustment factor information are needed to clarify the requirements for manufacturers and to assist staff in reviewing diesel OBD applications. Regarding the additional information for gasoline engines, section 1971.1(d)(6.2) currently requires manufacturers to adjust the emission test results for emission threshold monitors on “engines equipped with emission controls that experience infrequent regeneration events” to account for regeneration emissions. Currently only manufacturers of diesel engines have been establishing and using adjustment

factors for certification to account for the high emissions that may be emitted during regeneration events of their emission controls (e.g., PM filter). Manufacturers of gasoline engines have not submitted such data since gasoline engines generally have not been equipped with emission controls that experience such regeneration events. However, some manufacturers may design gasoline emission control systems that utilize emission controls traditionally used in diesel applications, such as NOx adsorbers, in order to meet emission standards. The current language in the HD OBD regulation, though, only requires the adjustment factor information for diesel engines, not gasoline engines. Thus, staff is proposing language to correct this.

**1971.1(j)(2.11)**: Staff is proposing amendments to the diagnostic connector information in the certification documentation. Specifically, staff is proposing language indicating that the diagnostic connector information should be representative of every engine covered by the application and allowing manufacturers to submit one set of information to cover a group of vehicles whose diagnostic connectors have the same design, orientation, and location.

Rationale: The proposed changes are needed for staff to ensure that all vehicles are meeting the DLC requirements of section 1971.1(h)(2) across the product line.

**1971.1(j)(2.13)**: Staff is proposing to require manufacturers to provide EI-AECD information in the certification documentation for all engines, not just diesel engines.

Rationale: Staff is proposing these changes to complement the proposed changes in section 1971.1(h)(5.2.1)(D), where staff proposed to require 2022 and subsequent model year gasoline and alternate-fueled engines to track EI-AECD activity.

**1971.1(j)(2.16)**: Staff is proposing to require that on the cover letter of the certification documentation, the manufacturer be required to include a list of modifications to the OBD system that were made as part of a running change or field fix applied to the previous model year (for this engine or another engine).

Rationale: Staff is proposing to include this additional information to better assist staff in reviewing OBD system certification applications.

**1971.1(j)(2.17**): Staff is proposing clarifying language to change the sentence from passive form to active form, requiring the manufacturers to use the required formats for the checklists.

Rationale: The proposed changes are needed for better readability.

**<u>1971.1(j)(2.20)</u>**: Staff is proposing that manufacturers provide a timeline showing the required deadlines for production engine/vehicle evaluation in-use monitoring performance data submission required under section 1971.1(l)(3). Staff is also proposing to change the phrase "production vehicle evaluation testing" to "production engine/vehicle evaluation testing."

<u>Rationale</u>: The regulation currently requires manufacturers to provide a timeline showing the required deadlines for production engine/vehicle evaluation testing of the standardized requirements (section 1971.1(l)(1.2)) and the monitoring requirements (section 1971.1(l)(2.1)), but inadvertently left out the in-use monitoring performance data submission required under section 1971.1(l)(3). Thus, staff is proposing language to address this. Staff is proposing to change "production vehicle evaluation testing" to "production engine/vehicle evaluation testing" to align the name to the one used in section 1971.1(l).

**<u>1971.1(j)(2.21)</u>**: Staff is proposing to require manufacturers to provide a statement of compliance indicating that the engines in the application comply with the requirements of HD OBD regulation and indicating that the manufacturer will comply with the required deadlines for submission of results/data for production engine/vehicle evaluation testing under sections 1971.1(l)(1) through (l)(3).

<u>Rationale</u>: The proposed statement is needed to better assist staff in reviewing OBD system certification applications.

**<u>1971.1(j)(2.22)</u>**: Staff is proposing that manufacturer include in the certification documentation a written description of the cold start emission reduction strategy, including a description of all the actions taken while the cold start emission reduction strategy is active and a description of all parameters and conditions necessary to enable and disable the cold strategy emission reduction strategy.

<u>Rationale</u>: Staff is proposing this information to help staff in reviewing HD OBD system application, specifically to ensure that manufacturers are meeting the cold start emissions reduction strategy monitoring requirements in the HD OBD regulation.

**<u>1971.1(j)(2.23)</u>**: Staff is proposing that manufacturers provide net brake torque information as part of the certification application. Specifically, for 2022 and subsequent model diesel engines, manufacturers would be required to provide data demonstrating the net brake torque reported by the engine dynamometer and the "calculated net brake torque" during the FTP and SET cycles. Manufacturers would determine the "calculated net brake torque" using the following equation and the engine reference torque, engine friction – percent torque, and actual engine – percent torque data stream parameters:

“Calculated net brake torque” = ‘engine reference torque’ x (‘actual engine – percent torque’ – ‘engine friction – percent torque’)

Rationale: Manufacturers have not been consistent in the torque output as reported by the scan tool, which has resulted in erroneous emissions calculations during PEMS testing used to verify NTE compliance. Thus, staff is proposing that manufacturers provide this additional information to address this issue. Manufacturers may choose to collect these net brake torque data during demonstration testing under section 1971.1(i). These traces, in addition to the torque-related data stream parameters described under section 1971.1(h)(4.2.2), would allow staff to verify that the net brake torque as calculated by a scan tool agrees with the net brake torque as calculated by an engine dynamometer, which would help ensure that PEMS emissions measurements are valid.

**1971.1(j)(2.24)**: Staff is proposing that manufacturer provide a written description of all parameters and conditions necessary for each NOx sensor to begin reporting NOx concentration data after engine start and, if applicable, all parameters and conditions that cause each NOx sensor to subsequently cease or pause reporting NOx concentration data.

Rationale: Staff is proposing this information to complement the proposed monitoring requirements in section 1971.1(e)(9.2.2)(E). This information would help staff in reviewing HD OBD system applications.

**1971.1(j)(2.25)**: Staff is proposing that manufacturers of diesel engines provide data identifying the NOx sensor status (e.g., if the NOx sensor is actively reporting NOx concentration data, not reporting NOx concentration data due to low exhaust temperature, not reporting NOx concentration data due to sensor instability) for each NOx sensor during the FTP cycle and the SET cycle. The data would also be required to identify specifically which parameters and conditions documented in the certification application caused the NOx sensor to transition from one status to another (e.g., from not reporting NOx concentration data to actively reporting and from actively reporting to not reporting). Manufacturers would be required to provide these data starting with the 2022 model year.

Rationale: Staff is proposing to require manufacturers to submit NOx sensor activity data to complement the proposed NOx sensor activity monitoring requirements in section 1971.1(e)(9.2.2)(E) and the proposed NOx sensor activity documentation requirements in section 1971.1(j)(2.24). Actual NOx sensor activity data collected during standard emissions testing would demonstrate what proper NOx sensor behavior looks like and illustrate the NOx sensor activity criteria in operation. As such, this information would help staff in reviewing HD OBD system applications. Because NOx sensor activity data can be collected in parallel with standard testing already required by the regulation, no additional testing would be needed to satisfy the proposed requirement.

**1971.1(j)(2.26)**: Staff is proposing to require manufacturers of 2022 and subsequent model year diesel engines to provide data showing the instantaneous NOx mass emission rate determined using the test facility's instrumentation and the instantaneous NOx mass emission rate determined by the electronic control unit that is responsible for NOx tracking (as required in section 1971.1(h)(5.3)) during one hot-start emissions test using the FTP cycle. The data would need to meet certain criteria detailed in this proposed section and would need to be provided at a frequency of at least 1 Hertz in a CSV file and summed to show the total NOx mass and total engine output energy over the cycle. The manufacturer would also be allowed to use vehicle-based testing using the EPA Urban Dynamometer Driving Schedule for Heavy-Duty Vehicles specified in 40 CFR Part 86, Appendix I as it existed on July 1, 2012.

Rationale: See section 1971.1(h)(5.3.4) above for the rationale.

**1971.1(j)(2.27)**: Staff is proposing that manufacturers provide a description of all inducement strategies, including all inputs to each inducement strategy.

Rationale: Staff is proposing this information to complement the proposed monitoring requirements in section 1971.1(g)(3.1.1) related to inducement strategies. This information would help staff in reviewing HD OBD system applications.

**1971.1(j)(2.28)**: Staff is proposing that starting with the 2022 model year, manufacturers provide a list of comprehensive components that are not OBD monitored due to meeting the criteria under sections 1971.1(g)(3.1.1) and (3.1.2), and the engineering evaluation analysis or associated data for each component, including all emission data, a description of how the worst case configuration was determined, and test cycles used to stabilize the system and assess the emission impact.

Rationale: This information would help staff ensure that unmonitored components do indeed meet the appropriate monitoring exemption criteria specified in the regulation.

**1971.1(j)(2.29)**: Staff is proposing that manufacturers provide a list of electronic powertrain components/systems that are not OBD monitored due to meeting the monitoring exemption criteria under section 1971.1(g)(5.7).

Rationale: This information would help staff ensure that unmonitored components do indeed meet the appropriate monitoring exemption criteria specified in the regulation.

**1971.1(j)(2.30)**: Staff is proposing that manufacturers provide a list of monitors that run during conditions that are not encountered during the FTP cycle as allowed under section 1971.1(d)(3.1.3), and, if applicable, the alternate test cycle during which the monitor runs.

Rationale: The proposed information is needed to better assist staff in reviewing OBD system certification applications.

**1971.1(j)(2.31)**: Staff is proposing that for monitors designed to run during the SET cycle under section 1971.1(d)(3.1.3) on 2022 and subsequent model year engines, manufacturers provide the information required under section 1971.1(d)(3.1.3), including the supporting in-use monitor performance ratio data.

Rationale: Staff is proposing this information to complement the proposed amendments in section 1971.1(d)(3.1.3) related to monitors that are designed to run on the SET cycle. This information would help staff in reviewing HD OBD system applications.

**1971.1(j)(2.32) through (2.33)**: Staff is proposing that for 2022 and subsequent model year engines, manufacturer would be required to submit information about the active, waste heat recovery, stop-start, and automatic engine shutdown technologies if equipped by the vehicle. The information would be required to include a description of the technology, the sensor signals and/or calculated values used to activate the technology, and the driver action (if any) required to activate the technology.

Rationale: These new proposed sections are needed to complement the proposed changes to section 1971.1(h)(5.4) and to assist staff during certification review.

**1971.1(j)(2.34)**: Staff is proposing that, upon request by the Executive Officer, the manufacturer be required to provide to CARB staff certain information and/or hardware as part of the certification package. This would include software design descriptions and source code of the ECU or any other on-board electronic powertrain control unit, a complete list of all control unit variables for real-time display and data logging, data acquisition devices to collect these variables, and methods to unlock production/prototype control units to allow this real-time display and data logging.

Rationale: Staff is proposing these changes based on past experiences with testing OBD systems on vehicles, including ongoing pre-certification screening testing programs. Due to the integral nature of the software to the proper operation of emission controls, the information/hardware staff is proposing to add would be especially helpful to staff attempting to review OBD systems and to determine if the systems meet the requirements of the OBD regulations. Manufacturers have argued that providing the source code would pose IP concerns for both engine manufacturer and suppliers, and that providing information about all variables would be a significant burden for manufacturers to provide and would not provide any value to CARB staff given the complexity of the source codes at issue. CARB staff, however, believes that it is this complexity itself that requires CARB to ask for such information to help staff understand the system. It is important to note that this information would not be requested as a matter of course for routine certification reviews, but instead in cases where detailed information is needed to enable a complete understanding of specific emission control diagnostics or to support pre-certification vehicle/engine screening. Although these information may currently be requested by CARB staff based on existing certification documentation regulatory language (section 1971.1(j)(2.21)), the staff proposal adds more specificity as to the types of information staff may request.

Staff understands manufacturer concerns regarding the risk of IP loss. However, CARB handles confidential IP as a matter of routine business. In addition, CARB staff are working with internal cyber-security experts to evaluate the internal procedures in place to protect sensitive manufacturer IP and reduce the risk of exposure to the extent feasible. However, given that CARB has the authority adopt regulations and request information to support certification and evaluation of compliance with the regulations, staff considers this proposal a clarification of existing requirements.

**Section 1971.1(k): Deficiencies**

**1971.1(k)(3)**: Staff is proposing changes to the deficiency fine amounts. Staff is proposing to move the current requirements for deficiency fines to newly proposed section (k)(3.1) and to apply the requirements to 2010 through 2020 model year engines. In newly proposed section (k)(3.2), starting with the 2021 model year, staff is proposing that deficiencies for monitors that do not detect faults before emissions exceed the emission threshold malfunction criteria defined in sections (e) through (g) would be based on the emission levels the monitor detects a fault above the threshold. Specifically, the per engine fine would be different based on how much the emissions level exceed the required malfunction criteria before a fault is detected: emission levels are 100 to 120 percent of the malfunction criteria (i.e., an Emission Threshold 1 (ET1) deficiency), 121 to 150 percent of the malfunction criteria (i.e., an ET2 deficiency), or 151 to 200 percent of the malfunction criteria (i.e., an ET3 deficiency). The proposed fine for each deficiency type is provided in Table 12 below. The proposal would allow 1 “free” deficiency for an ET1 deficiency for the first model year the deficiency is applied – this “free” deficiency would be 1 of the 2 currently allowed “free” deficiencies. All other emission threshold monitor deficiencies, however, (i.e., the 2$^{nd}$ and subsequent ET1 deficiencies, all ET2 deficiencies, all ET3 deficiencies) would not be “free” deficiencies, and would also not be included in the count of deficiencies used under section 1971.1(k)(2) to determine the number of deficiencies subject to fines. Staff is also proposing increases in the deficiencies for these emission threshold monitors based on the model year the deficiency was carried over to, as described in Table 12 below.

**Table 12: Emission Threshold Monitor Deficiency Fine Amounts**

| | | Applicable Model Year (MY) for Deficiency | | | |
|---|---|---|---|---|---|
| **Deficiency Type** | **Threshold Exceedance (% of malfunction criteria)** | **1st MY** | **2nd MY (1 MY carryover)** | **3rd MY (2 MY carrover)** | **4th MY (3 MY carryover)** |
| **ET1** | 100 - 120 | Free for 1 ET1, $100 for all other ET1 | $100 | $150 | $200 |
| **ET2** | 121-150 | $300 | $300 | $325 | $350 |
| **ET3** | 151-200 | $400 | $400 | $425 | $450 |

Staff is also proposing to increase the per-deficiency fines from $50 to $100 for non-compliances with any of the monitoring requirements specified in sections (e), (f), and (g)(4) (except for ET1, ET2, and ET3 deficiencies), and from $25 to $50 for non-compliances with any other requirement of section 1971.1. In determining the identified order of deficiencies, ET1, ET2, and ET3 deficiencies (except for one ET1 deficiency during the first model year the deficiency is applied) would not be included, and deficiencies subject to $100 would be identified first. Finally, staff is also proposing to increase the maximum total fine amount per engine from $500 to $750 for the 2021 model year, $1000 for the 2022 model year, and $1500 for the 2023 and subsequent model years.

Rationale: The HD OBD regulation allows manufacturers to certify OBD systems with “deficiencies” in cases where the manufacturer does not meet a requirement but has demonstrated a good faith effort to fully comply. However, to prevent misuse of the provision and ensure equity for manufacturers that are able to fully comply with the requirements, the manufacturer is subject to fines if the number of deficiencies for a particular OBD system exceeds a certain number (e.g., exceed 2 deficiencies). The HD OBD regulation currently specifies a $50 fine for deficiencies related to “major” monitors, which are considered significant requirements (e.g., emission threshold monitors), while $25 fines are specified for deficiencies for other non-compliances. Additionally, the regulation states that the maximum fine amount per engine is limited to $500, which, back when the HD OBD regulation was first adopted in 2005, was equal to the maximum fine amount per vehicle specified in Health and Safety Code 43016 for not complying with the vehicle air control pollution regulations.

Staff, however, has had concerns about manufacturers misusing these deficiency provisions. Specifically, there have been issues with manufacturers inappropriately requesting deficiencies instead of putting in the effort and resources needed to produce a compliant OBD system, specifically with emission threshold monitors. There have been concerns that manufacturers have not been putting in the work to design emission threshold monitors that appropriately detect faults before emissions exceeded the required thresholds, and that they instead may be motivated to design monitors that detect faults above the criteria specified in the regulation and even at emissions levels close to the mandatory recall levels (i.e., the emission levels the monitor detects a fault for which a mandatory recall would be considered under section 1971.5(d)(3)) in order to reduce in-use liability. Staff is also concerned that manufacturers are requesting deficiencies for emission threshold monitors to limit their manufacturer self-testing burdens and warranty risk. The current fine amounts in the HD OBD regulation, which are the same as those specified in the OBD II regulation, do not have as negative an impact (and thus do not encourage manufacturers to build fully compliant OBD systems) on manufacturers of heavy-duty engines as they do to light-duty manufacturers. This is due to the low volume of heavy-duty engines produced per model year compared to light-duty manufacturers. In order to address this issue, staff believes that changes are needed to the deficiency provisions to deter manufacturers from misusing deficiencies. Staff believes this involves increasing deficiency fine amounts specified in the regulation. Further, the Health and Safety Code had recently been updated to raise the maximum penalties for noncompliance with the regulations, increasing the amount to $37,500 per vehicle. Thus, staff is proposing that the $25, $50, and maximum fine amounts in the HD OBD regulation be increased based on how far above the emission threshold emissions are before the monitor is able to detect a fault. The proposed fine amounts for emission threshold monitors would also no longer be “free” (except for 1 deficiency if the emissions level is between 100 and 120 percent of the malfunction criteria). The purpose of these proposed increases in emission threshold monitor fines is to further motivate compliance, not to encourage manufacturers to change calibrations to achieve compliant emission threshold monitoring at the expense of in-use monitoring frequency, which carries a lower deficiency fine amount. Nonetheless, staff believes this proposal will result in manufacturers putting timely resources and efforts into implementing compliant OBD systems and avoiding paying deficiency fines to minimize in-use testing and warranty liabilities.

**1971.1(k)(3)**: Staff is proposing specific timelines in which manufacturers are required to submit their deficiency fines payments. Staff is proposing that that the manufacturer report the number of affected engines produced for sale in California during the quarter and submit the total payment for the engines produced for sale during that quarter. Staff would also allow the manufacturer to propose an alternate payment schedule for Executive Officer approval if the proposal results in paying the total fines in a timely manner and based on the projected sales volume of the entire manufacturer product line.

Rationale: The proposed language related to the payment schedule is needed to make clear to manufacturers the timeline on when they are required to pay the fines. The allowance for manufacturers to request an alternate payment schedule is needed to accommodate manufacturers that have very small volumes of engines across their product line, where a lump sum payment at the end of the year that covers all the affected engines seems more reasonable.

**1971.1(k)(4)**: Staff is proposing minor amendments to the section, including adding the example that 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. Staff is also proposing to change “it can be demonstrated” to “the manufacturer can demonstrate.”

Rationale: These proposed changes are needed for clarification since there have been confusion about the latest model year a deficiency can be carried over to.

**1971.1(k)(4.3)**: Staff is also proposing amendments to clarify carrying-over of deficiencies for emission threshold-based monitors. Specifically, in cases where there is an interim threshold (e.g., 3 times the standard) for a few model years and then a step down to a final threshold (e.g., 1.5 times the standard) in a later model year, the proposed language would clarify that 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.

Rationale: There have been confusion about when a deficiency would be considered a “carry-over” deficiency or a “new” deficiency. In the case of emission threshold monitors with interim required thresholds, manufacturers have asked if a deficiency for the interim threshold ‘starts the clock’ towards the maximum two or three years of carry-over or if the carry-over clock restarts when the threshold steps down to the final threshold. Initially, staff was concerned that the latter case (i.e., restarting the clock with the final threshold) would allow manufacturers to unnecessarily delay addressing deficiencies or attempt to carry them over longer than needed. However, given the existing criteria that a manufacturer must meet to qualify for a deficiency, namely a good faith effort to comply in full and to come into compliance as expeditiously as possible, staff believes there are valid cases where it would be appropriate to restart the carry-over clock. For example, a manufacturer could make an appropriate attempt to comply with the interim threshold and fall short and again make a valid attempt to comply with the final threshold with a completely different approach or monitor and still come up short. In other cases, granting deficiencies might not be appropriate (e.g., a manufacturer has not demonstrated a good faith effort to comply) and the existing deficiency qualifications would allow staff to deny such deficiencies and prevent further carry-over. Accordingly, staff believes it is appropriate that a change in the monitoring threshold would reset the clock for a deficiency, and is proposing to amend the regulation to clarify this requirement. The amendment would not obviate the need for a manufacturer to demonstrate a good faith effort to comply or to come into compliance as expeditiously as possible; both criteria would still be required to qualify both initially and in each subsequent year for a deficiency to be granted.

**<u>1971.1(k)(6.1)</u>**: Staff is proposing amendments to the timeframe in which manufacturers can request retroactive deficiencies, specifically deleting the timeframe of "the first 6 months after commencement of the start of engine production or the first 6 months after commencement of the start of vehicle production, whichever is later" to allow manufacturers to request a retroactive deficiency. Staff is now proposing a new deadline of either of the following date, whichever is later: (1) when the last affected engine or vehicle is produced, or on December 31 of the calendar year for which the model year is named, whichever is sooner; or (2) 6 months after commencement of the start of engine production or vehicle production, whichever is later. Staff is also proposing language clarifying that approved retroactive deficiencies would apply to all affected engines within the engine family "and model year."

<u>Rationale</u>: Staff originally adopted language limiting the approval of retroactive deficiencies to the 6-month timeframes specified above to align with the deadlines for production engine/vehicle evaluation testing of monitoring requirements specified in section 1971.1(l)(2). Manufacturers, however, have often found problems through means other than production engine/vehicle evaluation testing that require them to apply running changes and/or field fixes to address the problems. Some of the resulting running changes/field fixes would have been considered "deficiencies" for that model year under the HD OBD regulation. However, a lot of these running changes/field fixes are often applied after the 6-month timeframe. Thus, staff would most likely have granted a deficiency for this issue on the affected engines in the next model year, which would mean that manufacturers would be given an "extra" model year to fix the issue. In other cases, if that specific model year was the last model year for the engine, no deficiency would have been applied at all to the engine. Staff believes that this would unfairly give an advantage to manufacturers who come to CARB later than they should to report problems in the field and applicable running changes/field fixes, which is not appropriate. Thus, staff is proposing changes to extend the deadline to request retroactive deficiencies. The proposed addition of "and model year" to the description of the affected engines for which the retroactive deficiencies applied is needed to make clear that such retroactive deficiencies are only applicable to affected engines within the model year for which the deficiency is requested by the manufacturer, which is consistent with how deficiencies are applied in section 1971.1(k) (where a deficiency is applied for a given model year, not a group of model years).

**<u>1971.1(k)(9)</u>**: Staff is proposing to allow two of the deficiencies related to the newly proposed tracking requirements in sections 1971.1(h)(5.3) and (h)(5.4) to be "free" deficiencies (i.e., not subject to fines) for the 2022 and 2023 model years.

<u>Rationale</u>: The proposed change is needed to address manufacturers' concerns about implementation of the newly proposed NOx control and GHG tracking and

reporting requirements in sections 1971.1(h)(5.3) and (5.4). Specifically, manufacturers have indicated that due to the amount of new data parameters the engines would be required to track and the complexity with implementing the NOx control tracking requirements in the software, they are concerned that there is a high likelihood that there would be errors in the first few years these parameters are implemented. Staff understands manufacturers' concerns, and is proposing to allow two deficiencies related to these requirements to be "free" during the first 2 model years the parameters are required.

**1971.1(k)(10)**: Staff is proposing to change the section number from (k)(9) to (k)(10). Staff is proposing to change "non-compliant" to "a nonconforming OBD system subject to enforcement." Staff is also proposing language indicating that noncompliances for which deficiencies are granted may be subject to the enforcement provisions of title 13, CCR section 1971.5 if during testing (e.g., testing under sections 1971.5(b) or (c)), it was found that the details of the noncompliance are not the same as those disclosed by the manufacturer at the time the deficiency was granted.

Rationale: The proposed amendments are needed clarify the requirements for noncompliances that are granted a deficiency and noncompliances that are subject to the enforcement provisions of title 13, CCR section 1971.5. The regulation currently indicates that OBD systems that fail to meet the requirements of section 1971.1 and has not been granted a deficiency are considered "noncompliant." The change from "noncompliant" to "nonconforming OBD system subject to enforcement" is needed to avoid confusion and for consistency, since "noncompliance" as used within section 1971.1(k) can be granted deficiencies if certain criteria are met. Further, a person may incorrectly read the current language and conclude that noncompliances for which deficiencies were granted cannot be subject to the enforcement provisions of section 1971.5, which is untrue. Thus, staff is proposing language to clarify this. Finally, the proposed change to (k)(10) is needed since new language is proposed in section (k)(9).

## Section 1971.1(l): Production Engine/Vehicle Evaluation Testing

### Section 1971.1(l)(1): Verification of Standardized Requirements

**1971.1(l)(1.3.2)**: Staff is proposing language that would include more details on the software and hardware specifications that the off-board device would need to meet for testing of the standardization requirements on vehicles using the SAE J1939 protocol. Specifically, the device would need to meet the minimum requirements to conduct testing according to SAE J1939/84 using the software developed and maintained for the SAE J1939/84 committee and available through www.sourceforge.net and SAE J2534 compliant hardware configured for SAE J1939/84 testing.

Rationale: When the testing requirements were originally adopted, the software and hardware specifications required for this testing was already developed for vehicles using ISO 15765-4 protocol since these were the same specifications required in the OBD II regulation.  However, for vehicles using the SAE J1939 protocol, the software and hardware that were to be used for this testing were not yet developed, so the current HD OBD regulation language included a general statement indicating that the off-board device used for the testing needed to be "able to verify that vehicles tested are able to perform all of the required functions in section (l)(1.4) with any other off-board device designed and built in accordance with the SAE J1978/J1939 generic scan tool specifications."  Since then, such specifications have been developed by SAE, and thus staff is proposing to include these specifications in the regulation.

**1971.1(l)(1.4.3)(C)**: Staff is proposing to change "SAE J1979/J1939."  Staff is also proposing to add language including an example of an SAE J1939/73 message in the section ("SAE J1939/73 Diagnostic Message 24").

Rationale: This proposed changes are needed for completeness, since vehicles can use either SAE J1979 or SAE J1939, but the language in the section and the current examples listed are only apply to SAE J1979.

**1971.1(l)(1.4.3)(D)**: Staff is proposing to require the test to verify that the vehicle can properly communicate to any SAE J1978/J1939 scan tool the ECU Name.

Rationale: This proposed addition of ECU Name would ensure the correct information is being made available to the scan tool as required by the regulation.

**1971.1(l)(1.4.3)(E)**: Staff is adding language including an example of an SAE J1939/73 message in the section ("SAE J1939/73 Diagnostic Message 1").

Rationale: This proposed example is needed for completeness, since vehicles can use either SAE J1979 or SAE J1939, but the current examples listed are only SAE J1979 examples.

**Section 1971.1(l)(2): Verification of Monitoring Requirements**

**1971.1(l)(2.2.1)**: Staff is proposing to change the reference of "section (j)" to "section (i)."

Rationale: This proposed change is needed to correct an error.

**1971.1(l)(2.2.2)**:  Staff is proposing to allow manufacturers to distribute the testing required under section 1971.1(l)(2) across more than one engine/vehicle provided the additional engine/vehicle(s) is identical to the original test vehicle with respect to the emission control system hardware and OBD system calibrations.

Rationale: This proposed allowance is needed to address manufacturers' concerns about staff's proposal to test 10 additional monitors under section 1971.1(l)(2.3.7). Manufacturers have indicated that the proposed additional testing would add a considerable amount of testing time and that they may have issues in meeting the testing and reporting deadlines required by the regulation. Therefore, staff is proposing to allow manufacturers to distribute the testing over more than one vehicle/engine provided the additional vehicle/engine(s) is virtually identical (i.e., has identical emission control system hardware and OBD system calibrations) to the original test vehicle/engine.

**1971.1(l)(2.3.1) and (l)(2.3.5)**: Staff is proposing to require manufacturers to ensure that the OBD system is able to store and erase permanent fault codes during section 1971.1(l)(2) testing. Staff is proposing that manufacturers be required to include in the test plan a list of the specific permanent fault codes that would be tested and a description of the test procedures that the manufacturer would use for ensuring these fault codes can be stored and erased. The procedures would also need to verify that all monitors can fully execute and make "pass" decisions after a scan tool code clear command.

Rationale: Issues have arisen in the field involving OBD systems that are unable to erase permanent fault codes under any circumstances, which could erroneously cause vehicles to fail I/M programs that base pass/fail criteria on the presence of permanent fault codes in OBD systems. This proposal would ensure that OBD systems properly erase permanent fault codes in accordance with the regulation. Since requiring manufacturers to ensure all permanent fault codes are erased would be a huge additional testing burden, staff is proposing to allow manufacturers to propose a plan indicating which specific permanent fault codes would be tested. These specific fault codes would need to cover all the different "types" of monitors (fault codes) in each diagnostic or emission critical electronic control unit (e.g., monitors subject to the minimum ratio requirements of section (d)(3.2), monitors not subject to the minimum ratio requirements of section (d)(3.2), monitors that utilize an alternate MIL statistical MIL illumination and fault code storage protocol) and all the different permanent fault code erasure protocols (e.g., "natural" erasure without a clearing of the fault information in the on-board computer, erasure after a battery disconnect, erasure after a scan tool code clear command, erasure after a reprogramming event).

**1971.1(l)(2.3.3)**: Staff is proposing that during testing under section 1971.1(l)(2), the manufacturer be required to verify that the readiness status is able to set to "complete." This verification would be done using the "dynamic" testing portion of SAE J1699-3 and available at www.sourceforge.net for SAE J1979 compliant engines or the software described in SAE J3162 for SAE J1939 compliant engines and available at https://github.com/Equipment-and-Tool-Institute/iumpr.

<u>Rationale</u>: The proposed testing is needed to ensure that the vehicles are able to set the readiness status to “complete” as required under section 1971.1(h)(4.1). Manufacturers are already currently verifying the readiness status during this testing on engines using the ISO 15765-4 protocol, since SAE J1699-3 already incorporates this verification test. Additionally, this test has recently been added to the dynamic testing portion of SAE J1939, but has not been added to SAE J1939-84. However, the software incorporating this test is referenced in SAE J3162, which staff is proposing to incorporate by reference.

**<u>1971.1(l)(2.3.5) and (2.3.7)</u>**: Starting with the 2022 model year, staff is proposing that for engines that were already tested under the demonstration testing requirements in section 1971.1(i), manufacturers would be required to test 10 monitors that were previously demonstration tested. The 10 monitors would be proposed by the manufacturers and would be the 10 monitors with the lowest in-use monitor performance ratios among all the monitors demonstrated under section 1971.1(i).

<u>Rationale</u>: Staff is proposing this additional testing to address concerns about emission threshold monitors not being able to run and detect faults in-use. The HD OBD regulation currently exempts manufacturers from testing these monitors on engines that have also been tested under the demonstration testing requirements in section 1971.1(i). During this demonstration testing, monitors are tested with the engine itself on an engine dynamometer. However, when engines are installed on vehicles and driven in-use, the monitors may not behave the same way and may not run and detect faults in the real world.

**<u>1971.1(l)(2.4)</u>**: For the report of testing results that manufacturers are required to submit to the Executive Officer, staff is proposing that the report include a summary of any problems identified during testing

<u>Rationale</u>: The proposed information is needed to assist staff in reviewing the test results and determining if the requirements of the regulation are being met.

**<u>Section 1971.1(l)(3): Verification and Reporting of In-use Monitoring Performance</u>**

**<u>1971.1(l)(3.1) and (l)(3.4.1)</u>**: During in-use monitor performance data collection under section 1971.1(l)(3), staff is proposing that manufacturers also collect all the standardized data required under section 1971.1(h)(4.1) through (4.9) and (h)(5) from the same vehicles. Staff is also proposing to change the word “within” to “no later than” in section 1971.1(l)(3.1).

<u>Rationale</u>: The proposed collection of the engine run time tracking data (e.g., EI-AECD tracking data) is needed to assist staff in other CARB programs that would use these data to determine if the requirements of the programs are being met. The proposed collection of the other standardized data would assist staff is

determining if the engines are meeting the requirements of section 1971.1 in-use. The proposed change of “within” to “no later than” in section 1971.1(l)(3.1) is needed to prevent misinterpretation.

**<u>1971.1(l)(3.2.2)</u>**: Staff is proposing to allow the Executive Officer to require manufacturers to collect in-use monitoring performance data from a subgroup of the monitoring performance group if the Executive Officer believes that the subgroup of vehicles differs from other vehicles in the monitoring performance group and that a reasonable basis exists to believe that the differences may directly impact the data submitted.

<u>Rationale</u>: The HD OBD regulation currently requires manufacturers to collect in-use monitoring performance data for a “monitoring performance group” that is separated by the type of applications: line-haul, urban delivery, and all other engines. It was the belief that the data within each group would be similar such that staff can determine whether or not the engines in the group as a whole meet the required in-use monitoring performance requirements. However, based on years of reviewing the data, staff believes that this may not be the case for some applications. For example, a monitoring performance group that consists of urban delivery vehicles may have a wide range of in-use monitoring performance ratios (e.g., dump trucks, garbage trucks, street sweepers), which would likely have very different and sometimes low ratios for some vehicles but not all within the urban delivery group. Since many vehicle types are included within the urban delivery category, staff has observed instances where manufacturers selectively picked vehicles that have compliant IUMPRs or omitted specific vehicle types all together (e.g., garbage trucks) to increase the average IUMPR within the urban delivery group for compliance. Staff thus believes that more separation may be needed within specific groups and is thus proposing language to address this.

**<u>1971.1(l)(3.4)</u>**: Staff is proposing that the in-use monitoring performance data that manufacturers submit include the “distance traveled” data parameter. Staff is also proposing that manufacturers submit a report with the data that includes a summary of any problems found in the data.

<u>Rationale</u>: The proposed addition of parameter “distance traveled,” which is newly proposed in sections 1971.1(h)(5.3) and (h)(5.4), is needed to enable staff to determine if the vehicle had been recently reflashed or the engine control module replaced, which can result in the in-use monitoring performance data being erased. This information would help staff determine if the in-use monitoring performance data provided for that vehicle are representative of monitoring performance in-use. The proposed addition of the summary of problems is needed to assist staff in reviewing the data and determining if the in-use monitoring performance requirements of the regulation are being met.

**<u>Section 1971.1(m): Running Changes and Field Fixes</u>**

**1971.1(m)**: Staff is proposing specific requirements to apply to running changes and field fixes. Staff's proposed language would follow the general requirements currently specified for running changes in the CFR title 40, part 86.079-33 and part 86.082-34 with proposed modifications. Staff's proposed language details the information that manufacturers would need to include in the running change/field fix documents submitted to CARB and when the manufacturer would be allowed to submit running change/field fix documents (e.g., before implementation of the running change during production). The proposed language would allow manufacturers to include the details of more than one running change/field fix in a single document. Staff is proposing to limit the number of running change/field fix documents that manufacturers would be allowed to submit to one document within a 30-calendar day period. If the manufacturer wishes to implement a running change or field fix during a time period when they would not be allowed to submit the running change/field fix document, staff is proposing to allow the manufacturer to instead submit a running change/field fix notification to CARB concurrently with or before implementing the running change/field fix. The notification would not be as detailed as the running change/field fix document but would provide a short description of the running change/field fix, and manufacturers would be limited to a maximum of one notification per day. The manufacturer would need to submit the running change/field fix document related to the notification at a later date and in accordance with CARB's proposed submission schedule.

The earliest a manufacturer would be able to submit to CARB the first running change/field fix document would be 30 calendar days after the issue date of the OBD approval letter for the applicable engine family. Additionally, staff is proposing language indicating that if 30 days have elapsed since submission of a running change/field fix document and staff has not requested any additional information or rejected the running change/field fix, the running change/field fix would be considered approved. In addition to these amendments, staff is proposing to add specific guidelines regarding the time frames manufacturers would need to abide by with regard to providing staff-requested supporting engineering data. The language would also include the criteria that staff would use to determine whether or not to accept or reject a running change/field fix and would clarify that if a running change/field fix is rejected by staff, implementation of the running change during production would need to cease and engines introduced into commerce with the running change/field fix would need to be recalled.

Rationale: One issue of concern that staff have experienced after years of reviewing and certifying HD OBD systems are modifications (hardware and software calibration) to emission control systems and OBD systems after an OBD system certification has been issued. During development and validation of a heavy-duty engine, manufacturers try to identify and address every flaw in the system before the start of production, but occasionally fall short of this goal. Thus, these manufacturers make changes to their OBD systems after receiving certification. These changes, which may include refinements to calibration settings to improve malfunction detection capability, are implemented either while the product is still part of active assembly during the current model year (running change) or after the product has been manufactured (field fix). CFR title 40, parts 86.079-33 and 86.082-34 require reporting of these modifications through running change documents to the Executive Officer for review and approval. However, the CFR requirements are geared towards changes related to compliance with the exhaust emission standards, and do not specifically address the mechanisms that would trigger reporting of OBD system-related running changes and the criteria for staff's approval of such OBD system-related changes. The HD OBD regulation does not contain requirements regarding the reporting of running changes; as such, manufacturers have generally followed the CFR requirements to include OBD system modifications in the running change documentation. However, staff have had issues with manufacturers' submissions of running change documents, including manufacturers being unclear of the running change submission process, submitting changes too frequently, and failing to disclose major changes to the OBD system. A few manufacturers have submitted documentation to staff identifying extensive modifications to an OBD system that was certified by CARB a few days prior, which resulted in staff having to again review the entire OBD system for the engine family. Additionally, the CFR does not specifically address the reporting of field fixes.

To address these issues, staff is proposing new language in the HD OBD regulation (section 1971.1(m)) that would detail the requirements for running changes and field fixes. The addition of the proposed running change/field fix language addresses current inefficiencies with running change/field fix submissions. The proposed language would provide guidance to manufacturers regarding the process of submitting running change/field fix notifications and documents as well as what issues to highlight in the running change/field fix documents, the allotted time frame for staff to review the documents, and the permitted frequency of reporting these running changes/field fixes to staff. The proposed requirements would allow staff to better manage staff resources and have sufficient review time. Additionally, manufacturers would be allowed to submit notifications on a daily basis provided they keep record of all OBD system modifications within a 30 calendar day period and submit for approval a single running change/field fix document that encompasses several modifications without having to report each change individually. This strategy would provide relief on the number of simultaneously submitted running changes and streamline CARB and manufacturer review processes while cutting down on unnecessary staff review of individual minor changes.

**B. Proposed Amendments to HD OBD Regulation Section 1971.5**

**<u>Section 1971.5(a): General</u>**

**<u>1971.5(a)(3)</u>**: Staff is proposing new definitions for “Deficient Emission Threshold Monitor” and “Deficient In-Use Performance Monitor.” Staff is also proposing to change “federal test procedure (FTP)” to “FTP” in the definition of “OBD Emission Testing.”

<u>Rationale</u>: The new proposed definitions for “Deficient Emission Threshold Monitor” and “Deficient In-Use Performance Monitor” are needed to complement the proposed changes to the nonconformance criteria in section 1971.5(b)(6)(A)(iv) and to the manufacturer self-testing requirements in section 1971.5(c). The proposed changes to the definition of “OBD Emission Testing” are needed since the acronym FTP was already spelled out earlier in the regulation in the definition of “Deficient Emission Threshold Monitor.”

**<u>Section 1971.5(b): Testing Procedures for ARB-Conducted Testing</u>**

**<u>1971.5(b)(1) and (d)(4)(B)(xiii)</u>**: Staff is proposing language in section 1971.5(b)(1) stating that for noncompliances that were granted deficiencies under title 13, CCR section 1971.1(k), staff may perform ARB-conducted testing on engines to confirm that the details of the noncompliance provided by manufacturers at the time of OBD certification (i.e., when the deficiency was granted) are the same as it exists on the engine. Staff is also proposing language in section 1971.5(d)(4)(B)(xiii) indicating that the Executive Officer may impose other ordered remedial based on the degree to which the identified nonconformance differs from the deficiency based on the details disclosed by the manufacturer at the time of certification.

<u>Rationale</u>: As mentioned above, staff proposed changes to the deficiencies section in section 1971.1(k)(9) to clarify that noncompliances that are granted a deficiency may still be subject to the enforcement provisions of title 13, CCR section 1971.5 if the details of the noncompliance in-use differ from the details presented by manufacturers at the time of OBD certification. A manufacturer should be subject to enforcement for a deficient noncompliance if the problem is actually worse in-use than the manufacturer represented when CARB granted the deficiency. Thus, staff is proposing clarifying language in these sections to make this clear.

**<u>1971.5(b)(3)(A)(iv)</u>**: Staff is proposing changes indicating that EMFAC2014 instead of EMFAC 2007 would be used when determining the average age of the engines that may be tested.

<u>Rationale</u>: The proposed change is needed to update the EMFAC model used to the latest version approved by U.S. EPA, since the currently referenced EMFAC2007 is outdated.

**<u>19715(b)(3)(D)(ii)b.4. and 5.</u>**: Staff is proposing to change section “(b)(3)(D)(ii)3.” to “(b)(3)(D)(ii)b.3.”

<u>Rationale</u>: The proposed changes are needed to correct errors in the section number referenced.

**<u>1971.5(b)(3)(D)(iii)d.</u>**: Staff is proposing changes regarding the engine selection criteria specified under section 1971.5(b)(3)(D)(iii) for ARB-conducted enforcement testing. Specifically, staff is proposing that the Executive Officer is not required to meet the criterion under section 1971.5(b)(3)(D)(iii)d. (i.e., is not required to select an engine that has a mileage/age equal to or less than the certified full useful life mileage) in cases where the Executive Officer is testing to determine if the OBD system is designed to deactivate based on age and/or mileage.

<u>Rationale</u>: The proposed change is needed to correct an oversight and to be consistent with section 1971.5(b)(3)(A)(iv), which does not prohibit the Executive Officer from conducting testing on an engine class whose engines, on average, exceed the defined full useful life in cases where the Executive Officer is trying to determine if an OBD system is designed to deactivate based on age and/or mileage.

**<u>1971.5(b)(4)(A)</u>**: Staff is proposing language requiring manufacturers to make available certain information and/or hardware if requested by the Executive Officer during ARB-conducted testing under section 1971.5(b). This would include software design descriptions and source code of the ECU or any other on-board electronic powertrain control unit, a complete list of all control unit variables for real-time display and data logging, data acquisition devices to collect these variables, and methods to unlock production/prototype control units to allow this real-time display and data logging

<u>Rationale</u>: Staff is proposing these changes based on past experiences with testing OBD systems on vehicles. The information/hardware staff is proposing to add would be especially helpful to staff attempting to review OBD systems and to determine if the systems meet the requirements of the OBD regulations. Manufacturers have argued that providing the source code would pose IP concerns for both engine manufacturer and suppliers, and that providing information about all variables would be a significant burden for manufacturers to provide and would not provide any value to CARB staff given the complexity of the source codes at issue. CARB staff, however, believes that it is this complexity that requires CARB to ask for such information to help staff understand the system. To ensure security, staff is proposing to only require this information if requested by the Executive Officer during enforcement testing, not as a routine matter of course for enforcement proceedings. In addition, CARB staff are working with internal cyber-security experts to evaluate the internal procedures in place to protect sensitive manufacturer IP and reduce the risk of

exposure to the extent feasible. However, given that CARB has the authority adopt regulations and request information to support certification and evaluation of compliance with the regulations, staff considers this proposal a clarification of existing requirements.

**<u>1971.5(b)(6)(A)(ii), (b)(6)(A)(iii)a., and (b)(6)(A)(iii)b.</u>**: Staff is proposing changes to the nonconformance criteria for deficient emission threshold monitors. Specifically, to be considered nonconforming, the monitor would have to had not properly illuminated the MIL when emissions exceeded the mandatory recall levels specified under section 1971.5(d)(3)(A)(ii).

<u>Rationale</u>: Staff is proposing this language to correct an oversight. Specifically, the current nonconformance criteria for these engines deem an emission threshold monitor nonconforming if the MIL is not illuminated and emissions exceeded 2.0 times the malfunction criteria. However, it is possible for an emission threshold monitor to be granted a deficiency under section 1971.1(k) if it does not illuminate the MIL until emissions are greater than 2.0 times the malfunction criteria, as long as the emission levels are below the mandatory recall levels in section 1971.5(d)(3)(A)(ii) (e.g., for 2013-2015 model year engines, the mandatory recall level is 3 times the malfunction criteria). In these cases, it would be inappropriate to subject these monitors to enforcement penalties. Thus, staff proposed these changes to address this.

**<u>1971.5(b)(6)(A)(iii)c. and (b)(6)(A)(iv)</u>**: Staff is proposing changes to the nonconformance criteria for deficient emission threshold monitors on 2016-2018 model year engines not covered under sections 1971.5(b)(6)(A)(iii)a. and b. above and all 2019 and subsequent model year engines. Specifically, to be considered nonconforming, the monitor would have to had not properly illuminated the MIL when emissions exceeded either of the following, whichever is smaller: (1) 20 percent of the emission standard above the emission level at which a malfunction was detected when the OBD system was approved by the Executive Officer, or (2) the applicable emission level for mandatory recall under section (d)(3)(A)(ii).

<u>Rationale</u>: Similar to the proposed changes to sections 1971.5(b)(6)(A)(ii), (b)(6)(A)(iii)a., and (b)(6)(A)(iii)b. above, staff is proposing this language to correct an oversight. The current nonconformance criteria deems an emission threshold monitor nonconforming if the MIL is not illuminated and emissions exceeded 2.0 times the malfunction criteria. However, it is possible for an emission threshold monitor to be granted a deficiency under section 1971.1(k) if it does not illuminate the MIL until emissions are greater than 2.0 times the malfunction criteria, as long as the emission levels are below the mandatory recall levels in section 1971.5(d)(3)(A)(ii) (e.g., for 2019 and subsequent model year engines, the mandatory recall level is 2 times the malfunction criteria). In these cases, it would be inappropriate to subject these monitors to enforcement penalties. Thus, staff proposed that a system would not be considered

nonconforming unless emissions exceeded the smaller of the following: the mandatory recall level specified in section 1971.5(d)(3)(A)(ii) or an emission level based on the level the manufacturer certified the monitor to with a deficiency for OBD approval (i.e., the emission level at which the manufacturer indicated the monitor is able to detect a fault during OBD certification). For the latter criterion, staff proposed that emissions would need to exceed this emission level by 20 percent of the emission standard (i.e., the deficient emission threshold monitor emission level plus 20 percent of the emission standard) for the OBD system to be considered nonconforming. For example, a manufacturer is granted a deficiency for an emission threshold monitor that the manufacturer indicated during OBD certification detects a fault when NOx emissions reached 0.5. g/bhp-hr, where the OBD threshold is 0.4 g/bhp-hr and the NOx emission standard is 0.2 g/bhp-hr. For this example, the emission level considered nonconforming would need to exceed 0.54 g/bhp-hr, which is 0.5 g/bhp-hr plus 20 percent of 0.2 g/bhp-hr. Staff determined that 20 percent of the emission standard margin was needed to provide for test-to-test variability, and that the 20 percent needed to be based on the emission standard (not the emission level at which the monitor was certified with a deficiency) to avoid inappropriately giving an advantage to manufacturers that detect faults at a higher emission level than other manufacturers. Additionally, manufacturers have provided data indicating that test variability scales with the standard, not the certification level, and as such have previously supported using a percentage of the standard in other regulatory modifications.

**<u>1971.5(b)(6)(A)(iii), (b)(6)(A)(iv), and (b)(6)(A)(v)</u>**: Staff is proposing changes to the nonconformance criteria for alternate-fueled engines. Specifically, for 2018 through 2021 model year engines, to be considered nonconforming, the monitor would have to had not properly illuminated the MIL when emissions exceeded the mandatory recall levels specified under section 1971.5(d)(3)(A)(ii) for deficient emission threshold monitors and 2.0 times the malfunction criteria for all other monitors. For 2022 and subsequent model year engines, for a deficient emission threshold monitor to be considered nonconforming, the monitor would have to had not properly illuminated the MIL when emissions exceeded either of the following, whichever is smaller: (1) 20 percent of the emission standard above the emission level at which a malfunction was detected when the OBD system was approved by the Executive Officer, or (2) the applicable emission level for mandatory recall under section (d)(3)(A)(ii). For all other monitors, to be considered nonconforming, the monitor would have to had not properly illuminated the MIL when emissions exceeded the malfunction criteria.

<u>Rationale</u>: Staff is proposing this language to correct an oversight. Specifically, the HD OBD regulation (title 13, CCR section 1971.1(d)(7.5.3)) does not require alternate-fueled engines to be equipped with OBD systems that meets the requirements of section 1971.1 until the 2018 model year. For the first few years of OBD system implementation, staff generally provides for more relaxed nonconformance criteria to provide manufacturers time to gain more experience

with their OBD systems in the field before they are held to the final HD OBD requirements in-use. The current HD OBD enforcement regulation, however, holds these alternate-fueled engines to nonconformance criteria that match the requirements in the HD OBD regulation (i.e., the malfunction criteria specified in the title 13, CCR section 1971.1) from the 2018 model year, which is inappropriate. Therefore, staff is proposing changes that would provide for more relaxed nonconformance criteria for 2018 through 2021 model year alternate-fueled engines. The rationale for the nonconformance criteria for deficient emission threshold monitors were provided in the previous sections above.

**1971.5(b)(6)(B)(ii)**: Staff is proposing changes indicating this section applies to 2016 and subsequent model year engines "with monitors certified to a ratio of 0.100."

Rationale: The proposed change is needed for clarity since the current language "engines certified to a ratio of 0.100" does not take into account that different monitors on the same engine may be certified to different ratios (e.g., some monitors may be certified to 0.300, other monitors may be certified to 0.100).

**1971.5(b)(6)(B)(iii)**: Staff is proposing changes to the nonconformance criteria for the IUMPR. Specifically, for monitors on 2022 through 2025 model year engines certified to an IUMPR of 0.300, the monitor would be considered nonconforming if the average IUMPR of the engines in the test sample group is less than 0.177 or the IUMPR on more than 66.0 percent of the engines in the test sample is less than 0.200.

Rationale: As stated above, staff proposed changes to section 1971.1(d)(3.2.2) to increase the minimum IUMPR from 0.100 to 0.300 starting with the 2022 model year. The nonconformance ratio in section 1971.5(b)(6)(B) would also need changes to account for this increase. Accordingly, staff believes that manufacturers should be held to a lower IUMPR in-use during the first few years of the 0.300 IUMPR requirement to allow manufacturers to gain more experience with their monitors and the new IUMPR in the field. The critical ratio of 0.177 is based on a confidence interval such that a sample of 30 vehicles whose average ratio is less than 0.177 provides confidence at the 90% level that the population as a whole has an average ratio of less than the interim in-use nonconformance ratio of 0.200. This is calculated by simulating trials up to 100,000 times and taking 30 samples from a beta distribution with the desired mean, in this case 0.200. Once the averages are calculated, the $10^{th}$ percentile is determined and is equivalent to the specified critical ratio of 0.177.

To address the scenario in which the vast majority of the population of vehicles have in-use ratios below the required minimum ratio but a few have very high ratios, and the sample average exceeds the minimum in-use required ratio, the second criterion based on 66.0 percent of the ratios being less than 0.200 is used.  A sample average which does not contain at least 66.0 of the ratios above 0.2 would be considered noncompliant.

**<u>1971.5(b)(6)(B)(iv)</u>**: Staff is proposing changes to the nonconformance criteria for the IUMPR.  Specifically, for monitors on 2026 and subsequent model year engines certified to an IUMPR of 0.300, the monitor would be considered nonconforming if the average IUMPR of the engines in the test sample group is less than 0.265 or the IUMPR on more than 66.0 percent of the engines in the test sample is less than 0.300.

<u>Rationale</u>: As the final in-use nonconformance IUMPR of 0.300 is applied to in-use vehicles starting with the 2026 model year, the applicable critical ratio of 0.265 is used for compliance determination when considering the average of the test sample group.  Sample averages less than the critical ratio of 0.265 provide evidence that the population mean is lower than the required in-use nonconformance ratio of 0.300 with 90 percent confidence.  Similarly, the 66.0 percent less than 0.300 criterion is also applicable.  A sample average that does not contain at least 66.0 percent of the ratios above 0.300 would be considered noncompliant.

**<u>1971.5(b)(6)(C)(ii)a.</u>**: Staff is proposing to change “Society of Automotive Engineers” to “SAE International.”

<u>Rationale</u>:  The proposed change is needed to update the name “Society of Automotive Engineers” to the official new name “SAE International.”

**<u>1971.5(b)(7)(C), (c)(5)(E)(iii), and (d)(3)(C)</u>**: Staff is proposing to change the word “paragraph” to “section.”

<u>Rationale</u>: The proposed change is needed for consistency, since “section” is used throughout the regulation instead of “paragraph.”

**<u>Section 1971.5(c): Manufacturer Self-Testing</u>**

During the 2009 HD OBD rulemaking process, staff adopted HD OBD enforcement provisions to help ensure the effectiveness of the HD OBD regulation and the underlying more stringent emission standards that were adopted for 2010 and subsequent model year heavy-duty engines.  Among other things, the regulation provided that, in addition to CARB-initiated enforcement testing, engine manufacturers are responsible for compliance self-testing of OBD systems to ensure that the systems in-use actually meet certification requirements.  One of the reasons manufacturer self-testing is necessary is because of the uniqueness of engine dynamometer testing.  While chassis dynamometer testing of the complete vehicle as is done in light-duty can easily be replicated by CARB, manufacturers, and independent laboratories, engine dynamometer set-up and testing differs for each engine and involves the use of custom parts, modifications, and configurations.  Because the engine is removed from the vehicle, various inputs and outputs to the engine control computer must be generated to simulate operation in a vehicle.  Without intimate knowledge of all the individual component specifications and input and output signals, not to mention the custom hardware and software needed to replace the removed component, or tremendous reliance on the voluntary cooperation and resources of the engine manufacturer, successful engine dynamometer testing is very difficult to perform.  Engine manufacturers, who routinely perform engine dynamometer testing of their own engines, including testing for research, development, and tailpipe certification, have, by definition, the knowledge and equipment necessary to perform engine dynamometer testing.

The manufacturer self-testing program kicked off in 2016 with the testing of 2013 model year engines.  After completion of a year of self-testing, manufacturers found that the self-testing program was more time consuming and expensive than anticipated.  In addition, some manufacturers encountered challenges in procurement of the engines to be tested.  Staff reanalyzed the cost of the self-testing program and found that, due to differences in expected implementation, the cost was higher than expected (see Chapter VI of this Staff Report).  As such, staff worked with manufacturers to develop flexibilities for the procurement of engines and streamlined the testing procedures.

**1971.5(c)(2): Engine Selection for Manufacturer Self-Testing**

**1971.5(c)(2)(C)(i)c.**: Currently, the procured engine must be between 70 and 80 percent of full useful life.  Staff is proposing to expand the mileage window to between 70 and 100 percent of full useful life.

Rationale: This proposed change is needed to address the difficulties manufacturers have experienced in finding the selected engine with the currently required 70 to 80 percent of full useful life mileage.  This proposed change would greatly expand the pool of available engines for procurement, thereby reducing the cost of procurement.

**1971.5(c)(2)(C)(iii)**: Staff is proposing to allow manufacturers to propose alternate criteria for engine selection such as manufacturer-operation of the engine to accumulate miles, requesting additional time to accumulate more hours, or demonstrating mileage-to-hours equivalency.  Alternatively, the manufacturer could request to procure an engine of the same model year but different rating than the specific rating selected by staff.  Manufacturers would then rerate the procured engine to the selected rating.  Such engine rerating would be allowed only if the engine is otherwise identical to the initially-selected engine, and if manufacturer demonstrates that the engine proposed for rerating would result in worst-case emissions.

Rationale: As stated above, these proposed changes are needed to address the difficulties manufacturers have experienced in procuring engines that meet the currently required criteria in section 1971.5(c)(2)(C). These allowances would greatly expand the pool of available engines for procurement, thereby reducing the cost of procurement, while not adversely affecting the self-testing program since approval of the alternate criteria would be based on demonstration that the alternate is equal or worst-case compared to the standard engine procurement criteria.

**1971.5(c)(3): Compliance/Enforcement Testing Procedures**

**1971.5(c)(3)(A)**: Staff is proposing that, prior to conducting testing, manufacturers provide the sales volume, applicable running changes, and applicable field fixes for each engine group with a unique OBD system calibration. Using this information, the Executive Officer would notify the manufacturer of the specific system calibration to be used on the tested engine.

Rationale: The proposed information is needed so that staff could use those information to determine which engine calibration should be tested. While it is manufacturer's preference that the highest volume calibration be tested, there may be cases where staff is interested in testing a different calibration in order to see the validation of a specific running change or field fix, or because of warranty data indicating a potential issue with a particular calibration.

**1971.5(c)(3)(C)**: Staff is proposing to streamline the test procedures by reducing the number of component/system monitors tested from all monitors tested during demonstration testing to 15 monitors. The 15 monitors would be selected by CARB, with 8 tested by all manufacturers and 7 specific to each manufacturer. Any monitors with deficiencies for exceeding the threshold would also need to be tested if they were not among the 15 monitors chosen for testing. Additionally, staff is proposing to require manufacturers to verify the worst case emissions test cycle selection on 2 of the 15 selected monitors.

Rationale: In discussing the initial testing experiences with manufacturers, one of the biggest areas of concern was the number of monitors that are currently required to be tested and the associated amount of time in a certification-grade test cell that is required to complete a test program. In its initial estimate for the 2009 HD OBD regulatory update, staff assumed that manufacturers would be testing approximately 16 monitors. However, due to increased system complexity and the request that manufacturers verify all functional monitors, the number of monitors required to be tested ranged from 22 to 30. This increase in testing raised the time required and cost of the self-testing program. To help constrain the cost of this program, staff is proposing to reduce the number of monitors required to be tested to 15. Eight of these monitors would be the same for all manufacturers in a given year and would be chosen based on staff's evaluation of that model year's certification applications, durability demonstration engine data, and IUMPR data. This information would also be used along with prior year warranty claim information and prior year test results to inform the selection of the 7 monitors that are specific to that manufacturer.

Of these 7 manufacturer-specific monitors, staff may choose to have the manufacturer verify one or more functional monitors such that functional monitor verification would no longer be in addition to all threshold monitor testing. Because staff has observed that the worst case emission test cycle selection is not always accurate, staff is proposing to require that worst case cycle emission verification be conducted on 2 of the selected monitors. While this proposed requirement is adding 2 additional tests, this is not expected to significantly increase the time or cost of the test program since the SET is a hot test that can be conducted directly after an FTP test. Although there is some risk that a nonconforming monitor would not be discovered under this proposed streamlined test program, staff considers this risk to be minimal given that staff are intimately acquainted with manufacturers' system designs, prior year test results, and warranty reporting from prior model years. These data would all inform monitor selection and, along with the requirement that all deficient monitors be tested regardless of whether they are among the 15 chosen monitors, would ensure that those monitors most likely to have in-use durability and performance issues are verified compliant.

**1971.5(c)(3)(C)(i) through (iii)**: Staff is proposing to language to allow manufacturers to carry over the regeneration frequency factor determined at the time of OBD certification, to ignore invalid PM emission test results for monitors with no PM malfunction criteria, and to use alternate test procedures (such as less frequently calibrated emission analyzers) for all but one of the required test engines for those manufacturers required to test two or more engines. Manufacturers using alternate test procedures would still be required to meet the required malfunction criteria when emission tests are performed in accordance with official test procedures, and would be required to report to the Executive Officer any testing issues or failures that occurred during or immediately after testing, such as failed calibration checks.

Rationale: CARB staff is proposing to allow manufacturers to carry over the frequency factors determined at the time of OBD certification because the time, and therefore cost, savings to manufacturers are significant relative to any differences in the factors that might exist between those determined at the time of certification versus those determined on the engine procured for self testing. Manufacturers submitted data on the differences between the two frequency factors for model year 2013 engines. These data indicate that, for those monitors for which manufacturers calculated unique OBD frequency factors at the time of OBD certification (i.e., did not carry over the factor determined for tailpipe certification), there were no consistent trends when compared to the frequency factors calculated on the FUL engine. In fact, on average the difference between the two frequency factors was very small. As such, CARB staff believe it appropriate to allow manufacturers to apply those OBD certification frequency factors to the in-use self-testing results for applicable monitors.

Additionally, the proposal to allow manufacturers to use alternate test procedures (e.g., decreased calibration frequency) on their second and subsequent tested engines is already provided during durability demonstration testing (title 13, CCR section 1971.1(i)(4.4)) for those manufacturers who conduct demonstration testing on more than one engine.  Because fully 1065-compliant test cells are a limited resource at many manufacturers test facilities, staff believes it is reasonable to allow those manufacturers with higher test burdens to utilize facilities that, while not being certification grade, still provide test results with a high degree of confidence.  By also proposing that manufacturers notify CARB of any failures or test facility issues such as failed calibration checks, staff would be able to monitor the potential impact of any allowances that are granted and even stop allowing a given procedural change if it proves to be problematic.  Staff, though, is also proposing language to remind manufacturers that though testing is done in these other facilities, the manufacturer is still required to meet the required malfunction criteria for their emission threshold monitors if these engines were tested in 1065-compliant test cells.

**1971.5(c)(3)(E)**: Staff is proposing to delete mention of reducing the minimum mileage required in section 1971.5(c)(2)(C)(i)c. from this section.

Rationale: The proposed change is needed since this requirement has moved to the more appropriate section in section 1971.5(c)(2)(C)(iii).

**1971.5(c)(3)(F)**: Staff is proposing to add the word "section" to "(c)(3)."

Rationale: This proposed change is needed for consistency.

**1971.5(c)(3)(G)**: Staff is proposing to streamline the testing to just the 8 monitors required to be tested by all manufacturers if the following conditions are met: (1) all monitors tested were found to be compliant (i.e., all monitors tested did not trigger any additional testing under section 1971.5(c)(4)) over a 3-year period, (2) there were no deficient monitors for exceeding the threshold over that same 3-year period as well as the current year being tested, (3) there are no deficient IUMPR monitors and no IUMPR data meeting the nonconformance criteria of 1971.5(b)(6)(B) over the same 3-year period, and (4) no warranty claims exceeded 4 percent over the same 3-year period as well as the current year being tested.  The 3-year period would be required to be 3 consecutive model years prior to the model year of the engine being tested.

Rationale: To incentivize manufacturers to build fully compliant and durable engines, staff is proposing to add an allowance that can further reduce manufacturers' testing burdens.  If the manufacturer meets all the proposed criteria specified above, then the manufacturer would be allowed to waive testing of any manufacturer-specific monitors. The eight monitors selected for all manufacturers would still need to be tested on the procured engine, which also must be free of deficient threshold monitors and fully compliant with IUMPR requirements. Because a history of compliance and durability would need to be demonstrated, staff believes it reasonable to reward manufacturers by reducing the number of monitors to be verified. However, because manufacturers would still be required to test the eight monitors selected for all manufacturers, which are likely to be the most critical monitors for ensuring functioning emission control components, CARB would retain the ability to continue to spot check system design durability.

**1971.5(c)(4): Additional Testing**

**1971.5(c)(4)(A) through (D)**: In the case where the initial testing shows that the OBD system does not properly illuminate the MIL before emissions exceed the threshold, staff is proposing to define separate criteria for those monitors that were granted a deficiency for exceeding the emission threshold. For deficient emission threshold monitors, the threshold for compliance determination would be either 20 percent of the emission standard above the emission level at which a malfunction was detected when the OBD system was approved by the Executive Officer, or the applicable emission level for mandatory recall, whichever is smaller. If this new threshold for a deficient monitor is exceeded, additional engines would need to be procured for further testing per section 1971.5(c)(4). The new threshold would be used as the compliance level for all additional engine testing.

Rationale: During the initial development of the manufacturer self-testing program in 2009, CARB defined the level of noncompliance for triggering additional testing and determining nonconformance as the OBD threshold (i.e., the emission threshold required in title 13, CCR sections 1971.1(e) through (g)). However, no criteria were defined for monitors with deficiencies for exceeding the threshold, leading manufacturers to believe that deficient emission threshold monitors would only be considered nonconforming if the emissions exceeded the mandatory recall threshold. Staff believes using the recall threshold as the nonconformance criteria for deficient emission threshold monitors is not appropriate in all cases. Since manufacturers are presumed to have made a "good faith effort" in calibrating the monitor even though emissions are above the OBD threshold, the expectation is that in most cases the emissions will be close to the OBD threshold. Since the mandatory recall threshold ranges from 2 to 3 times the malfunction criteria (e.g., for 2 times the malfunction criteria, the threshold is 5.0 times the standard for a monitor with a malfunction criteria of 2.5 times the standard), using the recall threshold provides a significantly greater margin for compliance than for most other monitors, which are typically calibrated with a 10-20 percent compliance margin. Thus, staff is proposing to define the threshold of compliance for deficient threshold monitors as 20 percent of the standard above the emission level measured at the time of certification, or the mandatory recall threshold, whichever is smaller. This new compliance threshold would be noted in the OBD Approval Letter at the time of certification, and would be the trigger for both additional engine testing and for determination of nonconformance under the self-testing program.

**<u>1971.5(c)(4)(B)(ii)</u>**: Staff is proposing to change “(b)(3)” to “section (c)(3).”

<u>Rationale</u>: The proposed addition of “section” is needed for consistency, and the proposed change from (b)(3) to (c)(3) is needed to correct an error in the section number referenced.

**<u>1971.5(c)(4)(E)(i)</u>**: For additional engine testing, the proposed amendments would allow manufacturers to procure a “direct carry-over” engine in lieu of the identical model year of the initial engine. Procurement of the direct carry-over engine would be limited to one model year before or after the engine of concern and to engines that have substantially similar calibrations and emission-related hardware such that the testing of the direct carry-over engine would provide the same results as testing of the engine of concern.

<u>Rationale</u>: As mentioned above, the proposed changes are needed to address the difficulties manufacturers have experienced in procuring engines that meet the currently required criteria in section 1971.5(c)(2)(C). The initial engine tested under section 1971.5(c)(3) would need to be the same model year as the engine specified in the test letter. If additional engine testing is triggered, manufacturers would be able to use engines from either the previous or subsequent model year as long as the engine is only one model year away from the original test engine and has substantially similar calibrations and emission-related hardware. Manufacturers would be required to submit information at the time of the request to use a carryover demonstrating that the direct carry-over engine would provide the same results as testing of the engine of concern.

**<u>1971.5(c)(4)(E)(ii)</u>**: Additionally, for additional engine testing, staff is proposing to allow manufacturers to request usage of alternate test procedures such as less frequently calibrated emissions analyzers. Manufacturers would be allowed to use these alternate test procedures if they can demonstrate that the proposed procedures would be representative of official test results, and if they agree to report any testing issues or failures (e.g., failed emissions analyzer calibration checks) that occurred during or immediately after the testing.

<u>Rationale</u>: As with the proposal to allow manufacturers to utilize alternate test procedures when testing the second or more engine in section 1971.5(c)(3)(C) above, staff believes it is reasonable to propose this allowance for additional engine testing to provide relief for those manufacturers with higher test burdens. Utilizing these facilities, while not being certification grade, would still provide test results with a high degree of confidence. This proposed allowance is projected

to result in significant time and money savings. One manufacturer has indicated that it might save as much as two to three weeks of test time simply by extending a single calibration interval for an emissions analyzer.

**1971.5(c)(4)(F)**: Finally, staff is proposing to allow manufacturers to waive the additional testing requirements if the manufacturer acknowledges that the OBD system does not properly illuminate the MIL for the monitor(s) before the applicable thresholds specified in 1971.5(c)(4)(A), the manufacturer agrees that the OBD system is considered nonconforming according to the criteria of section 1971.5(b)(6)(A), and the Executive Officer approves the manufacturer's plan to correct the nonconformance issue.

Rationale: In some cases, during the course of self-testing the initial engine under section 1971.5(c)(3), manufacturers may discover the cause of a given monitor failure and determine that the most cost-effective path forward is to simply fix the issue in the field rather than procure additional engines to decisively demonstrate there is a noncompliance. This proposed allowance would provide a cost-effective path for manufacturers to expeditiously address noncompliances in the field.

**Section 1971.5(d): Remedial Action**

**1971.5(d)(3)(A)(i)**: Staff is proposing amendments to indicate that the requirements of this section also apply to major monitors subject to the nonconformance criteria of sections 1971.5(b)(6)(B)(iii) and (b)(6)(B)(iv). For monitors subject to the nonconformance criteria of sections 1971.5)(b)(6)(B)(iii), staff is proposing that the mandatory recall would be applied if the average IUMPR or the IUMPR for at least 66 percent of the vehicles in the test sample group is less than or equal to 0.066. Staff is also proposing to divide the section into sections 1971.5(b)(6)(B)(i)a. and b.

Rationale: The proposed change is needed to account for the newly proposed nonconformance criteria in sections 1971.5(b)(6)(B)(iii) and (b)(6)(B)(iv) and to provide some leeway in terms of mandatory recall for the first few years of the proposed 0.300 IUMPR requirement in order to allow manufacturers to gain more experience with their monitors and the new IUMPR in the field. The proposed division of the section into sections (b)(6)(B)(i)a. and b. is needed for better readability.

**1971.5(d)(3)(A)(ii)b., c., and d.**: Staff is proposing language to address alternate-fueled engines. Specifically, for emission threshold monitors, the mandatory recall level would be 3 times the applicable malfunction criteria for 2018 through 2021 model year alternate-fueled engines, while the mandatory recall level would be 2 times the applicable malfunction criteria for 2022 and subsequent model year alternate-fueled engines.

Rationale: Section 1971.1(d)(7.5.3) requires 2018 and subsequent model year alternate-fueled engines to implement “full” OBD systems that meet the requirements of the HD OBD regulation. Considering that 2018 will be the first model year that these engines will have experience with “full” OBD systems, staff believes that some leeway is needed in terms of enforcement for the initial years of “full” OBD system implementation. Thus, staff is proposing a higher mandatory recall level for emission threshold monitors on 2018 through 2021 model years alternate-fueled engines.

**1971.5(d)(3)(A)(ii)b.2.**: Staff is proposing to change the reference to section 1971.1(e)(8.2.1)(E) to 1971.1(e)(8.2.1)(F).

Rationale: The proposed change are needed since the requirements of 1971.1(e)(8.2.1)(E) moved to 1971.1(e)(8.2.1)(F) due to the proposed changes to section 1971.1(e)(8.2.1)(E).

**1971.5(d)(3)(A)(viii)**: Staff is proposing changes to the ordered remedial action (i.e., mandatory recall) criteria 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. Specifically, when the engine is tested in a vehicle and operated so as to reasonably encounter all monitoring conditions disclosed in the manufacturer’s certification application, if the monitor for these VVT systems cannot detect and illuminate the MIL for a malfunction, then the engine would be subject to mandatory recall.

Rationale: Staff proposed changes in title 13, CCR sections 1971.1(e)(10) and (f)(9) indicating that VVT systems with discrete operating states (e.g., two step valve train systems) are not required to detect a malfunction prior to exceeding the required emission thresholds, but instead are required to detect all failures that exceed the thresholds. The HD OBD enforcement regulation currently requires that emission threshold monitors are subject to mandatory recall if they do not detect a fault and illuminate the MIL before emissions exceed specific emission levels, which does not account for these VVT system monitors. Therefore, staff is proposing specific mandatory recall criteria that would apply to these VVT system monitors.

**1971.5(d)(3)(B)**: Staff is proposing to change the reference to the mandatory recall criteria set forth in “section (d)(3)(A)(i)-(vi)” to “section (d)(3)(A)(i)-(vi) and (viii).”

Rationale: The proposed change is needed to account for the newly proposed criteria for mandatory recall under section 1971.5(d)(3)(A)(viii).

**1971.5(d)(6)(B)(iv) and (e)(6)(B)**: Staff is proposing changes to the mailing address that the manufacturer would be required to submit the remedial action plan and the remedial action progress report to. Specifically, the new address is to the “Chief, Emissions Compliance, Automotive Regulations and Science Division, 9480 Telstar Avenue, Suite 4, El Monte California 91731 (or the mailing address indicated in the notice).”

Rationale: The proposed change is needed to update the mailing address to the correct division and address, and to indicate that the mailing address may change in the future but would be noted in the notice sent by CARB staff when notifying the manufacturer of an ordered remedial action under section 1971.5(d)(6).

## C. Proposed Amendments to OBD II Regulation Section 1968.2

Similar to what has been done during the previous rulemaking updates for the HD OBD regulation, staff is proposing to update the requirements for medium-duty vehicles certified to an engine dynamometer tailpipe emission standard in the OBD II regulation (title 13, CCR section 1968.2) to be consistent with some of the proposed amendments to the HD OBD regulation. This would allow manufacturers of both heavy-duty and medium-duty diesel engines to design to and meet essentially the same requirements. Additionally, staff is proposing other changes to the OBD II regulation that staff determined were needed immediately to correct errors and to ensure manufacturers are able to comply when they certify their current model year vehicles.

### Section 1968.2(c): Definitions

**“Active off-cycle credit technology”**: Staff is proposing changes to indicate that “engine stop-start systems” would be considered active off-cycle credit technologies and would be required to be tracked under section 1968.2(g)(6) starting with the 2022 model year.

Rationale: The proposed change is needed to correct a mistake. When staff first adopted the requirement to track and report the in-use activity of active off-cycle credit technology during the 2015 OBD II rulemaking update, staff inadvertently indicated that engine stop-start systems would not be considered active off-cycle credit technologies and would not need to be tracked under section 1968.2(g)(6), which staff didn’t intend to do. Since these types of systems are becoming increasingly common on vehicles, staff believes it is important to track the in-use activity of such systems to help staff verify the credits assigned at the time of certification are representative of actual usage. Thus, staff is proposing changes to correct this. As a reminder, while the data could not be used to retroactively increase or decrease the assigned credit values, the data could be used to more accurately assign credits for those technologies on future vehicles that get certified.

**<u>"Emission Increasing Auxiliary Emission Control Device (EI-AECD)"</u>**: Staff is proposing to modify the definition of an EI-AECD to refer to any approved AECD that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use, and meets (1) or (2): (1) the need for the AECD is justified in terms of protecting the vehicle against damage or accident, or (2) for 2022 and subsequent model year medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, is related to adaptation or learning (e.g., SCR system adaptation).

<u>Rationale</u>: The proposed change is needed to be consistent with the proposed change to the HD OBD regulation. The rationale for this proposed amendment was described in section 1971.1(c) above.

**<u>"Over-the-air reprogramming"</u>**: Staff is proposing a new definition for "over-the-air reprogramming."

<u>Rationale</u>: The new proposed definition is needed to complement the proposed changes to section 1968.2(g)(8). The rationale for this proposed amendment was described in section 1971.1(h)(6) above.

**<u>Section 1968.2(d): General Requirements</u>**

**<u>1968.2(d)(3.2.2)</u>**: Staff is proposing to add several monitors to the list of the monitors required to track and report in-use monitor performance data. The proposed additions would include the diesel EGR system high/low flow and feedback control monitors (section 1968.2(f)(6.3.1)(B) and (f)(6.3.3)), boost pressure control system over/under boost and feedback control monitors (section 1968.2(f)(7.3.1)), and PM filter frequent regeneration, missing substrate, and active/intrusive injection monitors (section 1971.1(f)(9.3.2)). These proposed changes would apply to 2022 and subsequent model year medium-duty vehicles certified to an engine dynamometer tailpipe emission standard.

<u>Rationale</u>: The proposed change is needed to be consistent with the proposed change to the HD OBD regulation. The rationale for this proposed amendment was described in section 1971.1(d)(3.2.1) above.

**<u>1968.2(d)(4.3.2)(G) and (I)</u>**: For medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, staff is proposing to require that the diesel NMHC converting catalyst monitor to stop using the denominator incrementing criteria in section 1968.2(d)(4.3.2)(G) by the 2021 model year and to starting using the criteria in section 1968.2(d)(4.3.2)(I) starting with the 2022 model year.

Rationale: The proposed change is needed to be consistent with the proposed change to the HD OBD regulation. The rationale for this proposed amendment was described in section 1971.1(d)(4.3.2)(G) and (H) above.

**1968.2(d)(4.3.2)(G) and (H)**: For medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, staff is proposing to require that the diesel PM filter frequent regeneration monitor to stop using the denominator incrementing criteria in section 1968.2(d)(4.3.2)(H) and to start using the criteria in section 1968.2(d)(4.3.2)(G) by the 2022 model year.

Rationale: The proposed change is needed to be consistent with the proposed change to the HD OBD regulation. The rationale for this proposed amendment was described in section 1971.1(d)(4.3.2)(F) and (G) above.

**1968.2(d)(6.2), (d)(6.2.7), and (d)(6.4)**: For 2021 and subsequent model year medium-duty vehicles using engines certified on an engine dynamometer, staff is proposing that manufacturers be required to use the procedure in CFR title 40, part 1065.680 (current as of August 21, 2018) to calculate IRAFs.

Rationale: The proposed change is needed to be consistent with the proposed change to the HD OBD regulation. The rationale for this proposed amendment was described in section 1971.1(d)(6.3) above.

**Section 1968.2(f): Monitoring Requirements for Diesel/Compression-Ignition Engines**

**1968.2(f)**: Staff is proposing changes to Table 3, which describes the "LEV III OBD II Diesel PM Filter Filtering Performance Monitor Threshold." Specifically, staff is modifying the footnotes to indicate that the PM multipliers listed for 2016 and subsequent model year chassis certified medium-duty vehicles (except medium-duty passenger vehicles) would not apply to vehicles included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(D)3. Instead, such vehicles would be subject to a PM threshold of 17.50 milligram-per-mile (mg/mi).

Rationale: The OBD II regulation currently requires 2016 and subsequent model year chassis certified medium-duty vehicles (except medium-duty passenger vehicles) included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2. to use a PM threshold of 17.50 mg/mi for the PM filter filtering performance monitor. Staff, however, overlooked that such vehicles may also be meeting the alternative phase-in of PM standards set forth in title 13, CCR section 1961.2(a)(2)(D)3. Essentially, any medium-duty vehicle certified to a 60 mg/mi or 120 mg/mi PM standard would be required to use the PM threshold of 1.50 times the standards, while any medium-duty vehicle certified to a 8 mg/mi or 10 mg/mi PM standard would be required to use the PM threshold of 17.50 mg/mi. Thus, staff is proposing changes to account for this.

**<u>1968.2(f)(1.2.3)(B)</u>**: For all vehicles, staff is proposing to modify the exemption criteria to test out of monitoring for the NMHC catalyst feedgas generation performance to limit the exemption criteria pollutant to only NOx emissions. Additionally, for medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, staff is proposing to increase the exemption criteria to test out of monitoring to 30 percent of the applicable full useful life standard as measured from an applicable emission test cycle. Specifically, catalysts on such medium-duty vehicles would be exempt from monitoring if (1) no malfunction of the catalyst's feedgas generation ability can cause emissions to increase 30 percent or more of the applicable full useful life NOx standard as measured from an applicable emission test cycle; and (2) no malfunction of the catalyst's feedgas generation ability can cause emissions to exceed the applicable full useful life NOx standard as measured from an applicable emission test cycle. For all vehicles, staff is also proposing to require manufacturers to submit a test out plan with testing conditions (e.g., performing the test out using a catalyst depleted of all platinum to remove feedgas generation capability) for Executive Officer approval. Finally, for all vehicles, staff is making clear that manufacturers can design feedgas monitors (and test out of monitoring) on a system level (e.g., monitor all catalysts/catalyzed PM filters used to generate a feedgas constituency to assist SCR systems with one OBD diagnostic) or separately/individually.

<u>Rationale</u>: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(e)(5.2.3)(B) above.

**<u>1968.2(f)(1.2.3)(D)</u>**: Staff is proposing to amend the existing "test-out" provisions for NMHC catalysts located downstream of the SCR system (e.g., catalysts used to prevent ammonia slip). Specifically, for all vehicles, staff is proposing that such catalysts would be exempt from the monitoring requirements if the catalyst is monitored as part of the SCR system under section 1968.2(f)(2.2.2) (i.e., the catalyst is located between the two NOx sensors used to monitor the SCR system) and the catalyst is aged as part of the SCR system for the purposes of determining the SCR system malfunction criteria under section 1968.2(f)(2.2.2). Additionally, staff is proposing language indicating that for catalyst located outside the SCR system (i.e., downstream of both NOx sensors) on 2022 and subsequent model year medium-duty vehicles (including medium-duty passenger vehicles (MDPV)) certified to an engine dynamometer tailpipe emission standard, monitoring of the catalyst would not be required if there is no measurable emission impact on the criteria pollutants (i.e., NMHC, CO, NOx, and PM) during any reasonable driving condition where in which the catalyst is most likely to affect criteria pollutants (e.g., during conditions most likely to result in ammonia generation or excessive reductant delivery).

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(e)(5.2.3)(D) above.

**1968.2(f)(5.2.2)(E) and (f)(5.3.1)(C)**: For 2022 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, staff is proposing that manufacturers be required to detect NOx sensor activity faults that cause the NOx sensor to not actively report NOx concentration data under conditions when a properly-working NOx sensor would. Staff is also proposing language indicating if the fault is caused by a component other than the NOx sensor, the OBD system would be required to monitor the other component for such faults. The monitor would be required to run continuously.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in sections 1971.1(e)(9.2.2)(E) and (e)(9.3.1)(C) above.

**1968.2(f)(6.3.1)(B) and (f)(6.3.3)**: Staff is proposing that manufacturers track and report the in-use monitoring performance data for the EGR system low flow, high flow, and feedback control monitors (sections 1968.2(f)(6.2.1), (6.2.2), and (6.2.4)) starting in the 2022 model year for medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(d)(3.2.1) above.

**1968.2(f)(6.4)**: Staff is proposing to change the MIL illumination and fault code storage protocol for 2022 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard. Specifically, staff is proposing the EGR high flow and low flow monitors use the same protocol that is currently required for other continuous monitors like the diesel fuel system monitor, which stores/erases fault codes and illuminates/extinguishes the MIL based on similar conditions.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(e)(3.4) above.

**1968.2(f)(7.3.1)**: Staff is proposing that manufacturers track and report the in-use monitoring performance data for the boost pressure control system over boost, under boost, and feedback control monitors (sections 1968.2(f)(7.2.1), (7.2.2), and (7.2.5)) starting in the 2022 model year for medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(d)(3.2.1) above.

**1968.2(f)(7.4)**: Staff is proposing to change the MIL illumination and fault code storage protocol for 2022 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard. Specifically, staff is proposing the boost pressure control system over boost and under boost monitors use the same protocol that is currently required for other continuous monitors like the diesel fuel system monitor, which stores/erases fault codes and illuminates/extinguishes the MIL based on similar conditions.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(e)(4.4) above.

**1968.2(f)(9.2.1)(A)(ii) and (f)(9.2.4)(A)**: Staff is proposing to require new NOx emission thresholds to the diesel PM filter filtering performance monitors and the catalyzed PM filter NMHC conversion monitor. Specifically, for 2022 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, these monitors would be required to detect a malfunction before emissions exceed the applicable NOx standard by more than 0.2 g/bhp-hr.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in sections 1971.1(e)(8.2.1)(D), (8.2.1)(E), and (8.2.4)(A) above.

**1968.2(f)(9.2.4)(B)**: Similar to the proposal for NMHC catalyst feedgas generation monitoring, staff is proposing amendments to increase the maximum test out criteria for catalyzed PM filter feedgas generation monitoring, limit the test out criteria pollutant to NOx emissions, require manufacturers to submit a test out plan with proposed testing conditions (e.g., using a catalyst depleted of all platinum to remove feedgas generation capability) for Executive Officer approval, and give manufacturers the option of implementing feedgas generation detection monitors (or testing out of monitoring) on a system level or individually.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(e)(5.2.3)(B) above.

**1968.2(f)(9.3.2)**: Staff is proposing that manufacturers track and report the in-use monitoring performance data for the PM filter frequent regeneration, missing substrate, and active/intrusive injection monitors (sections 1968.2(f)(9.2.2), (9.2.5), and (9.2.6)) starting in the 2022 model year for medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(d)(3.2.1) above.

**Section 1968.2(g): Standardization Requirements**

**1968.2(g)(1.12)**: Staff is proposing to change the version of SAE J2534-1 referenced here from the October 2015 version to the December 2004 version.

Rationale: Staff generally updates all the SAE document references in the OBD regulations to the most recent versions available during every OBD rulemaking update. Thus, during the 2015 OBD II rulemaking update, staff updated the SAE J2534-1 document reference from the December 2004 version to the October 2015 version, as that was the most recent version at the time. However, manufacturers have subsequently indicated to staff that the current SAE J1699-3 software (the July 2015 version) they use to conduct production vehicle evaluation testing under section 1968.2(j)(1) does not support the October 2015 version of SAE J2534-1. They indicated that SAE J1699-3 would have to be updated to accept this newer version, and that they would have to also update their hardware and tools to do so as well. Staff therefore is proposing to change the version of SAE J2534-1 to the previous version (December 2004) to accommodate this.

**1968.2(g)(4.2.2)(B) and (g)(4.2.3)(I)**: Staff is proposing that manufacturers of 2022 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard make available the following parameters if so equipped: DEF dosing mode (A, B, C, etc.), target ammonia storage level on SCR, modeled actual ammonia storage level on SCR, SCR intake temperature, SCR outlet temperature, NOx mass emission rate - engine out, NOx mass emission rate – tailpipe, stability of NOx sensor reading, EGR mass flow rate, hydrocarbon doser flow rate, hydrocarbon doser injector duty cycle, aftertreatment fuel pressure, charge air cooler outlet temperature, engine operating state, propulsion system active, distance since reflash or control module replacement, commanded/target fresh air flow, crankcase pressure sensor output, crankcase oil separator rotational speed, and evaporative system purge pressure sensor output. Additionally, staff is proposing that manufacturers of 2022 and subsequent model year medium-duty gasoline vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard make available the following parameters if so equipped: commanded DEF dosing, DEF dosing rate, and DEF usage for current driving cycle.

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in sections 1971.1(h)(4.2.1)(D), (4.2.2)(H), and (4.2.3)(F) above.

**1968.2(g)(4.10.4)(B)**: Staff is proposing to change the reference to sections "(g)(10.4.2) or (g)(10.4.3)" to "(g)(4.10.2) or (g)(4.10.3)."

Rationale: The proposed changes are needed to correct errors in the section numbers referenced.

**1968.2(g)(6.1.7)**: Staff is proposing that 2022 and subsequent model year medium-duty diesel vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard track and report the following: total run time with no delivery of reductant used to control NOx emissions (e.g., DEF) due to insufficient exhaust temperature, and total run time with the exhaust temperature below 200 degrees Celsius as measured just upstream of the NOx converting catalyst. If an engine has more than one NOx converting catalyst, tracking would be based on the temperature upstream of the catalyst that is closest to the engine.

Rationale: The rationale for this proposed amendment was described in section 1971.1(h)(5.2.1)(E) above.

**1968.2(g)(6.6.1) and (6.12)**: Staff is proposing to add NOx emission and engine activity tracking requirements to the regulation for all 2022 and subsequent model year medium-duty diesel vehicles. The proposal is described above in sections 1971.1(h)(5.3) and (h)(5.3.6).

Rationale: The overall rationale for this proposed amendment is described in sections 1971.1(h)(5.3) and (h)(5.3.6) above. Generally, staff's proposal to add the NOx emission and engine activity tracking requirements is motivated by a need to better understand real-world, in-use emissions and to have a screening tool for quickly identifying vehicles which may have an emissions-related problem that merits further investigation. Although medium-duty diesel engines and vehicles are all certified to stringent emission standards, there is concern over how well performance in the certification test cell translates to performance on the road. Enforcement actions in recent times underscore this concern and greatly motivate the need to implement REAL, particularly as it relates to tracking of real-world NOx emissions, as quickly as possible on as many diesel vehicles as possible. The proposed new tool will not only track real world emissions performance now, but will inform future mobile source program evolution to promote the development and implementation of more effective programs to attain air quality and climate change goals. Because of the importance of understanding real-world, in-use emissions across the diesel fleet, staff is proposing to expand this requirement to medium-duty vehicles in addition to medium-duty engines.  This expansion should have little to no impact on most manufacturers, since the vast majority of manufacturers of medium-duty vehicles also produce medium-duty engines and thus will already have developed the necessary tracking software.

**1968.2(g)(6.13)**: Staff is proposing that manufacturers of 2022 and subsequent model year medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard track and report the distance since the last 3 PM filter regeneration events and a lifetime counter of PM filter regeneration events.

Rationale:  The proposed PM filter regeneration parameters would improve the ability of technicians and CARB staff alike to track the in-use activity and performance of manufacturers' regeneration strategies.  Information on when the last 3 regeneration events occurred would shed light on the recent behavior and condition of the engine.  The lifetime counter of regeneration events would provide an overall picture of regeneration frequency for the engine that could be compared to recent behavior.  It would also provide CARB staff with real-world data that could be compared against manufacturers' estimated regeneration frequency factors that are part of the IRAF calculations used in the certification process.

**1968.2(g)(8)**:  Staff is proposing changes related to the preservation of vehicle operation tracking data when OTA reprogramming technology is used. Specifically, if any of the data stored pursuant to sections 1968.2(g)(5) and (g)(6) would be erased as a result of an OTA reprogramming event on 2022 and subsequent model year vehicles, the manufacturer would be required to first collect all of the data required to be stored by the sections.  The manufacturer would further be required to submit a data record to CARB indicating the average value and standard deviation of each required parameter for each affected certified test group.  The proposal would require manufacturers to submit the report within 60 calendar days of the availability of the update.  Details on how the data records are to be created, formatted, and submitted are included in a separate document incorporated by reference in section 1968.2(g)(8), entitled, "Data Record Reporting for Over-the-Air Reprogrammed Vehicles and Engines."

Rationale:  The rationale for this proposed amendment is described in section 1971.1(h)(6) above.

**Section 1968.2(h): Monitoring System Demonstration Requirements for Certification**

**1968.2(h)(2.3)**: Staff is proposing that for durability demonstration testing of 2022 and subsequent model year medium-duty diesel vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the manufacturer would be required to use a test engine that meets the provisions of title 13, CCR section 1971.1(i)(2.3.4).

Rationale: The proposed changes are needed to be consistent with the proposed changes to the HD OBD regulation. The rationale for these proposed amendments were described in section 1971.1(i)(2.3.4) above.

**Section 1968.2(j): Production Vehicle Evaluation Testing**

**1968.2(j)(2.3.1) and (j)(2.3.5)**: Staff is proposing modifications to the production vehicle evaluation testing requirements for all light- and medium-duty vehicles, specifically the requirement to ensure the OBD II system is able to erase permanent fault codes. Instead of manufacturers ensuring that ALL permanent fault codes can be erased, staff is proposing that manufacturers be required to include in the production vehicle evaluation test plan a list of the specific permanent fault codes that would be tested and a description of the test procedures that the manufacturer would use for ensuring these fault codes can be stored and erased. The procedures would also need to verify that all monitors can fully execute and make “pass” decisions after a scan tool code clear command.

Rationale: The proposed changes are needed to address manufacturers’ concerns. Specifically, since monitors must run and “pass” to erase permanent fault codes, manufacturers have indicated that re-running all monitors to ensure that all permanent fault codes are erased is a huge additional test burden. Staff understands manufacturers’ concerns and is thus proposing to allow manufacturers to propose a plan indicating which specific permanent fault codes would be tested. These specific fault codes would need to cover all the different “types” of monitors (fault codes) in each diagnostic or emission critical electronic control unit (e.g., monitors subject to the minimum ratio requirements of section (d)(3.2), monitors not subject to the minimum ratio requirements of section (d)(3.2), monitors that utilize an alternate statistical MIL illumination and fault code storage protocol) and all the different permanent fault code erasure protocols (e.g., “natural” erasure without a clearing of the fault information in the on-board computer, erasure after a battery disconnect, erasure after a scan tool code clear command, erasure after a reprogramming event). The proposal would lessen manufacturer’s testing workload while ensuring that the OBD system is able to appropriately erase almost all types of permanent fault codes.

## III. BENEFITS ANTICIPATED FROM THE REGULATORY ACTION, INCLUDING THE BENEFITS OR GOALS PROVIDED IN THE AUTHORIZING STATUTE

The HD OBD and OBD II regulatory proposal will help improve the realization of the emission benefits projected for the light-, medium-, and heavy-duty vehicle programs. The proposal provides performance standards for many component/system monitors such as the CV system monitors which would replace the previous design criteria that were in place for these diagnostics. Providing compliance flexibility in the other areas (e.g., NHMC catalyst feedgas generation performance monitoring) and setting performance-based standards instead of design-based standards provides manufacturers with different ways to meet the requirements and helps reduce the cost of compliance by allowing manufacturers to choose the cheapest approach to meet the requirements. The clarification of the regulation and setting of performance-based standards also helps streamline the review process for CARB since it is easier to determine compliance with the requirements. Should the OBD proposal not be adopted, the review of OBD system designs would likely result in more time-consuming determination of compliance for CARB and higher costs to manufacturers because the portions of the OBD regulations that are expanded with clarification and flexibility features would result in more stringent requirements that manufacturers may not be able to meet and end up with non-compliance fines or even inability to certify.

This proposal is not expected to result in direct emission benefits. However, it will greatly improve the reliability of the emission benefits expected from the light-, medium-, and heavy-duty vehicle programs. For example, the LEV III program emission benefits are based upon effective OBD II, emission warranty, and Smog Check programs. While the LEV III program sets stringent tailpipe and evaporative system requirements that requires a vehicle's tailpipe emission levels to be durable for up to 150,000 miles, there is no assurance these emission levels will be maintained in use for the required mileage and beyond until the vehicle is retired. As previously mentioned in this staff report, the HD OBD and OBD II regulations require all emission controls on an engine/vehicle to be monitored for proper performance. For emission control components that can affect emissions by large amounts when they fail, the OBD system must detect a malfunction before emissions exceed a certain emission threshold. While the OBD system can alert the vehicle operator to a problem by requiring illumination of the MIL on the vehicle's instrument panel, it does not force the vehicle operator to repair the malfunction. Inspection and maintenance programs such as the Smog Check program for light- and medium-duty vehicles, however, do require the vehicle operator to repair the malfunction detected by the OBD system. If there was no OBD program, both Smog Check and programs such as the LEV III program would not be as effective at keeping vehicle emissions low throughout its entire life.

Since the proposal consists mainly of changes to clarify the OBD requirements, add some streamlining and flexibility features, and require more collection of data from the engines, the proposal is not expected to significantly change the emission benefits that were calculated during the 2009 HD OBD regulatory process. Specifically, the lifetime cumulative emission reductions for HD OBD, on a per engine basis, were calculated to be 165 pounds of ROG, 2000 pounds of NOx, and 14 pounds of PM. Similarly, regarding the proposed amendments to the OBD II regulation, the proposal is also not expected to change the emission benefits that were calculated in the 2012 LEV III staff report which is incorporated by reference herein (a copy of which may be found at https://www.arb.ca.gov/regact/2012/leviiighg2012/leviiighg2012.htm).

The OBD proposal is also expected to provide consumer benefits that are difficult to quantify. Since the OBD system is constantly monitoring the emission control components on engines/vehicles, consumers are expected to benefit from more durable engines/vehicles because manufacturers would specify more durable emission control components in their engine/vehicle designs to avoid customer dissatisfaction from frequent MIL illuminations resulting from premature emission control component failures. Consumers also benefit from how the OBD system can provide engine/vehicle repair technicians with information pinpointing the likely component causing a MIL to be illuminated. This quick identification of the malfunctioning component results in quicker diagnosis and repair of engines/vehicles, which should also result in lower repair costs. Malfunctions found by the OBD system when the emissions warranty or new vehicle/engine warranty are effective will also benefit consumers by effectively documenting the failure with a corresponding MIL and other information for easier reporting of malfunctions and subsequent reimbursement for repairs. Because the OBD regulatory proposal affects many of the monitors that are calibrated to emission thresholds along with hybrid components, CV systems, and other emission-related components/systems, the consumer benefits mentioned above should also apply for these emission control components and systems.

Overall, the proposed amendments to the HD OBD and OBD II regulations would result in cleaner vehicles than those currently produced. The benefits of the regulations become increasingly important as certification levels become more and more stringent and as a single malfunction has an increasingly greater impact relative to certification levels.

## IV. ENVIRONMENTAL ANALYSIS

### A. Introduction

This chapter provides the basis for CARB's determination that the proposed amendments are exempt from the requirements of CEQA. A brief explanation of this determination is provided in section B below. CARB's regulatory program, which involves the adoption, approval, amendment, or repeal of standards, rules, regulations, or plans for the protection and enhancement of the State's ambient air quality, has been certified by the California Secretary for Natural Resources under Public Resources Code section 21080.5 of the California Environmental Quality Act (CEQA) (14 CCR 15251(d)). Public agencies with certified regulatory programs are exempt from certain CEQA requirements, including but not limited to, preparing environmental impact reports, negative declarations, and initial studies. CARB, as a lead agency, prepares a substitute environmental document (referred to as an "Environmental Analysis" or "EA") as part of the Staff

Report prepared for a proposed action to comply with CEQA (17 CCR 60000-60008). If the amendments are finalized, a Notice of Exemption will be filed with the Office of the Secretary for the Natural Resources Agency and the State Clearinghouse for public inspection.

### B. Analysis

CARB staff has determined that the proposed amendments are categorically exempt from CEQA under the "Class 8" exemption (14 CCR 15308) because it is an action taken by a regulatory agency for the protection of the environment.

Most of the proposed amendments merely provide clarifying language to the existing requirements manufacturers are currently required to meet on their vehicles or engines without changing the requirements.

A couple of the proposed amendments would affect certain monitoring requirements. The first includes modifying the criteria used to determine if manufacturers are required to monitor the feedgas generation performance of NMHC catalysts and catalyzed PM filters – the proposed modifications would make it easier to be exempt from meeting these monitoring requirements. While these requirements are considered technically feasible, manufacturers have been having difficulties implementing monitors that would detect and specifically pinpoint such malfunctions. It is expected that malfunctions that affect feedgas generation performance would also affect other aspects of the catalysts such that a failure would be detected by another monitor (e.g., the NMHC catalyst conversion performance monitor). Therefore, the changes to the requirement to monitor the feedgas generation performance of NMHC catalysts and catalyzed PM filters are not expected to adversely affect emissions benefits. The second proposed amendment includes decreasing the number of emission threshold monitors that manufacturers are required to test within 3 years after the model year of the engine was tested. This testing verifies that emission threshold monitors on engines in-use are compliant and indeed detecting faults before the required emission thresholds are exceeded. Though the number of tests conducted on a given engine would be decreased, the amendments are not expected to have a negative impact on emissions benefits since, in addition to some randomly selected monitors, CARB staff would be selecting for testing monitors specific to each manufacturer. Staff would base their selection of manufacturer-specific monitors based on those monitors most likely to have durability issues and show failures in testing. These monitors would be selected based on prior experience with that manufacturer's system, warranty information, and knowledge of the emission control system design.

The proposed amendments would also establish more stringent requirements that OBD systems on vehicles would be required to meet. These amendments include increasing the minimum frequency in which monitors are required to run in-use, more stringent monitoring requirements (e.g,. NOx sensor monitoring, CV system monitoring), more testing requirements of monitors during post-production engine/vehicle testing, and requirements mandating the engines to track and report specific parameters related to the emission control system. In general, these amendments include OBD systems detecting more failure modes that can affect emissions and providing more information from the on-board computer that would assist technicians in diagnosing and repairing emission-related malfunctions. Manufacturers would be expected to incorporate mostly software changes and a few possible hardware modifications to meet these new requirements. These amendments will encourage manufacturers to design and build more durable, cleaner engines to comply with the requirements. The proposed OBD amendments will help ensure that forecasted emission reduction benefits from adopted medium- and heavy-duty engine emission standards programs are achieved. The proposed amendments are necessary to accomplish this goal by achieving these emission benefits in two distinct ways: first, to avoid customer dissatisfaction caused by frequent illumination of the MIL due to emission-related malfunctions, it is anticipated that the manufacturers will produce increasingly durable, more robust emission-related components; and second, by alerting vehicle operators of emission-related malfunctions and providing precise information to the service industry for identifying and repairing detected malfunctions, thereby ensuring that emission systems will be quickly repaired. The benefits of the regulations become increasingly important as certification levels become more and more stringent, and a single malfunction has an increasingly greater impact relative to certification level.

While these amendments do change the current monitoring requirements, the overall emission benefits of the proposal are still greater than those of vehicles currently in-use due to the more stringent requirements described above. Therefore, CARB staff has determined that the proposed action is designed to protect the environment and help improve the realization of the emission benefits projected for the light-, medium-, and heavy-duty vehicle programs. CARB has determined there is no substantial evidence indicating the proposal could adversely affect air quality or any other environmental resource area, or that any of the exceptions to the exemption applies (14 CCR 15300.2); therefore, this activity is exempt from CEQA.

## V. ENVIRONMENTAL JUSTICE

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. Government Code, section 65040.12, subdivision (c). CARB is committed to making environmental justice an integral part of its activities. The Board approved its Environmental Justice Policies and Actions (Policies) on December 13, 2001, to establish a framework for incorporating environmental justice into CARB's programs consistent with the directives of State law (CARB 2001). These policies apply to all communities in California, but recognize that environmental justice issues have been raised more in the context of low-income and minority communities.

Over the past twenty years, CARB, local air districts, and federal air pollution control programs have made substantial progress towards improving the air quality in California. However, some communities continue to experience higher exposures than others as a result of the cumulative impacts of air pollution from multiple mobile and stationary sources and thus may suffer a disproportionate level of adverse health effects.

Adoption and implementation of the HD OBD and OBD II regulations will not result in any adverse environmental impacts on environmental justice communities. In fact, the proposed amendments would help ensure that measurable emission benefits are achieved both statewide and in the South Coast and San Joaquin Valley air basins. Additionally, the proposed REAL amendments would allow emissions performance to be better characterized such that CARB may adjust emissions programs accordingly as more is learned about real-world emissions performance. Although no location data would be collected through the tracking of REAL parameters, because heavy-duty vehicle impacts are known to have disproportionate impacts on low-income and minority communities, the proposed REAL amendments are expected to benefit environmental justice communities.

# VI. ECONOMIC IMPACTS ASSESSMENT

## A. Introduction

The proposed revisions to the HD OBD and OBD II regulation include various updates to the existing requirements. These updates include provisions to ensure the integrity of the HD OBD systems, clarify existing requirements, address manufacturers' implementation concerns, and provide information for other CARB programs. In order to determine the economic impact of the proposal, staff assessed the cost impact of each proposed revision. The majority of the proposed revisions are not expected to impact costs because the changes involve the updating and clarifications of existing requirements or only involve software changes which are not expected to impact costs with given adequate lead time such that manufacturers can bundle the required software changes when major software work is otherwise required. Some of the changes provide compliance flexibility or reduce monitoring requirements (e.g., catalyzed PM filter feedgas generation monitoring), which could result in cost savings to the manufacturers. Other proposed changes effectively increase the stringency of the regulation (e.g., revising the IUMPR requirements, adding monitors required to track and report the IUMPR data) and are projected to increase costs. Concurrently, staff is proposing to update the medium-duty vehicle diesel-related requirements in the medium-duty OBD II regulation (§ 1968.2) to be consistent with the proposed diesel-related amendments to the HD OBD diesel requirements. Staff is also proposing amendments to the OBD II regulation based on comments from manufacturers that changes are needed immediately in order to ensure manufacturers are able to certify near future vehicles that comply with the OBD II regulation.

The proposed changes expected to affect costs include changes to the minimum IUMPR and IUMPR tracking and reporting requirements for major monitors, recalibration of major monitors that previously ran only on the SET cycle to run on the FTP cycle, the addition of more stringent monitoring requirements for the CV systems on gasoline and diesel engines/vehicles, addition of NOx sensor monitoring for “inactive” sensors, the addition of NOx and GHG parameters, the addition of new data reporting requirements when conducting OBD demonstration testing or OTA software reprogramming, and changes to the manufacturer self-testing (MST) requirements. In addition, although considered a clarification and not a change, the costs associated with the proposed amendments to the accelerated aging requirements for HD OBD demonstration testing are also included in the cost analysis since these costs were inadvertently not included in previous HD OBD cost analyses. Tables located in Appendix F provide the cost assessment for some of the proposed modifications to the HD OBD regulation.

Changes to the OBD II regulation will primarily impact medium-duty diesel engines and vehicles which are expected to have similar costs as the heavy-duty diesel engines under the HD OBD regulations since these engines typically are derived from a similar heavy-duty diesel engine. Therefore, the cost impact to medium-duty diesel engines were assumed to be the same as for heavy-duty engines. Additionally, the OBD II regulation amendments will impact gasoline light- and medium-duty vehicles primarily through the reporting requirements for OTA reprogramming. Since the changes to the HD OBD regulation are more extensive than those for the OBD II regulation changes to gasoline light- and medium-duty vehicles, the costs associated with the HD OBD changes are more complex than those for the OBD II changes and require more explanation. Therefore, the costs for the HD OBD and OBD II amendments will be discussed separately in the sections below with a larger emphasis on the HD OBD costs and costs associated with OBD II changes that affect medium-duty diesel engines.

Although the proposed modifications to the HD OBD regulation affect both gasoline and diesel engines/vehicles, diesel engines/vehicles are expected to be impacted the most from a cost standpoint since the bulk of the cost-related changes apply to diesel engines/vehicles. However, since manufacturer production data submitted to CARB for the 2016 model year indicate gasoline engines/vehicles consist of only 27 percent of the total heavy-duty engine/vehicle fleet, staff decided not to conduct a separate cost analysis for heavy-duty gasoline vehicles. Instead, staff is estimating the costs of the proposal for heavy-duty engines/vehicles based solely on diesel engine/vehicle costs. This simplification is expected to result in a worst-case cost estimate for heavy-duty gasoline engines/vehicles.

The goal of cost analysis is to estimate the "learned-out" costs of the program to a heavy-duty engine purchaser for a "typical" heavy-duty engine purchaser. The analysis includes estimates of the incremental costs of implementing the proposed modifications to the HD OBD program for a typical heavy-duty engine manufacturer. Since the internal corporate costs of implementing the modifications to the HD OBD program are closely guarded by individual engine manufacturers and can vary significantly within the industry, CARB staff made assumptions regarding the corporate structure of the typical heavy-duty engine manufacturer. The CARB cost estimates assume that the typical heavy-duty engine manufacturer is a low-cost horizontally-integrated company (i.e., a company that relies heavily on suppliers to assist in the development and production of engines). Manufacturers rely on these suppliers to produce the final components rather than source the parts through their own internal facilities to achieve the lowest costs. The various types of costs that are addressed in this analysis are variable costs, support costs, capital recovery costs, and dealer costs. Results of the analysis indicate the learned-out initial costs per vehicle to incorporate the proposed HD OBD regulatory modifications would be $42.46. Details of the cost analysis methodology used to estimate the heavy-duty engine costs are discussed in the following sections.

The OBD II costs were estimated in a similar manner. Staff's analysis indicated the primary costs for the OBD II amendments are associated with the OBD data reporting that is required for OTA software reprogramming events. Since the OBD data reporting requirements for OTA software reprogramming are identical for both HD OBD and OBD II vehicles, the reporting costs are assumed to be identical for manufacturers of these engines or vehicles, but the incremental costs per engine or vehicle are different due to the different volumes of engines and vehicles for the different vehicle categories (i.e., light-and medium-duty vehicles for OBD II and heavy-duty engines for HD OBD).[6,7] Due to the reporting costs associated with OTA reprogramming, the OBD II portion of the proposed amendments is expected to increase the cost to consumers by $0.34 per vehicle.

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[6] Nikolewski, Rob. "California vehicle sales exceed 2 million for third straight year", February 22, 2018. San Diego Union Tribune; http://www.sandiegouniontribune.com/business/energy-green/sd-fi-car-sales-20180222-story.html

[7] "New Vehicle Registrations in State Predicted to Exceed 2 Million Units Again in 2018," February 2018. California Auto Outlook, Volume 14 Number 1, California New Car Dealers Association; https://www.cncda.org/wp-content/uploads/California-Covering-4Q-2017-1.pdf

## B. Cost Analysis

Methodology of the Heavy-Duty Engine Cost Analysis

*Assumptions*

The assumptions used in the cost analysis are described in this section. As previously discussed, the HD OBD costs are more substantial and complex than the OBD II costs. Therefore, the discussion of the cost analysis methodology concentrates on the HD OBD costs even though the same methodology is also applied to the OBD II costs. As with the previous HD OBD cost analyses, the costs are estimated when the proposed changes are all fully phased-in, which for this proposal is the 2027 model year. To conduct the cost analysis for heavy-duty engines, staff estimated the average nationwide sales numbers of large heavy-duty engines to be 500,000 units for the 2016 model year, which is the latest model year that CARB has complete data on regarding California engine production numbers.[8] This estimate is similar to the previous nationwide production estimates of 488,000 units for the 2012 model year during the last biennial review. Staff then surveyed the production offerings of all heavy-duty engine manufacturers that produce new engines for the California market to determine the characteristics of their product line (e.g., number of engine families, volumes, engine types). From this survey, staff determined there are a total of 12 major heavy-duty engine manufacturers that produce diesel or gasoline engines. Only engine manufacturers that designed and produced their engines were considered in the cost analysis. Engine manufacturers that convert other engine manufacturers' products to operate on other fuels or in hybrid vehicles were not considered in this survey since these manufacturers do not design and calibrate the base engine and OBD systems and therefore would not directly be fiscally impacted by the proposal. Of the 12 engine manufacturers, 11 are characterized as having 5 or less engine families while 1 engine manufacturer is characterized as having 5 to 10 distinct engine families. The lone engine manufacturer with more than 5 engine families also had considerably more engine production for the 2016 model year than all of the other manufacturers. Since the vast majority of engine manufacturers have 5 or less distinct engine designs, these manufacturers are characterized as "average" while the engine manufacturer with 5 to 10 engines is characterized as "large" in this analysis.

In order to simplify the analysis, the analysis assumes that all 11 engine manufacturers with 1 to 5 engine families will offer 5 engine families when the proposal is fully phased-in during the 2027 model year even though the vast majority of these manufacturers offered 3 or less engine families for the 2016 model year. For the single manufacturer that offered between 5 to 10 engine families for the 2016 model year, staff assumed 10 engine families in the 2027

[8] News Release: "U.S. Commercial Vehicle Market Expected to Grow Slightly in 2016, IHS Says," January 26, 2016, IHS Markit; http://news.ihsmarkit.com/press-release/automotive/us-commercial-vehicle-market-expected-grow-slightly-2016-ihs-says, (accessed on May 16, 2018)

model year.  This assumption is expected to produce a conservative cost estimate considering that the number of 2016 model year engine families offerings have not changed significantly for the past 3 model years.   In general, staff's assumptions for the cost analysis as with previous cost analyses were to err on the conservative side.

Although the regulatory proposal applies only to California-certified engines, the estimated cost of the proposal was applied to the manufacturers' entire nationwide new heavy-duty engines because virtually all heavy-duty engine manufacturers have chosen to design a single OBD system that meets both CARB and U.S. EPA regulations and have equipped all engines nationwide with the same system.  Therefore, any costs incurred by the engine manufacturers are expected to apply to all engines nationwide.

Changes to the Cost Analysis Methodology from Previous Analyses

Previous cost analyses of the HD OBD program utilized a hypothetical large engine manufacturer for determining the cost of the program for the entire industry.  Staff previously chose this methodology because there were several manufacturers fitting that description back in the 2005 timeframe when the first HD OBD program cost analysis was conducted.  Additionally, modeling the costs after a large manufacturer was expected to create a worst-case cost estimate since large manufacturers tend to have more engine families, which generally results in larger overall costs with more software development, calibration, and testing costs to deal with.  For the current proposed changes to the HD OBD program, staff has decided to estimate the costs in a different manner to better represent the product line of the industry.  As previously mentioned, after reviewing engine sales numbers reported by manufacturers for a recent model year, staff noticed that the vast majority of heavy-duty engine manufacturers' product lines consisted of 5 or less engine families and only one manufacturer produced more than 5 engine families per year.  As a result, staff decided to model the heavy-duty engine manufacturer industry as consisting entirely of 11 "average" sized manufacturers and 1 "large" manufacturer that each produce 5 distinct engine families and 10 distinct engine families, respectively.  Therefore, separate cost analyses were conducted for the "average" and "large" manufacturers.  It should be worth noting that the assumption of 5 distinct engine families for the average manufacturer cost analysis was chosen to simplify the analysis and provide a worst-case cost analysis since the majority of the average manufacturers produced 3 or less engine families for the 2016 model year. Additionally, since it is difficult to predict the future product lines of manufacturers in the 2027 model year, staff wanted to err on the conservative side and assume a larger number of engine families for the average manufacturer.

Variable Costs

In this section, the cost of new parts added to heavy-duty engines/vehicles, additional assembly operations, any increases in the cost of shipping parts, and any new warranty implications are addressed.

*Cost of Additional Hardware*

The first step in assessing costs was to define the systems and technologies likely to be used by manufacturers to meet the proposed HD OBD regulatory modifications. Staff assessed each of the proposed HD OBD regulatory modifications to determine if additional hardware would be required to comply with the proposal. Based on discussions with individual engine manufacturers, it was determined that the only new hardware that are projected to be needed to comply with the proposed requirements are increased ECU memory and a pressure sensor to monitor the high-load CV hoses for boosted engines. Once the technologies for meeting the proposed modifications were identified, the staff estimated the percentage of these technologies that would be required to comply with the requirements for the 2027 model year. The 2027 model year was chosen for the analysis because that is the year when all of the requirements of the HD OBD regulation are fully phased in on all heavy-duty engines/vehicles. Table 13 lists the technologies and application rates that staff project will be needed for heavy-duty engines to comply with the proposed HD OBD requirements and the associated costs to the engine manufacturers.

**Table 13: Cost of Additional Hardware**

| Emission Control Technology | 2018 tech cost estimate (2018 $) | % HDEs that will require tech for HD OBD | Incremental Cost only OBD (2018 $) |
|---|---|---|---|
| Increased ECU memory capability for tracking/reporting in-use monitor performance & data stream parameters | $10.00 | 50% | $5.00 |
| CV system pressure sensor | $8.00 | 10% | $0.80 |
| Total incremental component cost | | | $5.80 |

*Assembly Costs*

The proposal is not expected to impact assembly costs.

*Cost of Shipping*

Shipping costs for HD OBD engines are projected to be nearly the same for the proposed modifications. This is because for the majority of the vehicles, only an additional pressure sensor would be added to the heavy-duty engine. The cost of shipping the pressure sensor is expected to be negligible and is embedded in the hardware costs.

*Cost of Warranty*

Additional warranty costs due to the HD OBD regulatory proposal should also be minimal. The only added component needed to comply with the proposed requirements that is expected to require warranty repairs is the pressure sensor for CV leak monitoring. Based upon the data from HD OBD-equipped heavy-duty engines, staff project that the failure rate for the CV sensor will range from 0.3 percent to 2.7 percent within the warranty period of a heavy-duty truck.[9] For this sensor, staff assumed a failure rate of 1 percent would occur within the warranty period. This failure rate was chosen because CARB internal data has indicated CV system failures have not historically had high warranty failure claims. The labor rate for the repairs was estimated at $100/hour with an average repair time of 30 minutes. The labor rate was discounted by 20 percent from the typical retail repair rate of $120/hour in California to reflect the expected reimbursement amount from the manufacturer. The replacement cost of the pressure sensor was adjusted by 20 percent to account for the added cost of purchasing the replacement parts at smaller quantities compared to the production parts, cost of shipping and handling, administration costs, and dealer costs. The warranty costs for the CV sensor is estimated to be $0.06 per engine. Although not an added component, additional ECU memory is also expected to be needed to accommodate the new GHG and NOx parameter storage requirements of the proposal. The incremental warranty costs for this component is estimated to be about $0.03 per engine. Warranty costs are summarized below in Table 14.

**Table 14: Incremental Warranty Costs**

| Warranted Repair | Cost of | | | Warranty | |
|---|---|---|---|---|---|
| | Part (a) (dollars) | Labor (b)(c) (dollars) | Warranty rate% | % of HDEs that req. tech. only for OBD | Cost (dollars) |
| CV system leak | 9.60 | 50 | 1% | 10% | 0.06 |
| Increased ECU memory for GHG/NOx parameters (d) | 12.00 | 50 | 0.1% | 50% | 0.03 |
| Total Incremental Warranty Cost | | | | | 0.09 |

(a) Assume cost of parts are 20% higher for warranted parts than production parts.
(b) Total diagnostic and repair time is estimated at 30 minutes.
(c) Assumes dealer labor rate for warranty repair is $100/hour.
The labor costs include diagnostic and repair time.
(d) Assume only 20% if ECU memory is used for GHG/NOx parameter use.

<u>Support Costs</u>

[9] Staff Report: Initial Statement of Reasons: Public Hearing to Consider Proposed Amendments to California Emission Control System Warranty Regulations and Maintenance Provisions for 2022 and Subsequent Model Year On-Road Heavy-Duty Diesel Vehicles and Heavy-Duty Engines with Gross Vehicle Weight Ratings Greater Than 14,000 Pounds and Heavy-Duty Diesel Engines in Such Vehicles, Appendix C, May 8, 2018.

Support costs affecting the retail price of HD OBD modifications are estimated to include software development costs, testing costs, and reporting/miscellaneous documentation costs

*Software Development Costs*
Software Development costs include the engineering and other labor costs (e.g., technicians) needed to develop and calibrate the base HD OBD system algorithms, but do not include the vehicle or engine testing costs for the testing that is required when developing software for use in OBD II and HD OBD systems (e.g., validation testing). Instead, testing costs for software development are included with other testing costs in the testing cost category that is described in the following section.

To determine the cost impact of the proposed changes on software development costs, staff assessed each of the changes to determine their potential impact, if any, on the current HD OBD system algorithms and calibrations. From this initial screening, staff determined that several proposed changes are expected to affect current HD OBD systems, such as changes to minimum IUMPRs and tracking and reporting requirements for major monitors, recalibration of major monitors that previously ran only on the SET cycle to run on the FTP cycle, the addition of more stringent monitoring requirements for the CV systems on gasoline and diesel engines/vehicles, the addition of NOx sensor monitoring for "inactive" sensors, the addition of NOx and GHG parameters, the addition of new data reporting requirements when conducting OBD demonstration testing, changes to the intrusive monitoring requirements, and changes to the MST requirement.

Next, staff assumed an eight-step process to develop or modify the base algorithm for each new diagnostic on one engine platform. The eight steps include determining the scope of monitoring, developing the failure mode effects analysis (FMEA), developing the diagnostic concept, developing the limit/threshold part, testing the prototype/concept, validating, analyzing the sensitivity, and developing the tuning guide. It is assumed that a manufacturer will develop a single base algorithm that can be applied across every different engine variant within the manufacturer's product line-up without modifications to the algorithm. Staff also assumed that manufacturers will develop the algorithm on a pre-production engine that is close to production intent (i.e., develop hardware and emission calibrations that are close to its final production version). Staff believes that developing the algorithm on an engine that is not near its production state will be inefficient and would unnecessarily require significant redevelopment work when applied to the production engine.

To adjust the base algorithm to work on other heavy-duty engines, each algorithm will need to be individually calibrated. Staff assumed a 3-step process to calibrate each diagnostic on subsequent engines. Utilizing the tuning and validation guide developed during the algorithm development process, the 3 steps include reviewing the FMEA, testing the limit parts and nominal parts, and validation. The costs to calibrate other engines within the engine family were discounted with factors that took into account the similarity of engine designs relative to the base engine used to develop the algorithm, since the amount of engineering and testing work should be less on similar engines. The life of the diagnostic algorithm design and calibration for most monitors were estimated at 6 years without any major modifications. However, staff did account for minor algorithm and calibration modifications for some monitors after 3 years. The cost of the 3-year midpoint algorithm and calibration modifications was discounted by 80 percent (i.e., the cost of the midpoint modifications were estimated to cost 20 percent of the original software algorithm development and calibration costs). The final step involved estimating the percentage of all engine families that will require modifications to the software algorithms and/or calibrations to comply with the proposed regulatory changes.

As discussed previously, the testing costs for software development are included with other testing costs in the testing cost category. Software development costs were determined through discussions with industry combined with engineering judgement. Since software development costs primarily consist of labor costs, labor rates of $150,000 and $120,000 per year were assumed for software developers and calibrators respectively. From the industry discussions, an estimation of the amount of software algorithm and calibration changes and the associated labor hours needed to conduct the changes were determined. From these estimates, the total software development costs for engine manufacturers were determined by dividing the total annualized costs by 500,000 engines (the total number of engines sold annually nationwide by heavy- and medium-duty engine manufacturers) to determine the incremental software development cost of $8.74 per engine. The software development costs are summarized below in Table 15.

**Table 15: Software Development Costs**

| | Software Costs | Calibration Costs | Total Software Dev. Costs |
|---|---|---|---|
| Total Annual Costs | $1,302,002 | $3,069,586 | $4,371,589 |
| Incremental Costs/Engine | $2.60 | $6.14 | $8.74 |

*Testing Costs*

Testing costs were determined by evaluating the amendments for provisions requiring additional testing. Testing costs consist of the engine testing required under the proposal to develop OBD monitors and for OBD certification. To determine the testing costs, any additional testing required under the proposal was estimated through discussions with engine manufacturers and engineering analysis. The testing costs include the equipment and labor costs to conduct emission tests and certification data collection needed for HD OBD certification. The proposed HD OBD regulatory modifications that are projected to impact testing costs include, clarifications to the accelerated aging validation process for full useful life durability demonstration testing, changes to the production engine/vehicle evaluation testing requirements' verification of monitoring requirements, addition of new certification data collection requirements, and changes to the MST requirements. Additionally, the engine testing costs associated with the monitors described in the software development costs section are also included in the testing costs category. Estimating these testing costs are difficult since manufacturers tend to guard their internal costs very tightly. To help estimate these costs, staff contacted individual manufacturers for their internal cost estimates. Although most manufacturers participated in this survey, the information provided was not specific enough to separate out the costs for these testing and engineering activities. Ultimately, staff utilized the manufacturer cost information, but relied more heavily on cost estimates from independent laboratories and staff's best judgement to determine the testing costs. Since independent laboratory testing costs include the total cost of conducting the tests (i.e., labor, equipment, and overhead) along with a profit margin, the estimated costs should be significantly higher than conducting the tests internally and should therefore yield a conservative cost estimate. To determine the MST costs, staff queried several independent laboratories to determine the costs of conducting the various tests that are required such as FTP cycle engine dynamometer testing with emissions and SET cycle engine dynamometer testing with emissions. Similarly, cost estimates for the accelerated aging validation process were provided by independent laboratories and utilized in the analysis. For the production engine/vehicle verification of monitoring requirements, costs for testing the additional monitors is not expected to significantly impact costs since these tests do not have to be done on the dynamometer and are often done on the road. Therefore the additional MST tests are the primary testing costs for the proposed regulatory modifications. Using a similar methodology as described above for the software development costs, a total annual testing cost of $9,984,833 was determined, which when divided by 500,000 engines results in an incremental testing cost of $19.97.

*Reporting and Miscellaneous Documentation Costs*

Reporting and miscellaneous documentation costs were determined by evaluating the amendments for changes that apply additional administrative and reporting requirements. Reporting costs primarily consist of labor costs and the proposed OTA reprogramming requirements. Based on the estimated workload of administering the OTA data collection, aggregating the data, conducting quality control checks on the data summary, submitting the data report to CARB, and maintaining the raw data records, staff estimates OTA reprogramming reporting requires a compliance officer 8 hours per week to complete. Therefore, the OTA reprogramming reporting costs for a typical manufacturer with OTA reprogramming capability are estimated to cost about $20,000 (i.e., $45.27

hourly wage and benefit * 8 hours * 52 weeks) per year. Combining the reporting costs for each of the 12 primary engine manufacturers along with miscellaneous documentation costs results in a total annual cost of $267,200 which when divided by 500,000 engines results in an incremental cost of $0.53.

Cost Impact of Changes to the MST program

Since the proposal makes significant changes to the MST program, staff conducted a new cost analysis of the revised program to ensure costs are adequately addressed. The original MST program's cost analysis conducted in 2009 assumed that, on average, 16.3 emission threshold monitors would be required for testing by each engine manufacturer and that 10 percent of engine manufacturers' MST engines would have 1 monitor that would fail the initial testing (i.e., require phase 2 testing under section 1971.5(c)(3)) and 5 percent of all MST engines would have 1 monitor that fails both the initial and phase 2 testing (i.e., require phase 3 testing under section 1971.5(c)(4)(D)). The total costs for this scenario was estimated to be $275,705 in 2009 dollars. Assuming a 16.06% cumulative inflation rate, the 2009 estimate of MST costs per manufacturer is $319,983 in 2018 dollars.[10] However, back in 2009, staff did not realize that some manufacturers would have up to 30 emission threshold monitors by the 2018 model year, which is almost double the amount staff had originally assumed. Although the underestimation of the number of MST emission tests in 2009 resulted in an unintended undercounting of costs for the MST program, other "worst-case" assumptions helped reduce the cost discrepancy. For example, the 2009 analysis was based on the costs incurred when all proposed requirements are fully phased-in. Since the analysis was based on a "hypothetical" large engine manufacturer that produced 8 engine families per year, MST evaluations on 2 separate engine families must be conducted per year beginning with the 2013 model year. This assumption resulted in an overestimation of testing burden when considering that since the 2010 model year, only 1 heavy-duty engine manufacturer has produced enough engine families to require 2 MST evaluations per year.

The current proposal for the MST program reduces engine manufacturer's test burden from testing all emission threshold monitors to testing a maximum of 15 emission threshold monitors plus any deficient emission threshold monitors. As described earlier, staff requested that all engine manufacturers submit their costs for conducting one MST evaluation in as much detail as possible. Staff also received quotes from various independent testing facilities for work expected to be conducted if MST work is contracted out. While some engine manufacturers did provide MST cost information to CARB staff, overall, the cost information provided was limited and incomplete, which made it difficult for staff to delineate the costs of an MST evaluation. For example, some manufacturers included

[10] CPI Inflation Calculator, United States Department of Labor; https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=100&year1=200901&year2=201801 (accessed on May 16, 2018)

costs for testing of two MST vehicles that occurred in the same calendar year. Other manufacturers could not distinguish costs for the MST program from all other testing programs, so they included all testing costs for a calendar year.

In contrast, independent laboratories were requested to provide all costs associated with conducting MST on an engine, including costs for fueling, testing, engine shipping, engine installment and set-up on the dynamometer, engine removal and re-installment onto a freestanding truck. From the various cost estimates, a composite cost estimate of $230,000 excluding engine procurement costs was generated. It is expected that manufacturers who conduct MST in their own facilities will incur an even smaller cost since independent laboratories must include a profit margin (estimated to be around 20%) and shipping costs do not have to be applied. Threshold parts were assumed to be provided by the engine manufacturer along with the technical support needed to successfully complete the testing. Procurement costs provided by the engine manufacturers were then added to the testing costs. The procurement costs provided by the engine manufacturers ranged from $34,000 to $100,000 with the majority of the procurement costs between $49,000 and $85,000. From this range of data, staff decided to utilize a higher than average procurement cost of $75,000 for the analysis. When considering that the regulatory proposal also includes a relaxation of the engine selection criteria for MST engines that should significantly increase the number of engines eligible for MST evaluation, staff believes the procurement cost assumption of $75,000 is a conservative estimate. Adding the procurement cost results in a final cost of $305,000 for conducting a complete MST evaluation on 1 engine. Similar to the 2009 cost analysis, it was also assumed that 10 percent of engine manufacturers' MST engines would have 1 monitor that would fail the initial testing and 5 percent of all MST engines would have 1 monitor that fails both the initial and phase 2 testing (i.e., require phase 3 testing) which would add additional costs of $58,717 for a total of $363,717. This total is only $43,733 more than the 2009 MST cost estimate of $319,983 in inflation-adjusted dollars.

Additionally, staff also estimated the costs for the MST proposal for engine manufacturers that have performed well in MST testing for the previous 3 years. Manufacturers that qualify for this proposed "good behavior" MST testing option are only required to conduct testing on 8 monitors instead of the normal 15 monitors. The "good behavior" MST costs and other MST costs are summarized below in Table 16. Since costs for the MST program were previously included in the incremental cost analysis of the HD OBD program, only the difference between the proposed MST costs and the inflation-adjusted costs of the current MST program were included in the proposal's incremental cost estimates.

**Table 16: Manufacturer Self-Testing (MST) Costs per Manufacturer**

| Engine Manufacturer Size (a) | Required Number of MST Engines per Year | Total Engine Procurement Costs (2018 $) | Total MST Costs Phase 1 (b) (2018 $) | Additional Test Costs Phases 2 and 3 (c) (2018 $) | Total MST Costs (d) (2018 $) | Total Incremental MST Costs (e) (2018 $) | Total MST Costs for "Good Behavior" (2018 $) |
|---|---|---|---|---|---|---|---|
| Average | 1 | $75,000 | $305,000 | $58,717 | $363,717 | $43,733 | $189,267 |
| Large | 2 | $150,000 | $610,000 | $117,433 | $727,433 | $407,450 | $378,533 |

(a) Average manufacturers offer between 0-5 engine families annually; Large manufacturers offer between 5-10 engine families annually.
(b) Includes engine procurement costs.
(c) Assumes 10% of MST engines will enter Phase 2 testing and 5%.will enter Phase 3 testing.
(d) Includes testing costs of Phases 2 and 3.
(e) Incremental from 2009 when the MST cost estimate per manufacturer was $319,983 in inflation-adjusted dollars.

## C. Total Incremental Cost of the Proposed Requirements

The total incremental costs of the proposed requirements were obtained by summing up the incremental cost of the five primary cost categories (i.e., the costs of hardware, warranty, software development, testing, and reporting) as shown in Table 17. This incremental cost was then assumed to incur a markup at each step of the distribution chain consisting of an engine manufacturer mark-up of 6 percent, vehicle manufacturer mark-up of 6 percent, and dealership markup of 6 percent plus a mark-up of 1.5 percent for inventory holding cost (see Table 17). The final impact to the California consumer per new vehicle is anticipated to be $42.46. Therefore, the estimated combined costs of the HD OBD regulation and the HD OBD enforcement regulation are a summation of the inflation-adjusted costs of the 2005, 2009, and 2012 HD OBD regulations ($174.70) and the $42.46 per engine costs estimated here for an overall total incremental cost of $217.16 per new engine. The costs for the 2012 HD OBD regulation update only includes the reporting costs for the misfire monitoring changes in the total costs since the other costs from that update only impacted manufacturers of heavy-duty alternative-fueled engines.

**Table 17: Incremental Cost of Heavy- and Medium-Duty Engine OBD Systems**

| Incremental Consumer Cost of Heavy-and Medium-duty OBD System | | HDV (in dollars) |
|---|---|---|
| Variable costs | Component | 5.80 |
| | Assembly | 0.00 |
| | Warranty | 0.09 |
| | Shipping | 0.00 |
| Software Development | | 8.74 |
| Testing | | 19.97 |
| Reporting/Miscellaneous Documentation | | 0.53 |
| Engine manufacturer mark-up (a) | | 2.11 |
| Truck builder mark-up (a) | | 2.23 |
| Dealership holding costs (b) | | 0.58 |
| Dealership mark-up (c) | | 2.40 |
| Total cost (d) | | 42.46 |

(a) Cost of mark-up was calculated at 6% of the total incremental costs.
(b) Inventory holding costs of 1.5% were applied because engines are assumed to remain in inventory for 3 months.
(c) Dealership mark-up was calculated at 6%.
(d) Rounding of numbers to 2 significant figures may result in the total cost not matching the summation of the individual cost items shown in the table.

## D. Benefits of the Proposal

The proposed HD OBD revisions are not expected to reduce emissions beyond what is required of the current HD OBD program. However, it will more effectively improve the realization of the HD OBD program's estimated emission reductions. As stated above, the proposed HD OBD revisions are not expected to add significant cost to heavy-duty vehicles. In conducting the cost-effectiveness analysis for these proposed requirements, the staff revisited the cost estimates of the most recent HD OBD program update that was reported in the 2012 HD OBD staff report and updated that analysis to include the effects of the current HD OBD proposal. This analysis was conducted because the HD OBD program assumed a fully functioning HD OBD system when determining the benefits of the program. In order to ensure the assumed benefits of the HD OBD program are realized, the HD OBD regulation must be updated as proposed here.

Based on the emission benefit analysis and the additional cost numbers identified above, the cost effectiveness of the HD OBD regulation was re-calculated. The emission benefits were not recalculated since the proposal does not claim any additional emission benefits from the emission benefits claimed when HD OBD was first adopted in 2006. Based on the updated benefit analysis from the 2009 biennial review, HD OBD was calculated to generate a statewide benefit of 1.5 tons/day (tpd) of ROG, 109 tpd of NOx, and 0.6 tpd of PM in calendar year 2020. Lifetime cumulative emission reductions on a per engine basis were calculated to be 165 pounds of ROG, 2000 pounds of NOx, and 14 pounds of PM. For the cost estimation, it was assumed that half of the cost was for PM emission benefit and the other half was for reactive organic gases (ROG)+NOx benefit. Since the regulatory proposal only added an incremental cost of $42.46 per engine for diesel engines, the results from the 2009 biennial review still apply. As stated in 2009, the per-engine cost to implement OBD for the vehicle purchases was estimated at $630 per engine. This cost includes the incremental cost of a new engine to comply with the OBD requirements of the 2009 timeframe ($134) and the incremental cost of repairs due to OBD per engine over its life of $496 per engine. Adjusting this cost for inflation results in an estimated cost of $740 per engine in 2018 dollars. Adding the inflation-adjusted cost of the 2012 amendments ($0.61 per engine) and the proposal's incremental cost of $42.46 per engine results in a total estimated cost of $783 per engine.

Splitting that in half, $392 is attributed to PM benefit for a cost-effectiveness of $28 per pound of PM. The other half of the cost was attributed to ROG+NOx benefit for a cost-effectiveness of $0.18 per pound of ROG+NOx. If only NOx benefits were claimed, the cost-effectiveness for NOx is $0.20 per pound. These values compare favorably with the cost-effectiveness of other, recently adopted regulations. For example, CARB's public fleets rule[11] resulted in a cost-effectiveness of $11.47 per pound of NOx and $159 per pound of PM, and CARB's Drayage Truck Regulation[12] resulted in a cost-effectiveness of $6 to $8 per pound of NOx and $57 to $77 per pound of PM.

For the OBD II regulation, emission benefits have never been claimed and this proposal is no different. The OBD II proposal is not expected to result in direct emission benefits. Therefore, no emission benefits were claimed. However, it will improve the reliability of the emission benefits expected from the LEV III program. The LEV III program emission benefits are based upon an effective OBD II and Smog Check program. While the LEV III program sets stringent tailpipe and evaporative system requirements that requires a vehicle's tailpipe emission levels to be durable for up to 150,000 miles, there is no assurance these emission levels will be maintained in use for the required mileage and beyond until the vehicle is retired. As previously mentioned in this staff report, the OBD II regulation requires all emission controls on a vehicle to be monitored for proper performance. For emission control components that can affect emissions by large amounts when they fail, the OBD II system must detect a malfunction before emissions exceed a certain emission threshold. While the OBD II system can alert the vehicle operator to a problem by requiring illumination of the MIL on the vehicle's instrument panel, it does not force the vehicle operator to repair the malfunction. The Smog Check program, however,

[11] Staff Report: Initial Statement of Reasons: Proposed Diesel Particulate Matter Control Measure for On-Road Heavy-Duty Diesel-Fueled Vehicles Owned or Operated by Public Agencies and Utilities, October 21, 2005

[12] Staff Report: Initial Statement of Reasons for the Proposed Rulemaking: Public Hearing to Consider Regulation to Reduce Emissions from Heavy-Duty On-Road Drayage Trucks in California Port and Intermodal Rail Service, October 2007

does require the vehicle operator to repair the malfunction detected by the OBD II system. If there was no OBD II program, both Smog Check and the LEV III program would not be as effective at keeping vehicle emissions low throughout its entire life. Since the proposal consists mainly of changes to clarify the OBD II requirements and add some streamlining and flexibility features, the proposal is not expected to significantly change the emission benefits that were calculated in the 2012 LEV III staff report which is incorporated by reference herein (a copy of which may be found at http://www.arb.ca.gov/regact/obd02/obd02.htm).

**E. Impact Analysis on Businesses, Vehicle Operators, and Employment**

Affected Businesses and Potential Impacts

Any business involved in manufacturing, purchasing, or servicing light-, medium-, heavy-duty engines and vehicles could be affected by the proposed amendments. Also affected are businesses that supply parts for these vehicles. While there will be businesses affected, CARB does not expect there to be a significant statewide adverse economic impact directly affecting these businesses as a result of this proposal.

Potential Impacts on Vehicle Operators

For heavy-duty engines and vehicles, the proposed amendments would provide HD OBD information and encourage manufacturers to build more durable engines, which would result in the need for fewer repairs and savings for vehicle owners. The proposed amendments would also provide clearer HD OBD regulatory requirements and streamline the HD OBD certification process. Additionally, HD OBD systems detect malfunctions that may otherwise go undetected (and thus, unrepaired) by the vehicle owner. These additional repairs that are detected and repaired due to the presence of HD OBD will potentially result in emission benefits and cost savings by catching problems early before they adversely affect other components and systems in the engine and/or aftertreatment system. The proposed amendments are anticipated to have a negligible impact on new heavy-duty engine or vehicle prices, since the calculated increase in retail price of an engine is estimated to be $42.46 per engine, while the cost of a new class 8 heavy-duty truck is estimated to begin at $113,000[13]. Additionally, any individual that purchases new light-duty vehicles will incur an incremental cost of $0.34 per new vehicle purchased.

Potential Impacts on Business Competeiveness

The proposed amendments are not expected to adversely impact the ability of California businesses to compete with businesses in other states as the proposed standards are anticipated to have only a negligible impact on retail

[13] Cannon, Jason. "What does a Class 8 truck really cost?," January 25, 2016, CCJ Commercial Carrier Journal; https://www.ccjdigital.com/what-does-a-class-8-truck-really-cost/

prices of new engines and vehicles. Additionally, U.S. EPA has adopted federal HD OBD and OBD II requirements that are generally harmonized with those of CARB. To date, virtually all engine and vehicle manufacturers have chosen to design a single HD OBD and OBD II system that meets both CARB and U.S. EPA regulations and equipped all engines nationwide with the same system. Therefore, any increase in costs will also be experienced by non-California businesses due to the federal requirements. Thus, any price increases of light-medium-, and heavy-duty vehicles are not expected to dampen the demand for these vehicles in California relative to other states, since price increases would be the same nationwide.

Potential Impacts on Employment / Creation or Elimination of Jobs within California

The proposed amendments are not expected to cause a noticeable change in California employment because California accounts for only a small share of motor vehicle, heavy-duty engine, and parts manufacturing employment, and the minimal additional work done by engine and vehicle manufacturers can be done with existing staff.

Potential Impact on Business Creation, Elimination, or Expansion

The proposed amendments are not expected to affect business creation, elimination or expansion.

Potential Impacts on Small Businesses

Small businesses are estimated to mainly consist of businesses in the heavy-duty vehicle service and the smaller heavy-duty vehicle fleets. The impact to the small businesses in these industries is expected to be similar as for the large businesses since small businesses are purchasing, operating, and repairing the same vehicles as large businesses.

## VII. EVALUATION OF REGULATORY ALTERNATIVES

Government Code section 11346.2, subdivision (b)(4) requires CARB to consider and evaluate reasonable alternatives to the proposed regulatory action and provide reasons for rejecting those alternatives. This section discusses alternatives evaluated and provides reasons why these alternatives were not included in the proposal. As explained below, no alternative proposed was found to be less burdensome and equally effective in achieving the purposes of the regulation in a manner than ensures full compliance with the authorizing law. The Board has not identified any reasonable alternatives that would lessen any adverse impact on small business.

As described in the individual sections above detailing the proposed changes, manufacturers suggested alternatives to the proposed amendments, and staff explained why these alternatives were not considered. Additionally, staff considered two alternatives to the proposed amendments: (1) adopting no amendments; and (2) adopting less stringent amendments.

Adopting No Amendments Alternative

Compared to the baseline, this alternative would result in no costs to manufacturers or increase in vehicle purchase price for California businesses and individuals who purchase new light-, medium-, and heavy-duty vehicles. Compared to the proposed amendments, this alternative would result in a cost savings to businesses and individuals who purchase new light-, medium- and heavy-duty vehicles in California of $13 million over six years, or up to $42.46 per vehicle if manufacturers were able to pass on all costs and markup.

However, this alternative could prevent California from realizing all of the emission benefits projected for the heavy-, medium-, and light-duty vehicle programs. This could result in higher than anticipated emissions from malfunctioning vehicles which would lead to adverse health impacts for individuals in California and make it more difficult for the State of California to meet federal ambient air quality standards. Taking no action would also make it more difficult for manufacturers to comply with the existing HD OBD and OBD II requirements and more difficult and time consuming for CARB to review and approve the OBD II system design on vehicles. This could require more staff resources resulting in an additional fiscal impact. Staff rejected the no-action alternative because of the potential for adverse emissions impacts and lack of flexibility and clarity.

Adopting Less Stringent Amendments

Staff also rejected the second alternative of less stringent amendments. During the regulatory development process, manufacturers proposed adopting less stringent requirements for the HD OBD amendments. For the IUMPR requirements, manufacturers have proposed that a few monitors (e.g., NOx sensor monitors, NMHC catalyst monitors) should be subject to a lower ratio than CARB's proposed 0.300 ratio – in other words, that these monitors be allowed to run less frequently than CARB's proposal. Manufacturers have indicated that CARB's more stringent crankcase ventilation monitoring requirements should not be proposed. Additionally, manufacturers proposed that CARB's proposal to track and report NOx parameters in-use should be delayed until a later date, specifically after the future low NOx standards have been implemented. Further, while almost all the new requirements proposed by CARB would start in the 2022 model year, manufacturers have proposed that they start with the 2024 model year. For the manufacturer self-testing requirements, manufacturers have proposed the following: reduce the number of monitors tested to 25 percent of the existing emission threshold monitors, limit or eliminate the testing to confirm the infrequent regeneration adjustment factors, allow manufacturers to skip testing for a specific model year if the manufacturer shows "good performance" during testing of the previous model years, and widen the criteria for selecting engines to test even further than what CARB staff proposed

To estimate the costs of this alternative, the same methodology and assumptions used to quantify costs for the proposed amendments were also used here. This alternative would be less costly than the proposed amendments primarily due to less stringent IUMPR, deletion of the more stringent crankcase ventilation monitoring requirements, and reduced manufacturer self-testing requirements. The delayed implementation dates for the tracking and reporting for NOx parameters and other requirements would still have the same cost implications but at slightly later dates. When considering these changes, the costs result in an incremental cost to consumers of $34.28 per engine or vehicle compared to the baseline with all markups applied. Thus, this alternative results in an incremental cost savings to consumers of $8.18 per engine or vehicle compared to the HD OBD proposal's cost of $42.46. This represents a total lifetime savings of $1.7 million (i.e., $8.18 * 34,735 new California vehicles * 6 years) over the 6-year life compared to the proposed amendments. This alternative could preserve some emissions benefits compared to a baseline of current conditions.

Compared to the proposed amendments, staff anticipate this alternative would result in less certainty of preserving the emissions benefits. Staff further believes manufacturers are likely to use less durable emission control components under this alternative because the less stringent requirements suggested by engine manufacturers would effectively result in less robust OBD monitors that run less frequently in use thereby allowing manufacturers to save costs by utilizing less durable emission control components. The less frequent monitoring from this alternative could result in higher in-use emissions since malfunctioning components would take longer to be detected and repaired. This would result in California realizing less of the projected benefits of the heavy-duty vehicle program. In a similar manner, the elimination of the more stringent crankcase ventilation monitoring requirement for this alternative would result in manufacturers using less durable components for this emission control system since there would be no HD OBD monitor required. This would also result in higher in-use emissions and a shortfall of the projected benefits for the heavy-duty vehicle program, and only a relatively modest savings to consumers. Accordingly, staff rejected the less stringent alternative.

## Small Business Alternative

Board has not identified any reasonable alternatives that would lessen any adverse impact on small business.

## Performance Standards in Place of Prescriptive Standards

With respect to Government Code section 11346.2(b)(4)(A) and 11346.2(b)(1), the proposed amendments do not mandate use of specific technologies or equipment, nor do they prescribe specific actions or procedures on regulated entities.

**<u>Health and Safety Code section 57005 Major Regulation Alternatives</u>**

The proposed regulation will not result in a total economic impact on state businesses of more than $10 million in one or more years of implementation. Therefore, this proposal is not a major regulation as defined by Health and Safety Code section 57005.

## IX. JUSTIFICATION FOR ADOPTION OF REGULATIONS DIFFERENT FROM FEDERAL REGULATIONS CONTAINED IN THE CODE OF FEDERAL REGULATIONS

<u>HD OBD Regulations</u>

CARB initially adopted the HD OBD regulation in 2005. A waiver for the regulation was granted by U.S. EPA in 2008.[14] CARB amended the regulation in 2010, and was granted another waiver action by U.S. EPA in 2012.[15]. On November 7, 2016, the U.S. EPA again formally granted California's request for a waiver regarding the HD OBD regulation, as last amended on June 26, 2013,[16] recognizing that the HD OBD regulation is at least as stringent in protecting public health and welfare as the federal regulation, and that unique circumstances exist in California necessitating the need for the State's own motor vehicle regulations program.

The U.S. EPA has also adopted OBD requirements for vehicles and engines above 14,000 pounds, which is the weight range for California's "heavy-duty" class. The federal regulation was published on February 24, 2009, and subsequently amended on September 15, 2011 and June 17, 2013.

The federal regulation is consistent with CARB's California regulation in the most important aspects. However, the California HD OBD regulation in general still establishes more comprehensive and stringent requirements than the federal OBD regulation. For example, the HD OBD regulation generally requires California OBD systems on diesel engines to detect malfunctions before emissions exceed more stringent thresholds than those required by the federal HD OBD regulation. Further, the federal regulation does not require the OBD

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[14] *California State Motor Vehicle Pollution Control Standards; Notice of Waiver of Clean Air Act Preemption; California's 2010 Model Year Heavy-Duty Vehicle and Engine On-Board Diagnostic Standards*, 73 Fed. Reg. 52042 (September 8, 2008).

[15] *California State Motor Vehicle Pollution Control Standards; Notice of Waiver of Clean Air Act Preemption; California's 2010 Model Year Heavy-Duty Vehicle and Engine On-Board Diagnostic Standards*, 77 Fed. Reg. 73459 (December 10, 2012).

[16] *California State Motor Vehicle Pollution Control Standards; Malfunction and Diagnostic System Requirements for 2010 and Subsequent Model Year Heavy-Duty Engines; Notice of Decision*, 81 Fed.Reg. 78149 (November 7, 2016).

system to detect diesel oxidation catalyst malfunctions before a specific emission threshold is exceeded like the California OBD regulations - it is only required to detect a failure if the catalyst completely lacks NMHC conversion capability. As another example, under the federal HD OBD regulation, the malfunction thresholds for the emission threshold monitors are not required to be adjusted to account for emissions due to infrequent regeneration events.

The proposed 2018 amendments would continue California's efforts to require more comprehensive and robust monitoring of emission related systems and components than required by federal OBD regulations. The amendments also incorporate some new requirements (e.g., new data parameters required to be tracked by the engine) that would assist other California mobile source emissions programs. Although differences would exist between the state and federal requirements, heavy-duty OBD systems can be designed to comply with both the federal and California programs. In fact, U.S. EPA's regulation directly allows acceptance of systems that have been certified to California's HD OBD regulation and to date, all heavy-duty engine manufacturers have chosen this path for certification.[17]

OBD II Regulations

In 2014, the U.S. EPA adopted Tier 3 regulations that include provisions that generally align federal OBD requirements for 2017 and subsequent model year light duty vehicles, light-duty trucks, MDPVs, and complete heavy-duty vehicles between 8,501 and 14,000 lbs. GVWR with CARB's California OBD II regulation, as last amended in 2013. Although the federal OBD regulation is now generally harmonized with California's OBD II regulation, the federal requirements differ from corresponding California OBD requirements in several respects, as discussed below.

The OBD II regulation still establishes more comprehensive and stringent requirements than the amended federal regulation. First, the OBD II regulation requires California OBD systems to comply with monitoring requirements earlier than federal OBD systems must comply with the federal OBD regulation. For example, California's OBD II regulation requires OBD systems in medium-duty diesel vehicles and engines to detect PM filter performance faults before emissions exceed 0.03 g/bhp-hr beginning in the 2013 model year, and allows exclusions of specific failure modes until the 2015 model year. The federal OBD regulation requires federal OBD systems to detect PM filter performance faults at these same levels beginning in the 2019 model year, so California OBD systems must comply with this requirement (without excluding specific failure modes) at least three model years earlier than federal OBD systems.

Additionally, the federal OBD requirements do not incorporate the anti-tampering provisions of the OBD II regulation, (that prevent unauthorized modifications of

[17] 40 CFR 86.010-18 (a)(5) (as it existed on July 26, 2018)

the computer-coded engine operating parameters of the on-board computer), or the deficiency provisions of the OBD II regulation (which allow certification of vehicles with non-fully compliant OBD systems provided manufacturers demonstrate a good-faith effort to comply with OBD requirements as expeditiously as possible and pay fines, and provided the deficiency would not trigger an ordered recall for the OBD system). The federal OBD requirements also limit the requirement that OBD systems verify the alignment of the crankshaft and the camshaft to vehicles that are equipped with variable valve timing. Further, the federal OBD requirements establish compliance dates for certain categories of vehicles and engines and monitoring requirements that are delayed from the corresponding compliance dates in the OBD II regulation. Specifically, the federal OBD requirements for vehicles and engines defined as medium-duty vehicles under California law (heavy-duty vehicles between 8,501 and 14,000 lbs. GVWR) first apply to 2019 model year vehicles/engines whose Job 1 (first production date) is on or after March 4, 2018, and to all 2020 and subsequent model year vehicles and engines, while CARB's OBD II requirements generally require medium-duty vehicles and engines to comply with the same requirements no later than the 2015 model year.

The federal OBD requirements also incorporate provisions of the OBD II regulation that require OBD systems to monitor evaporative systems for malfunctions and to detect leaks that cumulatively are greater than or equal to a leak caused by a 0.02 inch diameter orifice, but establish a limited phase-in period that is not present in CARB's OBD II regulation. Specifically, the federal requirements allow 2016 model year vehicles that do not meet the 0.02 inch leak detection requirement to phase-in compliance with this requirement by the 2018 model year, while CARB's OBD II regulation required OBD systems to comply with these requirements since the 2003 model year. Finally, the amended federal OBD requirements establish a provision allowing manufacturers of emergency vehicles[18] to request a deficiency or a temporary or permanent exemption from otherwise applicable OBD requirements provided manufacturers demonstrate significant vehicle engineering or performance issues associated with compliance with OBD requirements.

The federal OBD regulations, however, retain the provision that allows U.S. EPA to deem California-certified OBD II systems to comply with the federal OBD regulation.[19] Historically, virtually every vehicle sold in the U.S. is designed and certified to California's OBD II requirements in lieu of the federal OBD requirements.

[18] Emergency vehicles are defined as motor vehicles manufactured primarily for use in medical response or for use by the U.S. Government or a State or local government for law enforcement or fire protection.

[19] 40 CFR 86.1806-5 (j) (as it existed on July 26, 2018)

## X. PUBLIC PROCESS FOR DEVELOPMENT OF THE PROPOSED ACTION (PRE-REGULATORY INFORMATION)

Consistent with Government Code sections 11346, subdivision (b), and 11346.45, subdivision (a), and with the Board's long-standing practice, CARB staff held public workshops and had other meetings with interested persons during the development of the proposed regulation. These informal pre-rulemaking discussions provided staff with useful information that was considered during development of the regulation that is now being proposed for formal public comment.

CARB began the HD OBD regulatory update process at the end of 2016, when CARB staff had several meetings with stakeholders (mainly engine manufacturers) to discuss the development of proposed amendments for the HD OBD regulations. CARB held a public workshop in El Monte on November 2, 2017 to discuss the proposal and to seek comments. Interested stakeholders participated in the workshop in person or via webinar. The workshop notice and workshop presentation were posted on the OBD Program website (https://www.arb.ca.gov/msprog/obdprog/obdprog.htm) prior to the workshop. Additionally, draft regulatory language was sent to members of the Truck and Engine Manufacturers Association (EMA), which represent the main stakeholders affected by the proposed rulemaking. CARB staff also presented and sought comments regarding elements of the upcoming proposed amendments to the HD OBD regulations during several SAE OBD symposiums, including symposiums held in March, 2016 (Stuttgart, Germany); September, 2016 (Indianapolis, Indiana); March, 2017 (Turin, Italy); September, 2017 (Anaheim, California); and March, 2018 (Barcelona, Spain). These symposiums were attended by vehicle and engine manufacturers, scan tool manufacturers, and individuals involved in various other aspects of the automotive industry.

Additionally, throughout the rulemaking process, CARB staff held 17 meetings, including 1 in-person meeting, with EMA as well as numerous meetings and correspondences (comprising of teleconferences, in-person meetings, and e-mail correspondences) with individual manufacturers. CARB staff also participated in numerous teleconferences with SAE committee members to help develop the specifications related to the proposed new data stream parameter and tracking requirements in the SAE standards. The proposal was developed in close collaboration with these stakeholders. As a result of the comments received throughout the regulatory process, staff made significant changes to the proposed amendments to the HD OBD regulations, which are reflected in the final proposal.

Concerning the proposed regulatory updates to the OBD II regulation, CARB staff sent draft regulatory language of the proposal to the Alliance of Automobile Manufacturers and Association of Global Automakers, which represent the main stakeholders affected by the proposed changes to the OBD II regulation. These associations provided comments to the proposal, which staff reviewed and accordingly made changes to the proposal as needed.

# XI. REFERENCES

Below is a list of references used in developing the proposed amendments and to support the Staff Report.


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# XIII. APPENDICES

**Appendix A**: 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

**Appendix B**: Proposed Regulation Order, HD OBD Enforcement Regulation
Title 13, California Code of Regulations, Section 1971.5, Enforcement of Malfunction and Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines

**Appendix C**: Proposed Regulation Order, OBD II Regulation
Title 13, California Code of Regulations, Section 1968.2, Malfunction and Diagnostic System Requirements--2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines

**Appendix D:** Data Record Reporting for Over-the-Air Reprogrammed Vehicles and Engines, August 16, 2018

**Appendix E**: Proposed Greenhouse Gas Parameters

**Appendix F**: Economic Analysis Support